Top 20 Most Destructive California Wildfires

	FIRE NAME *(CAUSE)*	DATE	COUNTY	ACRES	*STRUCTURES*	DEATHS
1	**CAMP** *(Powerlines)*	November 2018	Butte	153,336	**18,804**	85
2	**EATON** *(Under Investigation)**	January 2025	Los Angeles	14,021	**9,413**	17
3	**PALISADES** *(Under Investigation)**	January 2025	Los Angeles	23,707	**6,833**	12
4	**TUBBS** *(Electrical)*	October 2017	Napa & Sonoma	36,807	**5,636**	22
5	**TUNNEL - Oakland Hills** *(Rekindle)*	October 1991	Alameda	1,600	**2,900**	25
6	**CEDAR** *(Human Related)*	October 2003	San Diego	273,246	**2,820**	15
7	**NORTH COMPLEX** *(Lightning)*	August, 2020	Butte, Plumas, & Yuba	318,935	**2,352**	15
8	**VALLEY** *(Electrical)*	September 2015	Lake, Napa & Sonoma	76,067	**1,955**	4
9	**WITCH** *(Powerlines)*	October 2007	San Diego	197,990	**1,650**	2
10	**WOOLSEY** *(Electrical)*	November 2018	Ventura	96,949	**1,643**	3
11	**CARR** *(Human Related)*	July 2018	Shasta County, Trinity	229,651	**1,614**	8
12	**GLASS** *(Undetermined)*	September 2020	Napa & Sonoma	67,484	**1,520**	0
13	**LNU LIGHTNING COMPLEX** *(Lightning/Arson)*	August 2020	Napa, Solano, Sonoma, Yolo, Lake, & Colusa	363,220	**1,491**	6
14	**CZU LIGHTNING COMPLEX** *(Lightning)*	August 2020	Santa Cruz, San Mateo	86,509	**1,490**	1
15	**NUNS** *(Powerline)*	October 2017	Sonoma	54,382	**1,355**	3
16	**DIXIE** *(Powerline)*	July 2021	Butte, Plumas, Lassen, & Tehama	963,309	**1,311**	1
17	**THOMAS** *(Powerline)*	December 2017	Ventura & Santa Barbara	281,893	**1,063**	2
18	**CALDOR** *(Under Investigation)*	September 2021	Alpine, Amador, & El Dorado	221,774	**1,003**	1
19	**OLD** *(Human Related)*	October 2003	San Bernardino	91,281	**1,003**	6
20	**JONES** *(Undetermined)*	October 1999	Shasta	26,200	**954**	1

"Structures" include homes, outbuildings (barns, garages, sheds, etc) and commercial properties destroyed.
This list does not include fire jurisdiction. These are the Top 20 regardless of whether they were state, federal, local or tribal responsibility.
*Numbers not final *DINS Disclaimer: These numbers are preliminary based on aerial assessments dedicating heat sources which can include chicken coops, outbuildings, sheds, water containers, etc. *Validated inspections are currently being ground-verified by Damage Assessment Teams.

2/7/2025

IBHS RESEARCH



IBHS Early Insights

Lahaina Fire—2023

IBHS RESEARCH CENTER
WILDFIRE

Insurance Institute for Business & Home Safety (IBHS)

August 2023

Why It Matters: The August 9th Lahaina Fire on the island of Maui is the most recent example of a wildfire that transitioned to a nearby community with catastrophic and deadly results.

Dig Deeper: Like the 2021 Marshall Fire, high winds drove the fire, which entered the community of Lahaina though adjoining grasslands. It spread quickly once the built environment was ignited, and the resulting conflagration overwhelmed first response resources. Limited evacuation routes contributed to more than 100 known fatalities, making this fire more deadly than the 2018 Camp Fire, and potentially the largest loss of life from a wildfire in over 100 years.

It's Not Just One Thing: A notable exception to the widespread destruction is the survival of a development built in 2019–2020 with a mix of single family homes and a cluster of multifamily units in its interior. Within this development, no single-family structures were lost. Although several multifamily structures in the interior ignited (probably from embers), there was no structure-to-structure conflagration in this area. Despite close spacing, this area was spared in part because of:

- Class A roof covers, specifically asphalt shingles and metal.
- Non-combustible exterior wall materials.
- High-wind rated off-ridge attic vents, which have been shown by IBHS to also be effective at reducing ember entry.
- Due to the newness of the developed area, landscape vegetation did not cover as much area, providing less connective fuel between structures.

Real-World Impact: Modern building codes and community plans that consider wildfire along with programs like IBHS's Wildfire Prepared Home™ designation can reduce the losses and displacement caused by conflagration-level events such as the Lahaina Fire. Hawaii's modern building code has high-wind requirements that introduced elements that helped newer construction resist wildfire conditions.

OVERVIEW

The August 9, 2023, Lahaina Fire on the island of Maui, is the most recent example of a catastrophic wildland-urban interface (WUI) fire that transitions to a built environment conflagration. Fire entered the community though grasslands and spread quickly once the built environment conflagration took shape, overwhelming response resources. The rapid spread through both grasslands and the built environment coupled with limited evacuation routes contributed to over 100 fatalities so far, making this fire more deadly than the 2018 Camp Fire.

With over 2,200 structures destroyed, the Lahaina Fire is the seventh most damaging fire in the United States, based on structures destroyed, since 1990. The number of destroyed structures represents nearly three-quarters of all buildings in the community. Figure 1 provides a post-fire satellite view along with the estimated fire boundary and areas within Lahaina that survived.



Figure 1: Post-fire satellite image showing the boundary of the Lahaina Fire and larger areas within the community that survived (orange lines). Imagery courtesy of Maxar.

WEATHER CONDITIONS

- Parts of the island of Maui were under moderate drought conditions.
- Strong easterly trade winds were intensified by a strong ridge of high pressure to the north of the Hawaiian Islands and Hurricane Dora (low pressure center) passing approximately 700 miles south of the Hawaiian Islands.
- Easterly trade winds flowed down the sloping terrain toward Lahaina, helping to dry the airmass further. Relative humidities were between 20 and 30 percent.

  Although not as extreme as those observed during the 2017–2018 western US wildfires, the humidity levels were low enough to reduce the moisture content of fuels, such as grasses, to single-digit percentages[1], contributing to rapid fire spread.

- Typical wind gusts during the event were likely between 50 and 60 mph, with peak gusts near 70 mph. This estimate is supported by available video during the fire and the limited surface weather observations available.

  The closest observing station to Lahaina was a RAWS automated observing station at Kealia Pond National Wildlife Refuge, approximately 15 miles southeast of Lahaina. It measured a peak gust of 53 mph. Winds in Lahaina were likely stronger given the mean north-east wind direction, as this station was not affected as much by the downsloping terrain as in Lahaina. The peak wind gust measured on Maui during the event was 67 mph near Kula.

- Wind flow conditions were likely ideal for tilting and stretching the large flames. Given the elevated wind speeds, the chance of long-range spotting embers from grass and shrubs was minimal. These embers would likely burn out completely during their airborne journey. However, in the case of embers originating from structures, these wind speeds could facilitate ember transport over longer distances.

BUILDING CODE ENVIRONMENT

- Hawaii has currently adopted the 2018 International Residential Code and the 2018 International Building Code; however, the state has several amendments to the model code, and enforcement is at the county level.
- Hawaii has adopted NFPA 1 as the statewide fire code. Within the state fire code, WUI provisions are provided (Chapter 17). The WUI provisions are based on the NFPA 1144 standard and are contingent on WUI areas being defined. However, it is unclear where or when these are required for new construction and what areas of the state are defined WUI areas. Life safety elements related to ingress/egress requirements, interior fire spread, and interior sprinkler systems (commercial only), are required in all instances.
- Maui County has a County Wildfire Preparedness Plan, originally developed in 2014. The county also has a Hazard Mitigation Plan, most recently published in 2018.

---

[1] Overholt, K. & Cabrera, Jan-Michael & Kurzawski, A. & Koopersmith, M. & Ezekoye, Ofodike. (2014). Characterization of Fuel Properties and Fire Spread Rates for Little Bluestem Grass. Fire Technology. 50. 10.1007/s10694-012-0266-9.

BUILDING STOCK

As in all wildland-urban interface built-environment conflagrations, to slow or stop fire progression structures must function as fuel breaks rather than fuel sources. Many homes in Lahaina had some individual components of wildfire-resistant construction (for example, Class A roof covers or noncombustible wall material) but when all three ignition mechanisms (ember attack, direct flame contact, and radiant heat) are acting simultaneously in a built-environment conflagration, any major weak point in the system of protection is often exploited. Older construction, built prior to the common use of central air conditioning systems, is designed for cooling and ventilation by natural means which makes it more susceptible to ember entry. It does not appear likely that any structures were built with wildfire as a primary risk. Newer construction had the high-wind protection elements required by Hawaii's building codes.

- The building stock in Lahaina was approximately 80% single-family residential construction. The dominant era of construction was the 1960s to the 1980s. However, there are newer homes built under modern building codes.
- Commercial buildings ranged from historic structures along Front Street to typical light commercial seen in most communities. Multi-family construction was a mix of duplex, low-rise condominiums, and multi-structure apartment complexes.
- Roof cover was dominated by asphalt shingle roofs, with a small number of tile, metal, and wood shake roofs.
- Open eave roof construction is common, given the need for ventilation in a consistently warm climate.
- Wall cover materials are highly variable ranging from concrete masonry unit (CMU) block walls, wood panel siding (dominant on homes built in the 1960s and 1970s), concrete fiber board, stucco, and a small number with vinyl or aluminum siding.
- Structure separation distances are varied but on average were between 15 and 25 feet apart in most residential areas.

FIRE EVOLUTION

The evolution of the Lahaina Fire followed a classic wildland-urban interface progression, as outlined by Cohen (2008)[2], and quickly became a built-environment conflagration. In general, the sequence of events was like those observed during the 2021 Marshall Fire.

- Fire spread quickly through dry grasslands, down the gently sloping terrain toward Lahaina following the general mean wind direction. In this event, complex terrain was not present. The terrain is a nearly constant downward slope from approximately 160 ft of elevation east of Lahaina to the ocean. At this time, the exact cause of the fire is unknown. However, analysis of the fire boundary, distribution of destroyed structures and wind flow characteristics supports the potential for multiple points of ignition within or near the grasslands.
- Like the Marshall Fire, this fire likely entered the built environment through a combination of direct flame and radiant heat ignitions on the initial structures, likely in multiple locations. Once the initial structure ignitions occurred, all three ignition mechanisms took hold in these

[2] Cohen, J., (2008). The wildland urban interface fire problem: A consequence of the fire exclusion paradigm. *Forest Hist. Today*, 20–26.

areas. Structure separation distances of less than 20 feet were present and the area contained sufficient fuels connecting homes, both vegetative, and other elements such as vehicles and sheds.

- As with most WUI fires, a major weak link was the presence of tall dense vegetation and other connective fuels near homes, specifically in the 0 to 5-foot home ignition zone (also referred to as Zone 0). With combustible materials inside the home ignition zone, the open eave roof configuration was likely easily exploited by flames and radiant heat build-up. Also, general architectural design for cooling and ventilation may have contributed to a greater ember entry threat.

Post-fire satellite imagery courtesy of Maxar and Umbra Space synthetic aperture radar data does suggest varying degrees of fire exposure and severity within the community. An example of this is shown in the northern residential areas of Lahaina, north of Malanai Street (Figure 2 - left).



Figure 2: Satellite imagery of two areas where some of the most intense fire exposure possibly occurred, (left) south of Fleming Rd. to Kapunakea St. and (right) the area south of Shaw Street and bounded on the east side by the Honoapiilani Highway, including along Front Street. Satellite imagery courtesy of Maxar.

In this area of mostly single-family homes, the fire intensity was not enough to consume all vegetation and the presence of some sporadic homes that survived suggests that ember-driven ignitions (from both vegetative and structural fuels) may have been the dominant spread mechanism. This area also had structure spacing ranging from approximately 11 ft to greater than 25 ft for a few parcels.

South of Fleming Road, in a slightly denser area of older single-family homes, imagery indicates a more intense fire, with little materials remaining. In this area, all three ignition mechanisms (ember attack from structural fuels, direct flame contact, and radiant heat) were likely present and each were substantial contributors to the intense fire. It is likely fire spread from this area into the historic structures along Front Street. Pier and beam construction was common in this section of Lahaina. Wood lattice often surrounded the elevated structures along with a larger number of elevated decks. Vegetation coverage was near or greater than 50% on many parcels.

The area of mixed commercial construction between Kapunakea Street and the Kahoma stream channel survived and appeared to function as a partial fuel and ember break between this area and a new residential development immediately downwind to the south-southwest. However, fire spreading

through the grassland east of Lahaina appeared to enter the community through residential areas on the eastern side and either continued or started a new chain of structure-to-structure spread.

Fire ultimately spread through nearly the entire community, with another area of intense fire noted in the residential areas at the southern extent of Lahaina (Figure 2-right). The area south of Shaw Street and bounded on the east side by the Honoapiilani Highway, including along Front Street, appeared to also experience some of the most extreme fire conditions.

Efforts to decrease the fire's intensity in proximity to buildings, whether through the establishment of fuel breaks or protecting structures, did not yield the desired results. Several factors, including power outages, the failure of operational hydrants, and a scarcity of fire engines on the island, compounded these difficulties.

SUCCESSES

The most notable success story was a new development, built in 2019-2020. This neighborhood had single-family home construction with multi-family units in its interior. The development is located immediately south of the Kahoma stream channel and bordered by Front Street on the west, the Honoapiilani Highway to the east, and Kenui Street on the south side (see Figure 3). Within this development, no single-family structures were lost, but four multi-family structures in its interior ignited (initially likely from embers), but a structure-to-structure conflagration was avoided in this area.



Figure 3: Post-fire satellite image of a new development, built in 2019-2020, that survived the Lahaina Fire. Note the four multifamily structures within the development that were destroyed. The initial ignition here was likely ember-driven, but a structure-to-structure conflagration scenario did not unfold here. Imagery courtesy of Maxar.

Favorable elements may have included:

- Upwind fire and ember break from commercial construction and the Kahoma Stream channel.
- Class A roof covers, specifically asphalt shingles and metal.
- Non-combustible wall cover materials

- High wind-rated off-ridge attic vents (for wind and wind-driven rain mitigation). IBHS tests have shown that these vents are effective at reducing ember entry[3].
- Less dense connective fuels between structures, including vegetation.
- Vegetation, due to the new construction, was less mature, with lower areal coverage compared to other residential areas in the community.

Elsewhere, in the areas where fire exposure was not extreme, some individual structures survived amidst those that were destroyed, indicative of the sometimes-random nature of ember attack as a dominant ignition mechanism. In these cases, fuel density in the 0 to 5-foot zone was often less than neighboring structures, the presence of non-combustible wall materials, or structure separation distances greater than 40 feet. An example of a home that survived within an area of intense fire is shown in Figure 4.



Figure 4: An example of a home that survive, with low density fuel coverage, especially in the 0–5-foot home ignition zone, an asphalt shingle roof, and non- combustible concrete masonry unit wall material. Post-fire imagery courtesy of Maxar and pre-fire condition image courtesy of Google-Street View.

Homes that were built under modern codes have wind mitigation elements along with other requirements that can foster construction styles and materials that provide some level of mitigation against fire. An example is the potential use of ridge and/or off-ridge attic vents that have both high wind and wind-driven rain protection. These vents have also been found to reduce ember entry[3]. Also, the use of concrete foundations extending above 6-inches on-grade for termite protection is also an element that would meet the IBHS Wildfire Prepared Home™—Base level of protection.

[3] Quarles, S. 2017: Vulnerability of vents to wind-blown embers. *Insurance Institute for Business & Home Safety*. Technical Report. 24 pp. https://ibhs.org/wildfire/ember-entry-vents/

WILDFIRE PREPARED HOME™

Wildfire Prepared Home™ is a program that defines specific actions homeowners in a WUI area can take to reduce the possibility that their home is ignited by wildfire.

Wildfire Prepared Home – Base

The Wildfire Prepared Home™–Base level focuses on ember defense. It is not clear if this system would have been sufficient to stop the initial structure ignitions, which likely occurred due to direct flame and/or radiant heat from the grassland fire.

In areas with less extreme fire conditions and structure separation distances greater than 20 feet, and especially those greater than 30 feet, the Wildfire Prepared Home–Base level could have been effective in slowing or even potentially preventing structural ignitions.

If the mitigations are applied comprehensively in residential areas, at a minimum they would have been effective at reducing fire spread rates with some potential to stop the rapid chain of building-to-building fire spread.

Wildfire Prepared Home Plus

The Wildfire Prepared Home™ Plus system would have likely been effective at stopping the initial structure ignitions.

In areas of intense fire in neighborhoods with typical spacing distances of 10 to 30 feet, all three ignition mechanisms were probably acting simultaneously. In this situation, a full system of protection against all three types of ignition, such as the Wildfire Prepared Home Plus standard, is necessary for any success in slowing or stopping fire spread in the absence of large-scale fire service intervention.

In a dense community (less than 10 feet between structures) it is likely that the system of protection offered by Wildfire Prepared Home Plus would have needed to be coupled with other required defensible space measures outside the home ignition zone, effectively reducing the areal coverage of connective fuels, including vegetation. Ongoing research by IBHS and our academic partners suggests this may be as low as 20 to 30 percent areal coverage of any combustible fuel on the parcel.

SUMMARY

The Lahaina Fire is the most recent example of a wildfire acting as a catalyst for a built-environment conflagration. The pre-fire weather conditions readily supported the potential for a conflagration and the common vulnerabilities of the built environment, such as dense construction with little fire resistance, were present. The chain of events conceptually followed Cohen's (2008)[2] original wildland-urban interface fire concept and were very similar to that of the Marshall Fire.

The rapid fire spread into the built environment overwhelmed limited suppression resources and the limited number of evacuation routes unfortunately led to significant casualties. The Lahaina Fire is now the deadliest United States wildfire in 100 years. With over 2,200 structures destroyed, the Lahaina Fire is the seventh most damaging wildfire in the United States since 1990, based on structures destroyed.

With the absence of effective suppression efforts and the relatively homogenous, downsloping coastal topography, this fire presents an intriguing opportunity to examine how different buildings materials and designs responded to varying heat intensities depending on their surroundings. IBHS is currently considering deploying a ground team to conduct assessments of building performance in support of ongoing research objectives and the Wildfire Prepared Community initiative.

ACKNOWLEDGEMENTS

IBHS would like to acknowledge Maxar Technologies for their rapid and public dissemination of post-fire satellite imagery.

Special thanks to Umbra Space for providing access to post-fire synthetic aperture radar data.

Data from the Microsoft building footprint database was used to develop the initial insights presented here.

Lahaina Fire Incident Analysis Report

Steve Kerber
Derek Alkonis

This publication is available free of charge from:
https://doi.org/10.60752/102376.26858962

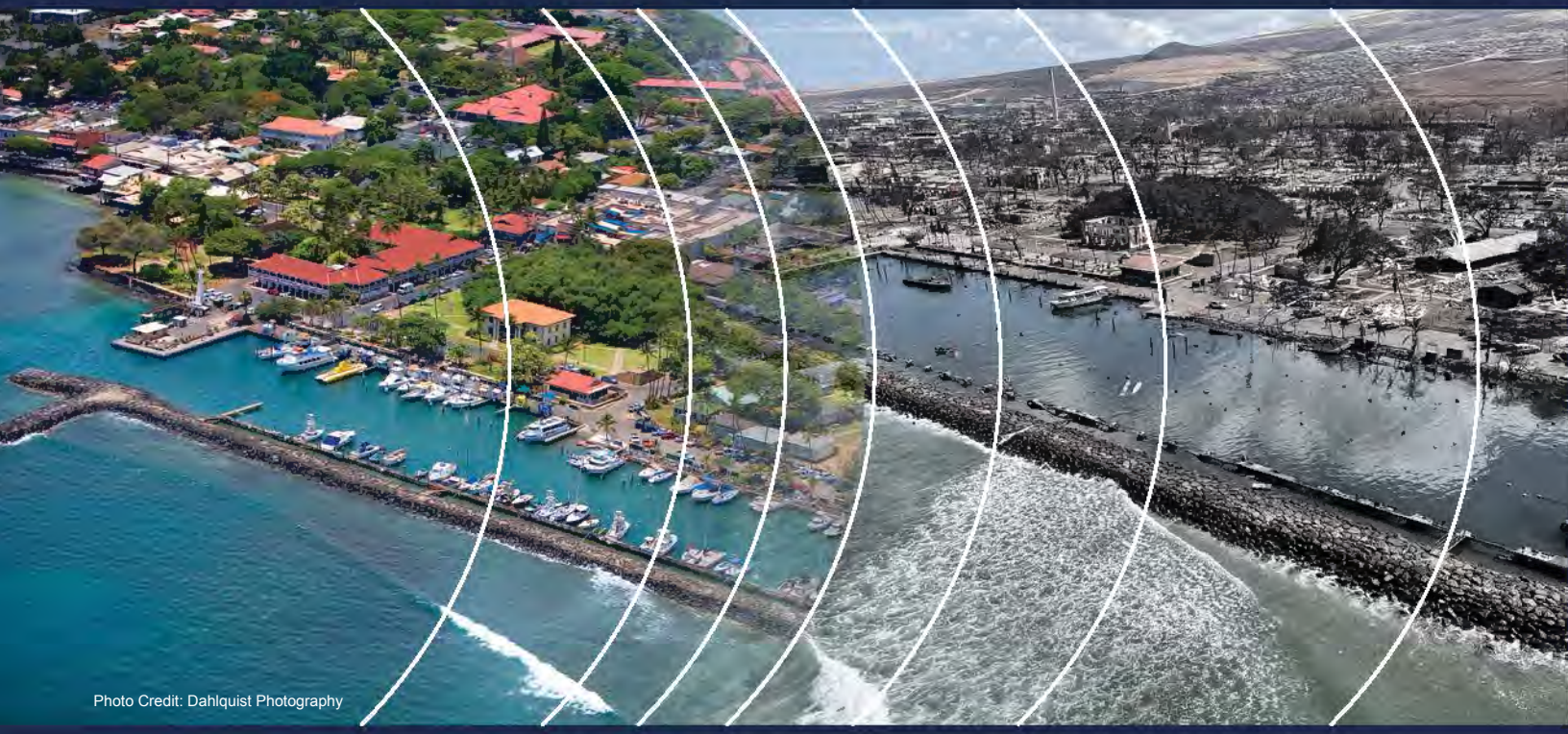


Photo Credit: Dahlquist Photography

September 13, 2024
Columbia, MD

Fire Safety Research Institute

© 2024 Underwriters Laboratories Inc.

Acknowledgments

The authors express sincere gratitude to the people of Maui for their willingness to share information and personal stories about this incident. The authors also acknowledge the steadfast commitment of the Hawai‘i Attorney General Anne E. Lopez and the Hawai‘i Department of the Attorney General to complete this independent research and analysis.

The authors also thank the County of Maui and the following individuals for their invaluable contributions: Clay Trauernicht from the University of Hawai‘i, John Bravender and Derek Wroe from the National Weather Service, Elizabeth Pickett from the Hawai‘i Wildfire Management Organization, Michael Walker from the State of Hawai‘i Division of Forestry and Wildlife, former Hawai‘i County Mayor and Civil Defense Agency Administrator Harry Kim, and Darus Ane, Jim Barnes, Leonard Casson, Alyse Finlayson, Anneka Imkamp, Tim Hagel, Todd Harms, Garrett Kim, T J Martin, Jessica Pickett, Kevin Roche, and Adam Thiel from FACETS. Their insights and data have been instrumental in the compilation of this report.

Special thanks also go to FSRI’s Gavin Horn and Daniel Gorham for their contributions to the analysis, as well as Charley Fleischmann, Dan Madrzykowski, and Dawn Ey for their supporting efforts.

Disclaimer
In no event shall UL Research Institutes (ULRI) be responsible to anyone for whatever use or non-use is made of the information contained in this report and in no event shall ULRI, its employees, or its agents incur any obligation or liability for damages, including, but not limited to, consequential damage arising out of or in connection with the use or inability to use the information contained in this report.

Abstract

This document is the second in a series of three (3) reports commissioned by the Hawai‘i Department of the Attorney General (DOAG) to provide an independent review of the tragic fire that destroyed much of Lahaina, Hawai‘i, on August 8-9, 2023.

Using a systems analysis methodology, the *Lahaina Fire Incident Analysis Report* presents relevant background information; discusses weather, fuel, and infrastructure conditions; describes communication, incident management, fire suppression, and evacuation efforts; and details the impact of the fire on Lahaina’s built environment. It also considers these factors in the context of the National Cohesive Wildland Fire Management Strategy (Cohesive Strategy).

This Phase Two report incorporates science- and evidence-based analyses with information from FSRI’s fire dynamics research, local subject matter experts, industry standards and best practices, and the collective experiences of FSRI’s research team. This report does not include an analysis of recovery efforts or the fire’s cause and origin, which is being investigated by the County of Maui with assistance from the United States Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF).

This report focuses on the events that occurred prior to, during, and immediately following the Lahaina PM fire, such as preparedness efforts, weather and its impact to infrastructure, and other fires occurring on Maui for the time period beginning at 14:55 (2:55 p.m. HST) on August 8, 2023, and concluding at 08:30 (8:30 a.m.) on August 9, 2023. Data from the three (3) other Maui fires is also included in specific sections to give context to the situation in Lahaina.

Keywords: Maui fire, wildland-urban interface, WUI, Lahaina Fire, grassland fire, urban conflagration

TABLE OF CONTENTS

02 ACKNOWLEDGMENTS

02 DISCLAIMER

03 ABSTRACT

04 TABLE OF CONTENTS

26 EXECUTIVE SUMMARY

29 **1.0 Introduction**

30 1.1 Systems Analysis Methodology

1.1.1 Framework for Analysis

1.1.2 General Topics within Phase One Requiring Further Study

1.1.3 Wildfire Resilient Landscapes

1.1.4 Fire-Adapted Communities

1.1.5. Safe, Effective, and Risk-Based Wildfire Response

1.1.6 Policy Analysis

1.1.7 Resident Observations and Experiences

1.1.8 Findings and Recommendations

1.1.9 Information Sources

1.1.10 Report Formatting Details

38 1.2 Limitations of Analysis

39 **2.0 Analysis of Background**

39 2.1 Statewide Background

2.1.1 Statewide Risk

2.1.2 Perception of Wildfire Risk within Hawai‘i

2.1.3 National Perception of Hawaii’s Wildfire Risk

2.1.4 Perception of Responsibility

2.1.5 Leadership and Accountability

44 2.2 County of Maui Background

2.2.1 County of Maui Wildfire Risk

2.2.2 Perception of County of Maui Wildfire Risk

2.2.3 Perception of Responsibility

2.2.4 August 2018, Lahaina Fire

2.2.5 Findings & Recommendations

TABLE OF CONTENTS

49 **3.0 Analysis of System Components**

49 3.1 Origin and Cause

49 3.2 Weather

3.2.1 Fire Weather Forecasting

3.2.2 Red Flag Warnings

3.2.3 Operationalizing the Weather Data

3.2.4 Resident Technical Discussion Information

3.2.5 Findings & Recommendations

59 3.3 Vegetative Fuel

3.3.1 Condition and Management of Vegetative Fuel

3.3.2 Vegetation Management on State Lands

3.3.3 Fuels Management Around Electrical Infrastructure

3.3.4 Fuels Management and Defensible Space within Subdivisions

3.3.5 Roadside Fuels Mitigation

3.3.6 Former Large Acreage Farmlands Unmaintained by Private Landowners

3.3.7 Challenges to Vegetation Management Implementation

3.3.8 Policy Challenges

3.3.9 Findings & Recommendations

69 3.4 Infrastructure

3.4.1 Planning, Zoning, and Codes

3.4.1.4 Findings and Recommendations

3.4.2 Road Networks

3.4.2.5 Findings and Recommendations

3.4.3 Water System

3.4.3.4 Findings and Recommendations

3.4.4 Electrical Power

3.4.4.5 Findings and Recommendations

101 3.5 Communications

3.5.1 Public Communications

3.5.2 Emergency Responders

3.5.3 Private Equipment Operators

3.5.4 Findings and Recommendations

112 3.6 Incident Management

3.6.1 MFD Incident Management

TABLE OF CONTENTS

3.6.2 MPD Incident Management

3.6.3 Analysis of MFD and MPD Incident Management

3.6.4 EOC Operations

3.6.5 Incident Command

3.6.6 Findings & Recommendations

127 3.7 Fire Suppression

3.7.1 Preparedness

3.7.2 Apparatus

3.7.3 Relief Staffing

3.7.4 Strategy and Tactics

3.7.5 Assessing Electrical Power Status

3.7.6 Private Equipment Operators

3.7.7 Mopup of Lahaina AM Fire

3.7.8 Findings & Recommendations

153 3.8 Evacuation

3.8.1 Population Density

3.8.2 Traffic Management and Egress Challenges

3.8.3 MPD Preparedness

3.8.4 MPD Actions

3.8.5 MFD Actions

3.8.6 Resident Communications During Evacuations

3.8.7 Rescue Operations

3.8.8 Resident Response to Evacuation Efforts

3.8.9 Evacuation Reflection

3.8.10 Fatalities

3.8.11 Findings and Recommendations

189 **4.0 Built Environment**

190 4.1 Lahaina Built Environment

4.1.1 Building Construction

4.1.2 Building and Fire Codes

4.1.3 Structure Separation

4.1.4 Building Density

4.1.5 Vegetation Adjacent to the Built Environment

4.1.6 Wildfire Risk

TABLE OF CONTENTS

193 4.2 Built Environment Analysis Methodology

4.2.1 Structure Damage Classification Map

4.2.2 Vehicles

4.2.3 Roadways

199 4.3 Fire Spread in the Built Environment

4.3.1 Structure Damage and Fire Spread Analysis

4.3.2 Central, South, and North Zones

4.3.3 Central Zone

4.3.4 South Zone

4.3.5 North Zone

4.4 Findings and Recommendations

300 **5.0 Summary**

303 **6.0 Appendix**

303 6.1 Full List of Findings and Recommendations

318 6.2 Lahaina Fire Comprehensive Timeline Report and Minute-by-Minute Timeline

319 6.3 Lahaina Resident Technical Discussion Summary - March 3, 2024

325 6.4 Subpoena Requests

334 6.5 2018 Lahaina Fire - Incident Commander Technical Discussion Questions

336 6.6 National Weather Service (NWS) - Honolulu Product Verification*

340 6.7 Brush & Vegetation Clearance Records

352 6.8 Drinking Water Treatment, Storage, and Distribution Systems

357 6.9 Amendments to the 2002 Water System Standards. Source: Hawai‘i Board of Water Supply

361 6.10 Comparison of MFD, MPD, and Hawaiian Electric’s AVL Timepoints

362 6.11 Statewide Siren Test Reports

6.11.1 Statewide Siren Test Report (May 2023)

6.11.2 Statewide Siren Test Report (June 2023)

6.11.3 Statewide Siren Test Report (July 2023)

6.11.4 Statewide Siren Test Report (August 2023)

382 6.12 County of Maui Policies

6.12.1 Traffic Operations G.O. 405.1

6.12.2 Traffic Operations G.O. 405.7

6.12.3 MFD Policy: Radio Communications E.O.300.04

6.12.4 MPD Policy: Radio Communications G.O. 301.5

TABLE OF CONTENTS

6.12.5 MFD Policy: Maui Incident Management Team D.O. 600.05

6.12.6 MPD Policy: ICS and SRT Operations G.O. 412.1

6.12.7 MPD Policy: Command Vehicle Standard G.O.304.11

6.12.8 MFD Policy: Hazard Zone Command E.O.302.01

6.12.9 MFD Policy: Accountability E.O. 300.08

6.12.10 MPD Policy: Natural and Man-Made Disaster Plan G.O.411.4

6.12.11 MFD Policy: Hurricane and High Wind Events D.O. 600.01

6.12.12 MFD Policy: Apparatus and Equipment Check, Management and Administration (M.A.) 100.25

6.12.13 MFD Policy: Emergency Callout E.O. 300.12

6.12.14 MFD Policy: Mayday E.O. 300.07

6.12.15 MFD Policy: Brush and Wildland Fire Policy E.O. 302.14

6.12.16 MPD Policy: Body-Worn Camera System G.O. 304.12

6.12.17 MFD Policy: Fire Ground Communication E.O. 302.02

491 6.13 Fatalities with Age, Sex, and Recovery Geolocation

497 **7.0 Glossary**

499 **8.0 Acronyms and Abbreviations**

504 **Sources**

LIST OF TABLES

54	Table 3.2.2.1	August 8, 2023 Wind Speed.
89	Table 100-18	Domestic Consumption Guidelines.
90	Table 100-19	Fire Flow Requirements.
91	Table 100-20	Demand Factors.
97	Table 3.4.4.2.1	Partial record of Hawaiian Electric communications with the MPD and MFD regarding power status. Central is the MPD's central dispatch.
168	Table 3.8.9.1	Summary of fatalities with respect to location found.
195	Table 4.2.1.1	Comparison between FEMA and FSRI structure damage datasets.
325	Table 6.4.1	Subpoena Requests.
335	Table 6.6.1	National Weather Service Product Verification Leading up to August 8, 2023.
340	Table 6.7.1	County of Maui Lahaina Brush Clearance Records.
342	Table 6.7.2	State of Hawai‘i, Department of Transportation Lahaina Brush Clearance Records.
491	Table 6.13.1	Fatalities with age, sex, and recovery geolocation.

LIST OF FIGURES

33	Figure 1.1.2.1	National Cohesive Wildland Fire Management Strategy (NCWFMS). Source: Wildland Fire Leadership Council.
37	Figure 1.1.10.1	Comparison of the Lahaina PM fire perimeters generated by FSRI and Wildland Fire Interagency Geospatial Services Group.
47	Figure 2.2.4.1	Overlay of 2018 and 2023 fire perimeters.
51	Figure 3.2.2.1	Red Flag Warning days in the State of Hawai‘i 2008 through 2023. Source: National Weather Service - Honolulu.
52	Figure 3.2.2.1.1	State of Hawai‘i High Wind Events by month from 1996 through 2022. High Wind Events are documented damage caused by the wind. Source: National Weather Service - Honolulu.
53	Figure 3.2.2.1.2	Hawai‘i State High Wind Events by month from 1996 through 2022. Colors indicate the source of the damaging winds and, by inference, the general wind direction. High-Trade wind direction (north-northeast); Low - Kona/non-trade wind direction (south-southwest); Tropical Cyclone - Adjacent to a tropical cyclone warning.
60	Figure 3.3.2.1	Map of Maui showing burn perimeters of the four (4) August 8, 2023 fires, land ownership, and fire response zones. Source: https://www.arcgis.com/sharing/rest/content/items/66a59db4bc-31459298b28a94564de533/info/metadata/metadata.xml?format=default&output=html; https://files.hawaii.gov/dbedt/op/gis/data/fireresponse_summary.pdf
61	Figure 3.3.2.2	Map of Lahaina showing burn perimeter and land ownership. Detail shows Lahaina fire origin just northeast of Ho‘okahua Street where the County of Maui, State of Hawai‘i, and private lands converge. Source: Hawai‘i Statewide GIS Program, Office of Planning and Sustainable Development, State of Hawai‘i.
65	Figure 3.3.8.1	Fire Risk Heat Map: In 2018, 41 individuals from Maui representing government organizations, businesses, private landowners, and residents participated in a workshop to identify and prioritize county areas by their values at risk, hazardous vegetation, and where to start the hazard mitigation effort. The areas of highest concern represent where the participants selected as high priority for each of the three (3) categories.
71	Figure 3.4.1.2.1	Zoning map of Lahaina and area impacted by fire.
72	Figure 3.4.1.2.2	Percentage of parcels covered by building, approximated by roof line.
72	Figure 3.4.1.2.3	Building coverage per one (1) acre grid cell. These cells cross parcel boundaries.
75	Figure 3.4.2.1.1	Road Network. Map shows Lahaina with fire perimeter and egress routes used throughout August 8, 2023. State highways in orange and county roads in yellow.
76	Figure 3.4.2.2.1	Kuhua Street Northbound: Map showing Kuhua Street looking north toward Aki Street. Pre-fire image taken September 2011 (bottom, right) and post-fire image taken October 6, 2023 (top, right).

LIST OF FIGURES

77	Figure 3.4.2.2.2	Kuhua Street Southbound: Map showing Kuhua Street looking south toward Kamamalu Street. Pre-fire image taken September 2011 (bottom, right) and post-fire image taken October 6, 2023 (top, right).
78	Figure 3.4.2.2.3	Map of the Lahainaluna neighborhood displaying a labyrinth of roads, multiple dead ends, and limited egress routes. Kuhua Street is where many of the 102 decedents were found.
79	Figure 3.4.2.3.1	Kaili Place showing narrow street and vehicle parking. Pre-fire image taken September 2011 and post-fire image taken October 6, 2023.
80	Figure 3.4.2.3.2	Pāʻūʻū Place. Image showing multiple no parking signs at the dead end of Pāʻūʻū Place in the Lahainaluna neighborhood. Pre-fire image taken September 2011 and post-fire image taken October 6, 2023.
81	Figure 3.4.2.4.1	Photo of Old Cane Haul Road, often referred to by police officers and firefighters as Oil Road, just north of Kapunakea Street. This road is accessed through a gate located on the north side of Keawe Street at Kuhua Street. Oil Road was used extensively during evacuations due to utility poles blocking Hwy-30 just north of Keawe Street. Inset: Old Cane Haul Viewpoint. Image showing the area depicted in the photograph above.
82	Figure 3.4.2.4.2	Unpaved Roads. Cane Haul Roads. Map of Lahaina's dirt road network, including fire perimeter. Road names are included with source. These roads were used by residents to evacuate as fire and smoke was bearing down.
83	Figure 3.4.2.4.3	Locked Gates Map. Map showing location of locked games preventing access to dirt roads used during August 8-9, 2023. MPD officers shared how they had to cut the locks to open the gates to allow vehicles to escape the fire and smoke.
99	Figure 3.4.4.3.1	Hawaiian Electric AVL data for vehicles operating in the Lahaina area on August 8, 2023.
101	Figure 3.5.1	FCC-registered cell sites out of service in the County of Maui, HI. Source: Federal Communications Commission, Communications Status Report for Areas Impacted by Hawai'i Wildfires August 9-17, 2023.
102	Figure 3.5.1.1	Number of cable and wireline subscribers out of service by date for Maui.
105	Figure 3.5.1.2.1	Map displaying locations and functional status of Lahaina outdoor warning sirens as of August 1, 2023 (first business day of the month = siren monthly test day). Base map provided by https://hiema.maps.arcgis.com/apps/dashboards/226e62cd78f340c29e52d4f38c46ac21. Siren status and maintenance records provided by MEMA and HI-EMA.
106	Figure 3.5.1.2.2	Shows the public sirens in Lahaina on August 8, 2023 and their operational status as of July 12, 2024. Source: ARCIS.
135	Figure 3.7.4.2.1	MFD AVL data aggregated to location within each hour, starting at the time of the Lahaina PM fire and through midnight. These maps are limited by the relatively sparse data provided for MFD units.

LIST OF FIGURES

138	Figure 3.7.7.1	Google Earth image of Lahaina with highlighted area indicating Lahaina AM fire location where fire suppression resources were working.
138	Figure 3.7.7.2	Google Earth pre-fire image (July 9, 2016) of the area where the Lahaina AM fire burned. Red outline marks the ravine with walls made of large boulders that contained voids where tufts of dry vegetation and combustible trash were concealed. The area outlined is approximately five (5) acres.
139	Figure 3.7.7.3	Post-fire image taken September 3, 2023, from near the top of the ravine southeast of the two-story home in the image at 8[redacted] Hoʻokahua Street. Image shows unburned vegetation in rocky terrain. Inset: Viewpoint of the image in the photograph above.
140	Figure 3.7.7.4	Post-fire image taken September 3, 2023, from near the east end (mauka) of the ravine southeast of the two-story home in the image at 7[redacted] Kuialua Street. Image shows unburned vegetation in rocky terrain. Inset: Viewpoint of the image above.
141	Figure 3.7.7.5	Google Street View image (pre-fire, date unknown) looking south from Lahainaluna Road. Home in the image is addressed at 8[redacted] Hoʻokahua Street and was the structure nearest the Lahaina AM fire point of origin. Image shows buffelgrass and haole koa at the base of several utility poles supporting overhead electrical lines. Inset: Viewpoint of the image above.
143	Figure 3.7.7.3.1	Video image captured on August 8, 2023, at 09:07, taken from a vehicle traveling eastbound (mauka) on Lahainaluna Road. At the far east end (mauka), a dust cloud can be seen near the location where the Lahaina AM fire burned. Insert: Viewpoint looking east (mauka) on Lahainaluna Road.
145	Figure 3.7.7.5.1	Map of Lahaina PM fire perimeter showing area of urban conflagration and vegetation fires on north and south flanks.
154	Figure 3.8.2.1	Several downed utility poles and powerlines in the northbound lane of Hwy-30 and Kapunakea Street. Photo taken August 8, 2023, at 16:52. Inset: Viewpoint of photo of downed utility poles and electrical lines at Hwy-30 and Kapunakea Street.
155	Figure 3.8.2.2	Northbound Front Street traffic over Kahoma Stream on August 8, 2023, at 17:05. Inset: Viewpoint of northbound Front Street traffic over Kahoma Stream on August 8, 2023, at 17:05.
156	Figure 3.8.2.3	Front Street at Hwy-30 on August 8, 2023, at 17:28 shows MPD vehicles redirecting southbound Hwy-30 traffic away from the fire, and vehicles on northbound Front Street merging onto northbound Hwy-30. Inset: Viewpoint looking south toward Front Street and Hwy-30 intersection.
157	Figure 3.8.2.4	Evacuation route used by residents exiting the Lahainaluna neighborhood as the fire burned through the Lahainaluna neighborhood. Route required breaking open three (3) locked gates (red circles), and driving on dirt roads to make access to Lahainaluna Road and ultimately the Lahaina Bypass.
157	Figure 3.8.2.5	Body-worn camera (BWC) images of a MPD officer captured August 8, 2023, at 16:27 and 16:28 on a private vacant lot north of 4[redacted] Komo Mai Street and south of Kahoma Stream. MPD officers and residents broke through the gate to travel on the dirt road to Kanakea Loop, and ultimately, out to the Lahaina Bypass via Lahainaluna Road. Inset: Viewpoint of BWC image of MPD officer assisting residents evacuating dirt road on a private lot on south side of Kahoma Stream.

LIST OF FIGURES

158	Figure 3.8.2.6	BWC image capture of a MPD officer August 8, 2023, at 16:43,16:44, and 16:46 breaking through a locked gate securing the County of Maui Department of Water Supply Lot (Parcel No. 450310010000) on Kanakea Loop, directly across from 10[redacted] Kanakea Loop. Gate restricted access to the county lot, leading to a second gate that provided access to the Kelawea Mauka Makai Park parking lot, and ultimately, Lahainaluna Road. Inset: Viewpoint of MPD officers making access through the locked gate, securing the county lot in the west side (makai) of Kanakea Loop, across from 10[redacted] Kanakea Loop.
159	Figure 3.8.2.7	BWC image captured on August 8, 2023, at 16:46 of a MPD officer within the County of Maui Department of Water Supply lot (Parcel No. 450310010000) just north of Kelawea Mauka Makai Park. MPD officers and residents broke through locked gates to exit the lot into the Kelawea Mauka Makai Park parking lot, then to Lahainaluna Road, and ultimately, to the Lahaina Bypass to escape the fire. Inset: Viewpoint of BWC image of MPD officer inside county lot residents used to travel through to escape the fire.
161	Figure 3.8.4.1.1	MPD AVL data aggregated to location within each hour, starting at the time of the Lahaina PM fire and through midnight.
165	Figure 3.8.10.1	Recovery locations and descriptions of fire fatalities for the central analysis zone.
166	Figure 3.8.10.2	Recovery locations and descriptions of fire fatalities in the north.
167	Figure 3.8.10.3	Recovery locations and descriptions of fire fatalities in the south.
168	Figure 3.8.10.4	Evacuation path of the resident of the Hale Mahaolu Eono independent-living apartment complex at 8[redacted] Kelawea Street who was recovered on Kuhua Street.
168	Figure 3.8.10.5	Front of 8[redacted] Kuhua Road from Google Street View (Sept 2011).
168	Figure 3.8.10.6	Potential egress routes for fatalities recovered from 8[redacted] Kuhua Street.
168	Figure 3.8.10.7	August 11, 2023, satellite image of 8[redacted] Kuhua Street and surrounding area.
170	Figure 3.8.10.8	Potential egress routes for those recovered in vehicles in front of 8[redacted]-8[redacted] Kuhua Street.
170	Figure 3.8.10.9	August 11, 2023, satellite image of 8[redacted]-8[redacted] Kuhua Street and surrounding area.
191	Figure 4.1.3.1	Example of distance measurement capabilities with aerial imagery and potential reference point for set back and separation distances.
193	Figure 4.2.1	Screen capture of University of Hawai‘i, National Disaster Preparedness Training Center tool. Map on the left shows the exact location, the lower right image is before the fire and the upper right image is after the fire.
196	Figure 4.2.1.1	Structure damage assessment map of Lahaina as a result of the August 8-9, 2023 fire.

LIST OF FIGURES

198	Figure 4.2.2.1	Overview of incident area with location of vehicles identified in aerial imagery captured August 11-13, 2023.
200	Figure 4.3.2.1	Overview map of Lahaina depicting North, Central, and South zones.
201	Figure 4.3.3.1.1	Pre-fire aerial imagery of Kuhua Street in the Kelawea Community taken August 26, 2021. The area this section is focused on is approximately 45 acres.
202	Figure 4.3.3.1.2	Damage classification assessment map of Kelawea Community analysis area.
203	Figure 4.3.3.1.3	EagleView image taken August 26, 2021 showing the high community density.
203	Figure 4.3.3.1.4	Historical planning document showing the northern area of Kahua Street in 1936.
204	Figure 4.3.3.1.5	Pre-fire aerial imagery captured August 2021 of the area along Kuhua Street depicted in Figure 4.3.3.1.4.
205	Figure 4.3.3.1.6	Post-fire aerial imagery (captured August 11-13, 2023) of Kuhua Street in the Kelawea Community.
206	Figure 4.3.3.1.7	Map showing egress route at 16:41 after the fire cut off the westbound exits via Komo Mai Street and Lahainaluna Road. Orange dots represent the location of the fallen trees and debris blocking Kuhua and Aki Streets. Red dots represent locked gates that police officers and residents forcibly opened to gain access to alternative egress routes depicted by the yellow lines.
207	Figure 4.3.3.1.8	Fatality locations in this area as provided by the MPD.
207	Figure 4.3.3.2.1	Post-fire aerial imagery Kelawea Mauka III subdivision, east (mauka) of Lahaina Bypass.
208	Figure 4.3.3.2.2	Damage classification assessment map of Kelawea Mauka III subdivision analysis area.
209	Figure 4.3.3.2.3	Example of wind damage in the Kelawea Mauka III subdivision—(top left) damaged roof sheathing and (top right) loss of roof covering.
210	Figure 4.3.3.3.1	Pre- and post-fire aerial imagery of homes that survived the fire on Komo Mai Street and Lu‘i Street. Annotations depict separation distances between perimeter structures and nearest destroyed structure.
211	Figure 4.3.3.3.2	Damage classification assessment map of Kahoma subdivision analysis area.
211	Figure 4.3.3.3.3	Damage classification assessment map to 3[redacted] Komo Mai Street from (destroyed) 3[redacted] Komo Mai Street; approximately 24 foot separation distance. Top left image shows both addresses, top right indicates the radiant heat vector in the generally opposite direction of fire spread. Bottom images show discoloration of fiber cement siding and deformation of vinyl window frames.
212	Figure 4.3.3.3.4	Isolated fire damage to 3[redacted] Komo Mai Street. Spot fire (ember ignition) caused localized damage, but did not spread to the structure, likely due to defensive actions.

LIST OF FIGURES

212	Figure 4.3.3.4.1	Pre-fire aerial imagery (captured August 10, 2021) of Opukea Apartments.
213	Figure 4.3.3.4.2	Damage classification assessment map of Opukea apartment complex analysis area.
214	Figure 4.3.3.4.3	Distance between nearest destroyed structure on Komo Mai Street, destroyed vehicles, destroyed apartment building, and undestroyed apartment building.
214	Figure 4.3.3.4.4	Destroyed apartment building showing CMU block exterior wall construction (first floor) and noncombustible sheathing with stucco finish coat and fiber cement siding.
215	Figure 4.3.3.4.5	Wind damage to undestroyed apartment buildings, including significant roof covering (composition shingle) loss and roof sheathing.
216	Figure 4.3.3.4.6	Broken window on third floor of eastern (mauka) side of apartment building, likely caused by windborne debris.
216	Figure 4.3.3.4.7	Ornamental vegetation (palm bracts) ignited by embers and burned without igniting adjacent vegetation.
217	Figure 4.3.3.5.1	Pre-fire aerial imagery (captured August 10, 2021) of Kahoma Village before the fire.
217	Figure 4.3.3.5.2	Damage classification assessment map of Kahoma Village analysis area.
218	Figure 4.3.3.5.3	Concrete barrier wall along Hwy-30.
218	Figure 4.3.3.5.4	Destroyed single family home at 2[redacted] Kahoma Village Loop from the front (north).
218	Figure 4.3.3.5.5	Body worn camera image captured by an MPD officer on August 8, 2023, at 17:41:23, showing the house fire in Kahoma Village.
219	Figure 4.3.3.5.6	Destroyed single family home from the rear on the other side of the concrete wall.
219	Figure 4.3.3.5.7	Aerial imagery of distances between Building 13 (damaged), Building 12 (destroyed), and Building 14 (destroyed).
219	Figure 4.3.3.5.8	Ground-based photograph of space between Building 13 (shown on left of image) and Building 14 (shown on right), showing damaged windows and heat damaged/dried (but not ignited) vegetation.
220	Figure 4.3.3.5.9	Ground-based photograph of space between Building 13 (shown on left of image) and Building 14 (shown on right).
220	Figure 4.3.3.5.10	Photograph of space between Building 12 (shown on right of image) and Building 13 (shown on left), showing minimal damage to the vinyl fence.
221	Figure 4.3.3.5.11	Thermal damage (window) to the front of Building 16, across from Building 15 (destroyed).
221	Figure 4.3.3.5.12	Distance between Building 15 (undestroyed) and Building 16 (destroyed) and several vehicles lost during the fire.

LIST OF FIGURES

221	Figure 4.3.3.6.1	Post-fire aerial imagery of Ala Moana Street to Kenui Street.
222	Figure 4.3.3.6.2	Damage classification assessment map of Front Street to the beach between Ala Moana Street and Kamaka Circle analysis area.
223	Figure 4.3.3.6.3	Pre- and post-fire Google Street View imagery of Ala Moana Street private driveway. This road is a demarcation of destruction, nearly all of the structures on the ocean (makai) side are destroyed.
224	Figure 4.3.3.6.4	Destroyed accessory structure at 4[redacted] Ala Moana Street (top left). The burning structure caused damage to 4[redacted] Ala Moana Street (top right and bottom left) and 5[redacted] Ala Moana Street (bottom right).
224	Figure 4.3.3.6.5	Post-fire aerial imagery (captured August 13, 2023) of the area of Puunoa Place.
225	Figure 4.3.3.6.6	Destroyed structure on Lahilahi Place caused damage to the rear side of 11[redacted] (top) and 11[redacted] (bottom) Front Street structures.
225	Figure 4.3.3.6.7	Post-fire aerial imagery of 1[redacted] Kamaka Circle (damaged), surrounded by destroyed structures.
226	Figure 4.3.3.6.8	Vegetation and fence on “B” side exposure of 1[redacted] Kamaka Circle.
226	Figure 4.3.3.6.9	Close-up images of the structure at 1[redacted] Kamaka Circle, showing that the extent of damage varied by multiple factors. Yellow arrow indicates the vinyl window frame that was impacted by radiant heat and fell out. Red arrow indicates ember ignition of wooden deck for what appears to be an outdoor shower.
226	Figure 4.3.3.6.10	Ember damage of a hot tub cover reveals the noticeable size variation of embers encountered during the fire.
227	Figure 4.3.4.1.1	EagleView image of the 400 block of Front Street showing the survival of six (6) primary structures on the west (makai) side of the street.
228	Figure 4.3.4.1.2	Damage classification assessment map of the 400 block of Front Street analysis area.
229	Figure 4.3.4.1.3	The orientation of wind impacting the 400 block of Front Street in Lahaina can be visualized in the grass fields on either side of Mill Street, around the Lahaina Aquatic Center and Boys & Girls Clubs of Maui (middle). Representative damage to trees oriented towards the west (makai). (bottom, bottom) Spot fire damage in the softball field, where the heel of the fire can be identified towards the east (mauka), indicating spread to the west (makai)—assuming flat terrain on the grass field.
230	Figure 4.3.4.1.4	Utility pole south of Mill Street that hit and damaged the roof of the Boys & Girls Clubs of Maui.
231	Figure 4.3.4.1.5	Lahaina Shores Beach Resort (4[redacted] Front Street) in southern Lahaina. Top panel depicts the street location and robotic street imagery before and after the fire. (bottom left) Overall view of structure from southeast (note fenced area in bottom left where trash bins and materials are typically stored). (bottom right) View from northeast beyond the destroyed Shops at 5[redacted] Front Street.

LIST OF FIGURES

232 Figure 4.3.4.1.6 Radiant heat damage to the north end of the Lahaina Shores Beach Resort (4[redacted] Front Street). More severe bubbling to the paint is noted on the western (makai) portion of the structure (middle right) compared to that on the east-mauka (middle left) for the bottom four (4) floors, though more bubbling is noted on the fifth and sixth floors on the west (makai). Larger amounts of lush vegetation between the eastern (mauka) portions of the building compared to the western-side (makai) may have aided in locally reducing radiant heat impacting the north face of this structure. Inset: Viewpoint showing Lahaina Shores Beach Resort.

232 Figure 4.3.4.1.7 Increased window damage on the lower floor windows on the west-makai (right) compared to the east-mauka (left). Cracking is noted on the second and fourth floor windows with screens partially dropped on the third and fourth floors for the rooms on the west (makai).

233 Figure 4.3.4.1.8 Close up of window damage on the second floor windows on the west (makai) room of 4[redacted] Front Street.

233 Figure 4.3.4.1.9 Close up of the open compartment on the fifth floor and thermal damage to furnishings on the sixth floor.

233 Figure 4.3.4.1.10 Ember and/or radiant heat ignited and destroyed the 4[redacted] Front Street garbage can/disposal area, which subsequently damaged a light post and the wood railing/fence on the northwest corner of 4[redacted] Front Street. Inset: Viewpoint showing the area depicted in the photograph above.

234 Figure 4.3.4.1.11 Ember-created spot fires in the front lawn of 4[redacted] Front Street (top). Bottom panel shows the map location and street image before and after the fire at 4[redacted] Front Street.

234 Figure 4.3.4.1.12 Debris in the open garage of 4[redacted] Front Street. Inset: Viewpoint showing the area depicted in the photograph above.

235 Figure 4.3.4.1.13 Window damage on the south side of 4[redacted] Front Street. Ember damage to shoes on doorstep indicates energetic embers were present in the area, which could have increased risk for ignition of interior combustibles had windows completely failed. Inset: Viewpoint showing the area depicted in the photographs above.

236 Figure 4.3.4.1.14 Overhead view of 4[redacted]-4[redacted] Front Street showing potential path of fire progression along a low stone wall west (makai) of the property lines and then east (mauka) along 4[redacted]-4[redacted] property line wood fence, into an accessory structure and a chair by on the patio of 4[redacted] Front Street (see Figures 4.3.4.1.15, 4.3.4.1.16, 4.3.4.1.17, 4.3.4.1.18).

236 Figure 4.3.4.1.15 Vegetation and fence fire west (makai) of the low stone walls along 4[redacted] and 4[redacted] Front Street. The vegetation fire remained west (makai) of the stone wall other than at the 4[redacted]-4[redacted] property line, where a gap is present.

237 Figure 4.3.4.1.16 Vegetation fire west (makai) of the property line for 4[redacted] Front Street appears to cross into the backyard at the 4[redacted]-4[redacted] Front Street property fence line and near large trees proximate to the wall. Note destroyed accessory structure to the left of the bottom, right image.

LIST OF FIGURES

238	Figure 4.3.4.1.17	Destroyed accessory structure in northwest corner of 4[redacted] Front Street (top) and spread into backyard turf in 4[redacted] Front Street due to embers and/or radiant heating (middle). Inset: Viewpoint showing the area depicted in the photographs above.
238	Figure 4.3.4.1.18	Destroyed chair proximate to rear patio door/window assembly on 4[redacted] Front Street, where the outer pane failed and inner pane remained intact. Note the indications of tempered glass in this assembly.
239	Figure 4.3.4.2.1	EagleView image of the 400 block of Waineʻe and ʻĀlīʻō Streets, showing a cluster of ten (10) surviving structures located west (makai) of Hwy-30 (see text for further details).
240	Figure 4.3.4.2.2	Damage classification assessment map of the 400 block of ʻĀlīʻō and Waineʻe Street analysis area.
241	Figure 4.3.4.2.3	Surviving cluster of structures along the 400 block of ʻĀlīʻō Street and Waineʻe Street including east (mauka)-west (makai) separation distances on (top right) pre-fire image and (bottom right) post-fire image. Inset: Viewpoint showing area depicted in photographs above.
242	Figure 4.3.4.2.4	Northernmost surviving structure in the cluster of homes along the 400 block of ʻĀlīʻō Street and Waineʻe Street was located at 4[redacted] ʻĀlīʻō Street.
243	Figure 4.3.4.2.5	Eave and roof damage to the structure at 4[redacted] ʻĀlīʻō Street.
244	Figure 4.3.4.2.6	Grass fire to the south of 4[redacted] ʻĀlīʻō Street appears to have ignited in multiple locations where charred sections of the fence from the 4[redacted]-4[redacted] ʻĀlīʻō Street property line landed in dry grass. While it propagated near the wooden structure on the southside of 4[redacted] ʻĀlīʻō Street, it did not transition to the structure.
245	Figure 4.3.4.2.7	Grass fire in the northwest yard of 4[redacted] ʻĀlīʻō Street appears to have been ignited where charred sections of the fence from the 4[redacted]-4[redacted] ʻĀlīʻō Street property line landed in dry grass, which then backed up to the fence and gate connected to the structure. Sprinklers were distributed throughout the yard, including in the center of this section of undamaged grass.
245	Figure 4.3.4.2.8	Localized ignition of landscaping materials in the backyards of (top) 4[redacted] ʻĀlīʻō Street and (bottom) 4[redacted] Waineʻe Street, including a section of deeply charred dimensional lumber that does not appear connected to any other structures in the immediate vicinity.
246	Figure 4.3.4.2.9	Viewpoint depicting the area shown in Figures 4.3.4.2.5 through 4.3.4.2.8.
246	Figure 4.3.4.2.10	A spot fire near the southwest corner of the 4[redacted] ʻĀlīʻō Street porch was confined to a small area, possibly through water application from the garden hose on the porch. Insert: Viewpoint of 4[redacted] ʻĀlīʻō Street.
247	Figure 4.3.4.2.11	South Zone—Kauaʻula Road showing the area shown in Figures 4.3.4.2.12 and 4.3.4.2.13.
247	Figure 4.3.4.2.12	Deep yards to the south of (top) 6[redacted] and (bottom) 7[redacted] Kauaʻula Road separated these surviving structures from destroyed structures to the south. A shed in the southeast corner of 7[redacted] Kauaʻula Road was destroyed, yet this fire did not appear to create thermal damage on the main structure.

LIST OF FIGURES

247 Figure 4.3.4.2.13 Exterior fire in the south yard of 7[redacted] Kaua‘ula Road destroyed outdoor furnishings and structures up to the corner of the main residential structure. However, these fires did not spread to the south of the residence and appeared to result only in damage to the plastic gutter in the southwest corner.

248 Figure 4.3.4.2.14 West (makai) side of 6[redacted] Kaua‘ula Road was severely impacted by radiant heat from the destroyed structure at 5[redacted] Kaua‘ula Road, located 12 feet to the west (makai). Heavy charring was noted in the fascia board at the end of the eave and plastic conduit melted, exposing a penetration through the exterior wall for AC access. Windows and screens on the sliding glass patio door were also damaged. Inset: Viewpoint showing the area depicted in the photographs above.

248 Figure 4.3.4.2.15 West (makai) side of 6[redacted] Kaua‘ula Road withstood extensive damage to windows, including three (3) casement style windows where frames were severely warped and both panes of glass failed and dropped out of the frame. The interior screen remained in place for all three (3) windows, and appears to have blocked some materials from entering the structure.

249 Figure 4.3.4.2.16 A wood fence connecting the west (makai) side of 6[redacted] Kaua‘ula to the wood fence on the 6[redacted]-5[redacted] property line was destroyed up to the easternmost (mauka) panel that was connected to the structure. Had fire continued along this fence, it could have directly exposed wood eave structure and increased heat flux to the already damaged window immediately south of the fence.

250 Figure 4.3.4.2.17 Surviving structures at 4[redacted] and 4[redacted] ‘Ālī‘ō Street, dimensioned from the pre-fire image (top) superimposed on the post-fire image (bottom). Inset: Viewpoint showing the area depicted in the photographs above.

251 Figure 4.3.4.2.18 Radiant heat damage to the structure and household belongings at 4[redacted] ‘Ālī‘ō Street was noted primarily on the north side.

252 Figure 4.3.4.2.19 Radiant heat damage to the structure at 4[redacted] ‘Ālī‘ō Street was noted only on the south side. Windows were severely damaged across the entire exterior wall, including four (4) windows where both panes failed and/or sashes fell out. Window screens over the sliding sash were less damaged than the fixed sashed with no screens.

253 Figure 4.3.4.2.20 Examples of open/broken windows and/or screens in this cluster of surviving homes.

254 Figure 4.3.4.3.1 Surviving structures at 3[redacted] and 3[redacted] Front Street, including approximate separation distances determined from pre-fire images (left), which were superimposed on post-fire images (middle).

254 Figure 4.3.4.3.2 Damage classification assessment map of analysis area.

255 Figure 4.3.4.3.3 Strong winds removed shingles and tar paper from the roof of 3[redacted] Front Street (top) and deposited much of this material in the west (makai) rear yard (middle).

256 Figure 4.3.4.3.4 Tall, lush vegetation was planted along block walls on either side of the driveway to 3[redacted] Front Street, which may have provided protection to the 3[redacted] and 3[redacted] Front Street lots. The block wall south of 3[redacted] Front Street also influenced the ember movement. Note pile up in corner of wall (bottom left) and wind driven burn scar in grass around the wall toward the front of the structure showing the likely path of ground based embers deflected towards the north and away from the open garage (bottom right).

LIST OF FIGURES

257	Figure 4.3.4.3.5	The east (mauka) facing exterior wall of 3[redacted] Front Street did not have any indication of radiant heat damage and there were relatively limited signs of embers along the ground. Tall, lush vegetation plated along a block half-wall between 3[redacted] and 3[redacted] Front Street was still standing, including some plants that remained green at the time of the post-fire analysis. Inset: Viewpoint showing the area depicted in the photographs above.
258	Figure 4.3.4.3.6	Window damage along the north wall of 3[redacted] Front Street.
258	Figure 4.3.4.3.7	Burnt, charred, and broken wooden fence from the 3[redacted]-3[redacted] Front Street property line directly connected to the structure at 3[redacted] Front Street. Wooden fences can act as a "wick," carrying fire from one structure to the next. The northernmost panel was disconnected from the rest of the fence, removing this mechanism of fire spread.
259	Figure 4.3.4.3.8	Gate and post moved away from burning fence pickets that interrupted the continuous wooden fuel from the 3[redacted]-3[redacted] property line to the east (mauka) wall of 3[redacted] Front Street. The charred end of the post remaining in the ground is indicated by the red arrow in the bottom right image.
260	Figure 4.3.4.3.9	Multiple burn scars on grass in the east (mauka) yard of 3[redacted] Front Street, particularly along the east (mauka) and north block half wall. One (1) spot formed near the southeast corner of the residence (bottom right), but did not extend to the structure.
260	Figure 4.3.4.3.10	Embers accumulated in both the side yard and open garage area but did not have enough energy (individually or accumulated) to create sustained ignition of combustibles. There are some indications of localized burning/melting, such as a tine on the plastic rake, but these did not spread.
261	Figure 4.3.4.3.11	Vegetation fire to the west (makai) of 3[redacted] Front, largely confined west (makai) of the low block wall at the edge of the grass yard.
262	Figure 4.3.4.4.1	Post-fire aerial imagery (captured August 13, 2023) of the (top) north and (bottom) central sections of Puamana community in southern Lahaina.
263	Figure 4.3.4.4.2	Damage classification assessment map of the Puamana Community analysis area.
264	Figure 4.3.4.4.3	Example construction features of Puamana community built between 1968 and 1973.
265	Figure 4.3.4.4.4	Trees downed by wind facing west (makai)-northwest in the vicinity of 6[redacted] and 7[redacted] Puakukui Place. Red arrows identify the approximate location and orientation of fallen trees. The overview image (top left) is oriented with north facing towards the bottom. Inset: Viewpoint showing the area depicted in the photographs above.
266	Figure 4.3.4.4.5	Wind damage in the vicinity of 1[redacted] Pualei Drive, including east-facing (mauka) corner of roof on to 1[redacted] Pualei Drive, a tree downed by wind facing south-southeast (middle left), and a tree facing west (makai)-southwest located to the south of 1[redacted] Pualei Drive (middle right). Red arrows identify the approximate location and orientation of fallen trees. Inset: Viewpoint showing the area depicted in the photographs above.
267	Figure 4.3.4.4.6	Three (3) surviving structures in the north part of Puamana (3[redacted], 4[redacted], and 5[redacted] Pualoke Place).

LIST OF FIGURES

268	Figure 4.3.4.4.7	Vegetation surrounding 3[redacted] Pualoke Place, including address-side view showing vegetation along Front Street (to the right of the structure) and rear view showing standing leafy vegetation immediately behind the rear porches of the surviving structure.
269	Figure 4.3.4.4.8	Damage to the north end of 4[redacted] Pualoke Place immediately adjacent to the destroyed structure at 3[redacted] Pualoke Place. A tree to the east (mauka) of the structure sustained deep charring, likely from embers gathering in cracks, fissures, or scars in the tree bark. Window damage on the north structure wall ranges from single pane cracking to vinyl frame warpage to complete pane fallout. Plastic vent cover and gutters melted and fell. Paint bubbled and peeled across most of the surface. No apparent indication of charring or damage to wood shake roofing materials or wood wall substrate. Grass remained green between the destroyed and damaged structure. Garden hose noted at the corner of the structure. Inset: Viewpoint showing area shown in the photographs above.
270	Figure 4.3.4.4.9	Kaua'ula Stream running through Puamana provided a physical separation between the northern section (where structures were destroyed between Hwy-30 and the coast) and the rest of the community (where destroyed structures were limited to the area between Hwy-30 and Pualei Drive).
270	Figure 4.3.4.4.10	Images along Hwy-30 and Mill Street indicating the southern termination of the grass fire on the bank east (mauka) of Mill Street coincides with the southern end of damaged vegetation along fence line west (makai) of Hwy-30. Approximate location of E11 radio transmission at 22:41 roughly coincides with this area (See Phase One report, Figure 4.3.1.40). Yellow siren provides a common orientation in each picture. Vegetation appears more heavily consumed around the drainage but remains more dense (yet damaged) further south until this transition to green foliage.
271	Figure 4.3.4.4.11	Spotting across Puakukui Place in front of structures (top left) 1[redacted] and (top right) 1[redacted]. Embers found a receptive fuel bed to ignite, but not sustain burning through the green grass. Inset: Viewpoint showing above images.
272	Figure 4.3.4.4.12	1[redacted] Pualei Drive is the farthest south structure destroyed in Puamana. It is bounded by 1[redacted] Pualei Drive to the northwest and 1[redacted] Pualei Drive to the south and parking structures to the west (makai). Inset: Viewpoint shows the area appearing in the photograph above.
272	Figure 4.3.4.4.13	Radiant heating damage on the southeast side of 1[redacted] Pualei Drive. Window damage includes cracking and drop out of some panes, melting and deformation of frames and screens, and potentially deformation of blinds behind windows due to transmitted radiant heating. Damage was noted to plastic vent covers and charring of fascia board on the end of the roof line. Inset: Viewpoint showing the area depicted in the photographs above.
273	Figure 4.3.4.4.14	Louvered windows left partially ajar where debris collected, including charred remains of possible embers. An intact screen behind this window kept these materials from entering the structure and possibly igniting interior contents.
273	Figure 4.3.4.4.15	Examples of open/broken windows on surviving structures in Puamana.
274	Figure 4.3.5.1.1	Post-fire aerial imagery of Lahaina Business Park.

LIST OF FIGURES

274 Figure 4.3.5.1.2 Damage classification assessment map of the Lahaina Business Park analysis area.

275 Figure 4.3.5.1.3 Kaiāulu o Kupuohi Apartment complex prior to the August 8, 2023, fire (Source: https://www.civilbeat.org/2024/04/a-low-income-housing-complex-is-ready-to-rebuild-after-lahaina-fire-it-just-needs-36m/)

275 Figure 4.3.5.1.4 Grasses burned looking east (mauka) toward the Kaiāulu o Kupuohi Apartment complex.

275 Figure 4.3.5.1.5 Grasses burned along Kahoma Stream and behind 2[redacted] Kupuohi Street (Tamura's Fine Wine & Liquors).

275 Figure 4.3.5.1.6 Grass lot burned at 2[redacted] Kupuohi Street, one of the first fires reported on the north side of Kahoma Stream.

276 Figure 4.3.5.1.7 Location where the brush fire spread stopped behind 4[redacted] Kupuohi Street.

276 Figure 4.3.5.1.8 Trailer and building materials ignited by embers (1[redacted] Kupuohi Street).

276 Figure 4.3.5.1.9 Vehicles consumed by fire in the parking lot of 1[redacted] Kupuohi Street.

276 Figure 4.3.5.1.10 Large spot fire west (makai) of the church (8[redacted] Ulupono Street).

277 Figure 4.3.5.1.11 Vehicles consumed by fire west (makai) of the church (8[redacted] Ulupono Street).

277 Figure 4.3.5.1.12 Additional vehicles consumed by fire west (makai) of the church (8[redacted] Ulupono Street).

277 Figure 4.3.5.1.13 Materials storage area burned by embers (1[redacted] Kupuohi Street).

278 Figure 4.3.5.1.14 Materials storage area burned by embers (1[redacted] Kupuohi Street).

278 Figure 4.3.5.1.15 Dumpster fire to the west (makai) of 2[redacted] Kupuohi Street.

278 Figure 4.3.5.1.16 Box truck consumed by fire behind 1[redacted] Kupuohi Street.

278 Figure 4.3.5.1.17 Car consumed by fire next to 2[redacted] Kupuohi Street.

278 Figure 4.3.5.1.18 Vehicles consumed by fire in the middle of Emerald Plaza Place (near 1[redacted] Kupuohi Street).

278 Figure 4.3.5.1.19 Van consumed by fire with thermal damage to 1[redacted] Kupuohi Street.

279 Figure 4.3.5.1.20 Emerald Plaza Building A consumed by fire.

279 Figure 4.3.5.1.21 Emerald Plaza Building B and C consumed by fire.

279 Figure 4.3.5.1.22 Kaiāulu o Kupuohi Apartment complex consumed by fire.

279 Figure 4.3.5.1.23 Lot of vehicles consumed by fire in the northeast corner of the business park.

LIST OF FIGURES

279	Figure 4.3.5.1.24	Kaiāulu o Kupuohi Apartment complex continuing to burn following the August 8, 2023, fire.
280	Figure 4.3.5.2.1	Post-fire aerial imagery of the Keawe Street Apartments at the Villages of Leialiʻi construction site and surrounding neighborhood.
280	Figure 4.3.5.2.2	Damage classification assessment map of the Keawe Street Apartments at the Villages of Leialiʻi analysis area.
281	Figure 4.3.5.2.3	Wind damaged apartments at the construction site.
282	Figure 4.3.5.2.4	Pre-fire aerial imagery (taken July 2021-December 2022) of the Keawe Street Apartments at the Villages of Leialiʻi construction site prior to construction and surrounding neighborhood (Source: Microsoft).
282	Figure 4.3.5.2.5	Pre-fire imagery (August 2021) depicting invasive grasses up to community before construction site.
283	Figure 4.3.5.2.6	Car located at edge of construction site that supported the fire jumping Oil Road from the east-mauka (right to left).
283	Figure 4.3.5.2.7	Resident video of car on fire at the northeast end of the construction site with heavy winds driving the fire toward 13[redacted] Kahoma Street.
283	Figure 4.3.5.2.8	Overhead view of the area at the northwest corner of the construction site, highlighting the interface where the fire stopped. To the north, the fire stopped at the top of Nahale Street (Source: EagleView).
284	Figure 4.3.5.2.9	12[redacted] Nahale Street on the left and 12[redacted] Nahale Street on the right.
284	Figure 4.3.5.2.10	12[redacted] Nahale Street on the left and 12[redacted] Nahale Street (destroyed) on the right.
284	Figure 4.3.5.2.11	(Left) Post-fire aerial image with annotated distance, 39 feet, between (destroyed) 12[redacted] ʻAinakea Road and (damaged) 12[redacted] ʻAinakea Road. (Right) Ground-based image of separation between destroyed and damaged structures.
285	Figure 4.3.5.2.12	Northeast corner of 12[redacted] ʻAinakea Road with blistering paint from radiant heat exposure (indicated by red arrow).
285	Figure 4.3.5.2.13	Post-fire aerial imagery of 12[redacted] ʻAinakea Road with distances to adjacent (destroyed) buildings.
285	Figure 4.3.5.2.14	12[redacted] ʻAinakea Road (Front view, oriented west).
285	Figure 4.3.5.2.15	12[redacted] ʻAinakea Road (side view, oriented north).
285	Figure 4.3.5.2.16	12[redacted] ʻAinakea Road (rear view, oriented northeast).
286	Figure 4.3.5.3.1	Aerial imagery of the North Zone, between Kaniau Road and ʻAipuni Street, which is the most northern area of Lahaina affected by the August 2023 Maui fires.

LIST OF FIGURES

286 Figure 4.3.5.3.2 Damage classification assessment map of analysis area.

288 Figure 4.3.5.3.3 Fire in the grassland along the eastern edge (mauka) of the northern zone crossed over Oil Road to the eastern edge (mauka) of properties on Lokia Street and Kaniau Road. The north flank vegetation fire remained east (mauka) of Oil Road between ‘Aipuni Street and Leiali‘i Parkway, after which the fire moved back west (makai). Note: North is to the right on these images.

289 Figure 4.3.5.3.4 Structure spacing along Lokia Street in the vicinity of the surviving structures on the east side (mauka) of the street, abutting the grassland fire.

289 Figure 4.3.5.3.5 The surviving accessory structure at 16[redacted] Lokia Street was near the eastern (mauka) property line, but was buffered from the grassland by a garden (note intact hoses and stone landscaping separating from the grass) and a fence. The structure was elevated such that the damaged windows were a longer distance from the burning vegetation than a single-story structure. Charred sections of fence were broken away from the posts and burning was stopped. Broken windows were boarded up from the inside by the time images were collected.

290 Figure 4.3.5.3.6 The 16[redacted] Lokia Street structure did not appear damaged by the grass fire to the east (mauka) sides (top left) or destroyed structure west (makai) of Lokia Street (top right). The structure was heavily damaged from radiant heating from the destroyed structure to the south (bottom left) and north (bottom, right).

290 Figure 4.3.5.3.7 (top) Overhead view of 16[redacted] Lokia Street lot with approximate location of sprinkler that may have been used to prepare the property for the fire and/or defend the property during the fire.

291 Figure 4.3.5.3.8 Structure spacing near destroyed accessory structure at 1[redacted] Kaniau Street.

292 Figure 4.3.5.3.9 Tall dry grasses are noted on the northeast corner of Kaniau Road and Hwy-30 in August 2020 (top), which could have provided a receptive fuel bed for fires fires along the railroad tracks or embers moving down (makai) Kaniau Road to ignite these grasses in August 2023 and travel to structures in the immediate vicinity (bottom). Note: North is to the left of these images.

293 Figure 4.3.5.3.10 The primary structure at 1[redacted] Kaniau Road, in close proximity to the destroyed secondary structure and vehicle, had damaged windows, particularly close to the vehicle fire and ember damage to outdoor furnishings that did not extend to the structure.

294 Figure 4.3.5.3.11 Water resources from 1[redacted] Kaniau Road were utilized to help control the fire from propagating farther east (mauka) from 1[redacted] Kaniau Road. Garden hose was deployed from a hose bib with the terminal end remaining at the next lot. Neighbors reportedly used the pump to control a fire along the plastic fence at the north property line of this lot.

295 Figure 4.3.5.3.12 Structure spacing near surviving structures on the west side (makai) of the south end of Lokia Street.

LIST OF FIGURES

296	Figure 4.3.5.3.13	The 15[redacted] Lokia Street lot experienced fire damage to the front entrance gate and destroyed a vehicle, but did not extend to the structure (top). The structure appears to have been defended, in part, by pumping water from the pool in the rear of the structure, powered by a battery system (middle). Damage to fences on the north and south sides of the properties (bottom), showing the end of the hose from the pump in the pool and along with a bucket (bottom left).
296	Figure 4.3.5.3.14	Structure spacing near surviving structures on the north side of Kaniau Street and south side of ‘Aipuni Street.
297	Figure 4.3.5.3.15	West side (makai) of 1[redacted] ‘Aipuni showing melted plastic components, damaged/broken window assemblies, and deformed window blinds likely caused by radiant heat transfer.
353	Figure 6.8.1	Lahaina drinking water treatment system.
355	Figure 6.8.2	Māhinahina drinking water treatment system.
356	Figure 6.8.3	Estimated water volume stored in Lahaina and Māhinahina on August 8, 2023.

EXECUTIVE SUMMARY

This document is the second in a series of three (3) reports commissioned by the Hawai'i Department of the Attorney General (DOAG) to provide an independent review of the tragic fire that destroyed much of Lahaina, Hawai'i, on August 8-9, 2023.

The first (Phase One) report in this series, *Lahaina Fire Comprehensive Timeline Report*, was prepared by the Fire Safety Research Institute (FSRI) and released on April 17, 2024. It contains a complete timeline of the August 2023 fires, based on available information, and provides essential context for reading this report.

This second report (Phase Two), *Lahaina Fire Incident Analysis Report*, outlines FSRI's independent analysis of the events surrounding the fires. This report includes findings and recommendations pertaining to each topic analyzed.

The *Forward-Looking Report* (Phase Three) of this comprehensive independent analysis will help answer critical questions like, "How do we prevent this from happening again?" This final report in the series will have several discrete and interrelated components, including a standards of cover (SOC) analysis to assess the capabilities of the County of Maui Fire Department (MFD), a Community Risk Assessment (CRA) to analyze natural- and human-caused risks to Maui, a community risk reduction plan to help mitigate risk, and a review of fire and building codes.

With a focus on assessing the resources needed to effectively and sustainably address the Maui community's risk profile, Phase Three will provide a forward-looking report with detailed recommendations on how similar events might be prevented, along with ensuring a safe and effective response to limit the impact of future fires.

Using a systems analysis methodology, this Phase Two report presents relevant background information; discusses weather, fuel, and infrastructure conditions; describes communications, incident management, fire suppression, and evacuation efforts; and details the impact of the fire on Lahaina's built environment.

It also considers these factors in the context of the National Cohesive Wildland Fire Management Strategy (Cohesive Strategy), whose tenets include 1) resilient landscapes, 2) fire-adapted communities, and 3) safe and effective risk-based wildfire response.

Phase Two incorporates science- and evidence-based analyses with information from FSRI's fire dynamics research, local subject matter experts, industry standards and best practices, and the collective experiences of FSRI's research team. Based on the comprehensive analysis, this report highlights key findings and recommendations.

This report does not include an analysis of recovery efforts or the fire's origin and cause, which is being investigated by the County of Maui with assistance from the United States Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF).

With this second phase of comprehensive independent review of the tragic fires that impacted Maui in August 2023, FSRI's overarching goal is to ensure similar events are prevented in the future: across Maui Nui (the islands that make up the County of Maui, including Maui, Moloka'i, Lāna'i, Kaho'olawe, and the islet of Molokini), throughout the State of Hawai'i, and in many other vulnerable communities around the globe.

There were four distinct fires that took place on Maui between August 8-9, 2023: the Olinda and Kula fires (Upcountry fires), Lahaina AM/PM fire, and Pulehu fire. The Lahaina PM fire is the incident that caused the majority of the destruction to Lahaina, and is the main focus of this report.

EXECUTIVE SUMMARY

The destruction caused by the August 2023 fires in the County of Maui, Hawai‘i, resulted from a complex interaction of contributing factors with root causes going back years. It is vital to reiterate, as demonstrated throughout this report, that no single factor, or set of factors, is directly responsible for the tragic outcome.

While much of Hawai‘i, including Maui, has a relatively high risk of wildfire occurrence, it appears the perception of this risk—at the local, state, and national levels—is not always aligned with the actual, growing threat wildfires pose to the population and built environment. This gap between risk perception and reality seems to have contributed to a relative underinvestment in wildfire prevention, preparedness, and response capacity over the years.

Despite the limitations of the weather forecasting data available for Maui during August 2023, forecasts predicting severe and “critical fire weather” were accurately developed and widely communicated to both the public and response agencies prior to the August 8-9, 2023, fires. Until the wildfires started in Olinda, Lahaina (AM fire), and Kula on August 8, 2023, it appears these forecasts did not cause residents much alarm, or spur meaningful preparedness actions by local officials, even as people began feeling the strengthening winds across Maui Nui.

Vegetation played a crucial role in the Lahaina PM fire. The availability of vegetative fuel on the landscape allowed the fire to ignite and spread across unmanaged lands and into the built environment. Mitigating the risk of extreme fire behavior and rapid spread requires vegetation management in both wildland and urban areas. Additionally, certain types of well-watered and maintained ornamental vegetation may have limited fire spread in the built environment.

The readiness and performance of any jurisdiction’s underlying critical infrastructure (e.g., roads, water and sewer, electricity, and telecommunications) are key factors that contribute to the resiliency of the overall built environment system when impacted by a major fire or other disaster event.

In the hours leading up to the Lahaina AM and PM fires, severe winds and extreme fire weather significantly degraded infrastructure systems across the County of Maui. The impact of the initial fire and resulting urban conflagration (a large, destructive fire that spreads rapidly through a community, often beyond natural or artificial barriers) further affected the already-deteriorating infrastructure, especially in the built-up areas of Lahaina.

Community planning and zoning regulations and enforcement also play vital roles in matching infrastructure to the surrounding built environment.

Timely and consistent communications are integral to wildfire management, connecting all three (3) tenets of the National Cohesive Wildland Fire Management Strategy. Clear and accurate information from trusted sources is crucial during incidents for overall safety, operational effectiveness, and community-related actions.

The preparedness and actions taken (or not) during the Lahaina PM fire, by both the public and response agencies, were significantly affected by how key communications were handled, including Red Flag warnings, notices of potentially extreme fire behavior, and evacuation plans.

Incident management is essential for a coordinated and effective wildfire response, aligning with the Cohesive Strategy’s goals of protecting lives, property, and natural resources through timely communication and risk management.

EXECUTIVE SUMMARY

The incident management organizations for the Maui Police Department (MPD), County of Maui Fire Department (MFD), and Maui Emergency Management Agency (MEMA) faced significant challenges in planning and executing emergency response functions during the August 2023 fires.

On August 8, 2023, while the MFD was also fighting wildfires in other locations across the island of Maui, fire suppression operations initially began on a fast-moving vegetation fire fanned by hurricane-force winds in an open field at the east end (mauka) of Lahaina.

Resources assigned to this fire, dubbed the "Lahaina AM fire," seemed to be making progress to contain the fire in hot, dry, and windy conditions. However, this fire would go from being reported as extinguished to a fire in the same area being reported at 14:55. This fire, dubbed the "Lahaina PM fire," burned over firefighters and residents, and ultimately, destroyed Lahaina several hours later.

Fire suppression operations were completely overwhelmed by the fast-moving urban conflagration. MFD resources were limited in capabilities due to: two (2) other Upcountry fires (Olinda and Kula) also drawing on the finite resources on the island, electrical wires and downed utility poles blocking access, no hydrant pressure, and other complicating factors. With nowhere else to turn for more structural firefighting resources, the MFD was resourceful with what they had and adapted the best they could.

Rapid evacuation of a community is difficult in the best of circumstances. With the addition of severe weather like what was experienced on August 8, 2023, it becomes especially difficult. This is exactly what was experienced during the Lahaina PM fire. The high winds drove rapid fire spread, necessitating swift and effective actions from the MPD and MFD.

The complexities of the evacuation were compounded by infrastructure failures and the dynamic nature of the emergency.

The Lahaina PM fire's rapid spread to residential, commercial, and industrial structures, ultimately caused it to become an urban conflagration. The speed of the fire's progression was influenced by various factors. The Red Flag Weather, especially the hurricane-force winds blowing downslope into a densely developed Lahainaluna neighborhood, quickly accelerated the fire's progression to the coastline.

Resource limitations are a recurring theme throughout this report and were a principal contributor to persistent challenges with prevention, preparedness, and response capacity before and during the August 2023 fires.

The entire FSRI team joins the survivors of this tragedy in mourning the loss of Maui residents and stands in support of their families, friends, neighbors, and community.

1.0 INTRODUCTION

With this second phase of the comprehensive independent review of the tragic fires that impacted Maui in 2023, FSRI's overarching goal is to ensure similar events are prevented in the future: across Maui Nui, throughout the State of Hawai'i, and in other vulnerable communities around the globe.

Phase One of this work, the *Lahaina Fire Comprehensive Timeline Report*, was released on April 17, 2024, and showed a comprehensive timeline of relevant events, based on available information, that occurred from August 8-9, 2023.

This document, the *Lahaina Fire Incident Analysis Report*, is Phase Two of the series and contains a detailed analysis of the facts presented in Phase One against current policies, procedures, and evidence-based best practices for the period from August 8, 2023 (14:55 HST), to August 9, 2023 (08:30 HST), along with preparedness efforts that occurred before August 8, 2023.

This report does not include an analysis of recovery efforts or the fire's origin and cause, which is being investigated by the County of Maui with assistance from the United States Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF).

Phase Three is a forward-looking report and will help answer critical questions like, "How do we prevent this from happening again?" Beyond providing additional detail on recommendations arising from findings specific to the August 2023 fires—identified in the Phase Two analysis—Phase Three will comprehensively address strategic, policy, and community-related considerations of vital importance to residents of Maui Nui, and across the State of Hawai'i.

Phase Three will include several discrete and interrelated components, including a standards of cover (SOC) analysis to assess the capabilities of the MFD and a review of fire and building codes. The report will also include a Community Risk Assessment (CRA) to analyze natural- and human-caused risks to Maui Nui, as well as a community risk reduction plan to help mitigate these risks.

From the very start of this comprehensive independent analysis, FSRI has desired to work collaboratively with state, county, and federal officials, community members, and other interested parties. We appreciate the cooperation received from so many individuals/organizations and sincerely hope for continued collaboration in Phase Three.



1.0 INTRODUCTION

Fire is a complicated phenomenon under any circumstances. The August 2023 fires on Maui occurred in a complex open system with myriad variables, all interacting in ways that are challenging to accurately specify, even with the best-available science.

The devastation caused by the Lahaina PM fire was ultimately the result of a complex chain of events years in the making; there was no single factor, or set of factors, that led to the tragic outcome. The systemic issues contributing to the fatal events of August 8-9, 2023, stem from a widespread lack of resources and investment that spanned multiple domains, including:

- Policy Activity and Norms
- Weather Alerts and Action
- Vegetative Fuels and Management
- Infrastructure, Community Planning, and Zoning
- Transportation
- Communications
- Incident Management
- Fire Suppression
- Evacuation

There was no single entity that controlled, or could have controlled, all of the system inputs/outputs and relationships that impacted the Lahaina PM fire's outcome.

Many of the challenges faced by responders to this incident have been documented and studied in other events, usually without clear, easy, or simple solutions. Moreover, the complex nature of the operating environment can cause a "solution" for one (1) facet of the identified problem sets to trigger unforeseen or unintended negative consequences elsewhere in the broader system. This potential discord arises from the complex interaction of the many factors involved and the systemic challenges encountered.

The Fire Safety Research Institute (FSRI), part of UL Research Institutes (ULRI), is a leading independent safety science organization with a global footprint and a lineage dating back to the formation of Underwriter's Laboratories (UL) in 1894. Fire safety was an initial catalyst for the formation of UL, and FSRI was the first research institute to be incorporated within ULRI. FSRI is widely recognized as the premier fire safety science organization in the world. Drawing on the resources of ULRI's global network of scientists and safety professionals, FSRI is uniquely positioned to apply science to complex real-world challenges.

FSRI's analytical approach in Phase Two is informed by the tenets of systems theory and the need to view what happened on Maui in August 2023 through a holistic and multifaceted set of lenses.

1.1 Systems Analysis Methodology

The methodology used to comprehensively analyze the August 2023 Maui wildfires, and more specifically, the Lahaina PM fire, requires a systems analysis approach. FSRI's analysis examines the overall prevention, preparedness, and effectiveness of the operational system.

1.1 INTRODUCTION

This approach is necessary due to the complex nature of wildfires, especially those leading to urban conflagrations. It considers the interplay of environmental conditions, human activities, policies, and norms. Wildfires—especially those that lead to urban conflagrations as occurred in Lahaina—are complex events influenced by a multitude of interconnected factors.

Addressing any single factor in isolation is insufficient. Considering the complex interactions and cumulative effects of these factors is a more effective way to adequately understand what took place and how the preparedness, prevention, and response systems performed.

A systems approach (a holistic and interdisciplinary method for understanding and solving complex problems) enables a comprehensive understanding of events and system performance, leading to recommendations and subsequent actions that address root causes, reduce risk, and improve future fire outcomes.

1.1.1 Framework for Analysis

The National Cohesive Wildland Fire Management Strategy (referred to as the Cohesive Strategy) provides a reference point that can be used to analyze the August 2023 Maui wildfires, and more specifically, the Lahaina PM fire. The vision of the Cohesive Strategy is: "To safely and effectively extinguish fire, when needed; use fire where allowable; manage our natural resources; and collectively, learn to live with wildland fire."[1]

The Cohesive Strategy establishes a widely accepted, integrated wildfire management approach[2] that facilitates a comprehensive understanding of this incident's multifaceted causes and impacts. Every Community Wildfire Protection Plan (CWPP) in Hawai'i (including those that cover the impacted areas on Maui) were specifically developed in alignment with the Cohesive Strategy, for example, the Western Maui[3], South Maui[4], and Leeward Haleakalā[5] Community Wildfire Protection Plans.

Analyzing contributing factors within the context of the Cohesive Strategy facilitates alignment between local, state, and national systems, policies, and best practices. It was used to identify areas of focus for deeper analysis and establish criteria for evaluating wildfire preparedness, prevention, and response efforts.

1.1.2 General Topics within Phase One[6] Requiring Further Study

The Cohesive Strategy categorizes the broad system of components that determine wildfire outcomes into three (3) major areas of focus:



Resilient Landscapes
Landscapes, regardless of jurisdictional boundaries, are resilient to fire, insect, disease, invasive species, and climate change disturbances, in accordance with management objectives.



Fire-Adapted Communities
Human populations and infrastructure are as prepared as possible to receive, respond to, and recover from wildland fire (that impacts communities).



Safe, Effective, and Risk-Based Wildfire Response
All jurisdictions, responding in all land types, participate in making and implementing safe, effective, and efficient risk-based wildfire management decisions.

1.1 INTRODUCTION

These focus areas make up the overarching goals of the Cohesive Strategy, with numerous management options within each. The Cohesive Strategy encourages the use of the best available science to inform the work within each area, underscoring the need for consistent and timely communication and coordination among all efforts.

The 2023 Cohesive Strategy Addendum[7] added several critical emphasis areas and key challenge priorities, including:

- Climate Change
- Diversity, Equity, Inclusion, and Environmental Justice
- Community Resilience
- Workforce Capacity, Health, and Well-Being
- Science, Data, and Technology



32

1.1 INTRODUCTION

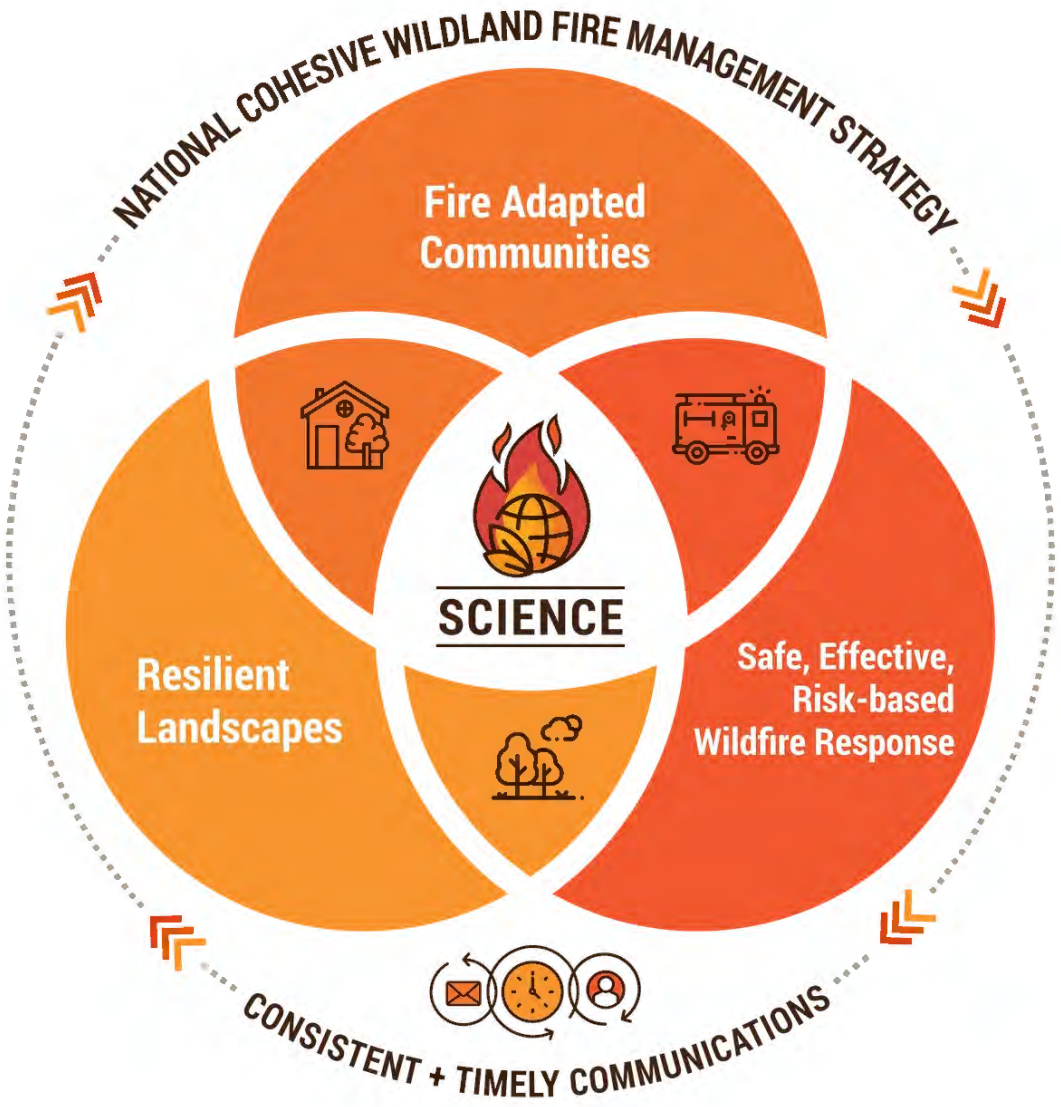


Figure 1.1.2.1 National Cohesive Wildland Fire Management Strategy (NCWFMS). Source: Wildland Fire Leadership Council.

National Cohesive Wildland Fire Management Strategy

The Cohesive Strategy graphic (Figure 1.1.2.1) represents these three (3) tenets and their over-arching goals. Each of the goals, and subsequent actions taken to address them, are inextricably intertwined and result in positive advancement of the other two (2) goals. All actions are informed by the best available science, information, and technology, which is placed at the center.

During Phase One, several system components were identified for further analysis, focusing on organizational leadership, preparedness, prevention, and response. In this report, these components were clustered into the Cohesive Strategy tenets to which they belong.

1.1 INTRODUCTION



1.1.3 Wildfire Resilient Landscapes

The Resilient Landscapes goal of the Cohesive Strategy focuses on 1) the threats to natural resources caused by wildfire and other disturbances and 2) the measures necessary to reduce fuels that contribute to ignitions and rapid wildfire spread. It aims for landscapes that are resilient to fire and other pressures in order to prevent, survive, and recover from wildfire.

The goal states, *"Landscapes, regardless of jurisdictional boundaries, are resilient to fire, insect, disease, invasive species, and climate change disturbances, in accordance with management objectives."*

The system component analyzed in Phase Two is:

- Vegetative Fuel



1.1.4 Fire-Adapted Communities

The Fire-Adapted Communities goal of the Cohesive Strategy focuses on the human system of laws, plans, budgets, and programs, as well as the safety and preparedness of the built environment and its residents.

The goal states, *"Human populations and communities are as prepared as possible to receive, respond to, and recover from wildfire (that impacts communities)."*

The system components analyzed within Phase Two include:

- Infrastructure (road networks, planning and zoning, water, and electrical)
- Evacuation
- Built Environment Impact on Fire Progression

Each of these topics includes a discussion of relevant policies.



1.1.5. Safe, Effective, and Risk-Based Wildfire Response

The Safe, Effective, and Risk-Based Wildfire Response goal of the Cohesive Strategy focuses on informed decision-making, risk management, and effective communication and coordination to enhance safety and efficiency in wildfire response. It aims to prevent injury and loss of life, while quickly and safely minimizing impacts of fire incidents.

The goal states, *"All jurisdictions, responding in all land types, participate in making and implementing safe, effective, and efficient risk-based wildfire management decisions."*

The system components analyzed in Phase Two include:

- Weather Forecast and Sensemaking
- Communications and Coordination (pre-incident and during)
- Incident Management
- Fire Suppression Preparations and Operations
- Evacuation Processes

Cohesive Strategy icons are embedded throughout the report to highlight where each section of the analysis falls within the Strategy's tenets and goals.

1.1.6 Policy Analysis

Each of the identified system components nested within the Cohesive Strategy framework is examined within this report. A detailed review of each component as it relates to the Lahaina PM fire is provided, discussing its role within the broader system and its specific circumstances and contributions to the incident outcomes.

Each system component is reviewed for comparison to county and state policies and procedures, and, where appropriate, to nationally recognized, evidence-based best practices. Where applicable, an examination is provided of what the policy states and how that compares with the actions taken by the organizations.

Findings are provided both incident-wide and per organization, as appropriate. Where immediate actions to reduce risk are most critical, recommendations are also provided. Recommendations requiring more extensive planning will be further detailed and supplemented in Phase Three.

1.1.7 Resident Observations and Experiences

As mentioned in the Phase One report (pages 28-29), FSRI researchers engaged in technical discussions (TDs) with residents after the fire. Although researchers had discussions with more than 100 residents who lived within the burn perimeter, or just outside it, a smaller number agreed to answer specific questions related to the fire.

The limitations of the data are that it represents a small group of individual experiences in a specific location. Having TDs with groups of individuals in all the areas impacted by the fire was nearly impossible due to many surviving residents and visitors leaving the island, residents relocating to other areas of Maui that FSRI investigators did not visit, or individuals being unwilling to answer questions.

In several cases, there was also a language barrier that hindered accurate sharing of information. The data from these discussions will be shared throughout the report to provide context to some of the sections. The complete resident technical discussion data set is provided in Section 6.3 of the Appendix.

1.1.8 Findings and Recommendations

At the conclusion of each section are “Findings and Recommendations” pertaining to the section’s topic. Findings are specific areas of interest that impacted the pre-event conditions and activities and incident operations. They can be related to policies, procedures, guidelines, decisions, organizations, actions, and equipment. A finding can also be related to information that is missing or incomplete.

Recommendations are connected to findings. They include information on how to improve the condition mentioned in the finding. In some cases, there may be several recommendations connected to one (1) finding, and some findings may have no recommendations. The findings and recommendations appearing at the end of each section can also be found in Section 6.1 of the Appendix.

In addition, resource and funding limitations will be noted throughout this report. While government funding is critical to mitigating wildfire risks, the ultimate solution must be rooted in establishing interorganizational partnerships that span the breadth of entities covered in this report and work collaboratively to establish policies, procedures, and guidelines designed to protect the community.

1.1 INTRODUCTION

1.1.9 Information Sources

Information and data was gathered from a variety of sources. Consistent with Phase One, requests for information from the County of Maui were made via subpoena. Details around the requests for information can be found in Section 6.4 of the Appendix.

Hawaiian Electric, National Weather Service (NWS)-Honolulu Office, and the State of Hawai‘i also provided information used within the analysis. Information related to planning, codes, and standards was gathered from the State of Hawai‘i and County of Maui webpages. Specific websites are identified throughout the report.

1.1.10 Report Formatting Details

Throughout the report, time is identified in a 24-hour format that includes two-digits for hour, colon/separator, and two (2) digits for minutes (i.e., 14:00 is 2:00 p.m.).

Points of Reference:

- Pre-fire: Events occurring before 06:30 HST on August 8, 2023
- Lahaina AM fire: Fire occurring August 8, 2023, between 06:34 and 14:17 HST
- Lahaina PM fire (Ku‘ialua fire): Fire occurring August 8-9, 2023, between 14:55 and 06:00 HST

Maps are used extensively throughout the report to display the location of landmarks, fire progression, and general and specific incident operations orientation. Many of these maps include the Lahaina PM fire perimeter and interior burned areas created by FSRI investigators, using data collected from ground-level observations.

This fire perimeter differs in certain areas, and excludes additional unburned areas, compared to the perimeter mapped by the Wildland Fire Interagency Geospatial Services Group. See Figure 1.1.10.1 for a comparison of the two Lahaina PM fire perimeters.



1.1 INTRODUCTION

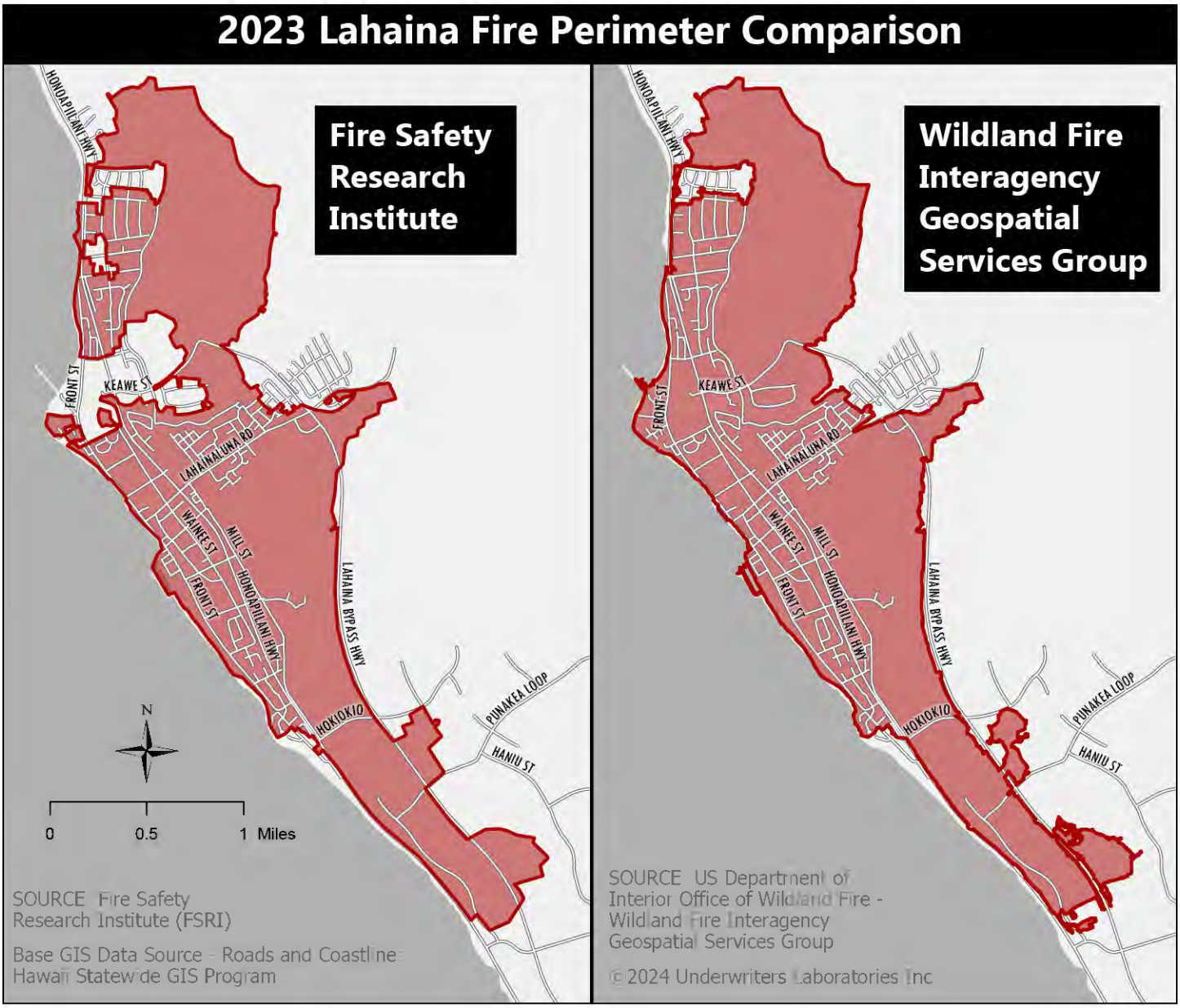


Figure 1.1.10.1 Comparison of the Lahaina PM fire perimeters generated by FSRI and Wildland Fire Interagency Geospatial Services Group.

1.2 Limitations of Analysis

Examining every part of a wildfire-initiated urban conflagration's contributing factors is challenging due to the complexity and interconnectivity of variables. Applying a systems approach is valuable and effective because it allows for a better understanding of the various factors and conditions that contributed to this event. It identifies multiple influences, reveals interconnections, and helps identify key leverage points for future intervention.

However, this approach has limitations due to complexity and scope, data, and time constraints, and is resource intensive. The vast range of factors and their interdependencies make it difficult to capture every detail and fully understand all interactions.

Accurate and comprehensive data for every component can sometimes be lacking and can potentially lead to intermittent and/or unintentional gaps in the analysis. Some of the data gaps are due to the County of Maui being unable to produce the data requested, or difficulties experienced extracting usable data from some file formats provided by the County of Maui. Known data gaps will be identified throughout the report. The clear framework of the Cohesive Strategy ultimately helps focus and define the boundaries of the analysis.

This analysis includes information gathered from before the morning of August 8, 2023. Not included within this report are efforts which have begun at the national, state, and county level to address some of these issues.

Despite the limitations, a good faith effort was made to account for and examine major factors that contributed to the catastrophic wildfire events that occurred on Maui in August 2023.



2.0 Analysis of Background

2.1 Statewide Background

During the analysis of the August 2023 wildfires on Maui, a broader statewide set of norms and context emerged, serving as an essential backdrop for this report. This statewide context plays strongly into the practices and conditions observed on Maui during this time, which is a microcosm of the general set of circumstances, drivers, and patterns of wildfire management across Hawai‘i. Acknowledging this statewide context provides deeper insight into the nature of the Maui incidents and their systemic influences.

Conducting a statewide assessment of wildfire norms, attitudes, available information, and practices is integral to utilizing the Cohesive Strategy as a tool for analysis and future action. It provides a comprehensive understanding of the current social and biophysical landscape of wildfire management in Hawai‘i, and reveals statewide conditions that significantly influenced fire patterns, decision-making, and outcomes in Lahaina. Laying out the policy, funding, and social attitudes that influence the entire system creates a foundation on which all other system factors can be better understood and evaluated for future change.

2.1.1. Statewide Risk

Much of Hawai‘i, including Maui, is fire-prone. Hawai‘i has a very high risk of wildfire—higher than 88% of other U.S. states.[8] Lahaina has a 98% higher risk than the rest of the country.[9] Other parts of Hawai‘i also have extreme risk, for example, Waikoloa Village on the island of Hawai‘i has 100% higher risk than any other place in the U.S., and is not the only community in Hawai‘i facing extreme risk of wildfire.

This context is crucial for understanding that the wildfire challenges faced on Maui are not unique to the island, but are indicative of a high-risk situation that exists statewide, with regions of high-to-extreme risk present on every island.

This is significant when considering that extreme fire behavior was also observed on other Hawaiian Islands under the same conditions that fueled the Maui fires. While the catastrophic loss of life and property on Maui understandably dominated news coverage, three (3) additional wildfires also broke out on the island of Hawai‘i on the same day (North Kohala, South Kohala, and Waimea).[10]

Wildfire risk and incidents have been growing across Hawai‘i over the last several decades, with 94% of Hawaii’s communities sitting along the wildland-urban interface (WUI)—the area where human development and undeveloped wildland meet—and are vulnerable to human-caused wildfire ignition and rapid fire spread.[11] [12] [13] Human-caused ignitions, large swaths of unmanaged fire-prone vegetation, and community design and infrastructure that are not adapted to the high level of wildfire threat are unmitigated statewide issues.

Around the North Kohala area of the island of Hawai‘i, the Akoni Pule Fire,[14] continued burning for days after the Lahaina PM fire, and a fourth fire on the island (South Point) began in the following days, all driven by similar low humidity and high winds that were gusting to 80 mph. These conditions prompted several evacuations on the island of Hawai‘i. While less publicized, these fires caused considerable damage to structures, lands, and community infrastructure, including the destruction of an auxiliary building of the Mauna Kea Beach Resort.[15]

Fire occurrence on the island of Hawai‘i under the same conditions is highlighted here to acknowledge

the ongoing statewide threat and the multi-island impact of the weather and fire events on August 8-9, 2023. However, this is not unique.

In 2018, when Hurricane Lane passed by Hawai‘i, it brought high winds and low humidity to the state, exacerbating the existing drought conditions. See Section 2.2.4 for additional information on this event. Also in 2018, four (4) separate fires ignited simultaneously on Maui and O‘ahu,[16] and one (1) followed in the subsequent days on the island of Hawai‘i.[17]

Each year, Hawai‘i experiences an average of 0.5% of its land burning, a statistic that is on par with the most fire-prone states in the U.S.[18]

2.1.2 Perception of Wildfire Risk within Hawai‘i

Historically, the majority of Hawaii’s native plants and ecosystems were not dependent on, nor adapted to, wildfire. Unlike other places with frequent wildfire occurrences that have taken place for millennia, Hawaii’s wildfire risk grew substantially in less than three (3) generations.

Over the last 20 years, much has been documented, published, and initiated across Hawai‘i by those most directly and regularly dealing with wildfire threats and impacts. Efforts to raise awareness of the growing issue and reduce risks include:

- Wildfire Preparedness Campaigns[19]
- Briefings to Elected Officials[20]
- Community Wildfire Protection Plans[21]
- Local and state natural resource management plans that acknowledge and seek to address wildfire threats[22]
- Academic and media publications about the increasing threats, fire ecology, the changing landscape leading to wildfire risk, and fire weather[23]

However, widespread misconceptions of wildfire risk in Hawai‘i persisted.

Limited, but notable, exceptions to a broader underestimation of risk were identified in a study conducted in October 2023.[24] The study, conducted by the Hawai‘i Wildfire Management Organization (HWMO), interviewed and held workshops with more than 120 fire, emergency, and forestry managers across the state. The summary of findings revealed many residents and professionals living and working in fire-prone areas have long recognized wildfire risk and sought or initiated action.

Despite the documented and diverse efforts by many to mitigate wildfire risk and advocate for funding to aid these efforts, they have encountered challenges to mitigating risk at scale due to inadequate political and financial support. For example, as long ago as 2007,[25] a memo submitted by the former Governor Linda Lingle noted an increase in wildfires, a “lack of public investment for wildfire prevention and pre-suppression,” and the Department of Land and Natural Resources’ (DLNR) need for an adequate budget, yet DLNR has continued to struggle to secure adequate funds to meet the wildland fire risk and operational needs of Department of Land and Natural Resources, Division of Forestry and Wildlife (DLNR-DOFAW)–managed lands.

Later, in both 2018 and 2019, the Pacific Fire Exchange fire science communication program, led by University of Hawai‘i, Mānoa, and HWMO, organized and hosted field trips for Hawai‘i state legislators to orient them to the growing threat of wildfire and the needs for funding to support proactive mitigation and prevention.

A more recent memo sent to the legislature in January 2023 from the Hawai‘i Governor’s office also noted the need for increased State investment and DLNR’s limited resources, indicating that money

2.1 ANALYSIS OF BACKGROUND

and lack of staff are the program's "greatest obstacle" in achieving its mandates.[26]

Additionally, the West Maui Community Wildfire Protection Plan (2014),[27] a collaboratively developed vegetative fuels management mapping and prioritization report for Maui (2019),[28] and a County of Maui Cost of Government Commission Report on Wildfire Prevention and Cost Recovery on Maui (2021)[29] each underscored the need for increased investment, policy, and regulation toward wildfire readiness, yet none resulted. Without funding and policy support, people in the sectors and communities working to reduce wildfire risk have been limited to actions they could take within restricted budgets, via competitive federal grant competitions, or volunteerism.

These issues were highlighted in recent articles that became Pulitzer Prize finalists for their in-depth investigation into the withholding of funding,[30] and were also presented at the 2023 Hawai'i Fire Chiefs Association annual conference as ongoing challenges.[31]

Historically, the counties and their cooperators have been largely successful in managing wildfire events, despite having limited resources. In 2007 and 2008, the first three (3) Community Wildfire Protection Plans were developed on the island of Hawai'i and Maui, with additional plans developed for every other high-risk area across the state since that time.[32]

Hazard assessments were completed and priority projects were identified, but implementation was limited due to lack of funding. Without exception, all of the plans prioritized community awareness, the management of vegetative fuels, ignitions from electric infrastructure, and firefighting capacity, access, and water.

Quantifying the value of fire prevention is a persistent challenge. The few projects that Hawai'i successfully implemented were primarily funded at low levels from competitive, small-scale national grant opportunities that were awarded project by project to practitioners, but were unable to achieve the breadth, scale, and continuity toward the priorities identified.[33] [34] [35] This may reflect a tendency against investing in proactive measures.

Similarly, having recognized the growing risk of wildfire, communities on the island of Hawai'i started organizing to take action as early as 2004. There were 16 nationally recognized National Fire Protection Association (NFPA) Firewise USA™ communities (which help raise awareness and organize at the community level to create fire-adapted communities through the implementation of defensible space standards) across Hawai'i by the time the August 2023 wildfires hit.

These communities include four (4) in the County of Maui, two (2) near the areas affected by the August 2023 wildfires, and six (6) near the fires that occurred on the island of Hawai'i on that same day.

A Joint Fire Science Program (JFSP) knowledge exchange program was started by the HWMO, University of Hawai'i, and United States Department of Agriculture (USDA) Forest Service in 2012 to increase the availability of regionally-specific fire science information in an effort to empower local fire and land management practitioners with Hawai'i-specific best practices.[36]

These programs and campaigns are cited to demonstrate there were many existing efforts to address Hawaii's growing wildfire risk before August 2023. However, these efforts were limited in scale and impact, as they only touched on a portion of the broader system necessary for wildfire safety and they were not institutionalized into broader governmental systems around funding and policy.

These limited policies and investments, as well as the lack of widespread public knowledge/recognition of wildfire risk, meant the system as a whole was not able to keep pace with the increasing wildfire threat level to Hawai‘i communities.

2.1.3 National Perception of Hawaii's Wildfire Risk

An inaccurate perception of a relatively lower wildfire risk in Hawai‘i has also been prevalent at the national level. Hawai‘i typically receives less wildfire funding (proportionally) compared to other states, particularly those in the western U.S., like California, Colorado, and Oregon, whose risk levels are similar.

While the number of acres that burn annually in Hawai‘i may be smaller when compared to larger states, Hawai‘i is on par with the most fire-prone states in the country when evaluated by percentage of land area burned each year.[37] This misperception of risk can be attributed to the unique fire management challenges of Hawai‘i, such as its tropical climate and diverse ecosystems.[38]

The problem is also attributed to national systems designed to measure, track, and model wildfire risk, and report wildfires to Congress. These systems often fail to accurately capture the:

- Hundreds of wildfires that occur each year in Hawai‘i
- Broad and long-lasting impacts of those fires from summits to nearshore coastal waters
- Unique types of vegetative fuels and their contribution to rapid fire spread even at high humidities
- Limited access to firefighting assets and resources that Hawaii's fire managers must contend with[39] [40]

The lack of consistent and accurate reporting of wildfires and WUI fires to federal organizations may also contribute to why Hawai‘i is not recognized as having a significant wildfire threat.

This may be due to inconsistent data entry and submission by Hawai‘i fire agencies. A review of the National Interagency Coordination Center's annual reports[41] from 2011 to 2022 show Hawai‘i wildfire data fluctuating widely year to year. Some years (2013[42] and 2014[43]) have no wildfire data included, and several others have few, such as 2012,[44] where only two (2) fires totalling 1,800 acres are included. These reports are inconsistent with Hawai‘i wildfire data showing substantially more wildfire activity throughout the Hawaiian Islands.[45]

A similar issue likely exists with reporting wildfires via the National Fire Incident Reporting System (NFIRS). In this case, the limitations of Hawai‘i wildfire data may be linked to incomplete data entry and inconsistent submissions, which may be related to a lack of a state agency responsible for all wildfire preparedness, prevention, and response coordination.

It is also significant that, nationally, Hawai‘i is perceived primarily as a vacation destination rather than as a fire-prone landscape with a significant wildfire threat. This perspective is evident even in established national wildfire training materials, which treat other regions with gravity but perpetuate the bias of Hawai‘i as primarily a recreational destination.

For example, one (1) common set of national materials encourages firefighters to seek assignments in Hawai‘i for its appeal rather than acknowledging it as a region prone to extreme fire behavior.[46] Combined, these national biases likely diminish the state's ability to compete for federal funding and attention in addressing its wildfire management and mitigation challenges.

2.1.4 Perception of Responsibility

In Hawai‘i, human activity, climate factors, landscape conditions, and a built environment that was not designed with considerations for wildfire all contribute to a high risk of significant wildfire impacts and rapid

fire spread. For this reason, the responsibility for improving wildfire outcomes must lie across many sectors, agencies, and stakeholder groups to address the entire system of components that contribute to wildfire risk.

Firefighting is the last line of defense. However, the perception of responsibility for addressing wildfire in Hawai‘i has led to a focus placed primarily on response. This is evidenced by local and state government structures, policies, and financial investment, which have pursued a limited focus primarily on firefighting and incident response. A persistent reliance on fire agencies, coupled with the expectation that firefighting alone can keep Hawaii's people and places safe from wildfire, has contributed to extreme vulnerability.

This approach misses the need to address underlying risk factors and leaves communities and natural resources exposed to conditions and vulnerabilities that are beyond the control of fire agencies. This limitation is especially important during times of critical fire weather like that of August 8, 2023, where conditions led to extreme fire behavior and rapid fire spread.

Additionally, equipment, resources, and other assets used for fighting wildfires were historically supplemented by agricultural operators. The majority of those plantations are no longer in place, leaving a gap that has yet to be addressed.[47]

2.1.5 Leadership and Accountability

Currently, there is no government organization within the State of Hawai‘i with the sole responsibility for wildfire readiness. In other states with significant wildfire threat, this effort is often led by a state funded organization, such as a state fire marshal's office, which has the authority, funding, and personnel to implement system-wide wildfire prevention and preparedness initiatives. In the State of Hawai‘i, prior to the 2024 state legislative session, there was no state fire marshal, and consequently, no such funded system-wide initiatives specific to wildfire.[48]

The State Fire Council (SFC), consisting of the four county fire chiefs (Hawai‘i, Honolulu, Maui, and Kaua‘i), a DLNR-DOFAW representative, and the fire chief of the State of Hawai‘i Aircraft Rescue Fire Fighting Unit is Hawaii's equivalent of a state fire marshal's office. The SFC has many responsibilities which include advising the governor and the legislature with respect to fire prevention and protection, life safety, and any other functions or activities for which the various county and state fire departments are generally responsible.[49]

Although wildfire prevention, preparedness, and technical guidance to decision-makers seems to fall under the responsibility of the SFC, minimal state funding, programming, and organizational support may indicate a lack of emphasis on the criticality of the wildfire situation.

Since 2000, without a state-funded organization to lead and coordinate wildfire prevention activities, the non-profit Hawai‘i Wildfire Management Organization (HWMO) has filled the gap in the absence of statutory responsibility.

In the 24 years since it was established, the HWMO has worked to:

- Prepare Community Wildfire Protection Plans for the majority of the state
- Establish Hawai‘i's primary wildfire incident database
- Establish 25 Firewise Communities across three (3) counties (with 12 more in process since August 8, 2023)
- Prepare and distribute community wildfire preparedness information
- Establish a fire science communications and research partnership with the University of Hawai‘i called the Pacific Fire Exchange

- Collaborate with landowners, farmers, and ranchers to implement vegetation management projects (most recently partnering with communities and local groups[50] to clear hazardous neighborhood vegetation)
- Coordinate all of these initiatives with the federal, state, and county fire agencies across the State of Hawai'i[51]

The fire departments, DLNR, and other government agencies, like the National Park Service, have come to rely on the HWMO to lead, coordinate, and carry out community wildfire prevention and preparedness activities statewide. This is further evidenced by consistent referrals to HWMO's information and programs on many emergency management and fire department websites, as well as the DLNR-DOFAW website.[52 53 54 55 56]

Without designated state funding, the HWMO has performed these critical functions using limited competitive federal grants and monies raised from community fundraisers. The role the HWMO has taken to address the State of Hawaii's wildfire threat cannot be overstated—nor can its persistent prioritization and care toward filling the existing wildfire safety gaps. Without dedicated and sustainable funding, these essential functions across the state will go unmet.

The CRA and community risk reduction planning elements of the Phase Three report will further address wildfire prevention.

2.2 County of Maui Background

2.2.1 County of Maui Wildfire Risk

Similar to the statewide background and findings, wildfire risk across the County of Maui was also well known and documented. Several expert- and practitioner-led efforts to affect change had already taken place prior to 2023. Plans and studies were in place since 2014 that identified wildfire risks and hazards and laid out priorities for risk reduction and preparedness actions.

These plans included the Community Wildfire Protection Plans for Western Maui[57] (2014), South Maui[58] (2016), Upcountry Maui[59] (2016), Moloka'i[60] (2016), Leeward Haleakalā[61] (2020), and the Wahikuli-Honokōwai Wildfire Mitigation Plan[62] (2014).

Within each of these plans, the top priorities identified for action include:

- Community Awareness and Preparedness Programs
- Vegetation Management
- Evacuation Planning and Additional Routes
- Ignitions by Electrical Infrastructure and Other Human Causes
- Access and Water for Firefighting
- Training and Equipment for Firefighters
- Emergency Communications
- Recovery Readiness

As of August 2023, four (4) communities on Maui were actively participating in the Hawai'i chapter of the Firewise USA™ program,[63] co-led locally by the HWMO and DLNR-DOFAW. The Ready, Set, Go! Wildfire Preparedness Action[64] guide was available and distributed broadly at community events and workshops across the County of Maui since 2016 by the HWMO, DLNR-DOFAW, and MFD.

An annual public wildfire preparedness campaign, called Wildfire and Drought Lookout!,[65] co-led by several local agencies and organizations, had also been taking place each May-September, with radio PSAs broadcast for one (1) to two (2) months across the County of Maui (on years when funding could be secured).

2.2 ANALYSIS OF BACKGROUND

Wildfire and Drought Lookout! wildfire preparedness campaign materials were sent by the HWMO to all elected officials representing districts in the County of Maui at both county and state levels, and included a request for assistance (RFA) in distributing these materials to community members, since the campaign was largely unfunded. The kick-off press conference for the campaign rotates among counties throughout the state and was first held on Maui[66] in 2018.

Additionally, a 2018-2019 project to map and identify vegetation management priorities[67] was conducted for Maui that mapped vegetation management per land ownership. That project subsequently brought stakeholders together to identify gaps and establish priority areas for vegetative fuels management to reduce wildfire risk and to pave the way for an "All Hands, All Lands" cross-boundary approach to wildfire risk reduction at the landscape-scale.

Section 3.3 on vegetative fuels discusses how the priority areas identified for fuels treatment coincide with the areas that burned in August 2023.

A report by the County of Maui, entitled "Cost of Government Commission Report on Wildfire Prevention and Cost of Recovery on Maui"[68] (July 2021), also highlighted the need to heavily bolster prevention, preparedness, and mitigation. Furthermore, the collaborative science communication project run by the University of Hawai'i and HWMO, called the Pacific Fire Exchange[69] (PFX), has published several maps, graphs, and fact sheets that detail Maui's wildfire history, including the trends and patterns of wildfire occurrence and its impacts (2000-2022).

2.2.2 Perception of County of Maui Wildfire Risk

While the risk of wildfire to the County of Maui has been identified as elevated compared to much of the rest of the country, there is a perception that the danger to the community is less compared to other hazards, such as tropical cyclones and tsunamis.

Over the past several years, even with the increased frequency of wildfires, historically the MFD and their collaborators have been largely successful in managing these events. Residents interviewed following the Lahaina PM fire expressed confidence in the ability of public safety agencies to control the fire. It is possible this perception led to a false sense of security and a misjudged understanding of MFD and MPD capabilities among first responders and residents alike.

2.2.3 Perception of Responsibility

Due to this low perception of wildfire risk, there may have been an assumption that the responsibility to prevent and control wildfires primarily lies with the fire department. Or a misunderstanding that wildfires rarely impact the built environment. This may have contributed to an overall lack of funding and regulation to address wildfire risk in the built environment or wildland landscape in the County of Maui.

Despite these limitations, several wildfire-aware groups and wildfire-informed practitioners (composed of agencies and nonprofit representatives) were trying to take effective action. These included the DLNR-DOFAW-led West Maui Fire Task Force and Leeward Haleakalā Fire Task Force, Maui Ridge to Reef, several watershed partnerships, and the HWMO, all of which had worked over the last two (2) decades to increase wildfire preparedness and reduce risk to protect both communities and natural resources.

The progress and efficacy of these groups and their activities was possible because of highly collaborative, multipartner participation. However, their ability to affect change and address the scope and scale of the issue is likely limited by the lack of available funding for projects, limited personnel capacity, and the overall lack of regulations and sustained funding needed to pursue and maintain widespread and continuous wildfire risk reduction actions.

2.2.4 August 2018, Lahaina Fire[70]

The Lahaina Fires of 2018 and 2023 shared similarities, but also had important differences. Both occurred in August and were fanned by high winds generated by a pressure gradient caused by an approaching tropical cyclone. They also shared a burn perimeter off the Highway 3000 Bypass (Lahaina Bypass) north of Punakea Loop and approximately 65 acres of shared burned area (Figure 2.2.4.1).

The 2018 fire ignited a distance away from densely populated areas in a location dominated by vegetation at approximately 01:00, giving firefighters time to react and position themselves before the fire reached populated areas. The 2023 incident occurred in close proximity to Lahaina‘s heavily populated areas at 14:55. It was reported that winds may have been stronger in 2023 and there were three (3) other active fires on Maui at the time, diminishing available resources for emergency response.[71]

The 2018 fire burned 2,100 acres and destroyed 21 structures and 27 vehicles, with estimated damages totaling $4.3 million. At the time, it was the most destructive wildfire in Hawaii’s history.

After this fire, MEMA was the only county agency to initiate an After Action Review (AAR).[72] The AAR was never finalized and was titled a “preliminary report” with an August 2019 date on the cover. The County of Maui released the report publicly in late October 2023 after receiving requests from the press and others a few months after the August 2023 wildfires.

The AAR mostly focuses on MEMA responsibilities and does not address the operational response efforts of the MFD and MPD.

Documenting experiences from previous incidents is essential to understanding where improvements to prevention, preparedness, and operations can occur. An AAR can also serve as an important benchmark for measuring change over time. Knowing the lessons learned from the 2018 fire, and the changes implemented afterwards, can help with tracking improvements over time.

In an effort to learn about incident operations, FSRI requested a technical discussion with the 2018 Lahaina fire incident commander (IC). The request was initially made via email to the County of Maui, and the Hawai‘i Attorney General later issued a subpoena.

The County of Maui filed a motion to quash the subpoena issued by the Hawai‘i Attorney General, arguing that the technical discussion with the IC was not essential to the Maui wildfire investigation conducted by FSRI. The Hawai‘i Attorney General filed a motion to strike the county’s motion to quash the subpoena, as well as an application to compel compliance with the subpoena. The Attorney General and the county each withdrew their pending motions after the County of Maui agreed to make the incident commander available for an interview with FSRI in September 2024. As a result, the analysis of the 2018 Lahaina fire was limited.

2.2 ANALYSIS OF BACKGROUND

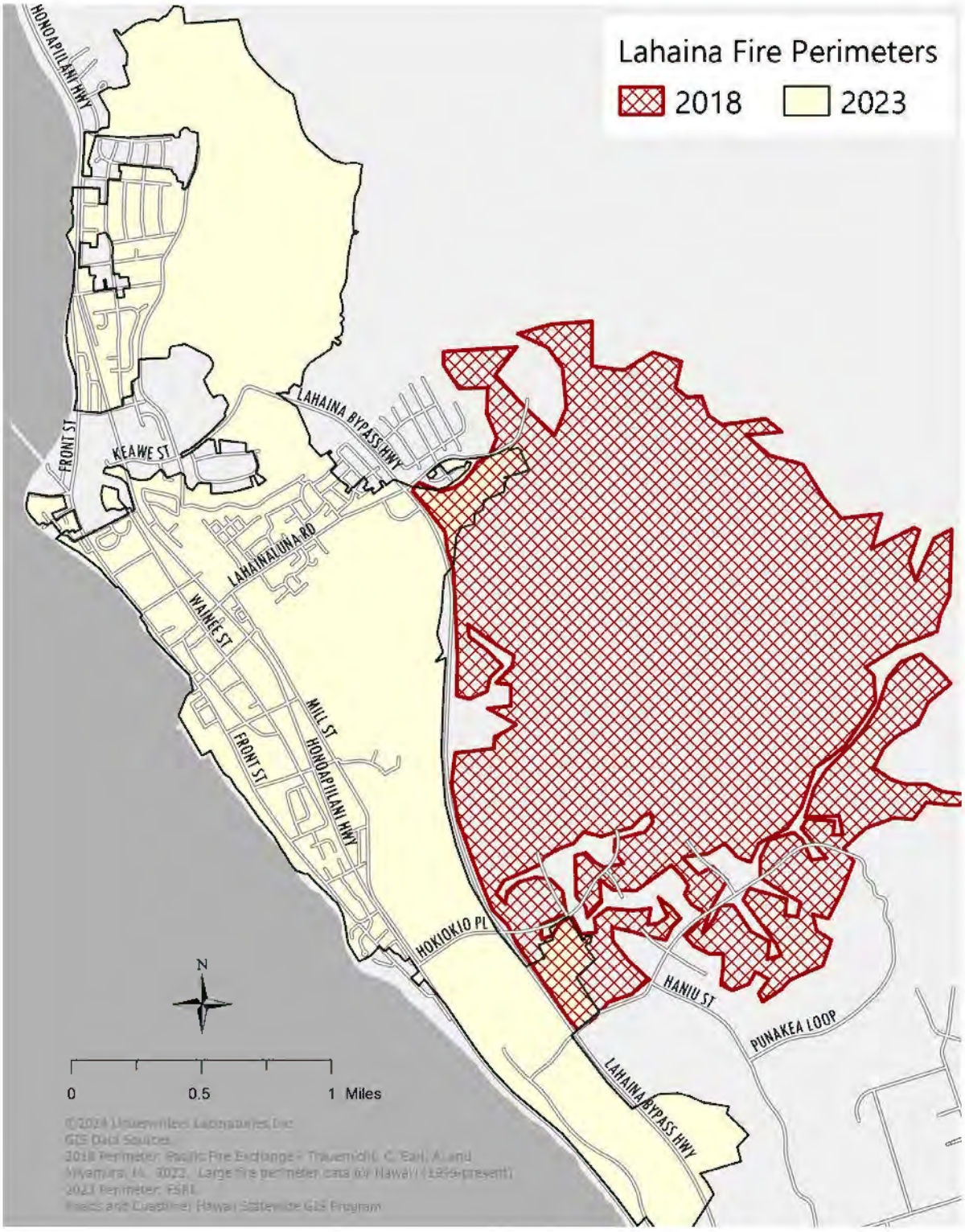


Figure 2.2.4.1 Overlay of 2018 and 2023 fire perimeters.

2.2.5 Findings & Recommendations

1. **FINDING:** Lack of state policy-making and investment addressing Cohesive Strategy components.	**RECOMMENDATION:** Pursue integrated solutions using a multidisciplinary team to address the entire system of factors that influence wildfire risk and outcomes, including land use and subdivision planning, agriculture, forestry and environmental protection, emergency response, economists and tax experts, and policymakers. Use the existing and established plans and studies as starting points for discussion and action. **RECOMMENDATION:** Learn from states that already have existing advanced wildfire-fighting policies and procedures in place that are more mature in their work on wildfire prevention, preparedness and response.
2. **FINDING:** Statewide wildfire prevention is led by the non-profit Hawai'i Wildfire Management Organization (HWMO) without state funding.	**RECOMMENDATION:** Establish dedicated and sustained funding for the HWMO to support the coordination and implementation of wildfire prevention and preparedness efforts, especially for communities and land stewards.
3. **FINDING:** Lack of standardized and consistent wildfire data collection and report submissions to federal organizations.	**RECOMMENDATION:** Standardize wildfire data collection process for all counties and require Incident Status Summary, Form 209[73] completion for wildfires meeting reporting criteria. **RECOMMENDATION:** Leverage the impending release of the National Emergency Response Information System (NERIS) to institutionalize fire reporting while ample resources are available and focused on onboarding and supporting fire agencies in this new federal program.
4. **FINDING:** The MFD and MPD did not initiate an AAR for the 2018 Lahaina Fire. MEMA did not finalize an AAR for the same incident.	**RECOMMENDATION:** MEMA, the MFD, and the MPD should create policies that include incident parameters requiring an AAR to ensure learnings are documented and changes required for improvement are implemented.

3.0 Analysis of System Components

This analysis is broken down into sections addressing the specific system components of prevention, preparedness, and response.

3.1 Origin and Cause

The MFD is responsible for fire suppression for the area where the Lahaina AM and PM fires burned. This responsibility includes completing an origin-and-cause investigation and a comprehensive fire report. Due to the fire involving electrical infrastructure, investigators from the ATF assisted with the investigation. At the time of finalization of this report, the official origin-and-cause report on the August 2023 Maui fires has not been released.



3.2 Weather

Preparing for a wildfire requires knowledge of the weather. The weather forecasts leading up to August 8, 2023, informed state and county emergency managers of when and where high-wind warnings and Red Flag conditions would persist within the state. These forecasts were sent via social media channels by state and county agencies to inform the public, and were also shared by local news media.

This section will analyze the forecast information to identify how it was, or was not, used to make decisions, and to determine where changes are necessary to match appropriate preparedness actions to critical fire weather.

3.2.1 Fire Weather Forecasting

Fire weather forecasting and sensemaking are crucial for preparing for possible wildfires under extreme conditions. This is critical to implementing the Cohesive Strategy because it directly influences all three (3) of the Cohesive Strategy's main goals. It requires effective, appropriately framed communication and coordination across the system, and often represents a collaboration between various agencies, including the NWS and local fire departments.

Utilizing advanced weather forecasting models and technologies ensures accurate and reliable predictions, which are essential for anticipating and mitigating the impacts of extreme fire conditions. These forecasts enable residents to understand and prepare for the risk of wildfire and the risk of loss, while also helping land managers prevent accidental ignitions and guide decisions about activities with ignition potential.

Moreover, forecasts support proactive pre-incident planning, such as evacuation planning, risk communication, and preparing firefighting tactics and strategies. By predicting fire behavior and anticipating dangerous conditions, fire weather forecasts allow for strategic resource allocation and adaptive decision-making. Timely, accurate weather forecasts ultimately protect residents and firefighters and contribute to safer, more effective wildfire management, especially during extreme weather events.

NWS Honolulu released numerous weather forecasts (products) leading up to August 8, 2023. Section 6.6 in the Appendix provides a summary of the products addressing wind and fire weather, date and time the product was released, and a comparison to what was actually experienced to verify the forecast matches what was experienced and/or measured.

A simple verification rating of yes/no was used. For example, the Kohala Ranch Remote Automatic Weather Station (RAWS)[74] on the island of Hawai'i

recorded the highest wind speeds of all RAWS and is located within the area the forecast indicated would experience high winds and Red Flag Weather.

A "yes" rating indicates the forecast was verified according to content, date/time, and location. The limitations of this data are that verification is evaluated based on reports of wind damage or fire spotting, and limited measurements from RAWS.

3.2.1.1 Remote Automatic Weather Stations (RAWS)

As stated in Phase One, and mentioned throughout this report, there were no RAWS in West Maui at the time of the fire or before, restricting the data available around the islands' diverse microclimates.

Since RAWS were not placed in high fire danger areas like West Maui, the weather data for these regions was not included in the dataset needed to determine when parts of the island were approaching or experiencing Red Flag conditions. Instead, Red Flag Weather is, and was at the time of the incident, determined by the Automated Surface Observation System (ASOS) at the Honolulu airport.

An example of why location is important is the Kohala Ranch RAWS[75] on the island of Hawai'i. This station is located on a southwest-facing slope, in an area similar to where the Lahaina PM fire started. As previously mentioned, the Kohala Ranch RAWS recorded the highest wind speeds of all RAWS and is located within the area the forecast indicated would experience high winds and Red Flag Weather.

In addition to the limited number of RAWS available, and the placement of these locations not enabling adequate resolution of data across all areas, other challenges were uncovered. Maintenance and repairs are expensive, and physical access to stations that are located in hard-to-access terrain can be challenging and limit the frequency of maintenance, leaving some RAWS inoperable and/or unreliable until maintenance resumes.

The information in Section 6.6 of the Appendix demonstrates the high level of accuracy of the NWS' forecast products, suggesting the level of confidence emergency managers should have with weather products released by the Honolulu Office.

3.2.2 Red Flag Warnings

Forecasters will issue Fire Weather Watches/Red Flag Warnings when the combination of dry fuels and weather conditions support extreme fire danger and/or fire behavior.[49] Red Flag Weather criteria for Hawai'i has been adjusted for its unique tropical environment and the specific high fire danger conditions that have been established by local experts.[77] A Red Flag Weather event is triggered for leeward portions of the state when all three (3) of the following criteria are met for two (2) hours or more during any part of a day at the Honolulu International Airport (PHNL):

1. Keetch-Byram Drought Index (KBDI) ≥ 600
2. Minimum Relative Humidity (RH) ≤ 45% (2 hours or more)
3. Wind ≥ 20 mph (≥ 17 kt) (2 hours or more)

A comparison of Red Flag conditions between Hawai'i and California illustrates those differences. For example, the Red Flag threshold for RH in Hawai'i is 30% higher than the California criteria.

According to historical data provided by the NWS in Figure 3.2.2.1, Hawai'i experiences five (5) Red Flag Weather days per year on average, occurring mostly in the summer and fall months. The challenge with Hawai'i Red Flag Weather is that there is little difference between a normal summer day and a Red Flag day. For example, it is typical for RH during

3.2 ANALYSIS OF SYSTEM COMPONENTS

summer months to be around 50%, which is only 5% higher than the RH criteria for Red Flag Warnings.

The same issue applies to wind. Breezy summer days are common in Hawai‘i with winds hovering around 15 mph, which is close to the 20 mph limit for Red Flag Warnings. The minor perceptible differences between Red Flag Weather and normal summer weather has the potential to impact how emergency managers perceive Red Flag conditions.

If a Red Flag day feels like a typical summer day, preparing for Red Flag conditions could be limited, which could result in fire managers staffing for a normal day. This could be a contributing factor as to why state and county emergency managers, Hawaiian Electric, and the County of Maui Department of Water Supply did not augment staffing prior to the weather arriving August 8, 2023.

Figure 3.2.2.1 displays the number of Red Flag Warning days in the State of Hawai‘i for each month during the years of 2008 through 2023. There were no Red Flag Warnings issued from 2014 through 2019 due to an overall wet period and the KBDI only briefly climbing above 600 at times, none of which coincided with strong winds/dry air. Notably, according to forecasters and fire managers, there were large wildfires during this period despite, there being no Red Flag Warnings.

The average number of Red Flag Warning days annually in Hawai‘i is similar to some areas in California where emergency managers and local officials have initiated significant changes to their preparedness efforts over the course of the last 30 years. Historical data from Los Angeles County coast (NWS Zone 241), which includes the Malibu area where several large WUI fires have occurred, shows that this area experiences six (6) Red Flag Warning days annually.[78]

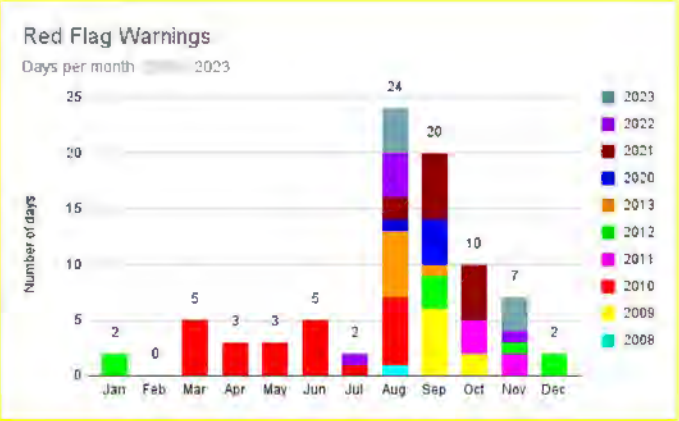


Figure 3.2.2.1 Red Flag Warning days in the State of Hawai‘i 2008 through 2023. Source: National Weather Service - Honolulu.

3.2 ANALYSIS OF SYSTEM COMPONENTS

3.2.2.1 High Wind Events

High Wind Events are another data point connected to the weather on August 8, 2023. Wind events are instances of damage caused by the wind as reported in the National Centers for Environmental Information (NCEI) Storm Events database.[79]

For the State of Hawai‘i on August 7-8, 2023, the wind-caused damage consisted of destruction to the built environment, as well as downed utility poles and trees causing a number of issues, including increased fire spread and evacuation challenges.[80]

Figure 3.2.2.1.1 highlights how infrequently damage is sustained in the State of Hawai‘i due to high winds in the summer months, in contrast to the relatively high number of Red Flag Warning days. The coupling of the high winds with Red Flag Weather on August 8, 2023, was unprecedented.

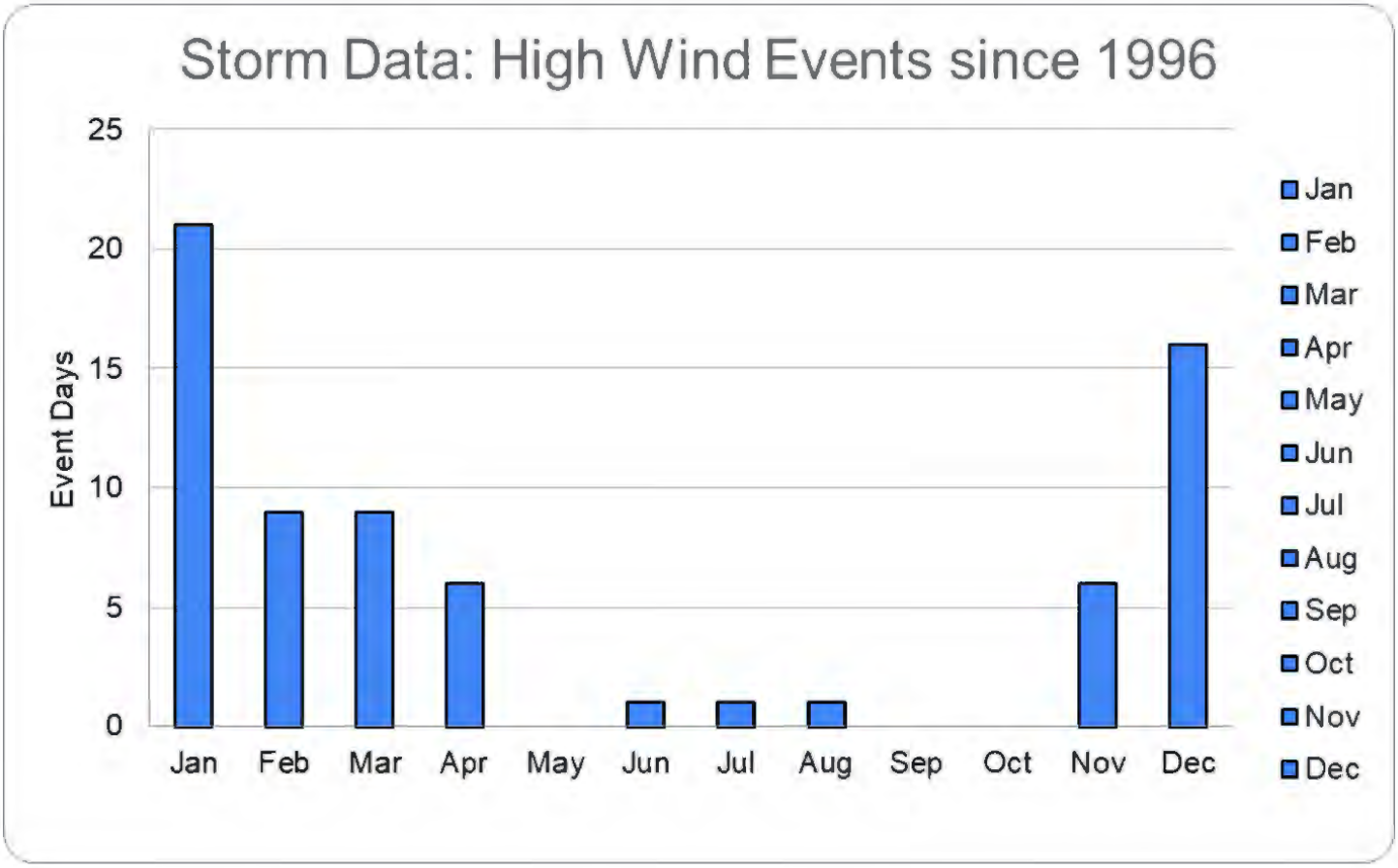


Figure 3.2.2.1.1 State of Hawai‘i High Wind Events by month from 1996 through 2022. High Wind Events are documented damage caused by the wind. Source: National Weather Service - Honolulu.

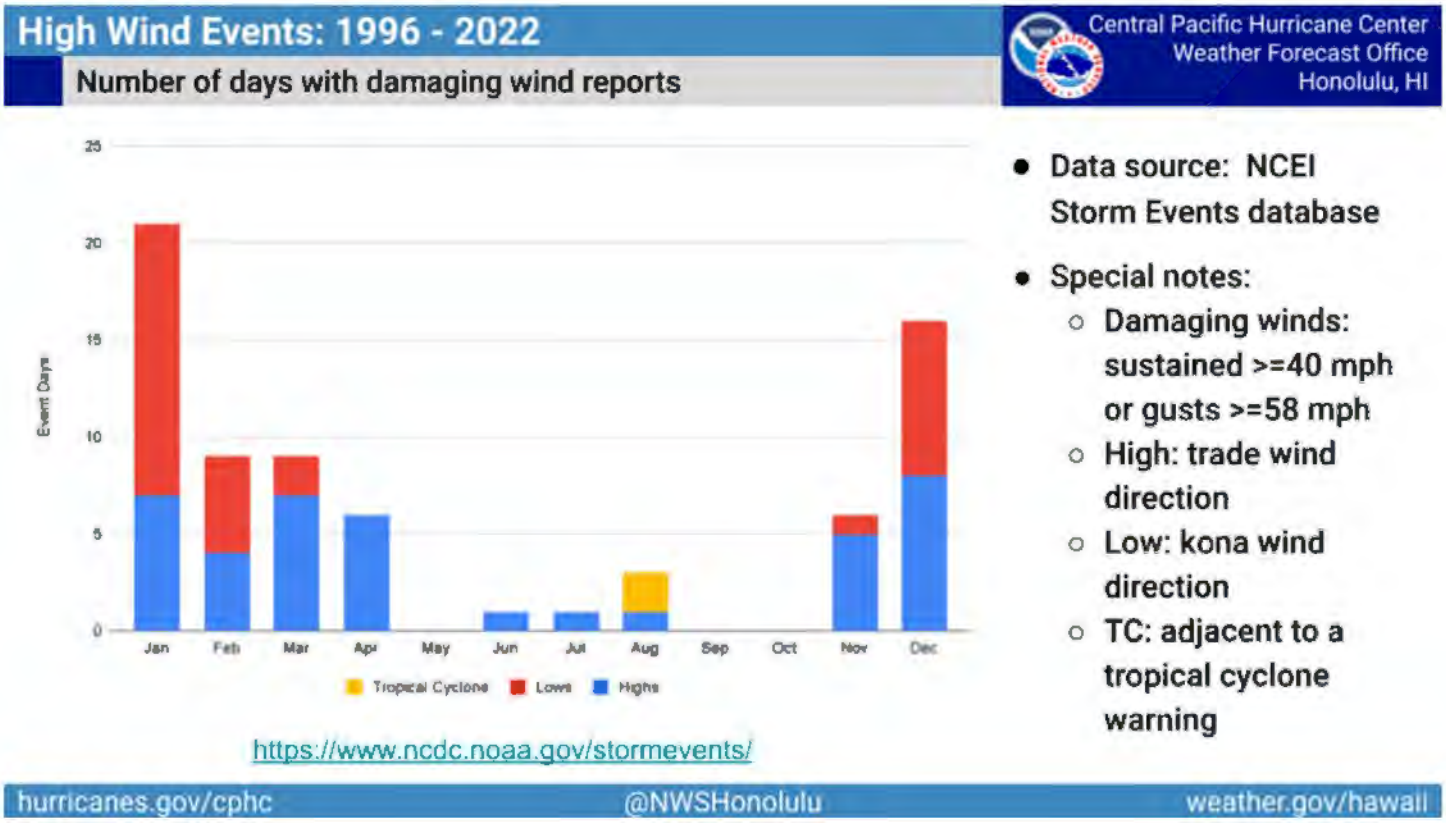


Figure 3.2.2.1.2 Hawai'i State High Wind Events by month from 1996 through 2022. Colors indicate the source of the damaging winds and, by inference, the general wind direction. High-Trade wind direction (north-northeast); Low - Kona/non-trade wind direction (south-southwest); Tropical Cyclone - Adjacent to a tropical cyclone warning.

The winds on August 8, 2023, ranged between 60-80 mph. The large-scale damage caused by the wind is consistent with the Beaufort Wind Scale—a measure for describing wind speed based on observed conditions at sea or on land. Table 3.2.2.1[81] includes the Beaufort Wind Scale for 60-80 mph winds.

3.2 ANALYSIS OF SYSTEM COMPONENTS

Table 3.2.2.1 August 8, 2023, Wind Speed.

Wind Speed August 8, 2023		
Impacts/Wind Speed	**60–70 mph winds** **10–11 on the Beaufort scale**	**70–80 mph winds** **12 on the Beaufort scale** **Hurricane Force**
On land	Trees may be uprooted, branches can break off, and debris, such as small objects and loose items, can become airborne. Powerlines can be blown and swing, and utility poles can become unstable and/or fall. Structural damage to buildings is likely, including broken windows, damaged roofs, and signs or fences being blown over.	Widespread damage to trees and structures can occur, with many trees likely uprooted and severe structural damage incurred to buildings. Powerlines and utility poles may be downed, leading to power outages.
On sea	Very high waves and poor visibility are observed. Waves can reach heights of 29-41 feet, and the sea surface appears white with foam and spray. Sea spray significantly reduces visibility.	Waves can exceed 45 feet–the air is filled with foam and spray, greatly reducing visibility. Ships may be at serious risk of damage or capsizing.
Experience	Walking or standing outside is extremely difficult and dangerous; individuals may be blown over.	Walking outside is nearly impossible; staying outside is extremely hazardous. There is a high risk of injury from flying debris, falling branches, or collapsing structures. It is generally unsafe to be outside during such conditions. The wind produces a loud, constant roar, and the sound of objects being moved or destroyed can be heard. The wind feels incredibly powerful and forceful, making it hard to stay upright or move forward. Breathing may become difficult due to the force of the wind.

3.2 ANALYSIS OF SYSTEM COMPONENTS

The extreme wind conditions on August 8, 2023, drove much of the fire spread and destruction that resulted. It was also the extreme environment within which emergency responders were conducting their suppression, mopup, and evacuation efforts.

Being outside and exposed to the elements in 60-80 mph winds can be extremely dangerous, typically requiring immediate shelter, yet emergency responders remained in these conditions to complete their public service and safety commitments.

3.2.3 Operationalizing the Weather Data

An August 4, 2023, email sent by a NWS forecaster to fire managers was above and beyond NWS' typical notification process. Due to the exceptional certainty of the forecast models, and the obligation to inform emergency managers of the wildfire risk, the email was sent to provide unprecedented advance warning of the approaching fire weather due to arrive late August 7, 2023, and strengthen into August 8, 2023.

Hawai'i Emergency Management Agency (HI-EMA) followed up with a statewide briefing on August 4, 2023, at 13:00. Several more high fire danger forecasts followed the August 4, 2023, email, as shown in Table 3.2.2.1.

The email included language not typically used by a forecaster:

> *"There is **higher than normal confidence** in the forecast track..."*
>
> *"…there is **significant concern** that strong trade winds will develop sometime Monday and peak Tuesday."*
>
> *"**Critical** fire weather on Tuesday…"*
>
> *"NWS conditions this many days away is **quite rare**."*

The strongly worded nature of the email, had it been communicated to fire managers in other states with better developed severity preparedness strategies, could have gained attention and prompted discussion and operational planning. It was a call for State of Hawai'i fire managers to prepare for the impending extreme weather.[82]

Although MFD chief officers discussed the forecasted weather well before August 8, 2023, no evidence of pre-event preparedness plans by the MFD were produced.

HI-EMA, County of Maui Department of Water Supply, the MPD, and Hawaiian Electric were also aware of the impending weather, but did not provide evidence of pre-event preparedness planning. MEMA responded by partially activating the Emergency Operations Center (EOC), installing two (2) personnel on the evening of August 7, 2023.

A plausible reason for the perception of inaction of fire managers could be related to the statewide context discussed in Section 2.1. Wildfire risk appears to be underappreciated within the spectrum of natural disaster risks threatening Hawai'i.

This response could also be related to fire managers focusing on the first sentence of the NWS' email, "NWS Honolulu expects Hurricane Dora to pass south of Hawai'i early next week," and not moving beyond it because, as a state, a hurricane is a higher priority risk. Since Dora would not be making landfall, the perceived risk was lessened, and therefore, provided less reason to engage.

3.2 ANALYSIS OF SYSTEM COMPONENTS



3.2.4 Resident Technical Discussion Information

Limited resident experiences regarding the weather were also captured. Nearly all (95%) of the 70 residents who had lived in Lahaina for an average of nearly 30 years, said August 8, 2023, was the windiest day they had ever experienced. Most were present during the 2018 Lahaina Fire and many were present during several tropical storms.

When asked if they were aware that August 8, 2023, was going to be a windy day, just over half of the 64 residents that responded said yes. These same residents also stated that they did not expect the winds to be as strong.

Although this data is constrained by the collection methodology, the information does point toward a possible issue with getting actionable weather information to residents. More study in this area is required.

3.2.5 Findings & Recommendations

5. **FINDING:** Actionable extreme weather forecasts were provided to fire chiefs and emergency managers prior to the August 2023 fires. However, adjusting staffing for extreme weather events and their resultant risk of extreme fire behavior was not standard.	**RECOMMENDATION:** Assign a point of contact within the MFD who is tracking weather conditions, and is disseminating that information to the rest of the department and across partner agencies. **RECOMMENDATION:** Establish standard operating procedures for Red Flag and severe fire weather warning conditions, to include: preparing and pre-positioning supplies, equipment, vehicles, and personnel in high-risk areas; ensuring clear and open lines of communication within and among agencies to optimize for rapid and coordinated deployment of resources; and communicating with the public to aid residents in translating the forecasted conditions and risks into evacuation readiness. The California Fire Weather Annual Operating Plan is a good place to start developing a Hawai‘i plan.[83]
6. **FINDING:** A lack of RAWS in West Maui, and other high wildfire risk areas, limits the capability to determine where Red Flag conditions may locally exist. The lack of resolution of fire weather data and monitoring yields uncertainty at the local level due to fire weather forecasts and Red Flag Warnings being based on data collected at the Honolulu airport, which is on O‘ahu (not Maui). It does not represent the conditions observed in the diverse and numerous microclimates across all high fire risk areas across the state, including Lahaina, and therefore, serves as a point of reference (or inference, at best) for other regions.	**RECOMMENDATION:** Install and fund the maintenance for a strategic set of RAWS that can provide information with resolution across the microclimates of high fire risk locations in the state.

3.2.5 Findings & Recommendations

7. **FINDING:** There is little perceptible difference between Hawai'i Red Flag criteria and a typical summer day, which may have contributed to the emergency manager's response to the forecast.	**RECOMMENDATION:** Engage federal partners to assist in refining Red Flag criteria to be commensurate with appropriate fire danger that is actionable by policymakers, emergency managers and responders, and the public.
8. **FINDING:** NWS-Honolulu fire weather forecast briefings to fire and emergency managers should occur on a more frequent basis.	**RECOMMENDATION:** Engage policymakers, emergency managers and responders, and the public with more frequent fire weather forecast briefings. This will elevate understanding of the weather, while informing the community of the risk.

3.3 Vegetative Fuel

Vegetation played a crucial role in the Lahaina PM fire. The availability of combustible vegetative fuel on the landscape allowed fire to ignite and spread across unmanaged lands, and eventually, into the built environment. Mitigating the risk of extreme fire behavior and rapid spread requires vegetation management in both wildland and urban areas.

The vegetation management, or lack thereof, leading up to August 8, 2023, left lands at high risk of ignition and rapid spread. This section will analyze the vegetation management practices across land ownerships to identify how vegetation was, or was not, managed to reduce the hazard posed by unmanaged vegetative fuels.

Effective vegetation management directly impacts fire behavior, ecosystem health, and community safety, tying in to all three (3) goals of the Cohesive Strategy. These actions are particularly important in achieving resilient landscapes that can resist, survive, and recover after disturbances, particularly fires. Thinning heavy fuel loads, creating fuel breaks, removing invasive species, and promoting native ecosystem restoration and active agriculture help reduce fire risks and protect both natural resources and communities from rapid ignition and fire spread.

Managing vegetation in wildland areas at the WUI, and around homes, creates defensible spaces where individual homes and communities stand a better chance of survival and firefighters have a safer area in which to work.

For maximum protection, vegetation management and defensible space must be incorporated into overall land use planning, with funding, policy, and education available to sustain and support adequate risk-reduction work, ultimately reducing hazardous fuels and creating safer conditions for both communities and firefighters.

3.3.1 Condition and Management of Vegetative Fuel

Adjacent to many of Lahaina's built subdivisions are wildland areas dominated by highly combustible vegetative fuels (Figures 3.3.2.1 and 3.3.2.2). Like most of Hawai'i, the undeveloped wildland areas across West Maui are owned by a patchwork of public entities and private individuals/entities.

There were limited-to-no active wildland vegetative fuels management efforts in the vicinity of Lahaina's urban areas before August 8, 2023, leaving the majority of vegetation to grow unimpeded, contiguous, and dense due to steady build-up over long time scales.

Composed mostly of grasses with some shrubs, these lands are subject to rapid drying during seasonally dry conditions, drought, and/or low-humidity conditions. The passing hurricane (which substantially dropped RH), the expected dry conditions and limited precipitation in August, and the additional ongoing drought conditions resulted in vegetative fuels being highly ignitable and capable of supporting rapid fire spread.

These dry, receptive fuels are especially hazardous in high-wind conditions, which were present on August 8, 2023. This dense, uninterrupted, and unmitigated standing dead vegetation posed a substantial risk of wildfire ignition and rapid fire growth.[84]

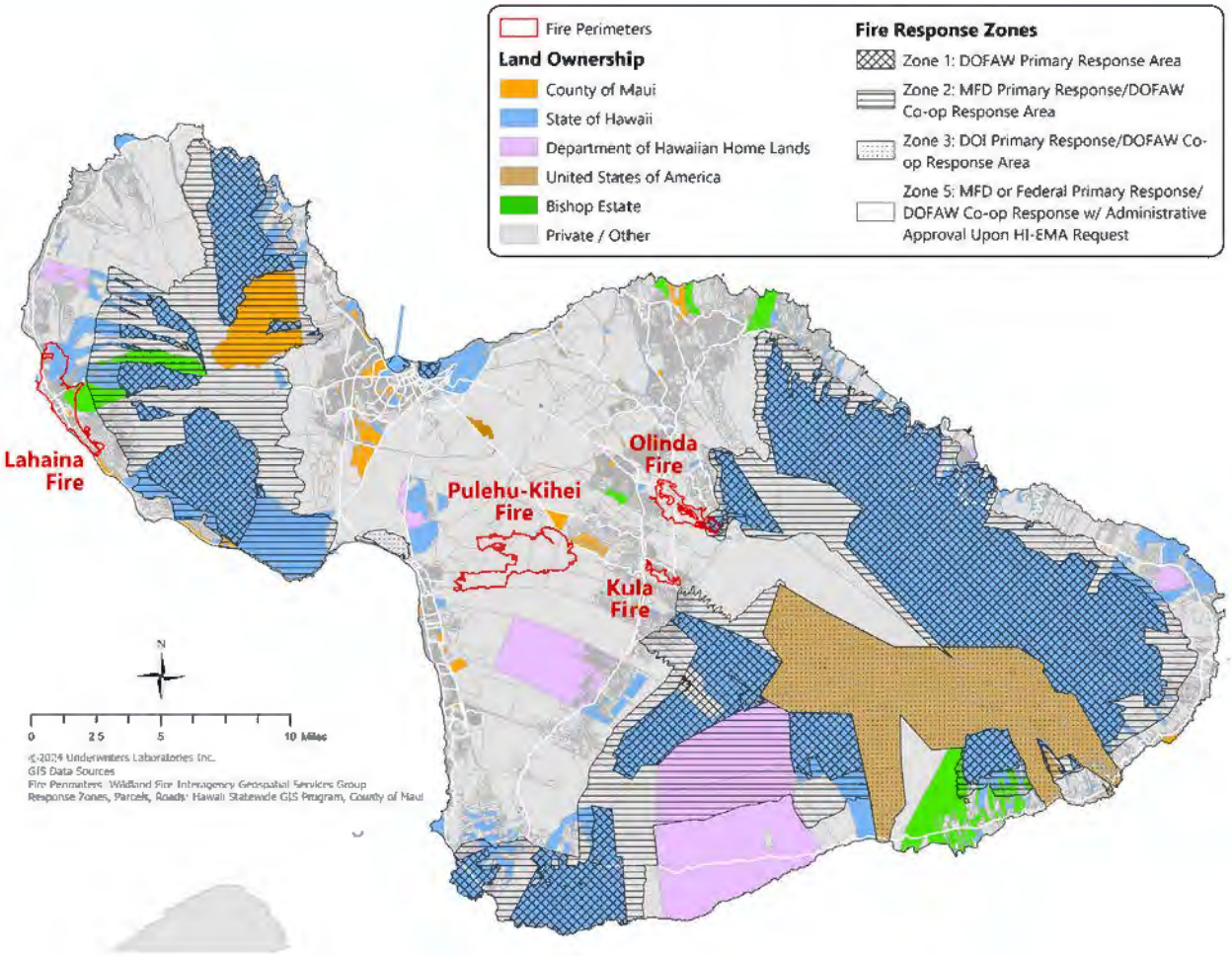


Figure 3.3.2.1 Map of Maui showing burn perimeters of the four (4) August 8, 2023 fires, land ownership, and fire response zones. Source: https://www.arcgis.com/sharing/rest/content/items/66a59db4bc31459298b28a94564de533/info/metadata/metadata.xml?format=default&output=html; https://files.hawaii.gov/dbedt/op/gis/data/fireresponse_summary.pdf

3.3.2 Vegetation Management on State Lands

Vegetative fuels management and suppression responsibilities on state lands vary widely. Wildfire prevention, vegetative fuels management, and suppression response on state forest reserves, natural area reserves, and areas managed for public hunting or conservation activities are managed by the DLNR-DOFAW.

While there is clarity on the parties responsible for firefighting response (Figure 3.3.2.1), the responsibilities for wildfire prevention and mitigation via fuels management are less defined on state lands that are not managed directly by the DLNR-DOFAW.

For example, two (2) of the four (4) August 2023 fires impacted state lands. In Lahaina, one (1) parcel of the impacted wildland area is under management of DLNR-Land Division, with no record of vegetation management. Several smaller parcels within the impacted developed area are owned and managed by the State Department of Education (within the blue State of Hawai‘i area), also with no clear accountability for wildfire risk reduction or vegetative fuels management (Figure 3.3.2.2).

3.3 ANALYSIS OF SYSTEM COMPONENTS

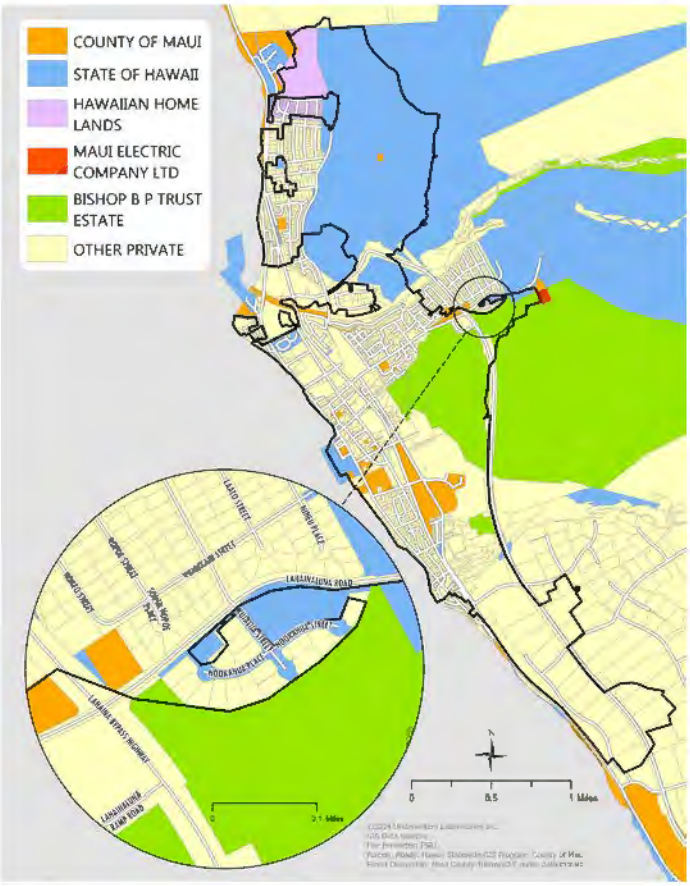


Figure 3.3.2.2 Map of Lahaina showing burn perimeter and land ownership. Detail shows Lahaina fire origin just northeast of Hoʻokahua Street where the County of Maui, State of Hawaiʻi, and private lands converge. Source: Hawaiʻi Statewide GIS Program, Office of Planning and Sustainable Development, State of Hawaiʻi.[85]

By contrast, the Olinda fire included forest reserve lands that were under management of the DLNR-DOFAW, where ongoing fuels management and wildfire risk reduction activities had been taking place. Yet, even with the responsibility and good faith effort by reserve managers to mitigate the wildfire risk posed by vegetation, the DLNR-DOFAW has had to do this work with a restrictively limited budget.

Statewide, the DLNR is responsible for managing 25% of the land in Hawaiʻi (around 1 million acres). However, under 1% of the current Hawaiʻi state budget has been allocated to the DLNR to carry out the diverse management mandates across all of its divisions. Only one (1) of its divisions, the DLNR-DOFAW, has part of its budget allotted to fire suppression and fuels management.[86]

A recent attempt to secure funding for community fuels projects through the legislature was unsuccessful. Senate Bill (SB) 409,[87] which was introduced in 2023, requested $1,500,000 for the DLNR-DOFAW to be able to complete community fuels reduction projects supporting wildfire prevention and hazardous fuel reduction measures.

3.3.3 Fuels Management Around Electrical Infrastructure

Highly ignitable vegetative fuels are also present under and around utility lines and substations across West Maui. Management of aerial vegetation touching powerlines, growing into conductors, and growing within substation boundaries is important for reducing wildfire risk and for providing continued electrical service to Maui customers. These measures are part of Hawaiian Electric's wildfire safety plan.

The wildfire risk posed by downed lines onto unmanaged vegetative fuels, a plan for fuels management under lines, and the opportunities for powerline vegetation management to serve as additional emergency access or fuel breaks, do not appear to be effectively addressed in Hawaiian Electric's previous or current wildfire safety plans,[88] and are not covered within the County of Maui's Title 14 Public Services Code[89] or the 2002 version of the National Electrical Safety Code referenced within the Hawaiʻi Public Utilities Commission (PUC) website.[90] [91]

3.3.4 Fuels Management and Defensible Space within Subdivisions

The tropical climate of Hawaiʻi and the growth rates of vegetation support prolific year-round growth of vegetation around homes and yards. Lahaina, specifically, has many residential areas that have

been in place for decades, some over a century. Old growth and/or dense vegetation was prevalent in many neighborhoods at the time of the August 2023 fires. How this vegetation impacted the fire is discussed within Section 4.0.

Very little, if any, proactive defensible space measures were taking place for the purpose of wildfire risk reduction within the built environment, with a few notable exceptions. These included a development built in 2019–2020, which was newer and lacked mature vegetation,[92] and Launiupoko on the edge of the impacted area, which has been working on vegetative reduction projects as part of its participation in the Hawai'i chapter of the Firewise USA™ program.[93]

3.3.5 Roadside Fuels Mitigation

Hawai'i Department of Transportation (HDOT) and the County of Maui Department of Public Works (DPW) reduces roadside vegetation to lower ignition probability and to ensure signage is visible. From January 1, 2023, to August 8, 2023, DPW cleared close to 20 acres of vegetation at a cost of approximately $58,000 within, and just adjacent to, the Lahaina burn scar area (see Table 6.7.1 in the Appendix).

The clearing methods included mowing and weed whipping. Although the type of vegetation cleared is not identified within the work orders, and maps with perimeters (area cleared) were not provided, the nearest street is included and does identify where the work was initiated.

Reviewing pre-fire images of the areas reveals these fuels were mostly buffelgrass, guinea grass, and haole koa. The challenge with these highly fire adaptive plants is that herbicide and complete removal (with bagging and disposal) can temporarily prevent regrowth, but abundant seed sources exist on nearby unmanaged lands and will continue to repopulate the area due to wind dispersal.

Fuel conversion, which involves planting a less fire-prone plant to occupy and protect the area from repeated invasion, is costly and requires adequate seed, water, and maintenance until the replacement plants are able to outcompete, shade out, or prevent the unwanted species from continuously invading. Coupled with the tropical climate and rapid growth rates of these grasses, frequent maintenance is needed to keep fire risk down.

The state has also been active with their roadside fuels mitigation. State records indicate they cleared approximately 180 miles of roadside vegetation in West Maui at a cost of approximately $63,000 within the Lahaina general area from January 1, 2023, to August 8, 2023 (see Table 6.7.2 in the Appendix).

3.3.6 Former Large Acreage Farmlands Unmaintained by Private Landowners

A portion of the lands involved in the Lahaina PM fire are within the footprint of an area on Maui that was converted from native vegetation to agricultural crops over the last century, and have since gone out of active agricultural production.

The subsequent private purchasing of land has led to ownership of lands for purposes that do not include active use or management, resulting in lands that are fallow, and unmaintained.[94]

Lack of maintenance or activity on these large acreage parcels leaves them vulnerable to highly invasive grasses that grow profusely when not managed. These species dry out rapidly, creating hazardous fuel loads and high fire risk. There is a notable lack of incentives in the tax and regulatory system to adequately ensure active management of large parcels for the purpose of risk reduction.

3.3.7 Challenges to Vegetation Management Implementation

The lack of broader context of wildfire in Hawai‘i, including misconceptions of risk and responsibility, and a persistent lack of action and prioritization of wildfire risk (see Section 2.1) contributed strongly to the overall lack of laws, codes, and funding pertaining to any wildfire risk reduction activities statewide.

Such activities could have included fuels management on undeveloped large acreage parcels, proactive defensible space inspection and enforcement, and the development of programs that can effectively deal with wildfire mitigation imperatives statewide.

Three (3) independent reports—West Maui Community Wildfire Protection Plan (2016),[95] County of Maui Cost of Government Commissioned Report on Wildfire Prevention and Cost Recovery on Maui (2021),[96] and a collaboratively developed vegetative fuels management mapping and prioritization report for Maui (2019)[97]—each underscored the need for robust prevention, mitigation, and fuels management, along with code updates and enforcement programs for the safety and health of both communities and natural resources on Maui.

All three (3) reports emphasized the need to recognize that investment in, and reliance on, fire suppression alone was insufficient.

The August 2018 fire in Lahaina demonstrated that under extreme weather conditions, the risk to life and property from wildfires starting on undeveloped lands with similar dried vegetative fuels could be substantial, and that managing vegetative fuel was an essential piece of reducing risk (see Sections 2.1-2.2 for information about Hurricane Lane).

No additional regulation or accountability for fuels management on unmaintained lands appears to have been put in place after the August 2018 fire, with the status quo culture, policies, and funding allocations directed toward fire suppression as the primary (and sometimes only) solution.[98]

There appears to be a belief that wildfires do not pose a significant threat to lives and property due to distance from the built environment. Under most conditions, fire agencies have been able to contain wildfires before reaching the built environment, perhaps diminishing a sense of public urgency and/or policy leadership to prioritize the mitigation of wildfire risks posed by undeveloped overgrown areas.

This misperception of risk may have contributed to the lack of policy action, program development, and code updates that prioritize and treat vegetative fuels that are on lands distant from the built environment.

The rate of grass regrowth presents an important challenge to vegetative fuel management as it necessitates continuous maintenance. Unlike mainland grasses with an average 7-month growing season, Hawaii’s grasses grow year-round.[99] Several species grow in dense bunches, reaching up to ten (10) feet tall, at a rate of up to six (6) inches per day. As they grow, they accumulate dead foliage, posing a high-to-extreme fire risk year-round.[100] This rapid growth can be prohibitively costly to manage.

Without ongoing dedicated funding programs to manage vegetative fuels, land managers in Hawai‘i have typically pursued competitive federal grant opportunities. However, these programs typically do not cover ongoing maintenance costs.

Several methods for fuels management can pose environmental challenges to Hawaii’s natural resources and nearby communities, and have contributed to the challenges to address fuels management needs.

For example, fire breaks scraped down to bare soil can lead to erosion and sedimentation into waterways, polluting nearshore waters, smothering coral reefs, and impacting fisheries, water quality, and recreation.

Additionally, using herbicides leaves standing dead fuel that still requires follow-up removal, and is often a source of controversy due to potential toxicity to waterways and community health. Prescribed fire is also not a primary tool for fuels management in Hawai‘i as it is in other parts of the world. Burning the highly fire-adapted invasive species that are a key driver of wildfires in Hawai‘i can promote more growth of these species.[101] [102]

Escaped burns also endanger native watershed forests and species that do not recover well from fire. There are limited tools for ongoing vegetation maintenance, which is why fuels conversion, native ecosystem restoration, or active agricultural use are recommended for longer-term risk reduction—the added community benefits of food production or restoration of native watersheds make them more viable options.

3.3.8 Policy Challenges

Current policy initiatives and financial allocations toward vegetation management and inspection/enforcement programs have been insufficient in reducing the risk of a catastrophic wildfire incident. Despite many years of dedicated efforts from the DLNR-DOFAW, local watershed partnerships, the HWMO, and community volunteers, a persistent lack of funding and policy support from governments at all levels has limited the capacity of these entities to reduce risk at scale, or consistently over time.

The priority needs of vegetation management, including maintenance funding, vegetation management around and/or under powerlines, maintenance around the perimeters of subdivisions in high-risk areas, and financial programs to assist the public and large landowners with vegetation management, have been identified and highlighted in many reports[103] [104] [105] without meaningful changes in policy, regulation, or funding.

For example, from 2018-2019, the HWMO completed a mapping and collaborative prioritization process to initiate an “All Hands, All Lands”[106] approach to vegetation management and to catalog vegetation management gaps, needs, and priorities. Its findings align with this analysis: vegetation management is needed under powerlines, around subdivisions, and along roadsides; consistently carrying these activities out requires additional funding, regulation, and policy action.

Despite Lahaina being identified as one of the highest priority areas for vegetative fuels management (Figure 3.3.8.1), it appears that relatively little work was actually done, due to the continued combination of funding challenges and lack of incentives, penalties, or financial support for private landowners to participate.[107]

3.3 ANALYSIS OF SYSTEM COMPONENTS

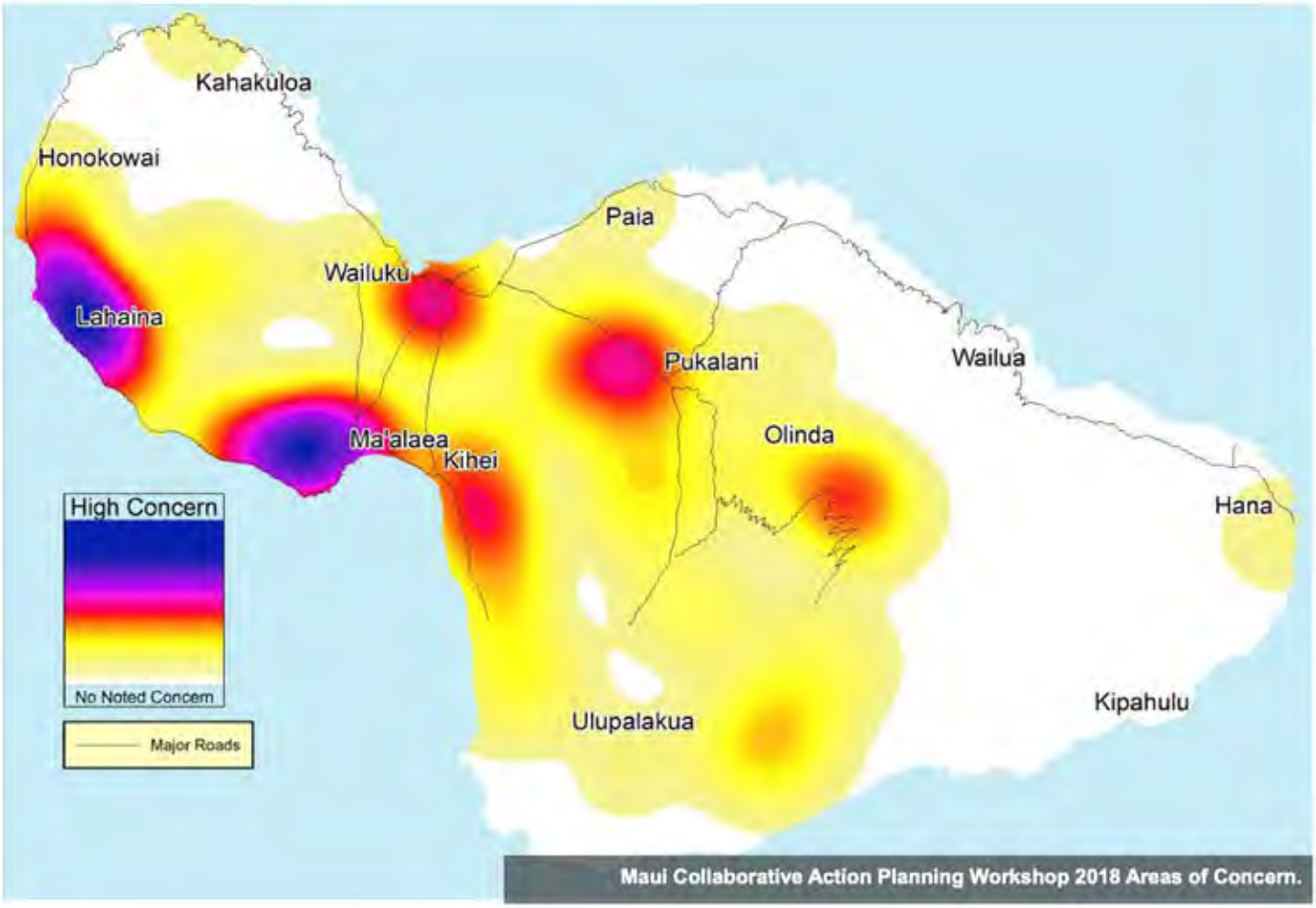


Figure 3.3.8.1 Fire Risk Heat Map: In 2018, 41 individuals from Maui representing government organizations, businesses, private landowners, and residents participated in a workshop to identify and prioritize county areas by their values at risk, hazardous vegetation, and where to start the hazard mitigation effort. The areas of highest concern represent where the participants selected as high priority for each of the three (3) categories.[108]

On September 10, 2020, the Hawai'i State Fire Council adopted the *National Fire Protection Association (NFPA) 1, Fire Code©, 2018 Edition* (as amended) as the state's fire code. Subsequently, the County of Maui passed Ordinance 5451 on November 23, 2022, which included amendments specifically addressing vegetation management.[109]

The amendment within Subsection 10.13.10 within Ordinance 5451 extends authority to the fire department to require property owners to mitigate the vegetation around structures and to establish and maintain fuel breaks when deemed necessary.

As of this writing, the County of Maui has not produced any evidence that the MFD has enforced these amendments in the Lahaina area, through inspection, follow-up, and ultimately, a $1,000 fine.

3.3.9 Findings & Recommendations

9. **FINDING:** A lack of vegetation management programs, including policy, regulation development and enforcement, and funding support to address vegetation management needs across the variety of landowner types contributed to a prevalence of unmanaged vegetation on the wildland and urban areas impacted by the August 8, 2023, fire.	**RECOMMENDATION:** Develop comprehensive vegetation management programs that address the many types of land ownership and risk-reduction needs, to include thinning vegetation, removing invasive species, and creating strategic fuel breaks: • On public lands, funding for vegetation management must be commensurate with the personnel, equipment, and maintenance costs needed to strategically and consistently reduce risk. • On private lands, a combination of tax incentives and penalties for active land management, as well as a robust and proactive defensible space code inspection and enforcement programs are needed. • Such programs must be funded and staffed at a level appropriate to adequately ensure risk-reduction measures are implemented and effectively mitigate the potential for fire ignition and rapid spread through unmanaged lands. **RECOMMENDATION:** Establish specific governmental authorities, responsibilities, and goals for the management of vegetative fuels. (Currently, authority to address vegetation hazards is covered by a vague responsibility by the mayor and fire chief to address any number of hazards). **RECOMMENDATION:** Establish a system of penalties to address owners of agricultural land who are not participating in active agriculture or vegetation management. **RECOMMENDATION:** Develop programs that support coordination and implementation of an “All Hands, All Lands” approach, where vegetation management strategies and projects reduce risk across land ownerships, according to topography and anticipated fire behavior, rather than in fragmented or siloed parcels. **RECOMMENDATION:** Implement and expand use of targeted grazing for non-native forage grass removal and fuels reduction at landscape scale.

3.3 ANALYSIS OF SYSTEM COMPONENTS

3.3.9 Findings & Recommendations

10. **FINDING:** Fire risk and protective measures are not generally considered or integrated into land use planning, ordinances, or permitting processes to ensure adequate defensible space or consistent management of vegetative fuels in and around communities.	**RECOMMENDATION:** Require integrated land use planning through zoning regulation that requires vegetation management in high-risk areas. **RECOMMENDATION:** Educate homeowners on how to create defensible space around their properties, and require them to maintain these spaces. **RECOMMENDATION:** Incorporate community-scale, maintained green spaces that are multi-use and could act as fuel breaks and public safe refuge areas.
11. **FINDING:** The existing landowner and land steward risk-reduction programs, which include best practices for vegetative fuels management, have limited capacity and have not been invested in by the government at a level that meets the current need.	**RECOMMENDATION:** Provide land steward and community education regarding vegetation management best practices. Invest in, and grow, the existing programs of Firewise USA™ and educational programs for land stewards offered by existing groups, such as those already led (but underfunded) by the HWMO, University of Hawai'i, and their established partners.
12. **FINDING:** There is no adequate system for monitoring fuel loads, fuel moisture, and other relevant characteristics.	**RECOMMENDATION:** Improve monitoring of fuels and utilize drones, satellite imagery, and ground-based monitoring systems to detect and assess vegetative fuel loads, fuel moisture, and high fire risk conditions. **RECOMMENDATION:** Establish an information dissemination system to fire and emergency managers to communicate high-risk locations and periods.

3.3.9 Findings & Recommendations

13. **FINDING:** There is a need for additional public and private investment in long-term ecosystem restoration and sustainable land management practices that promote healthy ecosystems, maintain active agriculture, reduce fire risk, and control erosion.	**RECOMMENDATION:** This investment can be accomplished as key components of integrated land use planning, financial incentive and assistance programs, and land steward education (all described above). **RECOMMENDATION:** Invest in watershed partnerships, conservation groups, and other existing ecosystem conservation and agricultural initiatives. **RECOMMENDATION:** Invest in and bolster plant material supply chain for bulk seed production to support adequate fuel conversion and post-fire mitigation. For example, these programs could include common native seed collection, plant propagation, and outplanting.

3.4 Infrastructure

The readiness and performance of any jurisdiction's underlying critical infrastructure are key factors that contribute to the resiliency of the overall built environment system when impacted by a major fire or other disaster events.

Infrastructure contributes to community resilience by ensuring critical services like hospitals, electrical grids, communication networks, and drinking water treatment, storage, and distribution remain operational during and after wildfire events.

Infrastructure plays a pivotal role across all three (3) goals of the Cohesive Strategy, and occupies a dominant role in the focal area of Fire Adapted Communities. Robust infrastructure, such as well-maintained roads and wildfire-safe subdivision design, enables swift deployment of firefighting resources to containment areas, minimizing fire spread.

In the hours leading up to the Lahaina PM fire, severe winds and extreme fire weather significantly degraded infrastructure systems across the County of Maui. The impact of the initial fire and resulting urban conflagration further affected the already-deteriorating infrastructure, especially in the heavily populated areas of Lahaina where many lots meant for single homes had multiple structures.

Planning and zoning regulations can influence where and how communities develop, impacting fire risk, structural ignitability, and evacuation routes. Properly planned infrastructure supports evacuation efforts by providing safe routes, emergency shelter locations, ignition-resistant structures, and adequate setbacks (the minimum distance required between a structure and the property line or other structures, dictated by zoning laws and building codes) and spacing to inhibit rapid fire ignition and spread.

Transportation infrastructure in Maui was challenged by the weather and fire conditions on August 8-9, 2023. The pre-existing road network in Lahaina left some neighborhoods with only one (1) way in or out. Many of these access/egress routes were blocked—by downed utility poles/wires, abandoned vehicles, traffic, smoke obscuration, and/or fire impingement—limiting first responders ability to access these neighborhoods and preventing many residents from getting out.

Water infrastructure that was sufficiently designed to handle daily demand in Lahaina under normal operating conditions was unable to continuously generate sufficient pressure and volume for firefighting purposes after the Lahaina PM fire destroyed a large number of buildings and their associated domestic water piping.

Electrical infrastructure also began failing early in the day on August 8, 2023; these failures negatively affected the ability of fire and police units to access and deploy into neighborhoods for firefighting, warning, and evacuation purposes. Collapsed utility poles and downed wires also prevented some residents from escaping along surface streets. It also appears that downed wires and related arcing may have caused additional fires across Lahaina, throughout the duration of the Lahaina PM fire.

The wind on August 8, 2023, proved too much for Lahaina's aging above-ground electrical transmission infrastructure. A small vegetation fire sparked by a downed line would ultimately become an urban conflagration where residents were challenged to evacuate densely populated areas with narrow streets and locked gates, and the rapid loss of hydrant pressure and flow would limit the water available for firefighting.

Zoning, fire/building code regulations, and road networks, as well as water and electrical infrastructure

are critical components of the built environment fire protection system. Infrastructure that lacks sufficient resilience to match the weather and wildfire threat increases the likelihood of failure over time.

This section will analyze elements of the preparedness and response efforts for each of these infrastructure components, while also examining how fire suppression resources interacted with the existing road network, the County of Maui Department of Water Supply, and Hawaiian Electric.

3.4.1 Planning, Zoning, and Codes

Community planning and zoning, with the adoption and enforcement of building/fire codes and standards, are critical components within the overall fire protection and life safety system. This section will analyze these elements with respect to how they impacted fire progression, suppression, and community egress on August 8-9, 2023.

3.4.1.1 Planning

The County of Maui Department of Planning[110] is responsible for offering technical advice, proposing zoning legislation, drafting updates to plans, providing reports and recommendations on development proposals, and overseeing programs, including special projects. Land use planning is an important aspect of community resilience to natural hazards, such as flooding and wildfire, especially at the WUI.[111]

The County of Maui General Plan[112] is a long-term, comprehensive blueprint for the physical, economic, environmental development and cultural identity of the county. The first component is the Countywide Policy Plan, which provides broad goals, objectives, policies, and actions that portray the desired direction of the county's future.

The second component is the Maui Island Plan,[113] which provides direction for future growth, the economy, and social and environmental decisions on the island through 2030. Additionally, each of the nine (9) communities in Maui Nui have developed a plan(s) providing recommendations specific to their areas. Lahaina and the communities impacted by the August 2023 fires are included in the West Maui Community Plan.[114]

Wildfire is addressed in the West Maui Community Plan as one of several hazards posed by a changing climate. The plan requires that all development projects incorporate defensible space around their perimeter and addresses the need for ongoing maintenance as recommended by the MFD.

The August 2018 fire in Lahaina is mentioned as an example of the potential for destructive fires during high winds. Recommendations include requiring defensible space around structures and vegetative fuels management in high fire hazard areas. Notably the plan does not recommend buildings to be built or retrofitted to recognized WUI standards, as it does for hurricane standards.

3.4.1.2 Zoning

Development standards, height regulations, and building setbacks are crucial elements in urban planning and fire safety, significantly impacting fire progression, suppression, and egress during emergencies. Development standards include minimum lot area and minimum lot width, and for some zoning classifications, such as apartments, maximum lot coverage and maximum floor area ratio.

Building setbacks are designed to provide sufficient space for firefighting operations, reduce the risk of fire spreading between buildings, and ensure safe evacuation routes.

In Lahaina, the issues related to building setbacks and property information became evident during the Lahaina PM fire. Many areas in Lahaina had closely spaced buildings, which increased the fire's rapid

progression. The limited setbacks meant that once one (1) structure ignited, the fire was able to spread more easily to adjacent buildings through radiant heating, and potentially, direct flame contact. This issue was particularly problematic in densely built neighborhoods where homes were often separated by only a few feet.

Title 19 of the Maui County Code of Ordinances[115] provides land use regulations in a manner encouraging orderly development in accordance with the County of Maui's General Plan and community-specific plans. The zoning requirements are also intended to provide development standards that help implement the community plans, including location, density, and use of buildings/structures.

There are 22 districts (zoning classifications), including residential, two-family, apartment, hotel, business, industrial, park, and agricultural. The zoning classifications may change over time as amended by the county. Current zoning maps for Maui, which consider existing structures on the property, became law on March 22, 2022.[116] Figure 3.4.1.2.1 shows the zoning classifications for Lahaina.

The zoning classification determines types of structures permitted on the property and development standards, including lot size, coverage area, building height, and setback distances. A majority of the area impacted is zoned residential. There are three (3) categories of residential with corresponding development standards. R-1 allows the most dense and narrowest lots with a minimum of 6,000 square-feet per structure and a minimum of 60-foot lot width. Minimum setback distances are 15 feet in the front and 6 feet in the side and rear. Lot size and setback distances create the basis for separation distances between structures—this is discussed further in Section 4.0 in the analysis of fire progression in the built environment.

In addition to the primary structure, outbuildings, shade structures, and accessory dwelling units (ADUs) are common on many properties. Figure 3.4.1.2.2 shows the percentage of each parcel occupied by a building and Figure 3.4.1.2.3 shows the approximate building cover per acre grid.

The Phase Three report will provide additional analysis, findings, and recommendations related to planning and zoning.

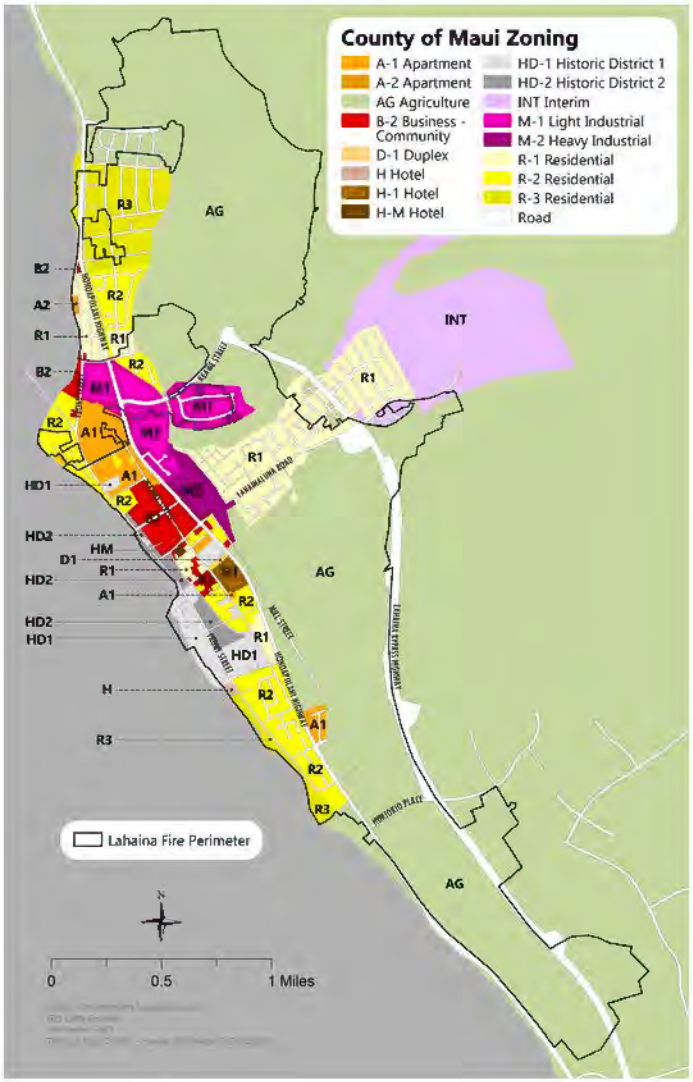


Figure 3.4.1.2.1 Zoning map of Lahaina and area impacted by fire.

3.4.1 ANALYSIS OF SYSTEM COMPONENTS

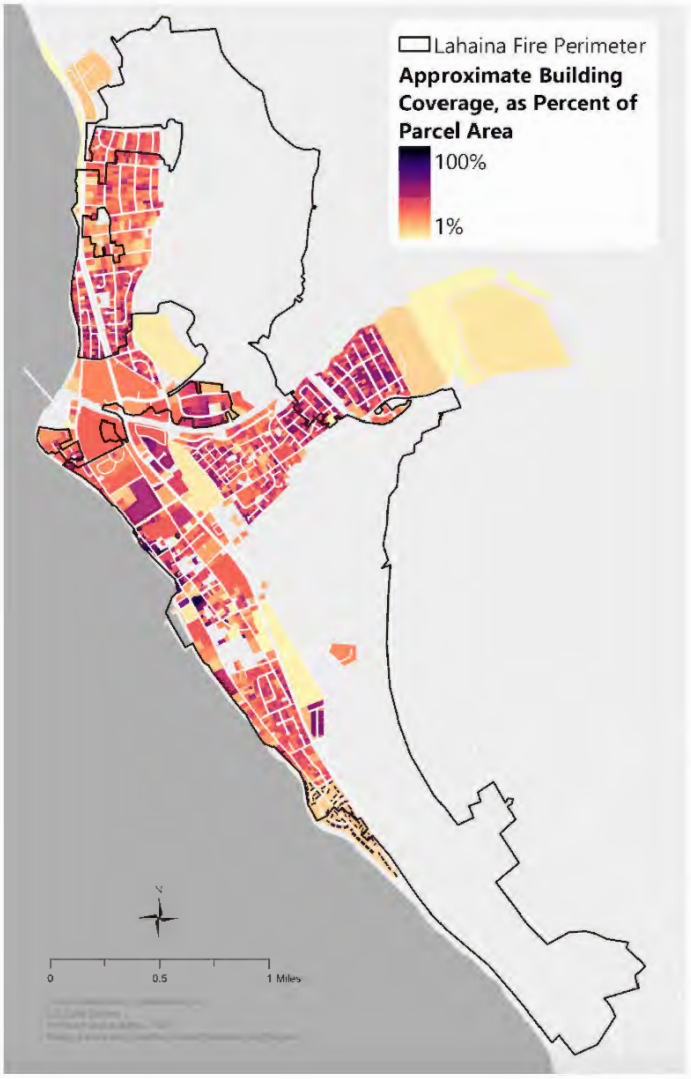


Figure 3.4.1.2.2 Percentage of parcels covered by buildings, approximated by roof line.

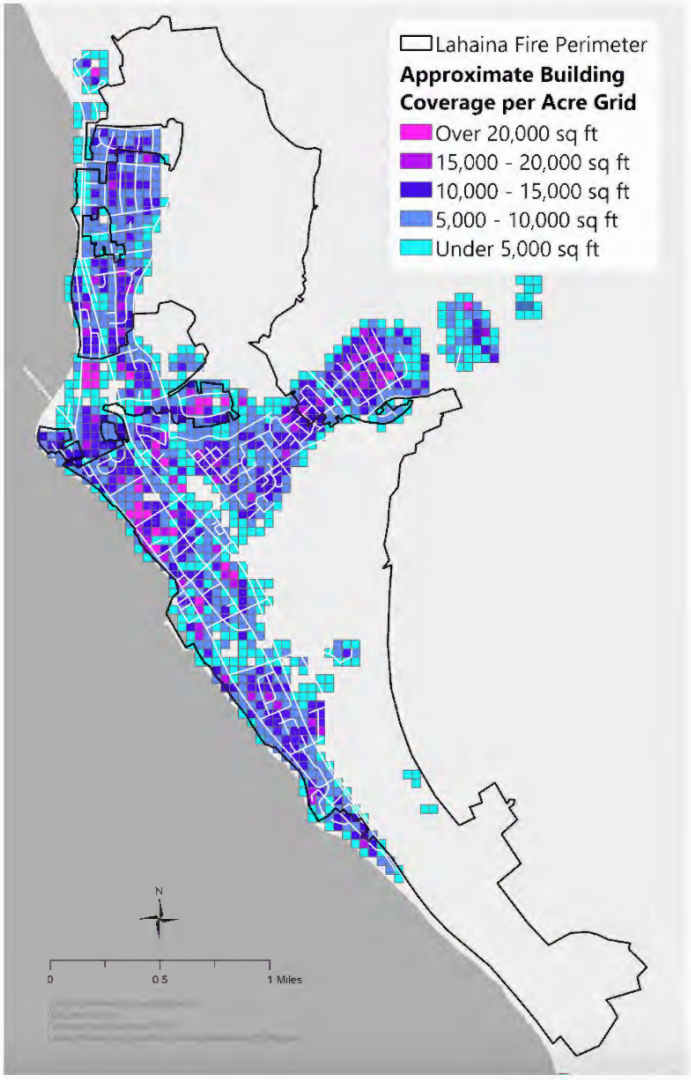


Figure 3.4.1.2.3 Building coverage per one (1) acre grid cell. These cells cross parcel boundaries.

3.4.1 ANALYSIS OF SYSTEM COMPONENTS

3.4.1.3 Codes

At the time of the August 2023 fires, the State of Hawai‘i used the 2018 *International Residential Code*©[117] (IRC) and the 2018 *International Building Code*©[118] (IBC), but there are two (2) important caveats.

First, the state has several amendments to the model code. Second, code enforcement is at the county level. The State of Hawai‘i has adopted NFPA 1 as the statewide fire code. Within the state fire code, WUI provisions are provided in Chapter 17.

The State of Hawai‘i statute[119] prescribes that each county shall amend and adopt the Hawai‘i state building codes and standards no later than two (2) years after the adoption by the state. Most recently, the State of Hawai‘i adopted the 2018 IRC and the 2018 IBC in April 2021, and the State Fire Council adopted the 2018 NFPA 1 with amendments as the state fire code in September 2020.

On and before August 8, 2023, the County of Maui was enforcing the 2006 IRC and IBC, which they had adopted in 2012 as Chapter 16.26B within the Maui County Code. Chapter 16.26B was amended by ordinance in 2016, 2017, 2018, and 2022.

In April 2023, the County of Maui passed ordinances to adopt, with amendments, the 2018 IBC. The ordinance specified the County of Maui would begin enforcing the updated editions of the codes on October 28, 2023.

The County of Maui has a County Wildfire Preparedness Plan, originally developed in 2014.[120] The county also has a Hazard Mitigation Plan, most recently published in 2018,[121] and updated in August 2020.[122]

Additional information related to the code adoption process and potential impact on fire protection will be included within the Phase Three report.



3.4.1 ANALYSIS OF SYSTEM COMPONENTS

3.4.1.4 Findings & Recommendations

14. **FINDING:** At the time of the fire, zoning in some areas of Lahaina was not commensurate with the modern built environment, environmental risks, and population growth.	**RECOMMENDATION:** Review and adjust zoning laws to better reflect the actual occupancy levels in Lahaina. **RECOMMENDATION:** Implement stricter enforcement to ensure compliance with occupancy limits. **RECOMMENDATION:** Enforce building codes and zoning regulations that require sufficient road width and access points in new developments to ensure better planning for future developments. **RECOMMENDATION:** Increase the availability of off-street parking solutions to reduce the reliance on narrow streets for vehicle parking. **RECOMMENDATION:** Emergency responders should have pre-determined plans, as well as uniquely adapted equipment (if available), tactics, and strategies for specific areas with narrow streets, outlining alternative access points, water supply strategies, and evacuation procedures.
15. **FINDING:** At the time of the fire, the County of Maui was enforcing the 2006 edition of the *International Residential Code* and *International Building Code*.	**RECOMMENDATION:** Review and ensure adoption process meets requirements of state statute (HRS 107-28).

3.4.2 ANALYSIS OF SYSTEM COMPONENTS

3.4.2 Road Networks

3.4.2.1 Lahaina Roads and Highways

Lahaina's road network provides access to residential neighborhoods, hotels, businesses, and recreational areas for a population of nearly 13,000.[123] Prior to August 8, 2023, 80% of the 2 million tourists visiting Maui each year would visit Lahaina.[124] Resident, business, and tourist traffic put tremendous stress on the road system during typical days, even when there was no emergency.

The Lahaina road system plays a critical role in providing egress during emergencies. Egress (north and south) out of Lahaina is mostly supported by the larger state highways cutting through the center of Lahaina, including the four-lane Honoapi'ilani Highway (Hwy-30) and the two-lane Lahaina Bypass that extends along the eastern (mauka) border of the town. Although more narrow than the state roads, a few county roads provide alternate options for north and south traffic flow through the central portion of Lahaina.

See Figure 3.4.2.1.1 for a map of the road system.



Figure 3.4.2.1.1 Road Network. Map shows Lahaina with fire perimeter and egress routes used throughout August 8, 2023. State highways in orange and county roads in yellow.

3.4.2 ANALYSIS OF SYSTEM COMPONENTS



Figure 3.4.2.2.1 Kuhua Street Northbound: Map showing Kuhua Street looking north toward Aki Street. Pre-fire image taken September 2011 (bottom, right) and post-fire image taken October 6, 2023 (top, right).[126]

3.4.2.2 Description of Roadways in the Area

Narrow roads with limited ingress and egress points in Lahaina impede normal daily traffic flow and can severely interfere with expedient evacuations during an emergency. Road standards in neighborhoods can vary based on multiple factors, such as anticipated traffic volume, the dimensions and characteristics of vehicles using the roads, and pertinent local regulations.

The National Association of City Transportation Officials (NACTO)[125] notes that a curb-to-curb width of 28 to 30 feet is common for residential streets with parking on both sides, balancing the need for vehicle movement and parking space, while also promoting slower traffic speeds (NACTO). This prescribed width facilitates the unimpeded passage of vehicles, including those of emergency services.

This recommended road width was often not present in Lahaina. For example, Kuhua Street, a narrow dead-end road bordering the former Pioneer Sugar Mill industrial area, often encountered daily traffic challenges due to both legal and illegal parking. Additionally, this street is located within a densely populated residential area, which impeded the evacuation of residents during the fire.

According to police maps, 29 of the fire victims were located on Kuhua Street (Figure 3.4.2.2.1 and Figure 3.4.2.2.2). Other narrow roadways and alleys throughout Lahaina posed similar challenges during the evacuation process.

3.4.2 ANALYSIS OF SYSTEM COMPONENTS



Figure 3.4.2.2.2 Kuhua Street Southbound: Map showing Kuhua Street looking south toward Kamamalu Street. Pre-fire image taken September 2011 (bottom, right) and post-fire image taken October 6, 2023 (top, right).[127]

Safety issues also arise, as emergency vehicles struggle to navigate through parked cars and heavy traffic, delaying their response times. Several fire apparatus were trapped in the Lahainaluna neighborhood (east of Hwy-30) and vehicles eventually destroyed, which further limited response capabilities, including the loss of critical firefighting and life-saving equipment and delayed availability of emergency response personnel to address other response needs.

Pedestrian safety was also compromised as increased congestion posed risks, especially in areas lacking proper sidewalks or crosswalks.

The county roads providing access to older communities, such as the area locally known as the Lahainaluna neighborhood, are narrow, some less than 20 feet wide. This particular subdivision also has a labyrinth of roads that terminate in dead ends, or intersect with other roads that do not lead to a road tied directly to one of the major egress options

Analysis of the road network and the built environment from before August 8, 2023, was conducted through the use of Google Street View,[128] Rapid Integrated Damage Assessment Tool,[129] and EagleView,[130] which allowed for the evaluation of the area from a time period prior to the August 2023 fires. The date range of the images evaluated were from 2011 to 2022. Post-fire images were also used to measure road widths using EagleView.

(Figure 3.4.2.2.3). Street signs existed for most streets, however, signage informing drivers of dead ends, or indicating egress route direction were mostly not present.

3.4.2 ANALYSIS OF SYSTEM COMPONENTS



Figure 3.4.2.2.3 Map of the Lahainaluna neighborhood displaying a labyrinth of roads, multiple dead ends, and limited egress routes. Kuhua Street is where many of the 102 decedents were found.

3.4.2.3 Vehicle Parking

In the more established neighborhoods of Lahaina, such as the Lahainaluna neighborhood, the number of occupants in homes directly influences the number of vehicles on the subdivision's narrow streets. According to the U.S. Census Bureau's American Community Survey,[131] the average vehicle ownership per household in Lahaina is approximately 2.3 vehicles. However, in high-density neighborhoods, this number can be significantly higher due to extended family living arrangements.

Many homes in Lahaina house more residents than originally envisioned. Multi-generational living arrangements and the need for affordable housing contributes to higher occupancy levels. With more occupants per home, the number of vehicles per household typically increases, leading residents to park on narrow streets due to limited off-street parking, which increases congestion. This situation created several bottlenecks during the evacuations on August 8-9, 2023.

3.4.2 ANALYSIS OF SYSTEM COMPONENTS

Zoning laws and housing regulations are designed to control the density of residential areas. These laws are often based on an estimated number of occupants per household and aim to ensure adequate infrastructure, including roads, to support the expected population. Local ordinances often specify parking requirements, such as the number of off-street parking spaces per dwelling unit, to prevent congestion on narrow streets (Figure 3.4.2.3.1).

The discrepancy between regulations and actual behaviors exacerbated these issues, highlighting the need for more effective planning and enforcement of existing zoning laws, ordinances, and housing regulations.

The County of Maui's Parking Law[133] (Chapter 10.48 Stopping, Standing, and Parking) includes requirements generally seen in other municipalities. However, in many of the older Lahaina neighborhoods with small lot sizes and narrow streets, it is not possible to legally park where parking is restricted within four (4) feet of either side of a public or private driveway. On and before August 8, 2023, there were too many vehicles and not enough parking spaces to accommodate them.

Signage restricting stopping and parking is mentioned in Chapter 10.48 of the County of Maui's Parking Law.[76] "No Parking" signs can be seen in Google Street View images at the end of roads in the Lahainaluna neighborhood (Figure 3.4.2.3.2). The degree to which parking violations within the neighborhoods (not in the business districts) are enforced is unknown.



Figure 3.4.2.3.1 Kaili Place showing narrow street and vehicle parking. Pre-fire image taken September 2011 and post-fire image taken October 6, 2023.[132]

3.4.2 ANALYSIS OF SYSTEM COMPONENTS



Figure 3.4.2.3.2 Pāʻūʻū Place. Image showing multiple no parking signs at the dead end of Pāʻūʻū Place in the Lahainaluna neighborhood. Pre-fire image taken September 2011 and post-fire image taken October 6, 2023.[134]

3.4.2.4 Dirt Roads – Cane Haul Road Network

Dirt roads formerly used during the plantation era are maintained to some extent even today (Figure 3.4.2.4.1). FSRI team members drove and/or walked all of the roads within the burn area, beginning in late August 2023 through October 2023.

The roads within the north flank of the burn area were all drivable and some even experienced considerable vehicle traffic during the team's visits. During a vegetation fire in the east (mauka) Kāʻanapali area, team members encountered a number of vehicles on dirt roads, including private contractor heavy equipment, civilian vehicles, and motorcycles.

Many of the roads were groomed with pull outs and turnarounds in several locations, and some were two (2) lanes wide. It is unknown if the dirt roads were in this condition prior to the fire. It is likely that some of the roads were graded during the fire to accommodate redirected traffic from streets blocked by downed electrical equipment, burned and disabled vehicles, and other debris.

3.4.2 ANALYSIS OF SYSTEM COMPONENTS

Signage identifying the dirt roads was not observed during FSRI's visits and names are not always visible or consistent in available mapping resources (e.g. Google Maps or EagleView).

The Old Cane Haul roads, as many locals referred to them, were well known even though they were unmarked. Firefighters, police officers, and residents referred to specific roads by different names (Figure 3.4.2.4.1).

For example, the dirt road running north to south along the eastern (mauka) border of the Wahikuli neighborhood was sometimes referred to as the "Old Road," "Oil Road," "Old Oil Road," "Stuart Road," or "Old Stuart Road" by emergency responders and residents. Google Maps refers to this road as Old Stuart Road just north of the Lahaina Civic Center, and then refers to it as Oil Road after crossing north of Pu'ukoli'i Road.

Dirt roads in central and south Lahaina also served as evacuation routes. The dirt road extending along the south bank of Kahoma Stream, parallel to Komo Mai Street, and the dirt road cutting through the vegetation on the south end were both critical egress options. These dirt roads also lacked signage and are not consistently identified on maps.

See Figure 3.4.2.4.2 for a map of Lahaina's dirt road network.



Figure 3.4.2.4.1 Photo of Old Cane Haul Road, often referred to by police officers and firefighters as Oil Road, just north of Kapunakea Street. This road is accessed through a gate located on the north side of Keawe Street at Kuhua Street. Oil Road was used extensively during evacuations due to utility poles blocking Hwy-30 just north of Keawe Street. Inset: Old Cane Haul Viewpoint. Image showing the area depicted in the photograph above.

3.4.2 ANALYSIS OF SYSTEM COMPONENTS



Figure 3.4.2.4.2 Unpaved Roads. Cane Haul Roads. Map of Lahaina's dirt road network, including fire perimeter. Road names are included with source. These roads were used by residents to evacuate as fire and smoke was bearing down.

3.4.2 ANALYSIS OF SYSTEM COMPONENTS

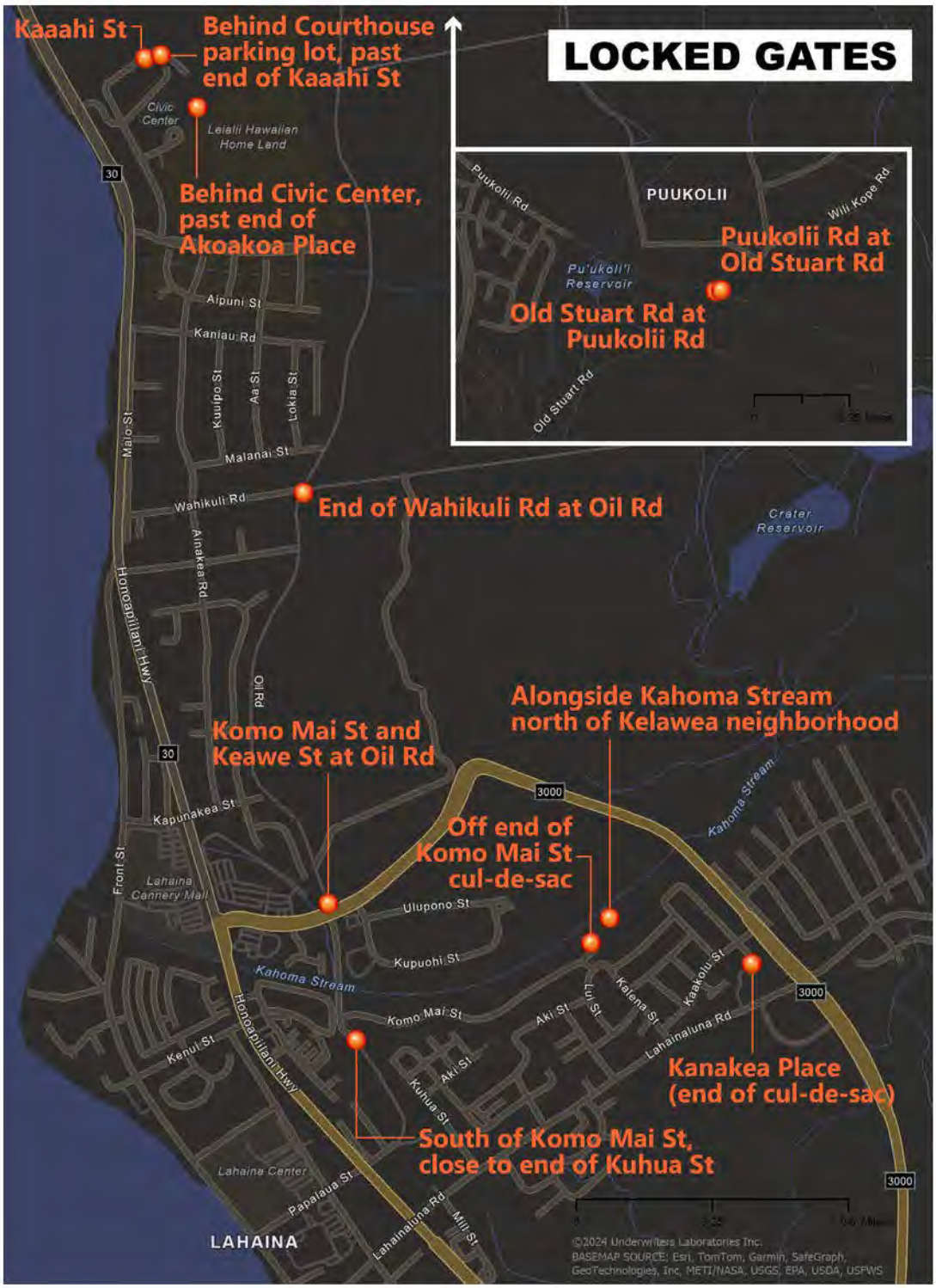


Figure 3.4.2.4.3 Locked Gates Map. Map showing location of locked games preventing access to dirt roads used during August 8-9, 2023. MPD officers shared how they had to cut the locks to open the gates to allow vehicles to escape the fire and smoke.

3.4.2 ANALYSIS OF SYSTEM COMPONENTS

There were several instances where dirt roads located on private properties were difficult to access due to locked gates. MPD officers shared experiences of having to use cutting tools to break the locking mechanism to allow the gate to be opened. In some cases, vehicles were used to ram or pull the gate open as residents waited in their vehicles while fire and smoke impacted the area. The location of the locked gates identified during technical discussions are shown in Figure 3.4.2.4.3.

Additional discussion on the impact of dirt roads and locked gates is provided in Section 3.8.

The unplanned use of these roads during the emergency highlighted several issues. The lack of maintenance of these roads over the years has led to deterioration, making them difficult to navigate quickly and safely. Overgrown vegetation, erosion, and debris further complicate their use. The emergency nature of opening gates to connect paved roads to these dirt roads pointed to an important gap in pre-planned alternate routes for emergency evacuations and access.

Moreover, the blocked and gated roads greatly impeded access to these escape avenues by first responders, who were forced to use tools to cut through locks and chains or find local residences with access keys. This delay and additional effort might have been avoided with pre-arranged access permissions and coordinated efforts with landowners and local authorities.

The situation also highlighted the importance of regular maintenance and inspections of these potential evacuation routes to ensure they remain viable options during emergencies.

The reliance on these dirt roads during the fire exposed the need for improved signage and mapping. Many residents, tourists, and first responders were not familiar with the layout of these roads, leading to confusion and potential delays. Enhanced communication, training, and detailed mapping of these routes could improve response times, egress, and firefighting access in future emergencies.

While the unnamed dirt roads provided a critical alternative during the fire, the experience underscored the necessity for better planning, maintenance, and coordination to ensure these routes can be effectively used in future emergencies.



3.4.2 ANALYSIS OF SYSTEM COMPONENTS

3.4.2.5 Findings & Recommendations

16. **FINDING:** Emergency responders did not have ready capability to unlock emergency gates at various locations, including schools, to facilitate evacuations. They were often forced to rely on a third-party response for such access.	**RECOMMENDATION:** The MPD and MFD should develop an assessment of its ability to access local utilities (Hawaiian Electric), flood control, waterworks, farms, resorts and public facilities (ex. private and public schools), flood control roads and gates, agricultural roads and gates, harbor areas, etc.) for emergencies. Create a system of universal lock security access that is available to all emergency responders and landowners.
17. **FINDING:** Severe congestion due to parked cars along neighborhood streets hindered evacuation and response efforts.	**RECOMMENDATION:** The MPD and county authorities should assess the parking needs and challenges within neighborhoods. This may include evaluating factors, such as population density, housing types, availability of off-street parking, street width, proximity to commercial areas or public transportation, and existing parking issues.
18. **FINDING:** Limited written traffic plans or guidelines for emergencies and escalating incidents.	**RECOMMENDATION:** Develop a pre-incident plan for the MPD to manage traffic during a wildfire that involves coordinating efforts to ensure public safety, facilitate evacuation, if necessary, and maintain traffic flow in affected areas. Update MPD G.O. 405.1 Traffic Section and G.O. 405.7 Traffic Direction and Control to include instruction on wildfire evacuation (Appendix 6.12.1-2). **RECOMMENDATION:** Implement and enforce strict no-parking zones on critical streets and encourage the use of off-street parking solutions to reduce the number of vehicles parked on narrow streets. **RECOMMENDATION:** Where possible, redesign traffic flow in congested areas, including implementing one-way street systems, to optimize vehicle movement. **RECOMMENDATION:** Residents in areas with narrow streets should be educated on fire safety procedures, importance of clear buffer zones/ defensible spaces, and evacuation plans to ensure a more coordinated response.

3.4.2 ANALYSIS OF SYSTEM COMPONENTS

3.4.2.4 Findings & Recommendations

19. **FINDING:** Roadways and evacuation routes were not adequately maintained prior to August 8, 2023, to sustain effective evacuation efforts during the fire event.	**RECOMMENDATION:** Identify, name, map, and provide signage on dirt roads that serve as alternate egress/ evacuation routes so residents and emergency responders refer to them by the same name. **RECOMMENDATION:** Inspect and maintain dirt roads annually. Modernize, standardize, and maintain barriers on dirt roads to help ensure they can be used during emergencies. **RECOMMENDATION:** Where feasible, widen roads to accommodate more parking, traffic, and provide room for emergency vehicles.

3.4.3 ANALYSIS OF SYSTEM COMPONENTS

3.4.3 Water System

Potable water supply infrastructure is crucial for wildfire management, supporting the goals of the Cohesive Strategy by enhancing response and suppression efforts, landscape resiliency, and community protection. Collaboration among local communities, water departments, firefighting agencies, and land management organizations is necessary to strategically manage water resources.

Drinking water is essential for fire suppression—efficient storage and distribution systems help ensure availability where and when needed to fight fires. Toward resilient landscapes and fire-adapted communities, drinking water infrastructure and distribution systems can also support the maintenance of defensible space around homes and subdivisions, as well as agricultural and ecological restoration efforts.

In Lahaina, the demand for drinking water on August 8-9, 2023, exceeded the ability of the drinking water treatment, storage, and distribution system to deliver sufficient quantities of water at adequate volume and pressure within the distribution system. The number of structures on fire at one time, and subsequent loss of large amounts of water due to failed domestic water lines, left many of the hydrants with little to no pressure.

The scale and speed of the destruction could not be addressed rapidly enough with the resources available to the County of Maui Department of Water Supply. Water availability played an important role in the Lahaina PM fire. For this reason, an analysis of water infrastructure was conducted. This section will analyze the water supply system and explain its operation throughout the incident.

3.4.3.1 Lahaina Water Supply System

Drinking water is provided to the Lahaina area by the County of Maui Department of Water Supply. In the County of Maui, as well as the rest of the United States, drinking water may be used for a variety of reasons, including drinking, showering/bathing, flushing toilets, washing clothes, watering plants and lawns, washing vehicles, and firefighting.

Two (2) county water treatment plants produce drinking water that is used in this area on the west side of the county. The Lahaina treatment plant to the south, located near the Lahainaluna High School, has a capacity of 1.8 million gallons per day (MGD) equivalent to 1,250 gallons per minute (GPM).

The Māhinahina treatment plant to the north, located near the Kapalua Airport, has a capacity of 2.0 MGD (1,390 GPM). These treatment plants are also supplemented by a system of three (3) small groundwater well/tank combinations that enter directly into the distribution system. Water storage tanks fed by these plants and wells can store approximately 10 million gallons of treated drinking water.

Although the storage and distribution systems for these two (2) drinking water treatment facilities are connected, there is no interconnection with other parts of the County of Maui water system or other smaller water providers in the Lahaina area.

The County of Maui Department of Water Supply was seemingly in compliance with the Drinking Water Design Standards for the State of Hawai‘i[135] by having sufficient drinking water stored prior to the August 2023 fires. However, the drinking water distribution system was unable to meet the hydraulic objective of providing a sufficient quantity of water at sufficient pressure for the large-scale August 2023 fire event in Lahaina.

3.4.3.2 Water System Standards

The United States Environmental Protection Agency (EPA) is responsible for the enforcement of all aspects of the Safe Drinking Water Act (SDWA) and public health protection involving Community Water Systems (CWS) within the United States and its territories.

The EPA delegates primary enforcement responsibility (also called primacy) for public water systems to states, territories, and tribes if they meet certain requirements set by section 40 CFR 141 of the Code of Federal Regulations (CFR). An entity with primacy is the agency with responsibility for implementing the SDWA. The State of Hawai‘i has primacy within the state for enforcement of all drinking water standards.

Within these regulatory boundaries, professional engineers determine drinking water storage and distribution systems using:

- Their engineering judgment and experience based upon engineering studies
- Design guidance from the American Water Works Association (AWWA)
- Published engineering textbooks
- State design standards
- The ten (10) state standards for water: *Recommended Standards for Water Works* (2012)[136]
- Other technical material from governmental and professional organizations—ex. *Insurance Services Office Inc. Guide for Determination of Needed Fire Flow* (2014)[137]

Water System Standards for the State of Hawai‘i

Water system design standards for Hawai‘i[138] were developed in 2002 and have been amended to address specific design concerns and technological improvements in water system planning, design, and operation. The last amendment to these standards occurred on December 14, 2023, to address pipes and appurtenances. A complete list of the amendments are included in Section 6.9 of the Appendix.

These water system standards are applicable to all community water supplies in Hawai‘i. It should also be noted that these standards may be slightly different between county governments within the state. They apply to the Department of Water Supply for the County of Hawai‘i, Board of Water Supply for the City and County of Honolulu, Department of Water for the County of Kaua‘i, and the Department of Water Supply for the County of Maui.

In general, three (3) primary factors control the sizing of drinking water systems. These factors are domestic consumption, demand factor, and specific fire flow requirement (the amount of water needed to control a fire in a building or structure). The state standards require that the capacity of the distribution system deliver the maximum daily demand simultaneously with the required fire flow. The distribution system should also deliver the peak hour flow (without fire flow).

Table 100-18[139] from the Water System Standards is a listing of the domestic consumption guidelines based upon the zoning designation and county within the State of Hawai‘i. These guidelines were in effect at the time of the August 2023 fires and would have been used by the county to determine the adequacy of the Lahaina and Māhinahina drinking water systems based upon the zoning designation and the population of the surrounding communities.

Based on the domestic consumption requirements of Table 100-18, and County of Maui zoning information, the average daily water demand in Lahaina was conservatively estimated to be slightly less than 6 million gallons (MG). Using a demand

3.4.3 ANALYSIS OF SYSTEM COMPONENTS

factor of 1.5 from Table 100-20, Lahaina had a maximum daily water demand of slightly less than 9 MG. A demand factor of 3.0 from Table 100-20 is required for the peak hourly flow. The required peak hourly water usage would be 0.75 MG delivered with a minimum pressure of 40 pounds per square inch (psi).

The total amount of water capable of being stored in the combined Lahaina and Māhinahina drinking water storage and distribution systems was 10 MG with all tanks full. This value was above the maximum required daily demand estimated in this report of 9 MG. The amount of water stored in each individual system also exceeded the peak hourly storage requirement of 0.75 MG.

As per Figure 6.8.3, total system volume on August 8, 2023, ranged from just less than 7 MG to less than 6 MG until 15:30 when data was no longer available. Therefore, the amount of water stored in the two (2) systems met the state requirements for the required average daily demand until data was no longer available as described above.

The most demanding fire flow case for Lahaina, from Table 100-19,[140] is heavy industrial/hotels at 2500 GPM for two (2) hours at a critical fire hydrant with a residual pressure of 20 psi. This value equates to 0.3 MG of water stored. The water stored in each individual system at the time of the fire exceeded these requirements.

Table 100-18 Domestic Consumption Guidelines. Source: Board of Water Supply, City and County of Honolulu.

Table 100-18 - DOMESTIC CONSUMPTION GUIDELINES

AVERAGE DAILY DEMAND*

ZONING DESIGNATION	HAWAII	KAUAI	MAUI	OAHU
RESIDENTIAL:				
Single Family or Duplex	400 gals/unit	500 gals/unit	600 gals/unit or 3000 gals/acre	500 gals/unit or 2500 gals/acre
Multi-Family Low Rise	400 gals/unit	350 gals/unit	560 gals/unit or 5000 gals/acre	400 gals/unit or 4000 gals/acre
Multi-Family High Rise	400 gals/unit	350 gals/unit	560 gals/unit	300 gals/unit
COMMERCIAL:				
Commercial Only	3000 gals/acre	3000 gals/acre	6000 gals/acre	3000 gals/acre
Commercial/Industrial Mix	–	5000 gals/acre	140 gals/1000 sq. ft.	100 gals/1000 sq. ft.
Commercial/Residential Mix	–	3000 gals/acre	140 gals/1000 sq. ft.	120 gals/1000 sq. ft.
RESORT (To include hotel for Maui only)	400 gals/unit (1)	350 gals/unit	350 gals/unit or 17000 gals/acre	350 gals/unit or 4000 gals/acre
LIGHT INDUSTRY:	4000 gals/acre	4000 gals/acre	6000 gals/acre	4000 gals/acre
SCHOOLS, PARKS:	4000 gals/acre or 60 gals/student	4000 gals/acre or 60 gals/student	1700 gals/acre or 60 gals/student	4000 gals/acre or 60 gals/student
AGRICULTURE:		2,500 gals/acre	5000 gals/acre	4000 gals/acre

* – Where two or more figures are listed for the same zoning, the daily demand resulting in higher consumption use shall govern the design unless specified otherwise.

(1) – Subject to special review and control by the Manager.

3.4.3 ANALYSIS OF SYSTEM COMPONENTS

The County of Maui Department of Water Supply was seemingly in compliance with Hawai'i State standards for the required average daily demand until data was no longer available after 15:30 on August 8, 2023. It should also be noted that both the Lahaina and the Māhinahina drinking water treatment plants continued to produce water throughout the fire event. The demand from the fire and system losses due to uncontrolled water release in burned structures seemingly overwhelmed the system's capability to deliver water at fire hydrants with sufficient pressure as the fire progressed.

Table 100-19 Fire Flow Requirements. Source: Board of Water Supply, City and County of Honolulu.

Table 100-19 - FIRE FLOW REQUIREMENTS

LAND USE	FLOW (GPM)/DURATION (HRS)/FIRE HYDRANT SPACING (FT.)			
	HAWAII	KAUAI	MAUI	OAHU
Agriculture	500/0.5/600 (1)	250/1/500	500/2/500	1000/0.5/700
Rural			1000/2/500	
Single Family	(2)	(4)	1000/2/350	1000/1/350
Duplex	1500/1/300	(4)	1250/2/350	1000/1/350
PUD Townhouse and Low Rise Apartments	1500/1/300	(4)	(5)	1500/1/250
Schools, Neighborhood Businesses, Small Shopping Centers, Hotels (except Maui), and High Rise Apartments	2000/2/300	2000/2/350	2000/2/250	2000/2/250
Light Industry, Downtown Business, Large Shopping Center, and Hospitals	2,000/2/300	3000/3/350	2000/2/250	4000/3/250
Heavy Industry, Hotels	2,000/2/300	3000/3/350	2,500/2/ 250	(3)

(1) - Applies to one acre lot size or less
(2) - 10,000 sq. ft. or larger lot size = 500/2/600; Less than 10,000 sq. ft. lot size = 1000/1/600
(3) - Subject to special review and control by Manager
(4) - R-2 = 500/1/500 R-4 = 750/2/500 R-6 = 1000/2/500 R-10 = 1250/2/350
R-20 = 1500/2/350 RR-10 = 1500/2/350 RR-20 = 2000/2/350
(5) - A-1 = 1500/2/250 A-2 = 2000/2/250

Note:
1. On dead end streets, the last F.H. shall be located at one half the spacing distance for F.H.s from the last house/unit (frontage property line or to the driveway/access for the property).
2. Spacing of fire hydrant shall be measured along the roadway.

3.4.3 ANALYSIS OF SYSTEM COMPONENTS

Table 100-20[141] from the Water System Standards shows the demand factors for the various county governments in Hawai‘i that are used for the design of drinking water storage and distribution systems. Although the peak demand is consistent throughout the state, under the state standards, the peak hourly flow for Kaua‘i, Maui, and O‘ahu is calculated as only three (3) times the daily average.

Finally, the County of Maui Department of Water Supply was seemingly in compliance with Hawai‘i State standards for the amount of water stored for a community population of more than 13,000.

Table 100-20 Demand Factors. Source: Board of Water Supply, CIty and County of Honolulu.

Table 100-20 - DEMAND FACTORS		
Island	Maximum Daily Demand	Peak Hour
Hawaii	1.5 x Average Day	5.0 x Average Day
Kauai, Maui, Oahu	1.5 x Average Day	3.0 x Average Day



3.4.3 ANALYSIS OF SYSTEM COMPONENTS

Drinking Water System Storage Capacity
At the time of the August 2023 fires, the population of Lahaina was approximately 13,000.[142] As a result, the maximum daily water demand for a community of that size would be approximately 3.5 MGD, which was in line with state standards.

The total water storage capacity in both the Lahaina and Māhinahina systems is 10 MG. This storage amount is almost three (3) times the maximum water demand for Lahaina, meaning the County of Maui was meeting current state standards for both the Lahaina and the Māhinahina treatment, storage, and distribution systems for water treatment capacity and water storage capacity.

All drinking water storage tanks have an effective storage volume that may be used on a daily basis, depending upon the hydraulics and operational philosophy of the drinking water treatment, storage, and distribution system. During unexpected water demand events (like the August 2023 fires), storage tanks can utilize emergency storage volume.

Depending upon the system design and operational philosophy, the storage tank levels may drop during an emergency to an ineffective storage level. At this level, there may still be water in the tank, however, it may not be hydraulically feasible for this water to be available in all parts of the distribution system.

Water Distribution System Pipe Sizes and Standards
Drinking water distribution pipelines can be divided into two (2) general categories based upon their size and number of connections. Distribution pipelines or mains are generally smaller diameter water pipes, ranging from six (6) to 16 inches in diameter that provide water to a relatively small area of service and have multiple service connections.

Transmission pipelines or mains are generally larger in diameter (greater than 16 inches), do not generally have service connections, and are designed to transport larger quantities of water within the storage and distribution system during periods of peak demand.

There are currently no pumps in the Lahaina water distribution system, it is fed entirely by gravity.

The Water System Standards for the State of Hawai‘i require water distribution pipelines to be sized according to the following standards:

1. Provide the maximum daily flow plus fire flow with a residual pressure of 20 pounds per square inch (psi) at a critical fire hydrant

2. Provide peak hourly flow with a minimum residual pressure of 40 psi

3. Provide a maximum velocity in the distribution main (without fire flow) of 6 feet per second (fps)

4. **For Maui Only**: In addition, the maximum velocity in the mains shall apply as follows:
    a. Distribution Mains – 10 fps with fire flow at max day domestic flow
    b. Transmission mains without water services or fire flow – 10 fps

3.4.3 ANALYSIS OF SYSTEM COMPONENTS

3.4.3.3 The Fire Event of August 8, 2023, and the Water System

During the Lahaina PM fire, water demand in parts of Lahaina exceeded the ability of the water storage and distribution system to deliver sufficient quantities of water at adequate pressure within the system. In central parts of Lahaina, water system pressure and capacity were observed to be insufficient to support firefighting operations.

As per FSRI data, 3,336 structures were exposed to fire in Lahaina and 2,118 of those structures were classified as destroyed. As homes and other buildings burned, domestic drinking water pipes failed and water ran freely. Pressure in water lines dropped and very little water was available for use by firefighters in central and southern Lahaina.

It should be noted that the water supply did not fail in all parts of Lahaina. Some areas of Lahaina had water service throughout the fire. Water shortages were most common in central and southern Lahaina. Additionally, the County of Maui Department of Water Supply continued to produce water throughout the duration of the fires. Both plants had electrical power and produced water throughout the fire.



3.4.3 ANALYSIS OF SYSTEM COMPONENTS

3.4.3.4 Findings & Recommendations

20.	**FINDING:** The County of Maui Department of Water Supply was seemingly in compliance with the Water System Design Standards for the State of Hawai‘i in August 2023.	**RECOMMENDATION:** Given the increasing threat of wildfires and wildfire-initiated urban conflagrations, it may be necessary for the State of Hawai‘i to revisit its design standards and guidelines for storage and distribution systems that could be used for firefighting purposes.
21.	**FINDING:** No pumps are used outside of the water production facilities to provide pressure in the system. Both systems had uninterrupted electrical power during the August 2023 fires and produced water at capacity for the duration of the fire.	**RECOMMENDATION:** N/A
22.	**FINDING:** The amount of drinking water in storage tanks at the beginning of the August 2023 fires seemingly met standard design requirements as required by the Water System Design Standards for the State of Hawai‘i.	**RECOMMENDATION:** N/A
23.	**FINDING:** As per the Phase One report (pages 237-239), the water supply monitoring system failed at 15:30 (3:30 p.m.) on August 8, 2023, and no storage tank data was recorded for the duration of the fire event. Once this data connection was lost, the County of Maui Department of Water Supply did not know how much stored water was available for firefighting during the fire.	**RECOMMENDATION:** Develop, install, and maintain a resilient drinking water tank level monitoring system for the Lahaina and Māhinahina storage and distribution systems that can be monitored from the County of Maui EOC and other locations.
24.	**FINDING:** As homes and other structures were damaged and destroyed by fire, household plumbing (e.g., plastic and other piping) inside of the buildings failed, allowing unrestricted flow of water from one (1) or more locations in each home or structure, resulting in water freely flowing from more structures and diminishing the overall water pressure and flow in the fire area.	**RECOMMENDATION:** N/A

3.4.3 ANALYSIS OF SYSTEM COMPONENTS

3.4.3.4 Findings & Recommendations

25.	**FINDING:** As per the Phase One report (page 239), County of Maui Department of Water Supply employees were unable to enter the fire area to assist firefighters due to multiple factors, including traffic congestion and the danger presented by the fire. Firefighters did not have the time, training, or tools to shut off water.	**RECOMMENDATION:** Develop a plan to coordinate with the County of Maui Department of Water Supply to address water system needs at the incident command post (ICP). (See Section 3.6.3 for more information)
26.	**FINDING:** Due to the hydraulics of the drinking water storage and distribution system, and given the excessive demand caused by the flow from damaged/destroyed structures, water was not provided with sufficient volume and sufficient pressure (i.e., the system could not meet the required demand) for use in firefighting for the entire August 2023 fire event in Lahaina.	**RECOMMENDATION:** Perform a hydraulic analysis of both the Lahaina and Māhinahina storage and distribution systems. Use the results of this analysis to design larger and/or multiple interconnected pipes between the two (2) drinking water storage and distribution systems. Consider the use of pumps, as appropriate, to supplement pressure and volume. Determine pressure and volume limits for a major fire event that stakeholders understand and can operate to.
27.	**FINDING:** Water quality and cost concerns make it impractical to size a drinking water treatment, storage, and distribution system to accommodate the firefighting demands for a fire conflagration event similar to the one that occurred in August 2023 in Lahaina.	**RECOMMENDATION:** Provide alternate means of firefighting water supply for extreme events. This may include portable pumps to draw water from public and private pools, ponds, and other bodies of water (including sea water), large diameter hose equipped apparatus, sites, or connections for marine vessels to draw water from the Pacific Ocean, and other means.

3.4.4 Electrical Power

Electrical power infrastructure is crucial for wildfire management, as its proper management mitigates fire risks, ensures public safety, and maintains reliable power during and after wildfires. Coordination among utility companies, fire and emergency response agencies, and consumers is required, aligned with the timely and consistent communication focus recommended by the Cohesive Strategy.

Policies and practices that support adopting preventative vegetation management programs around power infrastructure, investing in resilient electrical infrastructure, implementing Public Safety Power Shutoffs (PSPS) during extreme fire weather, and supporting backup power solutions work together to enhance community wildfire safety and system reliability.

Power companies must also have strategies for rapid response to extreme weather and wildfire incidents, ensuring quick restoration of services to support community recovery and firefighting efforts, and coordinating with fire agencies to prioritize power shutoffs and restorations.

Electrical power infrastructure played an instrumental role in the Lahaina PM fire, including both ignition hazards and safety challenges to the public and emergency responders.

The specific role Lahaina's electrical system played in the ignition of the fire will be covered in the origin-and-cause report being prepared by the County of Maui and ATF.

3.4.4.1 Hawaiian Electric Preparedness

As stated within the Phase One report (page 41), Hawaiian Electric staffed for normal operations on August 8, 2023. This was consistent with how the MFD, MPD, and the County of Maui Department of Water Supply staffed, and can also be related to the statewide perceptions of wildfire risk mentioned in Section 2.1.

Preparing for extreme weather events is critical to being able to best prevent and respond to anticipated emergencies, such as the August 2023 fires. Prevention of electrical infrastructure failure due to high winds and wildfire requires years of planning, investment, execution, and government oversight by the PUC.

Beginning July 22, 2019, Hawaiian Electric established a Resilience Working Group (RWG) consisting of more than 70 individuals representing a broad cross-section of industries and government agencies.[143] The group assisted with developing the Climate Adaptation Transmission and Resilience Program that would ultimately be approved by the PUC, thus paving the way for Hawaiian Electric to receive $95 million in funds granted under the federal Infrastructure Investment and Jobs Act to match an equal contribution from customers.[144] Details of the program and the proposed projects are included within Hawaiian Electric's website.[145]

In Lahaina, there was a mixture of above-ground and below-ground transmission wires. It appears the above-ground infrastructure had little to no vegetation management around utility poles. Pre-fire images from Google Earth Street View show dry grass growing along roadsides and right up to the base of the poles. Many utility poles caught fire

and 29 ultimately fell to the ground, while numerous transmission lines were compromised due to the extreme downslope winds from the northeast.

3.4.4.2 Knowledge of Power Status and Coordination with the MPD and MFD

Firefighters and law enforcement officers are trained to work with extreme caution around electrical equipment. If they are uncertain that lines are de-energized, they are instructed to treat them like they are energized and to remain at a safe distance and protect their crews and the public.

The MFD and MPD personnel encountered many downed utility poles and compromised electrical transmission lines, starting in the early morning of August 8, 2023. They communicated these hazards along with non-operational traffic signals to Central Dispatch on numerous occasions.

The minute-by-minute timeline[146] within the Phase One report includes more than 150 radio transmissions addressing electrical power and infrastructure issues. Nearly half of these communications (70) occurred between the hours of 01:00 to 10:00 on the morning of August 8, 2023.

Most of these communications were to advise Central Dispatch of the hazard (i.e., downed or leaning poles and transmission lines on the ground), so they could inform Hawaiian Electric. Several were requests to know the status of the power.

Table 3.4.4.2.1 provides a partial record of Hawaiian Electric's communications with MPD and MFD dispatchers informing Hawaiian Electric of leaning poles and requests for the status of the power during four (4) separate times.

Table 3.4.4.2.1 Partial record of Hawaiian Electric communications with the MPD and MFD regarding power status. Central is the MPD's central dispatch.

Hawaiian Electric Communications with Maui Police Department (MPD) and Maui Fire Department (MFD) Regarding Power Status (Partial Record)		
August 8, 2023	21:33:00	**Hawaiian Electric:** Hello, Maui Electric. **Central:** This is the police department; we are trying to confirm that the lines down in front of the Lahaina Station on Honoapi'ilani are all deenergized. **Hawaiian Electric:** Yes, it is but it is not grounded, so you still cannot touch the lines, but the substation is burning. **Central:** OK, because they need to evacuate, so can they drive over it? **Hawaiian Electric:** Oh, what is the location? Where is it? Lahainaluna Road? **Central:** On Honoapi'ilani Highway, in front of the Lahaina Station. **Hawaiian Electric:** The Lahaina substation, right? **Central:** The Lahaina Police Station. **Hawaiian Electric:** Oh, Lahaina Police Station. (talking in the background asking about running over lines.) Yea. You can have them run over the lines.
*Now known as Hawaiian Electric. Red text: Indicates that the power supply is cut off.		

3.4.4 ANALYSIS OF SYSTEM COMPONENTS

Hawaiian Electric's response regarding the power status indicated a measure of uncertainty. On some of these recordings, you can hear the dispatcher asking other personnel in the work space if they knew if power was shut off to an area in question.

A full record of these communications can be found in Table 4.3.4.3 in the Phase One report (pages 235-236).

The conversation may not have instilled confidence with the Central dispatcher responsible for relaying the power status to firefighters and police officers. These inconclusive communications may have resulted in firefighters and police officers operating with extra caution and restricting their engagement with traffic control, evacuation, and fire suppression when it was known that lines were down.

Hawaiian Electric, the MFD, and the MPD do not have written guidelines or policies for first responders working around electrical equipment.

Best practices taken from a major California utility states the following:[147]

- **Secure the area.** Keep yourself and the public at least 100 feet away from fallen powerlines. Fallen transmission lines from large towers require 100 feet of clearance.
- **Stay clear of all downed lines** and anything they are contacting, including nearby fences, trees, cable or phone lines, and the ground.
- **Be extremely cautious when using water to fight fires near downed powerlines.** If you must use water, use only a mist or spray. Do not use a stream—it can create a clear path for current.

In addition, Hawaiian Electric issued a news release on August 8, 2023, at 15:30 informing West Maui and Upcountry residents of downed electrical equipment. The news release stated:

> *With the forecast of continued high winds, if you see a downed powerline, assume it is energized and dangerous. Stay away from downed powerlines – at least 30 feet or more (at least two (2) car lengths). Report downed lines immediately by calling Hawaiian Electric's Trouble Line; the number is 808-871-7777, available 24 hours a day, 7 days a week.*[148]

This communication was released just over thirty minutes after the Lahaina PM fire was called in by Hawaiian Electric crews. If residents were able to receive this information via their cell phones, which as per resident accounts were unreliable at that time, the information may have contributed to the inefficient movement of traffic through Lahaina as residents may have treated the downed utility poles and electrical transmission lines as if they were energized.

3.4.4.3 Incident Command Post (ICP) Presence and Operational Positioning

There was no evidence of Hawaiian Electric personnel coordinating and planning with MFD and MPD ICs. This is feasible due to the MFD and MPD maintaining their own incident command organizations and both being mostly mobile through the morning of August 9, 2023.

Not having an assigned Hawaiian Electric representative working closely with MFD and MPD incident commanders at a command post may have contributed to the lack of real-time information pertaining to the electrical hazards and the status of the electrical power throughout the many different areas of the incident.

Hawaiian Electric provided automatic vehicle locator (AVL) data for their operations personnel assigned to Lahaina. This data shows where crews responsible for clearing streets of fallen utility poles and electrical lines, and providing access to structures, were

located at the time the Lahaina PM fire was reported through midnight on August 8, 2023 (see Figure 3.4.4.3.1).

AVL timepoints (a moment in time when an event or measurement takes place) indicate Hawaiian Electric units were positioned where downed utility poles and electrical wires were located as per the Phase One report (page 231). AVL timepoints generally decreased as the fire progressed throughout the day. As the fire extended into areas where downed electrical equipment was located, the situation became too dangerous for Hawaiian Electric units to remain in the area.

The presence of timepoints in the north area of Lahaina near the Civic Center during the 22:00 hour is consistent with the Phase One report (page 231) where a downed utility pole and electrical lines were partially blocking traffic on Hwy-30. The absence of timepoints from 23:00 to 24:00 is due to no AVL data being provided for this time period.

This could be due to conditions being too dangerous for Hawaiian Electric crews to be in the operational area. During this time, the fire had burned through the majority of Lahaina and extended as far north as the northern edge of the Wahikuli neighborhood and as far south as the Puamana area near Hwy-30 and Hokiokio Place (see Phase One Figure 4.3.1.2, page 47).

See Section 6.10 of the Appendix for a comparison of MFD, MPD, and Hawaiian Electric's AVL timepoints.

3.4.4.4 EOC Presence

A Hawaiian Electric representative was present at the Maui EOC starting at 05:15. This individual sent an email to Hawaiian Electric managers on the status of the fires and EOC operations at 06:15 (Phase One report, page 327). The email included instructions for MFD and MPD crews, stating:

"*Proactively asking the MPD/MFD where their crews are and to be sure that they assume all downed lines are energized. The MPD is checking to see if they need to request lines to be de-energized.*"

A Hawaiian Electric EOC representative was present throughout the critical periods of the incident as per the EOC sign-in sheets (Phase One report, page 316).

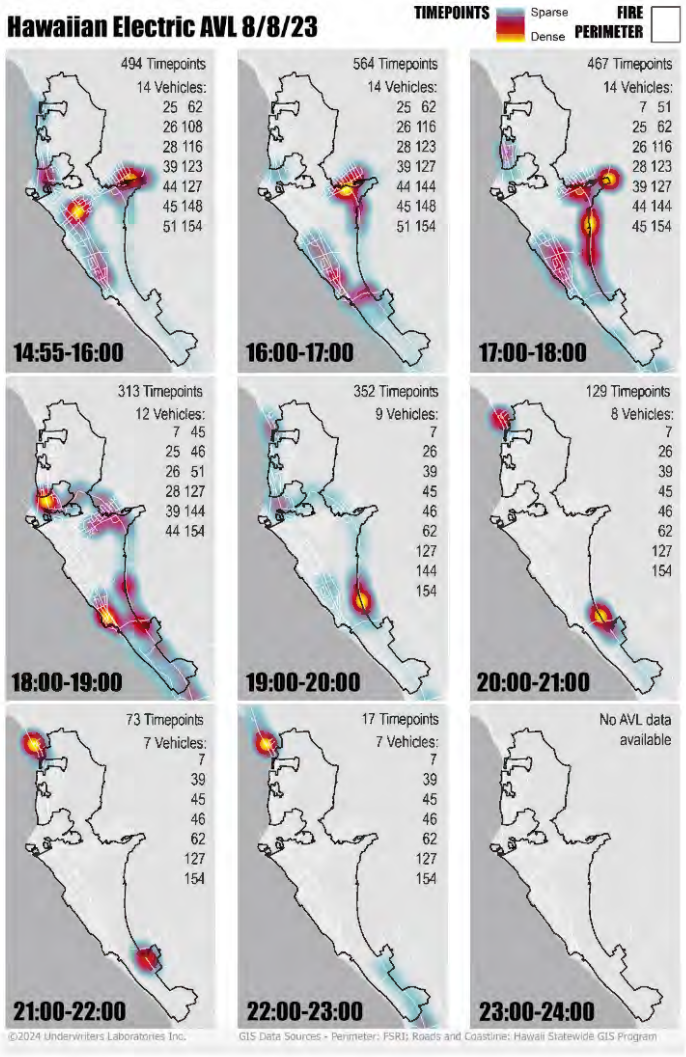


Figure 3.4.4.3.1 Hawaiian Electric AVL data for vehicles operating in the Lahaina area on August 8, 2023.

3.4.4 ANALYSIS OF SYSTEM COMPONENTS

3.4.4.5 Findings & Recommendations

28. **FINDING:** Hawaiian Electric (in partnership with the MFD and MPD) did not have an adequate staffing plan to prepare for the wildfire conditions of August 8, 2023.	**RECOMMENDATION:** Hawaiian Electric should work closely with the MFD and MPD to develop a staffing plan in preparation for high fire danger days. The plan should include implementing spotters and an artificial intelligence-enabled camera network, which can assess vulnerable areas of the infrastructure so failure points can be addressed quickly; operating a dedicated phone line to the MFD and MPD to communicate power and repair status; and assigning a representative to the ICP.
29. **FINDING:** A lack of electrical utility vegetation abatement regulations and enforcement may have contributed to vegetation at the base of utility poles and near transmission lines, creating a receptive fuel source for arcing electrical wires.	**RECOMMENDATION:** Hawaiian Electric should continue to work closely with the PUC to execute the Climate Adaptation Transmission and Resilience Program and develop a long-term investment plan to protect infrastructure from high wind events and wildfire. The plan should include immediate vegetation management and enforcement requirements, a phased approach for undergrounding transmission lines in vulnerable areas, strategic replacement of bare overhead wires with covered conductors, and a Public Safety Power Shut-off program.
30. **FINDING:** Hawaiian Electric did not have a Public Safety Power Shut-Off program in place at the time of the fire.	**RECOMMENDATION:** Establish a Public Safety Power Shut-Off program and communication protocol in collaboration with the community. Shutting off power to vulnerable areas of the grid reduces the chance of ignition due to electrical infrastructure failure.
31. **FINDING:** The lack of execution of a Hawaiian Electric pre-event organizational plan led to having to staff more field positions during the event to address problems with electrical and water infrastructure.	**RECOMMENDATION:** Hawaiian Electric to prepare a staffing plan that is coordinated with the pre-event incident action plan (IAP).

3.5 Communications

Timely and consistent communications are integral to wildfire management, connecting all three (3) tenets of the Cohesive Strategy. Clear and accurate information from trusted sources is crucial during incidents for overall safety, operational effectiveness, and community-related actions.

For resilient landscapes, effective communication informs land managers about best practices for vegetation management, fire prevention, and operational changes during high-risk periods. In fire-adapted communities, educating residents about fire risks, defensible space, and evacuation procedures ensures proactive risk reduction and readiness.

For safe and effective response, continuous communication within and among response agencies enables coordinated efforts, while public communication about evacuation routes and orders ensures safe evacuations. Emergency alert systems (EAS), supported by pre-event educational campaigns about their uses and meanings, provide timely warnings and instructions, enhancing overall preparedness and response efficiency.

During the August 8-9, 2023, fires, there were several key communication tools available to, and used by, County of Maui residents, government officials, and others, including the wireless emergency alerts (WEA) system, wireless phones, a public safety radio system, traditional landlines, voice over IP (VoIP), and satellite phones. It is important to develop strategies for communicating when technology fails.

Wireless (cellular) telecommunications service availability and effectiveness appears to have been highly variable at the time of the fire, as indicated by residents (Section 3.5.1.1), and likely the result of multiple factors, such as:

- Individual wireless carrier/providers
- Individual or organizational subscriber's specific service type or plan
- A person's particular location
- Desired mode of transmission (i.e., voice call, SMS text, or app-based messaging)
- Local/area network traffic at the time of transmission/receipt

It should also be noted that 911 calls continued to be received by dispatch throughout August 8, 2023, indicating there was service. Understanding the degree to which the cellular network was out of service on August 8, 2023, is difficult to determine due to the limited data available at the time this report was published.

For August 9-12, 2023, the Federal Communications Commission report indicates that 100% of the cell sites were out of service (Figure 3.5.1).

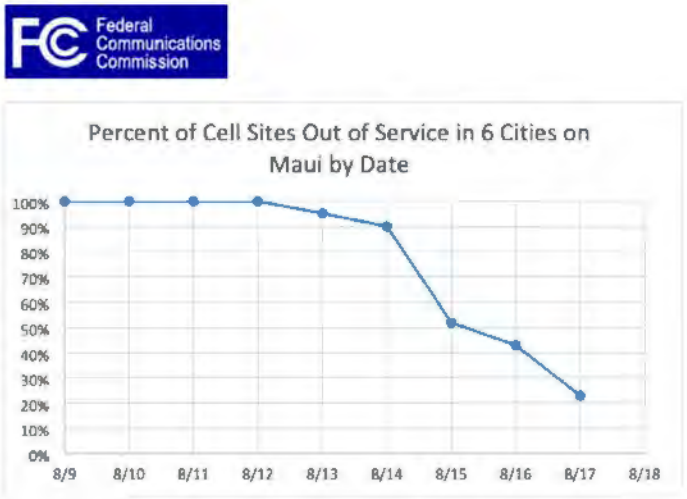


Figure 3.5.1 FCC-registered cell sites out of service in the County of Maui, HI. Source: Federal Communications Commission, Communications Status Report for Areas Impacted by Hawai'i Wildfires August 9-17, 2023.

3.5.1 ANALYSIS OF SYSTEM COMPONENTS

The dedicated public safety radio system used by County of Maui agencies appears to have been fully-functional throughout August 8-9, 2023, and was used by first responders during the incident.

Off-island communication could also be accomplished with landline telephones using POTS (plain old telephone system) or VoIP technology. Satellite phones were also an option for the limited number of people who have access to these devices.

Regardless of the technical mode of communication, the "human" factor must always be accounted for, such as (1) understanding the message content as intended by the sender(s); and (2) taking action(s) based on the content of the message(s) and/or the sender's direction(s)—if applicable.

3.5.1 Public Communications

The preparedness and actions taken (or lack thereof) during the Lahaina PM fire, by both the public and response agencies, was impacted by how key communications were handled, including Red Flag Warnings, notices of potentially extreme fire behavior, and evacuation plans.

From the documentary evidence provided, the County of Maui and others sent multiple public-facing messages, which warned of impending weather conditions, provided fire notifications, and directed evacuations. Most of these messages were transmitted using the nationwide WEA system that relies on commercial carrier cellular networks for effective transmission. Other messaging was sent that required recipients to have access to other forms of communication technology.

Wireline and cable telecommunications services were also rendered inoperable for many subscribers from the impacts of the August 8-9, 2023, fires, including electrical failures, fire impingement, etc. (Figure 3.5.1.1)

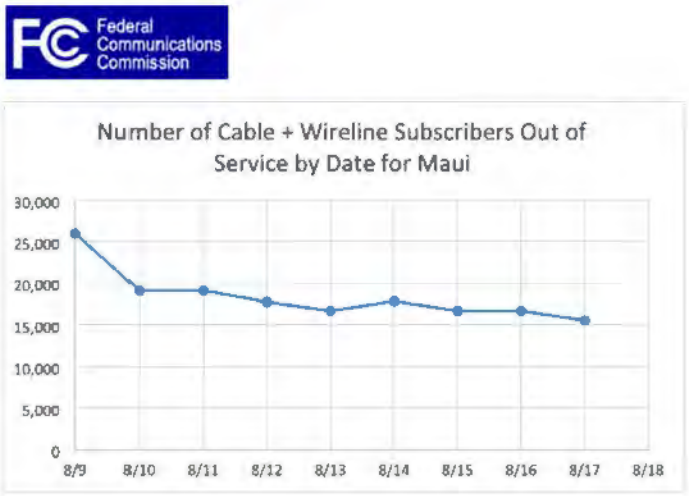


Figure 3.5.1.1 Number of cable and wireline subscribers out of service by date for Maui.[149]

According to the Federal Communications Commission, public AM and FM radio stations across Maui remained operable during the August 2023 fires.

3.5.1.1 Observations and Experiences from Resident Technical Discussions

In TDs with Lahaina residents, 71 individuals responded to the question: Did you receive a text notification from the county regarding the high winds and high fire danger?

- 87% (62/71) stated they did NOT receive a text notification
- 13% (9/71) stated they DID receive a text notification

There were many comments regarding text notifications. The majority of the residents stated they received no notification prior to or during the event. Some stated that they did not receive texts/ alerts while the person next to them did.

3.5.1 ANALYSIS OF SYSTEM COMPONENTS

Another experience shared was that the alert appeared as a scrolling message that could not be retrieved or reread. Overall, residents felt the text notifications were ineffective because they did not reach everybody. And for those that did receive them, some felt it did not adequately inform them of the urgency of the situation.

The experiences of the residents point to challenges with cell signals as stated above, but could also be due to lack of message clarity. These challenges should both be topics of further study.

3.5.1.2 Outdoor Warning Siren System

The State of Hawai'i maintains an All-Hazard Outdoor Warning Siren System (previously known as the County of Maui Outdoor Warning Siren) within each county to alert residents of natural and human-caused events.[150] The County of Maui provided no evidence of discussing siren activation prior to, or during any, of the four (4) Maui wildfires on August 8-9, 2023.

The effectiveness of warning sirens remains an open question. On August 8, 2023, it seems unlikely that—if the sirens had sounded—Maui residents and visitors alike would have known what the signal(s) meant they should do. At the same time, siren activation may have provided an additional cue to alert residents of an emergency and to seek further information.

Sirens are placed strategically around the island and can be activated within specific geographic areas. Sirens have been traditionally used to alert residents of impending tsunamis. According to HI-EMA staff, there has been an emergency siren trigger every 3-5 years on average.

Both the state and the county have the capability to sound the sirens (broadly or localized to a specific area), but the state coordinates with the counties prior to triggering any alerts. Although the sirens can be used for other types of emergencies, the false missile alert of January 13, 2018,[151] has caused some hesitancy in using them for other emergency situations. The sirens are based on mobile connection and during disruptions of cellular service, the sirens may not work.

Siren test records indicate approximately 20% of the sirens statewide are inoperable on any given day (Appendix Section 6.11). The counties are responsible for monthly testing of the siren system and for reporting those results to HI-EMA.

The TELCOMM branch within HI-EMA is required to maintain and repair the sirens. There is no set maintenance schedule for the sirens. HI-EMA does not have adequate staffing to keep up with the maintenance of the siren systems. Sirens within tsunami zones are given priority for repair.



3.5.1 ANALYSIS OF SYSTEM COMPONENTS

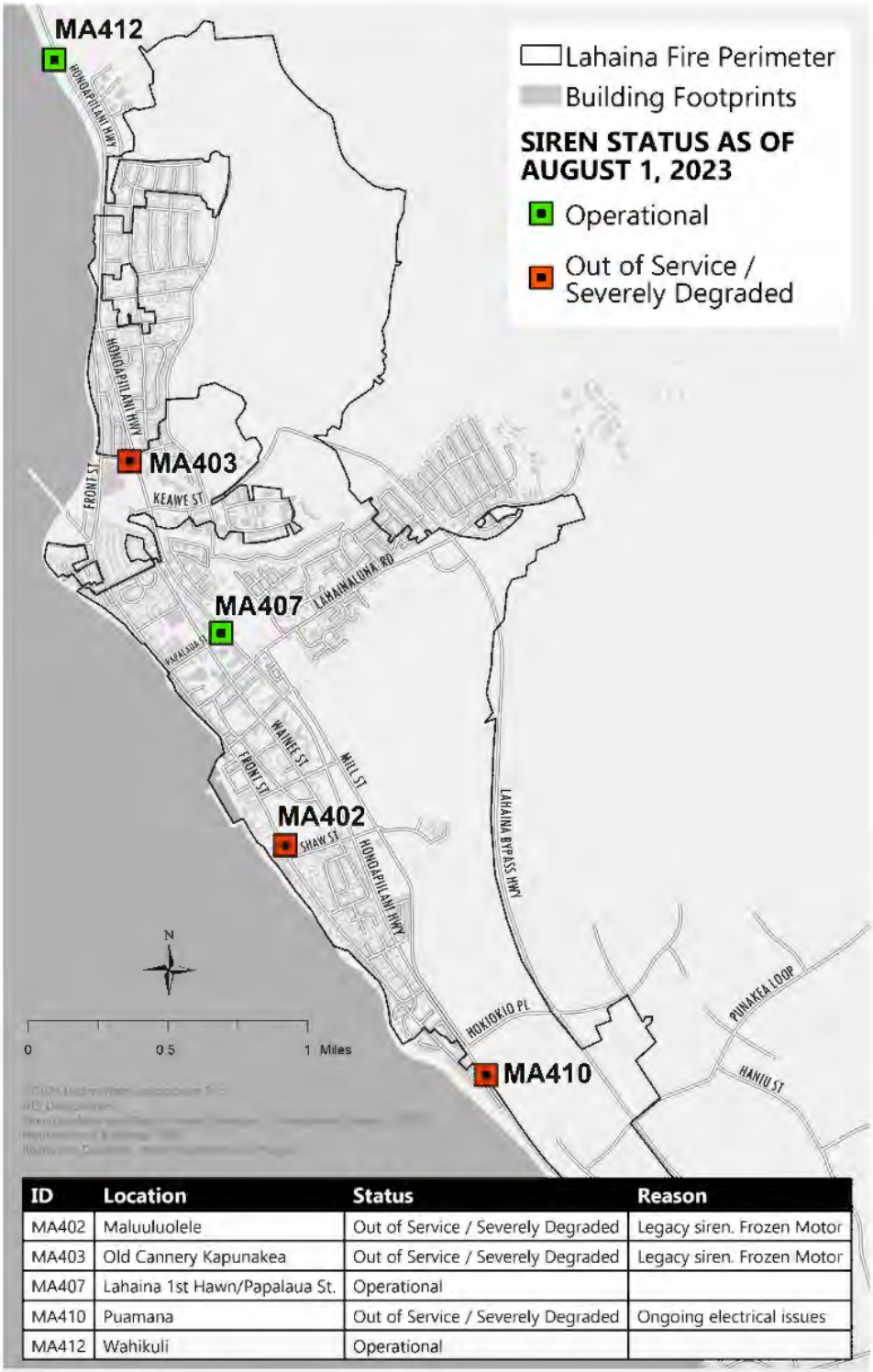
Prior to the Lahaina PM fire, the sirens had never been used for warning of WUI fires (including the 2018 Lahaina fire). During TDs with MEMA and HI-EMA members, they stated that activation of the siren system was not discussed during August 8, 2023.

On August 8, 2023, there were five (5) sirens located off of Hwy-30 and near the coastline in the area of the Lahaina PM fire[152] (Figure 3.5.1.2.1). According to siren test records (Appendix Section 6.11) provided by both MEMA and HI-EMA, siren MA407, located near Papalaua Street and Hwy-30, and siren MA412, located off Hwy-30 just north of the Lahaina Civic Center, were the only two sirens operable at the time of the fire.

The records provided are exception-type reports, where only inoperable sirens are listed for each county. Although siren's MA407 and MA412 may have been operable on or before August 8, 2023, they were also very likely inoperable throughout August 8, 2023, due to the area experiencing intermittent cell service. Without a reliable cell signal, it would have been difficult to activate them.



3.5.1 ANALYSIS OF SYSTEM COMPONENTS



ID	Location	Status	Reason
MA402	Maluuluolele	Out of Service / Severely Degraded	Legacy siren. Frozen Motor
MA403	Old Cannery Kapunakea	Out of Service / Severely Degraded	Legacy siren. Frozen Motor
MA407	Lahaina 1st Hawn/Papalaua St.	Operational	
MA410	Puamana	Out of Service / Severely Degraded	Ongoing electrical issues
MA412	Wahikuli	Operational	

Figure 3.5.1.2.1 Map displaying locations and functional status of Lahaina outdoor warning sirens as of August 1, 2023 (first business day of the month = siren monthly test day). Base map provided by https://hiema.maps.arcgis.com/apps/dashboards/226e62cd78f340c29e52d4f38c46ac21. Siren status and maintenance records provided by MEMA and HI-EMA.

3.5.1 ANALYSIS OF SYSTEM COMPONENTS



Figure 3.5.1.2.2 The public sirens in Lahaina on August 8, 2023, and their operational status as of July 12, 2024. Source: ARCIS.

The status of the State of Hawai'i Outdoor Warning Siren System is shared via the Public Siren Dashboard.[153] The July 12, 2024, dashboard for the Lahaina area in Figure 3.5.1.2.2 indicates that MA412, just north of the Lahaina Civic Center, is currently (as of July 2024) the only operable siren.

It also identifies four (4) of the five (5) Lahaina sirens as "Beyond Repair." Although the specific reason for being out of service is not disclosed, it is likely MA407 sustained significant thermal damage due to being directly in the fire's path.

Test and maintenance records for MA402, MA403, and MA410 indicate they had been out of service for several months prior to August 8, 2023 (Appendix Section 6.11).

Since the Lahaina PM fire, HI-EMA has taken an all-hazards approach to utilizing the siren system. Adopting the use of this "all-hazards policy"[154] requires additional public education about what a siren alert may mean and how the public should respond.

Maintenance of the system also needs to be addressed to ensure an adequate number of sirens are operational to effectively alert residents of the hazard.

Approximately two (2) weeks after the August 2023 fires, HI-EMA coordinated with the County of Maui and activated localized (geomapped) sirens for a wildfire.

3.5.2 ANALYSIS OF SYSTEM COMPONENTS

3.5.2 Emergency Responders

By all accounts, the County of Maui's land mobile radio (LMR) system—used by the MFD and MPD—remained fully functional, from a technical/serviceability standpoint, throughout the duration of the fires.

One of the communication challenges identified by responders was having to wait for open airtime on the radio to be able to transmit. This challenge is clearly evidenced from the master timeline where it is common to see 10-12 transmissions per minute during the height of the Lahaina PM fire operations. Options for reducing the communications load on the radio system were limited due to the simultaneous Olinda, Kula, and Pūlehu-Kīhei fires using the other tactical channels and having no additional dispatchers.

Both the MFD and MPD maintain a radio communications standard operating guideline (SOG) within their general policies. The MFD's Radio Communications policy (E.O. 300.04) was last revised on July 21, 2020, with an effective date of September 1, 2020 (Appendix Section 6.12.3).

The MPD's Radio Communications policy (G.O. 301.5) was last revised on December 23, 2021, with an effective date of February 28, 2022 (Appendix Section 6.12.4). Although each agency generally followed their radio communications SOGs, there were areas where personnel indicated improvements could be made. These areas will be explored within this section.

3.5.2.1 Central Dispatch

The 911 center ("Central"), located at Wailuku Police Station, is responsible for 911 emergency call-taking and dispatch, answering non-emergency calls, and answering and assisting with police administrative calls for the County of Maui (including a secondary location on Molokaʻi for coverage of Molokaʻi and Lānaʻi). Central dispatches the MPD, MFD, and AMR (American Medical Response) emergency medical services ("Med Comm"). During emergency events, Central is responsible for incident coordination, personnel tracking, and potentially assisting with resource requests from field personnel (e.g., requesting Hawaiian Electric's assistance).

Central staff are trained in call-taking (e.g., answering emergency, non-emergency, and MPD administrative calls), and are cross-trained to dispatch and monitor incidents for police, fire, and medic units. Each dispatcher is trained to staff the terminals and radio channels. Staffing may rotate on a daily basis.

On the island of Maui, Central has five (5) radio consoles, including a dispatch terminal, three (3) call-taking terminals, and one (1) training terminal that can be put into use if needed. Staffing on the island consists of a supervisor and three (3) dispatchers. This is considered "normal" staffing on a day-to-day basis.

During the Lahaina PM fire, MPD officers primarily used the Main D-1 Dispatch channel for calls for help or service, while also having the option to switch to tactical channels as needed. Tac 1 saw a lot of use, particularly by an Assistant Chief and the Lahaina MPD Captain, who coordinated their efforts and discussed various operational details. Tac 2 was also available and referenced occasionally, providing an additional communication line.

At 17:51 on August 8, 2023, Assistant Chief Reid Pursley (A-4) began using the radio extensively on the main dispatch channel and Tac 1, discussing operations, the National Guard, and the Red Cross with the captain. Pursley had a significant amount of radio traffic at the EOC level.

He transmitted 237 times during the fire, with 227 broadcasts after 17:52 when he began working from the EOC, covering logistics, planning, closures,

evacuations, possible deaths, and road conditions. Throughout the incident on the evening of August 8, 2023, the captain and Assistant Chief Pursley mainly used Tac 1 to communicate.

Initially, the Kīhei and Lahaina districts (District 6) shared the same primary dispatch radio. However, at 20:57, dispatch advised all non-Lahaina units to switch to a different channel called the Kīhei PD channel. Consistently, through every interview, officers confirmed the radio system infrastructure was working well. They could receive and transmit messages, although sometimes it was difficult to hear when they were out in the hurricane/fire area wind. Overall, the radio system functioned effectively.

Central is also responsible for six (6) fire department (FD) channels. When a dispatcher answers an incoming call, they are responsible for the entirety of that call (i.e., dispatch of units and monitoring tactical radio operations until the resolution of an incident). The primary radio channel for fire operations is FD1. Multiple incidents may use FD1 as the primary communication channel between Central and field personnel.

On August 8, 2023, Central had five (5) dispatchers operating on Maui responsible for emergency, non-emergency, and administrative calls. As calls began to stack in Central, one (1) dispatcher on Moloka‘i, without notification or preparation, began receiving emergency calls from Maui. Police channels were also in use and being monitored by Central dispatchers.

Due to the multiple fire events, as well as other emergency calls across Maui, individual dispatchers were responsible for monitoring, tracking, and dispatching response, and assisting with resource requests for multiple large-scale events. The lack of radio channels, coupled with limited infrastructure and personnel, added to communication challenges during this event.

3.5.2.2 MFD and MPD Communications

Some firefighters were responding in relief apparatus (older apparatus that were no longer front line) and utility vehicles (typically standard pickup trucks—no water tank or pump—used to transport personnel into the operational area) that were not equipped with individual portable radios. Face-to-face communications were challenging for responding personnel due to the severe wind and low visibility from heavy smoke and fire.

Firefighters were entering Immediately Dangerous to Life or Health (IDLH) environments without the ability to readily communicate with each other. This may have led to complications during the mayday/burn-over event (see Section 3.7.4.2), as well as a report of a missing firefighter on August 9, 2023, during fire suppression efforts in the Launiupoko neighborhood.

The lack of a standardized call sign for self-deploying MPD officers hampered coordination and accountability. Without clear and unique identification, the communications center and other on-duty personnel struggled to identify who was on scene. This led to challenges in tracking resources, assigning tasks, and managing the overall response.

The absence of a clear call sign system for self-deploying officers can result in overlapping assignments or critical areas being neglected. Safety and risk management are key considerations. Knowing the precise identity and location of every officer on scene is crucial for safety, especially in hazardous situations or when an officer requires immediate assistance.

To reduce confusion in the future, Section III.F. Assignment of Radio/Call Designations of G.O. 301.5 (Appendix Section 6.12.4) could be enhanced to address how self-deploying resources obtain a radio designator when conditions require an all-hands response.

3.5.2 ANALYSIS OF SYSTEM COMPONENTS

Cellphones are also a critical communication tool for responders, which are used to communicate via voice (longer messages), transmit confidential information that should not be communicated over the radio, address non-emergent needs (e.g., staffing), back-up radio communications, and document conditions (record video or photos).

In many instances, responders reported that cellphones were unreliable, which contributed to the lack of coordination between on-scene resources, support personnel, supervisors, and the EOC.

3.5.2.3 Channel Operations

Police channels operate separately from Fire channels, and it has not been the past practice for field personnel to communicate directly with other agencies (i.e., police cannot hear fire/medic traffic and fire/medics cannot hear police channels).

MFD portable radios do not have a scan function (i.e., the ability to automatically hear traffic on another channel), rather personnel must physically change the radio channels. These factors may have contributed to a lack of situational awareness for the firefighters operating on the Upcountry fires, as it pertained to the Lahaina PM fire, or for firefighters operating at different locations on the PM fire.

3.5.3 Private Equipment Operators

Private contractors providing heavy equipment have become integral in MFD and DLNR-DOFAW wildfire suppression. The MFD and DLNR-DOFAW maintain formal and informal agreements with multiple private contractors for use of dozers, loaders, excavators, and water tankers, which are needed to supplement each organization's limited resources.

These private contractors mostly rely on cellular service both for dispatch instructions and for operational coordination. Although the MFD and DLNR-DOFAW also maintain a limited cache of tactical radios that can be provided to the private contractors, they were not trained to use portable radios.

During the Lahaina PM fire, cellular service was intermittent or unavailable. The responding private assets relied on communications with Central and face-to-face communications with MFD crews. Coupled with the loss of public water access, the inability to communicate reliably via cell phones led to a lack of coordination and reduced effectiveness of private water tankers. At times during the Lahaina PM fire, MFD personnel flagged down water tankers to initiate protective measures and structural firefighting.



3.5.4 ANALYSIS OF SYSTEM COMPONENTS

3.5.4 Findings & Recommendations

32.	**FINDING:** Central Dispatch ("Central") was limited by the availability of equipment and personnel.	**RECOMMENDATION:** Expand Central's surge capacity by increasing the terminals/necessary equipment for call taking and dispatching operations and consider training personnel (including members from the MFD and MPD) to serve as "call takers" capable of transferring emergency 911 calls, and managing the non-emergency/administrative calls. **RECOMMENDATION:** Complete a comprehensive study of Central Dispatch to assess staffing, workloads, and technology to identify any gaps or additional resource needs to help ensure resilient communication during major emergencies and disasters.
33.	**FINDING:** Central Dispatch, and many other responding personnel, were deeply affected by this incident.	**RECOMMENDATION:** Continue providing opportunities for individuals and crews to meet for a "report back/ debrief." Ensure members know warning signs for PTS, PTSD, depression, suicide, and related impacts on personnel mental health. Provide access to Employee Assistance Programs (EAP) and peer support networks—encourage use when warning signs are present.
34.	**FINDING:** Dispatchers were responsible for monitoring multiple large fires and other associated events. Most of the dispatchers were experienced, but all dispatchers were overwhelmed and some expressed lack of adequate knowledge, ready access to needed information, and concern about the safety of the instructions they were providing callers. There were persistent communication challenges between Central, the MPD's Department Operations Center (DOC), and the EOC.	**RECOMMENDATION:** Staff a MFD fire officer and a MPD officer at the rank of lieutenant (or higher) in Central Dispatch to aid with operational monitoring, EOC/DOC coordinations, incident tracking, communications, and assistance with command decisions when the EOC is activated.

3.5.4 ANALYSIS OF SYSTEM COMPONENTS

3.5.4 Findings & Recommendations

35.	**FINDING:** Private equipment operators primarily communicate with response entities and field personnel using personal cell phones.	**RECOMMENDATION:** Create a formal communication plan for private contractors to use during emergency situations that includes resilient hardware and appropriate training.
36.	**FINDING:** Many residents did NOT receive a text notification from the county regarding the high winds and high fire danger.	**RECOMMENDATION:** Assess the resiliency of communication systems and establish redundant public alert programs and warning processes, including best practice messaging guidance.
37.	**FINDING:** Only one (1) siren from the All-Hazard Outdoor Warning Siren System was operable within the burn perimeter of the Lahaina area on August 8, 2023.	**RECOMMENDATION:** Implement a statewide sustainable program for the All-Hazard Outdoor Warning Siren System, which includes functioning hardware resilient against mass communications failure, regular maintenance, public education, and additional resources and staffing.
38.	**FINDING:** The All-Hazard Outdoor Warning Siren System had not been utilized for warning of WUI fires prior to August 8, 2023. As of the publication date of this report, MEMA has implemented a process for activating sirens for wildfires.	**RECOMMENDATION:** N/A
39.	**FINDING:** Even when people were told to evacuate and conditions seemed obvious that evacuation was necessary, many refused because there did not appear to be official notification that danger was imminent.	**RECOMMENDATION:** Engage the community to provide additional public education regarding the importance of what to do in an emergency and to heed all evacuation instructions.

3.6 Incident Management

Incident management is crucial for a coordinated and effective wildfire response, aligning with the Cohesive Strategy goals of protecting lives, property, and natural resources through timely communication and risk management. The Safe and Effective Response involves pre-incident planning, risk assessments, resource inventories, agency engagement, and tactical response strategies.

During a wildfire, incident management coordinates communication and tactical decision-making through unified command structures, monitors real-time fire behavior and weather conditions, and ensures rapid deployment and synchronization of available resources. Additionally, incident management oversees evacuation efforts, ideally providing accurate and timely information to the public about fire status, evacuation orders, and shelter locations.

3.6.1 MFD Incident Management

The MFD has standard operating procedures (SOPs) that require incident command systems (ICS) to be used for managing all types of emergency incidents, including fire events (Appendix Section 6.12.4). The department routinely employs ICS to successfully resolve emergencies, including wildfires and structural fires. FSRI team members have observed MFD units using ICS to manage incidents since the August 8-9, 2023, fires.

The MFD's existing ICS was used to manage the Lahaina AM fire to a point where the fire was determined to be "extinguished." After which, the IC role was transferred from the on-duty battalion chief back to an engine company supervisor.

At the beginning of the Lahaina PM fire, it appears the MFD's ICS was used effectively until the fire jumped the Lahaina Bypass and became a fast-moving urban conflagration that quickly overwhelmed the department's available resources. Nonetheless, the MFD always had a designated IC for the Lahaina PM fire.

On both the AM and PM fire, the MFD and MPD would have benefitted from a unified command post, which could have enhanced the coordination of operational tasks, streamlined communication, and improved situational awareness. A unified command increases the likelihood that all responding units work toward common objectives, reduces misunderstandings, and optimizes strategic goals.

Throughout the balance of the Lahaina PM fire, MFD chief officers—in their roles as ICs—established multiple ICS groups and divisions in an attempt to manage the fire. These efforts were hampered by the complex, dynamic, and fast-moving nature of the fire, and were compounded by the severe resource constraints under which the MFD was operating during this entire period.

It is also apparent that neither the ICs nor anyone else had sufficient information on the full scale of the incident to develop an accurate common operating picture (COP) of the situation in Lahaina until aerial assets became available after daylight on August 9, 2023.

3.6.2 MPD Incident Management

While the MPD has a policy—ICS and SRT Operations (G.O. 412.1)—in place for managing incidents, there was limited expansion of the ICS during the Lahaina PM fire on August 8, 2023, particularly in the context of the large-scale evacuation of residents (Appendix Section 6.12.6).

Most tactics employed by the MPD were focused on task-level operations of traffic coordination and evacuation. These tasks did not benefit from a fully expanded ICS structure that would have provided a more strategic and coordinated approach.

3.6.3 ANALYSIS OF SYSTEM COMPONENTS

The MPD and MFD do not have a history of establishing a unified command on emergency responses where both departments are operational. The lack of prior experience and practice in unified command operations meant that during the PM fire, there was inadequate coordination and integration between the two (2) departments. The MPD Lahaina captain, while actively engaged on the streets of Lahaina at the task level, did not establish a formal command post with the MFD.

It is notable that on August 9, 2023, the MPD did establish a Department Operations Center (DOC). The DOC served as a centralized hub for coordinating response efforts, as well as facilitating communication, resource management, and strategic planning. Establishing the DOC allowed the MPD to better organize their recovery efforts, streamline information flow, and improve situational awareness.

3.6.3 Analysis of MFD and MPD Incident Management

When analyzing MFD and MPD responses to the fire, it is important to take into consideration that on the morning of August 8, 2023, the MFD was fighting multiple wildfires simultaneously, with limited available personnel, vehicles, and equipment resources.

On that morning, it appears the entire on-duty complement of the MFD assigned to the island of Maui, plus many “off-duty” firefighters staffing relief apparatus and support vehicles, were fighting the Upcountry fires, working the Lahaina AM fire, or responding to other emergency incidents across the island.

Given the high winds, helicopters were not available after 11:26 on August 8, 2023, to help with fire suppression, nor could Hawai‘i Army National Guard (HIARNG) helicopters fly to Maui to assist.

It seems likely the MFD crews that responded to the Lahaina AM fire were aware of these resource limitations. From the dispatch records, it is clear that these units were responding to, or being requested at, other emergency incidents for the duration of that morning.

From the very start of the Lahaina PM fire, MFD and MPD resources in and around Lahaina were overwhelmed.

In fact, given the conditions and limited resources available, the front-line firefighters, police officers, medics, Coast Guard members, lifeguards, and ordinary Lahaina residents made an extraordinary number of rescues—often at great personal risk.

Off-duty MFD firefighters and MPD police officers left their own homes, some of which were at risk from the Lahaina PM fire, and responded throughout the incident. These dedicated first responders did their best to cobble together the necessary vehicles (in some cases privately owned), equipment, and personnel to place additional response units in-service. Their collective efforts are admirable and unquestionably resulted in saving lives across Lahaina.

The MFD command staff was also stretched thin for the entire period from August 8-9, 2023, as they attempted to manage several major fires in Olinda, Kula, Lahaina, and Pūlehu-Kīhei simultaneously. Throughout the time of the Lahaina PM and Upcountry fires, the IC for each of the fires was a battalion chief.

It is perfectly reasonable and understandable that the fire chief, in any fire department, will occasionally be unavailable due to the same range of circumstances as any other employee. During the time of the Lahaina PM fire, the MFD Fire Chief was out of town on personal leave (Phase One report, page 41).

3.6.3 ANALYSIS OF SYSTEM COMPONENTS

The other command officers, Deputy Chief Fire 2 (F2) and Assistant Chief Fire 3 (F3), appear at various points in the dispatch record, but did not establish themselves in relevant tactical or strategic positions, nor did they assume the IC role for any of the fires on August 8-9, 2023 (Phase One report, pages 188-192).

Sometime after 17:30, F2, F3, and BC3 left the Lahaina PM fire to travel to the hospital where E6 Captain was being transported. This relocation of staff took three (3) chief officers out of command functions and left BC5 alone to command the fire. See Section 3.7.4.2 for more information on the E6 Mayday.

Given the size and scale of the Lahaina PM and Upcountry fires, the entire operation would have benefitted from experienced, high-level command engagement. The PM fire, with all of its emergent conditions (i.e., failing infrastructure, hurricane force winds with fire, and blocked egresses), demanded the attention of augmented incident command overhead.

It is these types of large incidents that require top-level chief officers to be in charge, making strategic decisions, interfacing with assisting and cooperating agencies, and implementing an incident action plan. Possible roles F2 and F3 could have filled were Area Commander (if Area Command was implemented) and Lahaina Incident Commander.

BC5 and BC3 could have assisted in command support roles or as Deputy Area/Incident Commanders. This organization may have improved communications with the Assistant Chief (F4), who was the MFD liaison in the County of Maui EOC for the duration of the incident.

It also appears that there was no one formally in charge of strategic resource allocation or future planning. This is perhaps to be expected during the Lahaina PM fire, since the MFD was overwhelmed from the start.

It is surprising that the MFD and MPD did not prepare more for these Red Flag conditions, especially given the advance warning provided by NWS Honolulu and having previous experience with the 2018 Lahaina Fire. As mentioned in Section 2.1, this lack of preparation could be related to the lack of attention wildfire preparedness and prevention receives statewide.

Based on our findings, it does not appear that any consideration was given to adding resources in advance of the Red Flag days, or planning responses to various “what-if” scenarios, from a strategic and resource deployment perspective.

There is an opportunity for the MFD, MPD, DLNR-DOFAW, and MEMA to work on their joint/shared procedures for incident management, in particular the value of unified command and area command(s) for managing major wildfire incidents with a multi-/interagency/-jurisdictional footprint.

These procedures are very common in many other jurisdictions across the United States, where cross-agency communication, collaboration, and coordination are almost always needed continuously throughout major incident responses and recovery operations.

The value of establishing a fixed (unified) ICP with representatives from all key responding agencies should be reinforced. The MFD, MPD, Hawaiian Electric, MEMA, County of Maui Department of Water Supply, and/or DLNR-DOFAW could be included depending on the type of incident and in what jurisdiction it occurs.

3.6.3 ANALYSIS OF SYSTEM COMPONENTS

Training for private operators and procedures for ensuring communication, coordination, and collaboration with those firms and individuals is also important from a resource management and operational safety perspective.

The MFD has used the Blue Card Incident Management System (IMS) training in the past and appears to be currently engaging in additional training and implementation opportunities. These efforts will benefit from synchronization with, and participation from, partner agencies/organizations, including MEMA, the MPD, the DLNR-DOFAW, HDOT, and Aircraft Rescue and Fire Fighting (ARFF).

The MFD also sponsors a county-wide Type 3 incident management team[155] (IMT) that could be useful for major events, especially if activated and used prior to an emergency, potentially during periods where extreme weather, or other potentially challenging scenarios that might be reasonably anticipated. IMTs can play a central role in organizing resources, coordinating efforts, and ensuring efficient communication during preplanned and emergency incident operations.

3.6.4 EOC Operations

Like the MFD and MPD, MEMA went into August 8, 2023, understaffed and with limited available resources.

County of Maui Mayor, Richard Bissen, received a text alert around 05:00 and went directly to the EOC, arriving at approximately 06:00/06:30. He reported that, over the course of August 8-9, 2023, “we were opening shelters left and right, 6 or 7.”

Due to changing conditions, such as the approaching fire front, loss of power, and loss of water, shelters were opened, closed, or relocated throughout the incident.

MEMA ostensibly uses the National Incident Management System (NIMS) for incident management during EOC activations. NIMS utilizes the ICS to define the operating characteristics, management components, and structure of incident management organizations throughout an incident.

According to FEMA, NIMS-ICS is a comprehensive, national approach to incident management that is applicable at all jurisdictional levels and across functional disciplines.

The intent of NIMS-ICS is to be applicable across a full spectrum of potential incidents and hazard scenarios, regardless of size or complexity, and improve coordination and cooperation between public and private entities in a variety of domestic incident management activities. NIMS-ICS provides a consistent nationwide template to enable all government, private-sector, and nongovernmental organizations to work together during domestic incidents.

Due to severe weather alerts, MEMA staff made a decision to partially activate the EOC on the afternoon of August 7, 2023. Two (2) MEMA employees reported to the EOC that afternoon at 21:00 to monitor conditions within the County of Maui. This activity is consistent with the EOC Activation and Deactivation SOGs (pages E-1 and E-2) within the County of Maui Emergency Operations Plan (EOP).[156]

Overnight, the first report for the Olinda fire was received at 00:22. As the wind severity intensified, widespread reports of power outages, road obstructions, downed poles and powerlines, and structural damage increased. Emergency call volume continued to increase, with the Lahaina AM fire reported at 06:34 and the Kula fire at 11:27.

Agency representatives began to self-report to the EOC throughout the day. However, the EOC was not

3.6.4 ANALYSIS OF SYSTEM COMPONENTS

fully activated until 16:30 when representatives from all county and partner agencies were required to report. Although many EOC members were present prior to full activation, the delay in declaring full activation, coupled with the delayed posting of the Maui Emergency Proclamation, is not in alignment with the County of Maui EOP.

In addition to the challenges associated with the Upcountry fires, by 16:30, the Lahaina PM fire had already burned over nearly all MFD resources and residents living in the Lahainaluna neighborhood east of (mauka) Hwy-30.

At the time of the PM fire, MEMA had a staff of nine (9) full-time personnel. In addition to their daily planning and preparedness duties, each MEMA staff member is trained to assume a specific ICS role during EOC activations. The MEMA administrator, who is appointed by and reports directly to the Mayor, serves as the EOC Director during EOC activations.

Other positions filled by MEMA staff members may include: Operations Section Chief, Planning Section Chief, Logistics Section Chief, Recovery Section Chief, County PIO, Mitigation Specialist, and Situation Awareness Lead. Each role has defined responsibilities, support functions, and expected deliverables.

On August 8, 2023, seven (7) of the nine (9) MEMA personnel were on Maui (the MEMA Administrator was on O‘ahu attending an emergency management conference and one (1) staff specialist had been deployed for training with the National Guard).

When the MEMA Administrator is not available, each staff member is expected to “bump up” to a different position, or positions, within the NIMS-ICS framework to ensure all essential emergency functions are covered. In this case, the Operations Section Chief became the Acting MEMA Administrator/EOC Director, the Planning Chief was assumed to fulfill the role of Operations and Planning Chief, and so on.

There were more roles than there were MEMA personnel, which may have led to some overlap and gaps within essential functional areas.

Through TDs conducted individually with MEMA personnel, it appears there was a lack of clarity as to who was filling each role, and what their corresponding responsibilities were, within the EOC. MEMA staff gave conflicting accounts as to who was responsible for the specific support functions as the events of August 8, 2023, unfolded.

Additionally, there were conflicting accounts regarding communications and briefings occurring within the EOC. Some MEMA staff stated formal briefings (where all agency representatives gather during regular intervals to report priority information regarding the incident) were being held at regular intervals, whereas other staff members did not recall the occurrence or schedule of any formal briefings.

It is also unclear if timely and accurate situation reports (sitreps)—a standard practice during any EOC activation—were being drafted or distributed with any regularity, or who (if anyone) was assigned this responsibility.

NIMS-ICS best practices call for the development of formal incident action plans (IAP) for each operating period to help monitor the scale and trajectory of the incident and ensure continuity of operations and situational awareness among oncoming and off-going shifts.

The intense pace of the incidents made it difficult for MEMA staff to provide regular status reports. These factors likely contributed to a lack of situational awareness and recognition of the severity of the Lahaina PM fire within the EOC.

3.6.4 ANALYSIS OF SYSTEM COMPONENTS

Given the range of hazards across Maui Nui and the lack of immediate mutual-aid, it seems likely that MEMA does not have a sufficient budget/personnel allocation to effectively and sustainably perform the wide range of preparedness, response, and recovery missions assigned to it; this was starkly evident on August 8-9, 2023.

For any EOC to fulfill these critical functions, it must be properly staffed and operationalized with designated representatives from all cooperating/involved agencies/organizations to provide subject matter expertise, resource coordination/tracking, and immediate information relays to ICs in the field.

Through TDs with EOC representatives, challenges within the EOC became clear. Multiple personnel reported that as the incidents escalated, the EOC became crowded within its limited space (the FSRI team was not permitted to physically visit the space). It was reported that communication within the EOC was challenging due to these space limitations.

Individuals had to find alternate work locations, such as using the kitchen and other common areas, to monitor and support operations, which may have contributed to miscommunications and missed information.

In the months prior to the August 8, 2023, fires (exact date not provided), MEMA transitioned to the WebEOC platform for EOC incident reporting and tracking. MEMA utilizes software, such as WebEOC, during routine and emergency activations for a variety of functions, including, but not limited to:

- Drafting and storage of IAPs
- Providing situational awareness among county-level EOC cooperators
- Tracking evacuations and shelter openings
- Sending requests for information (RFIs) and RFAs to HI-EMA

HI-EMA also uses WebEOC for similar functions at the state-level.

It is important to note that, while the systems are technically interoperable, the county and state WebEOC systems have been maintained as separate platforms requiring different levels of permissions. MEMA staff cannot readily or routinely view HI-EMA's WebEOC files or system, and the state does not have access to the County of Maui's WebEOC framework.

Through TDS with MEMA staff, it became clear the MEMA EOC personnel did not have a high-level of familiarity or proficiency with the WebEOC software. This may have contributed to the lack of available EOC documentation during the August 8-9, 2023, time period.

Similarly, HI-EMA does not appear to have sufficient resources to effectively conduct its work across the State of Hawai‘i, and during all phases of the comprehensive emergency management cycle.

HI-EMA relies heavily on the individual counties' emergency management agencies and EOCs to provide the State Warning Point (SWP) and State Emergency Operations Center (SEOC) with awareness of what's happening on the ground in their jurisdictions.

During a major incident, HI-EMA staff are understandably reluctant to push the local EOCs for information. There are opportunities, as acknowledged by HI-EMA's Administrator James DS. Barros, for HI-EMA to develop a better understanding of local conditions, before, during, and after disasters.

3.6.4 ANALYSIS OF SYSTEM COMPONENTS

3.6.4.1 Difference Between Incident Command and EOC Functions

It's important to distinguish between the roles of EOCs and ICPs. Emergency incidents, like the Lahaina PM fire, are primarily managed from ICPs. However, EOCs fulfill essential functions during emergencies that require effective coordination and synchronization with incident management resources (such as the ICS), any active area commands, and incident-level ICPs, whether directly or through an area command structure.

In emergency response, incident command and EOC command work together, but play distinct roles. Incident command focuses on the tactical response at the scene itself. This is where the ICS comes in, providing a standardized structure for on-site operations.

The ICS system is scalable and the structure can be built out, depending on the size and scope of the incident. Within the ICS, incident command operates at the ICP located on scene. The ICP is the focal point for tactical decision-making and resource management for the immediate emergency. The IC utilizes ICS functions like operations, planning, logistics, and finance to directly manage responder activities and resource allocation.

Each fire that occurred between August 8-9, 2023, had an IC assigned. Each IC was in charge of a specific fire incident (i.e., Olinda, Kula, Lahaina, and Pūlehu-Kīhei), and was responsible for making quick decisions that directly impacted responders and how they handled the immediate situation.

The IC can divide the incident into divisions and assign division supervisors that have oversight of the strategy and operational tactics within a defined area. Information is relayed in a timely manner to the IC, who maintains an overview of the incident, directs overall strategy and tactics as warranted by the changing conditions, maintains accountability of assets, and requests additional resources from the EOC (or Central dispatch) as needed.

The EOC, in contrast, serves as a centralized, off-site location for strategic coordination and support. It is the emergency response center responsible for supporting field operations and coordinating additional resources, including, but not limited to, coordinating utility control and requests for private assets, distributing evacuation notices, establishing shelters, and monitoring and sending alerts regarding road closures.

Representatives from various agencies (e.g., fire, police, public health, Hawaiian Electric, public works, etc.) are trained regarding their agency's role within the EOC and they collaborate with the other agencies within the EOC. The EOC Director facilitates information sharing, analyzes the broader impact of the incident, and coordinates the deployment of additional resources based on the IC's requests and evolving conditions. The EOC Director, while crucial for facilitating communication and resource support, does not directly control incident response.

Following best practices, the ICS and the EOC should work in tandem to ensure a well-coordinated and effective response to emergencies. This division of responsibility between on-scene incident command and off-site EOC support allows for a focused tactical response by the IC, while leveraging the EOC's capabilities for broader strategic planning and resource management.

3.6.5 Incident Command

The incident management organizations for the MPD and MFD faced significant challenges in planning and executing emergency response functions during the Lahaina PM fire on August 8, 2023. These challenges were exacerbated by a lack of pre-incident preparation and readiness for the escalating incidents caused by extreme fire weather. Prior to the fire, there was insufficient preparation despite ongoing incidents and information forecasting across Maui, which should have heightened awareness and readiness.

As the fire rapidly expanded, stretching available resources thin, the MFD and MPD incident commanders did their best to focus on immediate priorities and tactical levels of command, but quickly became task-saturated and overwhelmed. These conditions contributed to the ICs' difficulties developing overall situational awareness and the strategic focus that would help effectively manage the growing complexity of this unprecedented incident.

The MPD's focus on routine duties like traffic control and calls for service, rather than preemptively preparing for a wildfire evacuation, further hindered their ability to pivot to an emergency response role effectively. This lack of proactive planning and preparedness underscored the challenges in coordinating a cohesive response effort among the MPD, MFD, and MEMA.

Consequently, the ICSs were ill-prepared to scale up in response to the increasing demands of the wildfire incident. This lack of readiness and coordination left responders struggling with the dynamic and rapidly escalating conditions of the Lahaina PM fire, highlighting critical gaps in both preparedness and response coordination across the agencies involved.

One of the primary challenges was the lack of adequate command level resources and infrastructure to manage such a dynamic incident. Blocked roads hindered evacuation efforts, while the absence of water availability in certain areas exacerbated firefighting efforts. Visibility was severely limited by smoke, complicating navigation and situational awareness for responders.

For both the MPD and MFD, communications were strained due to limited channel availability, leading to congestion and difficulty in coordinating between multiple responding agencies. Additionally, intermittent cell service further hampered communication capabilities, isolating responders from critical information and updates.

The absence of a stationary ICP during the fire on August 8, 2023, significantly impacted operational effectiveness for both police and fire departments. Although the MPD and MFD share the use of a mobile command vehicle as per MPD policy—see Command Vehicle Standard Operating Procedures (G.O. 304.11) in Section 6.12.8 of the Appendix—the County of Maui did not provide evidence of it being deployed or used.

Had the command vehicle been positioned in Lahaina prior to the PM fire, it could have served as an assembly point for representatives of assisting and cooperating agencies assigned to the AM fire and those addressing evacuation issues, such as downed utility poles and electrical lines. A stationary ICP supports effective incident management by providing a clear focal point for information gathering, information sharing, situational awareness, and strategic planning.

It allows command to maintain oversight of the entire incident area, while remaining safely out of the immediate operational zones, thereby optimizing operational effectiveness and safety for personnel involved in emergency response efforts. Instead of a fixed location serving as a centralized command

3.6.5 ANALYSIS OF SYSTEM COMPONENTS

hub, command operations for the Lahaina PM fire were mobile, moving with the evolving incident.

While mobility can offer flexibility and adaptability, it also presents challenges, such as compromised communications, limited visibility of operations, and being potentially within or near the immediate operational area, which can pose safety risks.

The lack of an overall IAP during the fire posed significant challenges to effective emergency response coordination. It is understood that the Lahaina PM fire was highly dynamic with fire moving from structure-to-structure at a rate MFD members had likely never previously witnessed, at the same time that large-scale evacuations demanded the attention of both the MPD and MFD.

However, a basic IAP at the start of the incident could have provided a foundation that continued to be developed over time. An IAP serves as a comprehensive blueprint for managing complex incidents, outlining objectives, strategies, and operational tactics to guide responders. Without this structured framework in place, there was a notable absence of clear priorities, resource allocation strategies, and coordinated efforts among responding agencies.

This deficiency hindered the ability to streamline operations, optimize resource deployment, and adapt to the rapidly evolving fire dynamics. As a result, the ICs faced heightened difficulties in managing critical tasks, such as firefighting, evacuation coordination, and communication logistics. The absence of an IAP underscored the critical need for robust pre-planning and preparedness measures to enhance response capabilities and resilience.

The lack of unified command during the Lahaina PM fire between the MFD and MPD operations posed significant challenges to effective emergency response coordination. Unified command is essential in complex incidents where multiple agencies must coordinate efforts to ensure public safety and optimize resource allocation.

During this incident, the MFD and MPD operated separately, which hindered decision-making and joint operational IAPs. Without a unified approach, there was a risk of duplication of efforts, conflicting priorities, and gaps in communication and resource utilization. While the MPD had one (1) captain overseeing command responsibilities, there was insufficient collaboration and integration with fire operations. This disjointed approach prevented unified decision-making and resource allocation during a critical phase of the emergency.

Evacuation operations, critical for ensuring the safety of residents and visitors, also suffered from the lack of unified command. Clear and coordinated direction between the MFD and MPD is crucial to efficiently execute evacuation plans, manage traffic flow, and communicate evacuation orders effectively to affected populations.

In emergencies, unified command fosters a collaborative environment where agencies can pool resources, share critical information, and make decisions collectively based on the evolving situation. This approach enhances overall response effectiveness, minimizes response delays, and maximizes public safety outcomes by ensuring a unified front in managing complex incidents like the Lahaina PM fire.

When Maui faced the challenge of multiple simultaneous wildfire incidents, establishing an area command structure became crucial in the Incident Management organization. This structure could have played a pivotal role in managing the multiple, concurrent emergencies effectively and efficiently.

3.6.5 ANALYSIS OF SYSTEM COMPONENTS

An area command would have allowed for centralized decision-making, ensuring that all incidents are managed under a unified strategy, which prevents conflicting actions and promotes a coordinated response. With multiple incidents, resources like personnel, equipment, and support services will be stretched thin. An area command ensures that these resources are allocated based on priority and immediate need, maximizing their effectiveness across all incidents.

Establishing an area command would have also facilitated clear and consistent communication channels, which ensures all units involved in the response are informed and coordinated. The area command structure allows for efficient coordination between different agencies and departments involved in the response, including fire, police, EMS, and public works, each supporting an integrated approach to managing incidents.

During the August 2023 wildfires, several challenges underscored the need for an area command. Multiple fires required immediate and coordinated responses to prevent escalation and minimize damage. Limited resources had to be strategically deployed to the areas of greatest need, which could have been effectively managed through an area command.

Resource limitations also impacted the ability for the MFD and MPD to stand-up an IMT reactively. This challenge may be moderated by staffing an IMT prior to an event, where personnel are pre-designated to perform in a variety of overhead roles. The MPD and MFD should explore training Ocean Safety personnel for these roles like some mainland departments have done with success.



3.6.6 ANALYSIS OF SYSTEM COMPONENTS

3.6.6 Findings & Recommendations

40.	**FINDING:** Although there were opportunities for the MFD to provide staff support for the Battalion Chief(s) managing the incident, a formal command team was not established. The ICs were overwhelmed with the demands of the event and possessed limited situational awareness during a rapidly expanding emergency, which included a mayday; these factors contributed to challenges with tactical decision-making throughout the Lahaina PM fire.	**RECOMMENDATION:** Review and modify the dispatch algorithm to reflect the resource availability. **RECOMMENDATION:** Provide the resources and training necessary to establish and maintain effective support for the initial incident commander (IC). **RECOMMENDATION:** Within MFD Hazard Zone Command SOG (E.O. 302.01), include requirements for all chief officer engagement within the incident command structure for large complex incidents.
41.	**FINDING:** The MFD and MPD never connected to establish a unified command.	**RECOMMENDATION:** The MFD, MPD, and other assisting and cooperating agencies should include guidance within their respective incident management SOGs on when unified command should be considered and how it could be established.
42.	**FINDING:** Available public safety resources were inefficiently utilized. This resulted in the failure to establish and scale an effective incident management organization during the first 24 hours of the incident.	**RECOMMENDATION:** Provide sufficient staffing to establish and maintain an effective incident management organization, while maintaining the capacity to conduct unit-level tactical actions. Once established, develop a robust incident action plan (IAP). An IAP should outline objectives, strategies, and tactics for managing the incident, including evacuation procedures, traffic management, and resource allocation. Communicating the IAP to all responding personnel and stakeholders ensures a shared understanding of roles, responsibilities, and priorities.
43.	**FINDING:** There was no comprehensive plan for the MPD's wildfire response.	**RECOMMENDATION:** Develop a comprehensive plan in coordination with the MFD for MPD's response to a wildfire that prioritizes public safety, efficient evacuations, and effective traffic management.

3.6.6 ANALYSIS OF SYSTEM COMPONENTS

3.6.6 Findings & Recommendations

44. **FINDING:** Limited sharing of critical information occurred between field operations units, the MPD Department Operations Center (DOC), and the EOC.	**RECOMMENDATION:** Review and update policies and develop new processes for information flow between MPD Command Personnel on site, command staff, dispatch, and the EOC. **RECOMMENDATION:** All commanders, captains, and above should receive training on activation of the DOC and a Department Operations Center quick reference guide should be developed for commanders to be utilized for any crisis.
45. **FINDING:** The MPD Natural and Man-Made Disaster Plan, G.O. 411.4, does not include wildfire incidents.	**RECOMMENDATION:** Update policy to include plans specifically related to wildfires.
46. **FINDING:** There was limited pre-event incident action planning for anticipated events or incidents by the MFD, MPD, and MEMA.	**RECOMMENDATION:** The MFD, MPD, and MEMA should update the current policies and procedures regarding pre-event planning (including preparing pre-event incident action plans), staffing, and equipment.
47. **FINDING:** There were no written procedures or guidelines for Continuity of Operations (COOP).	**RECOMMENDATION:** The County of Maui, MPD and MFD to prepare Continuity of Operations Plans (COOP) that outline procedures to ensure essential functions can continue during and after various types of emergencies or disruptions.
48. **FINDING:** Communication was limited between MEMA and HI-EMA EOC.	**RECOMMENDATION:** Additional resources are needed to have a persistent durable communication link prior to, and during, a major emergency or disaster event.
49. **FINDING:** Given the known conditions forecasted for the County of Maui on August 8, 2023, agency representatives self-reported to the EOC throughout the day, but full activation of the EOC did not occur until 16:30.	**RECOMMENDATION:** Under similar conditions, and given appropriate resources, consider full activation earlier to aid collaboration between all relevant emergency support functions.

3.6.6 ANALYSIS OF SYSTEM COMPONENTS

3.6.6 Findings & Recommendations

50. **FINDING:** MEMA does not have a sufficient budget/personnel allocation to effectively and sustainably perform the wide range of preparedness, response, and recovery missions assigned to it.	**RECOMMENDATION:** EOCs fulfill essential functions during emergencies and must be properly staffed and operationalized with (A) qualified overhead personnel to perform emergency management-related functions and (B) designated representatives from all cooperating/ involved agencies/organizations to provide subject matter expertise, resource coordination/tracking, and immediate information relays to ICs in the field.
51. **FINDING:** During the EOC activation on August 8, 2023, there was a lack of clarity regarding the roles and responsibilities among MEMA personnel.	**RECOMMENDATION:** Provide clearly defined roles and responsibilities for each staff member during EOC activations. Staff members should be trained and fully competent to fulfill their designated role. MEMA should also ensure staff training for secondary roles and responsibilities for when personnel are expected to shift to a different position (e.g., when vacancies occur).
52. **FINDING:** Some MEMA personnel were unfamiliar with the software platform used for documentation and incident tracking during EOC activations.	**RECOMMENDATION:** Ensure all personnel are fully trained and proficient with use of the designated EOC software program (WebEOC or any other software program designated by the MEMA Administrator). **RECOMMENDATION:** Ensure all MEMA EOC personnel understand the NIMS-ICS requirements for documentation during EOC activations.
53. **FINDING:** The EOC was overcrowded and personnel had to find alternative work locations.	**RECOMMENDATION:** MEMA should examine the needs for the physical location and expand the EOC.

3.6.6 ANALYSIS OF SYSTEM COMPONENTS

3.6.6 Findings & Recommendations

54. **FINDING:** Both the MPD and MFD were unable to maintain personnel accountability for officers, firefighters, and crews during the Lahaina PM fire.	**RECOMMENDATION:** MPD roll calls should be initiated by dispatch and/or command staff as needed to maintain accountability. A policy should be established with defined roll call procedures. **RECOMMENDATION:** Ensure sufficient resources are available to support MFD ICs and division/group/unit-level supervisors with all functions of command/management, including personnel accountability. **RECOMMENDATION:** Adoption and consistent use of a common and resilient AVL platform on all MPD, MFD, and cooperators' (e.g., DOFAW, ARFF, and EMS) vehicles would assist dispatchers and command officers with personnel accountability and incident management.
55. **FINDING:** The MFD sponsors a Type 3 IMT that was not used August 8-9, 2023.	**RECOMMENDATION:** Consider pre-deploying the Type 3 IMT when severe weather and/or fire danger conditions are forecasted. **RECOMMENDATION:** Enhance training and expand participation to include personnel from multiple disciplines, reinforcing the value of an all-hazards IMT and fostering collaboration across agencies. Consider securing training and experiences for Ocean Safety personnel to be able to perform in specific IMT overhead roles.
56. **FINDING:** Hawaiian Electric should be at the incident command post (ICP), or tied in closely with the incident commander if an ICP is not established, to inform command of safety issues, other coordination opportunities, and act as a liaison to their organization.	**RECOMMENDATION:** Create and follow a protocol to embed Hawaiian Electric representatives in the ICP (when established) as liaisons.

3.6.6 ANALYSIS OF SYSTEM COMPONENTS

3.6.6 Findings & Recommendations

57. **FINDING:** The MPD and MFD did not deploy or use the mobile command vehicle as per MPD policy G.O. 304.11. Deployment and use of the vehicle in Lahaina before the PM fire may have initiated the unified command organization that was absent throughout the PM fire.	**RECOMMENDATION:** Follow G.O. 304.11 to ensure the mobile incident command vehicle is used for appropriately sized incidents, such as the Lahaina PM Fire. **RECOMMENDATION:** Deploy the mobile command vehicle at planned events to exercise the deployment process and equipment.
58. **FINDING:** There were no established unit identifiers for off-duty MPD officers or supplemental MFD units.	**RECOMMENDATION:** Create a call sign procedure for identification of off-duty MPD officers who self-deploy and MFD personnel assigned to supplemental MFD units. The existing MPD G.O. 301.5 policy should be revised regarding the establishment of call signs for incoming off-duty officers and self-deploying officers. The MFD should establish a policy to standardize identification of staffed supplemental resources.

3.7 ANALYSIS OF SYSTEM COMPONENTS

3.7 Fire Suppression

Even though firefighting is (ideally) the last line of defense in wildfire management, fire suppression preparations and operations are key to the Cohesive Strategy. Effective fire management and impact reduction are achieved through preparedness, early detection, weather monitoring, rapid response, training, and coordination. Preparedness planning can aid in assessing the wildfire risks to optimize the allocation of resources and ensure rapid deployment for a robust initial attack.

Training ensures firefighter readiness to respond appropriately and effectively. Continuous weather monitoring and training to make sense of both forecasts and real-time conditions and situations help firefighters anticipate fire behavior and adjust strategies in real-time. An effective incident management structure, communication, resource sharing, and informed, risk-based decision-making are essential for protecting life, property, and natural resources.

On August 8, 2023, while the MFD was also fighting wildfires in other locations across the island of Maui, fire suppression operations initially began on a fast-moving vegetation fire fanned by hurricane force winds in an open field at the east end (mauka) of Lahaina.

Resources assigned to this fire (dubbed the Lahaina AM fire) seemed to be making progress to contain the fire in hot, dry, and windy conditions. However, this fire would go from being reported as extinguished to a fire in the same area being reported at 14:55. This fire burned over firefighters and residents, and ultimately, destroyed Lahaina several hours later.

MFD resources were limited in capabilities due to a variety of factors, including two (2) other Upcountry fires also drawing on the finite resources on the island, electrical wires and downed utility poles blocking access, no hydrant pressure, and other complications.

With nowhere else to turn for more structural firefighting resources, the MFD was resourceful with what it had and adapted the best it could. This section will analyze the response to the Lahaina AM and PM fires, while also discussing policy, procedures, and best practices.

3.7.1 Preparedness

As stated within the Phase One report (page 39), the MFD started August 8, 2023, with normal staffing. As events unfolded during the day, additional staff came to work and operated relief apparatus and other vehicles.

The MFD does not have policies supporting pre-event staffing when high fire danger and/or Red Flag Weather is forecasted. However, the MFD's Hurricane/High Wind Events policy (D.O. 600.01) does include instructions for preparing for High Wind Events when the forecast warrants it (Appendix Section 6.12.12).

Although the wind on August 8, 2023, did not arrive with a hurricane hitting any part of the islands, as is inferred within the policy, the hurricane's impact offshore created the pressure gradient that helped generate the 80 mph northeast winds experienced on the leeward sides of the islands.

The policy includes preparedness activities in advance of the event to include ensuring fuel tanks are filled, securing fire stations, and staffing fire stations and incident facilities. The policy also mentions staffing unified incident management positions and preparing a plan to address objectives.

3.7.2 ANALYSIS OF SYSTEM COMPONENTS

Although there was forewarning of the impending weather, there was no pre-event operational planning. The lack of pre-event engagement could be related to the policy not including Red Flag Weather or high fire danger conditions. Because the hurricane was not going to hit the islands directly, there was less attention on the impact the high winds, coupled with a dry air mass, would have on wildfire potential. See Section 3.1 for more information about weather conditions.

Pre-event staffing and pre-positioning of resources in wildfire-prone areas is common in the Continental United States (CONUS). It is standard operating procedure for fire managers in some areas to hold conference calls to brief personnel and to coordinate resources before arrival of a severe weather event. Some jurisdictions have pre-plans that consist of staffing an IMT and preparing an IAP in advance.

Calendaring annual in-person reviews of master mutual aid agreements with on-island federal and state partners can ensure they are kept current. Reviewing agreements with representatives from the National Park Service, ARFF, and DLNR-DOFAW can also serve as an opportunity to discuss fire weather forecast products, vulnerable wildfire areas, command principles, and resource availability well in advance of impending weather.

3.7.2 Apparatus

3.7.2.1 Apparatus Readiness

The MFD did not formally upstaff (increase staffing in anticipation of increased call volumes) on the morning of August 8, 2023. As a result, pre-event and relief apparatus were not fully prepared for response. Some stations equipped with Minis or wildland apparatus (Type 6[157]) split their crews to put these specialty vehicles in service—in anticipation of increased call volume and increased risk of vegetation fires. Relief Engine 11 (RE11) was staffed by MFD personnel from the offgoing shift on the morning of August 8, 2023.

The MFD's Apparatus and Equipment Checks policy (M.A. 100.25), "ensures the readiness and maintenance of all apparatus (both front line and relief), and establishes standardization, tracking, and accountability guidelines for the use, maintenance, and loss prevention of emergency equipment." (Appendix Section 6.12.13)

The MFD does not have enough fully-equipped relief apparatus to provide a sustainable surge capacity that would readily allow upstaffing for major events to supplement their front-line fleet. The MFD also would benefit from fully-equipped apparatus that are readily available for response to major incidents, akin to the California OES (CAL-OES) "all-risk fleet"[158] that is pre-distributed to local fire departments across the state.

When personnel were called back to assist, most personnel reported to Fire Station (FS) 10 where the majority of relief apparatus are housed. FS3 and FS11 house their own relief engines. Despite department policies (M.A. 100.25) requiring equipment and inventory standardization of all MFD apparatus (dependent on type), each piece of relief apparatus had to be outfitted for wildfire and structural fire response prior to responding.

This process included having to locate and load hoselines, appliances such as nozzles (if available), hand tools, and other operational and safety equipment. With a full complement of equipment already on relief apparatus, the MFD may have been able to reduce response times as off-duty personnel arrived for work during the afternoon and early evening of August 8, 2023.

The lack of necessary equipment was exacerbated when units had to abandon hoselines and tools as fire conditions became life threatening. As the incident continued to evolve, crews collected usable equipment encountered throughout the area (e.g.,

retrieving nozzles from burnt hoselines, retrieving hand tools, etc.).

On August 8, 2023, there was limited use of aircraft for surveillance in the morning hours. Aircraft were grounded due to the weather and unable to engage in fire suppression (Phase One report, page 194, Table 4.3.2.19).

This report does not include an evaluation of appropriate aviation assets to address wildfires in Maui. Further study is advised to determine the appropriate number and type(s) of aircraft needed to address the multi-hazard threats that exist on all of the islands.

3.7.2.2 Personal Protective Equipment (PPE) & Radios

Frontline apparatus have self-contained breathing apparatus (SCBA) equipment and portable radios assigned to each riding position. Not all relief engines (or other apparatus) have SCBA or portable radios assigned to each riding position. This left firefighters to respond to the incident without respiratory protection equipment or the ability to communicate with others operating throughout the area.

Depending on the apparatus type, some apparatus had mobile radios (a radio fixed and mounted within the vehicle) and some did not. In some cases, crews that had portable radios for each riding position gave those radios to other units that lacked radios.

3.7.2.3 Personnel Resourcefulness

MFD personnel were resourceful throughout the duration of the event. Without direction, some firefighters responded to their own fire stations to gather personal protective gear and firefighting equipment, either before or after being assigned to a crew at FS10.

As personnel continued to call back to FS10, all available resources were utilized, including relief lifeguard pickup trucks and relief battalion chief SUVs. Firefighters operating out of non-traditional vehicles, including patrol cars and privately-owned vehicles (POVs) at different times, were able to perform rescues and coordinate with suppression apparatus to aid fire attack and evacuation efforts, despite a lack of respiratory protection, firefighting equipment, or portable radios.

3.7.3 Relief Staffing

The MFD's Emergency Callout policy (E.O. 300.12) includes guidance for "recalling off-duty personnel during emergency operations." (Appendix Section 6.12.14)

Under normal operating conditions, two (2) Battalion Chiefs (BC) are staffed by the MFD daily, with shift change occuring at headquarters (FS10 in Kahului). One (1) BC is tasked with "911 Operations," which involves handling all operational staffing for that day and the next (e.g., filling vacancies from sick leave, injury leave, etc.).

It is up to the BC on duty to maintain daily staffing and next-day staffing. To fill vacancies, BCs use the CivicReady app to send mass texts for callback, and BCs report that they generally have a good response for callback requests. F2 can make the decision to implement pre-event upstaffing and establish time parameters guiding overtime, within the framework of the Collective Bargaining Agreement (CBA).[159]

There are some days where F2 would implement pre-event stand-up crews, such as direct-hit storms or hurricanes (Hurricane Dora was not predicted to hit Hawai'i and was tracking far south). F2 considers select days of the year for "standard" upstaffing, including the Fourth of July and New Year's Eve, when fireworks use increases community risk.

3.7.3 ANALYSIS OF SYSTEM COMPONENTS

When upstaffing is authorized, it is the responsibility of the on-duty BCs to handle fulfillment of staffing. If both BCs are committed to incidents, they have the ability to call back or hold over another BC to assist with the daily and next-day staffing. A new policy was being piloted when the August 8, 2023, Lahaina PM fire occurred. This policy allowed for an additional BC to hold over or be called back. In the event three (3) BCs are on duty, one (1) on-duty BC runs the incident, the other on-duty BC is responsible for reporting information to EOC, and the holdover/ callback BC assumes staffing duties.

3.7.3.1 36-hour Rule

The 36-hour rule dictates how long MFD field personnel can continuously remain on duty. As governed by the CBA, non-excluded employees receive double time for working over the 36-hour threshold. As a safety measure, if the non-excluded employee's next day is a regular duty day, they must take an 8-hour break after working 36 hours.

As excluded employees (management), the rank of BC and above are not ruled by the CBA time restrictions. BCs must remain cognizant of who they are calling back based on the number of hours worked.

Keeping account of the roster is a manual system requiring BCs to come to the office and cross-reference the duty roster and the Fire Reporting Management System to determine who is eligible for callback and how units will be staffed.

Due to the specific job functions and task-level responsibilities, each apparatus has a minimum number of personnel required for the unit to be put in service. For instance, a fire engine requires a minimum staff of four (4) qualified personnel. [Note: On a day-to-day basis many are assigned five (5) personnel. The "extra person" provides additional manpower for the crew and can also be detailed to other fire stations to cover vacancies (e.g., sick leave) as needed, reducing reliance on overtime.]

On August 8, 2023, many B-Watch crew members were held over and began to "time out" at or before 19:00. Many C-Watch members reported for callback on August 8, 2023, and had to report for regular duty starting at 07:00 on August 9, 2023.

Depending on their reporting time, they would be over the 36-hour threshold and "time out" at or before 19:00 on their duty day. A-Watch personnel were scheduled for duty on August 8, 2023, at 07:00. Depending on their reporting time, they would "time out" at or before 19:00 on August 9, 2023.

During the events of the August 2023 fires (Olinda, Kula, Lahaina, and Kīhei-Pūlehu), the BCs were tracking personnel time-on-duty and logistically arranging crew swaps, often on scene, in the midst of the operations, for all operational fire personnel.

This may have led to confusion among crew members working together and interrupted rescue and fire suppression attack operations. MFD personnel also had to be shuttled back and forth, utilizing an additional asset, to be brought to the incident scene or returned to the station.

Under normal conditions, for health and safety purposes, the 36-hour rule is a practical operating procedure; given the conditions and events of August 8-9, 2023, however, this rule might have been waived to help sustain MFD staffing.

3.7.4 Strategy and Tactics

August 8, 2023, was a weekday, and normally many (if not most) residents would have been at work or school. However, due to the severe weather conditions and widespread loss of power, many schools and businesses were closed and most

3.7.4 ANALYSIS OF SYSTEM COMPONENTS

residents remained at home. This likely increased the number of vehicles lining the narrow, winding residential streets, making the road even more difficult for MFD apparatus to navigate.

MFD units initially responded to the Lahaina PM fire according to their established SOPs and normal operating practices, but they were quickly overwhelmed by extreme conditions and resource limitations. The fire's rapid spread through densely populated areas, combined with the loss of firefighting equipment and personnel, created a catastrophic situation that outpaced the department's ability to respond effectively.

3.7.4.1 Initial MFD Resource Response

The Lahaina PM fire was first reported at 14:55 near Ku'ialua Street (the location of the Lahaina AM fire). At this same time, MFD units were still fighting the Upcountry fires, which reduced the immediate availability of MFD resources.

The road conditions encountered by responding personnel had drastically changed since the AM fire, as multiple roads, including Hwy-30, had been blocked by downed utility poles, powerlines, and trees. This led to longer response times for some units. The fire spread rapidly through the grass as Engine 11 (E11) took command and mounted a fire attack while coordinating with incoming units. Chief officer BC5 assumed command and instructed Central to add additional units to the call.

The rocky terrain, limited access due to challenging topography, severe wind, and abundance of light flashy fuels hampered MFD access to and containment of the fire. The initial vegetation fire quickly spread, jumping the Lahaina Bypass into Kelawea Mauka Makai Park at 15:24.

Tanker 3 (T3) personnel reported that the apparatus overheated and needed to be shut down at 15:27 (T3 had been operating off dirt roads in an effort to flank the fire) and remained inoperable until 15:32. At 15:28, fire spread to the exterior of a structure on the east side (mauka) end of Dickenson Road and on the south side of Lahainaluna Road.

The Lahainaluna neighborhood (Kelawea neighborhood/subdivision) is a densely populated residential area (both north and south of Lahainaluna Road). The neighborhood has many narrow, winding streets branching off of Lahainaluna Road, which is the main ingress and egress for the entire neighborhood.

It is common for multiple generations to live together. As such, many of the residential structures had additions, such as ohanas or ADUs, adjacent to the primary structures. Multiple residents per lot increased the number of vehicles within driveways, between structures, and along both sides of the street. Additional outdoor furniture, patio coverings, and other miscellaneous belongings created ladder fuels, which aided fire spread between structures.

Resident self-evacuations and MFD/MPD-initiated evacuations began on both sides of Lahainaluna Road. Due to road blockages from fallen trees, as well as downed utility poles and powerlines, traffic quickly backed up along Lahainaluna Road. This created additional challenges for responding MFD apparatus.

Modern fire apparatus are relatively large vehicles, due to the size of their onboard pumps, water tanks, and/or aerial devices; they are challenging to navigate through tight streets. Narrow, winding streets made the effective positioning of fire apparatus very difficult. Fire apparatus carry a limited supply of tank water and require an external water supply (typically either a fire hydrant or supply from a tanker) to extinguish fires with heavy fuel loads, such as the fully involved structures found in this neighborhood.

3.7.4 ANALYSIS OF SYSTEM COMPONENTS

The large number of parked cars on either side of the street(s), along driveways, and parked on property created an additional physical barrier that challenged access to hydrants and deployment of firefighting hoselines and equipment. Several of these vehicles ignited, providing many distributed sources of intense heat and thick smoke. See Section 4.2.2 for a map of vehicle locations.

As fire began to spread from structure-to-structure, a large ember cast, driven by strong winds, ignited buildings throughout the neighborhood. The severe winds escalated the fire spread, while also laying a heavy blanket of dense black smoke horizontally across the neighborhood, reducing visibility. Residents and MFD personnel reported near black-out conditions during severe wind gusts.

These conditions and the fast-moving nature of the urban conflagration contributed to the overall lack of situational awareness experienced by units operating throughout Lahaina. This lack of situational awareness likely contributed to some tactical decisions that were not matched to the circumstances, along with an inability to maintain personnel- and unit-level accountability throughout the Lahaina PM fire.

Residents were evacuating primarily by personal vehicles down Lahainaluna Road when the road became impassable due to stopped traffic and windblown debris. At least one (1) passenger vehicle collided with a structure, which led to a stacking of cars along the road. MFD units that had responded onto Paunau Street became trapped as both access points onto Lahainaluna Road were completely blocked by cars trying to evacuate.

The initial MFD resources were mostly positioned in front of the fast-moving urban conflagration in an attempt to save lives and property. Ultimately, all the resources would be driven from their locations. Their hose streams were simply outmatched by the heat produced from multiple structures burning and downslope winds pushing the energy directly at them, limiting the reach of their water. The loss of water pressure from fire hydrants ultimately caused MFD units to re-position to locations where they could be more effective or were forced to shelter in place.

3.7.4.2 Critical Event

Engine 6 Mayday

The term “Mayday” is used internationally as a distress signal, and in firefighting, it is specifically reserved for the most critical emergencies involving firefighter safety. A Mayday call typically indicates the situation is life-threatening and immediate help is urgently needed.

When a Mayday is called, a rapid intervention protocol is triggered in which other firefighters immediately shift their focus to locate and rescue their endangered colleagues. When a Mayday is declared, it often results in a dramatic shift in incident priorities, with resources being redirected to rescue the firefighter(s) in distress, while simultaneously maintaining overall incident control. Common situations that might prompt a Mayday call during a wind-driven WUI fire include:

- Burn over - when an uncontrolled fire burns over an individual or resource
- Firefighter(s) suffering from a medical emergency

The declaration of a Mayday event is considered one of the most serious situations in firefighting operations, as it indicates that one of the responders has become a victim, complicating the ongoing emergency response.

At approximately 16:00, just over an hour after the Lahaina PM fire was called in, MFD units Engine 6

3.7.4 ANALYSIS OF SYSTEM COMPONENTS

(E6), Engine 1 (E1), Mini1, Wildland 6 (WL6), and Relief Engine 1 (RE1) arrived in the neighborhood off of Pauoa Street, just south of Lahainaluna Road. Their route of travel coming from the south was northbound on Hwy-30 to eastbound (mauka) on Lahainaluna Road.

This created a situation where they were positioned to fight the fire from a downwind position, and in this case, it would have been like coming face to face with a blowtorch due to the extreme downslope winds coming from the east (mauka).

Not long after their arrival, conditions deteriorated even more. Fierce downslope winds continued to spread the fire from structure-to-structure with numerous structures fully involved by this point. Heavy traffic congestion with residents evacuating with severely limited visibility contributed to an already untenable environment. Flames 20 to 30 feet high encroached on the firefighters' positions.

Realizing the immediate danger, E6 ordered all units to evacuate. However, escape routes were blocked by collapsed structures, abandoned vehicles, and downed utility poles and powerlines. Firefighters attempted to find alternative routes and clear debris using MFD apparatus, but visibility was poor and getting worse. Cell phones and mobile maps were not working.

As one (1) unit maneuvered to evacuate, it collided with a fire hydrant, shearing it off and causing water to spray freely into the air, which impacted water supply for the entire area. As another searched for an escape route, crew members were shocked to see a deceased victim in the roadway. They had not yet heard of any reported deaths.

By 16:32, Command ordered all units to evacuate, but several units reported being unable to leave.

At approximately 16:47, the situation inside E6 was becoming critical. The crew was unsure if they would be able to hold their position because they were low on air and the intensity of the heat was becoming untenable. An E6 crew member exited the cab to retrieve spare SCBA air cylinders from the exterior compartments and found one (1) compartment door had melted shut.

An E6 crew member went to Mini1, which was in a parking lot nearby, to retrieve air cylinders. When he discovered Mini1 was operable, he drove it over a curb, through debris, and exited the parking lot by narrowly navigating in between E1 and E6. He tried blowing the horn to get the attention of all the crew on scene, but he had little to no visibility and heard no response.

Knowing Lahainaluna Road was blocked, he launched Mini1 over a concrete barrier, powerlines, a rock wall, and through the yard of a substation to access Hwy-30, where he encountered heavy traffic. He made several attempts to call a Mayday, but was unsure if radio transmissions were being relayed.

At 17:02, Central reported that a Mayday had been transmitted by E6 and the emergency alert button on a portable radio had been activated. Despite multiple attempts, neither Central dispatch nor Command could establish radio contact with E6 or E1 crews.

As the E6 crew member driving Mini1 reached Shaw Street, smoke and visibility were improving. When he met a police officer directing traffic, he removed his SCBA, called another Mayday, and told the officer that multiple MFD crew members were trapped and Mini1 was compromised (it had powerlines, debris, and a shopping cart wrapped around the axles and wheel wells).

The MPD officer advised the E6 crew member to take the MPD SUV to retrieve E1 and E6 crew

members. As he returned to the scene, visibility was so poor he could not tell where the flames were coming from or what structures were on fire. He found his way back to the substation yard, went over the rock wall and concrete barriers, and pulled up beside E1 and E6.

E1 crew heard an MPD siren and saw the MPD SUV suddenly pull up next to them, being driven by an E6 firefighter. Crews began leaving their apparatus to get to the SUV. One disoriented E6 crew member collapsed before making it to the SUV. After removing equipment from the vehicle and their own SCBAs, all eight (8) crew members, including the now unresponsive member of E6, loaded into the MPD SUV. The E6 firefighter took the same route, with little to no visibility, back to the intersection of Shaw Street and Hwy-30, where the crew unloaded the unresponsive member and immediately initiated CPR.

At 17:11, Central reported CPR in progress at Shaw Street and Hwy-30. Central reported the arrival of medics on scene at 17:22 and the unresponsive E6 crew member was transported to the hospital. BC3, F2, and F3 followed them to the hospital and did not return to the incident. See Phase One report (pages 185-193) and Section 3.6.3 of this report for further information.

It is understandable why the chief officers may have wanted to be with their distressed member. Leaders have a responsibility for the health and safety of their subordinates. The radio traffic indicated a perilous situation. There is no doubt the chiefs wanted to be present for their personnel—to help in some way.

However, there was nothing they could have done to improve the care and transport of the member once in the ambulance. Leaving the Lahaina incident took three (3) chief officers out of critically needed command roles and left one chief officer (BC5) on his own.

At 17:26, RE1 crew advised they had all personnel accounted for and they were in a safe location in a dirt field off Dickenson Street.

This sequence of events highlights the rapid escalation of the fire, and the extreme dangers faced by the firefighters in a chaotic and unprecedented situation. Despite their training and experience, the firefighters found themselves overwhelmed by a burn-over event, while a firefighter suffered a medical emergency—an incident within an incident (IWI).

Operational Impact – Incident Within an Incident
Managing an IWI, such as the Mayday situation involving MFD E6, has far-reaching impacts on fire operations from an incident command perspective. A Mayday situation indicates an emergency involving a firefighter, which requires immediate and specialized response protocols to ensure the safety and well-being of the trapped or injured personnel.

The E6 Mayday occurred at a critical point during evacuations while fire was spreading rapidly. These factors contributed to the companies becoming trapped and burned over.

An IWI diverts critical resources and attention from ongoing firefighting efforts to focus on the emergency at hand. ICs must quickly assess the severity of the Mayday situation, mobilize rescue teams, and coordinate medical assistance while maintaining overall incident control. This priority emergency can strain available resources, requiring additional personnel and equipment to handle both the primary firefighting operation and the Mayday incident simultaneously.

During this Mayday event, E6, E1, WL6, and Mini1—four (4) out of the five (5) MFD apparatus operating in the area south of Lahainaluna Road at the time—were essentially out of service from 16:30 to after 18:00. See Section 3.6.3 for further information.

3.7.4 ANALYSIS OF SYSTEM COMPONENTS

The IWI may impact operational timelines and tactics. The IC may need to adjust firefighting strategies, such as defensive operations or temporary withdrawal, to prioritize firefighter safety and facilitate the rescue operation.

Managing an IWI requires training, decisive leadership, effective communication, and coordinated response efforts to mitigate risks, ensure firefighter safety, and maintain operational effectiveness during complex and demanding firefighting operations.

Automatic Vehicle Location Data – Apparatus Location

The positioning of MFD apparatus throughout the incident was communicated by MFD personnel during their TDs. Personnel assigned to each resource identified their location on a map and used the dispatch/communications record to verify their location in most cases.

For apparatus equipped with AVL capabilities, location was also verified using the data provided by the County of Maui.

For the resources assigned to the Lahaina PM fire, MFD AVL data was provided for Engine 3 (E3), Ladder 3 (L3), Engine 11 (E11), Engine 1 (E1), and Engine 6 (E6). Although AVL data was received for these five vehicles, only AVL timepoints for three vehicles was provided for the timeframes included within Figure 3.7.4.2.1.

The AVL heatmaps in Figure 3.7.4.2.1 display MFD resource location over time. The warmer the color, the more timepoints recorded in that location. Each one (1) hour time period displaying a heat signature represents a collection of units with their associated timepoints within a geographic area. At times, there were no units with timepoint data for the hour period, or there was only one (1) or a few units with only one (1) or a few timepoints—a limitation of the heatmap.

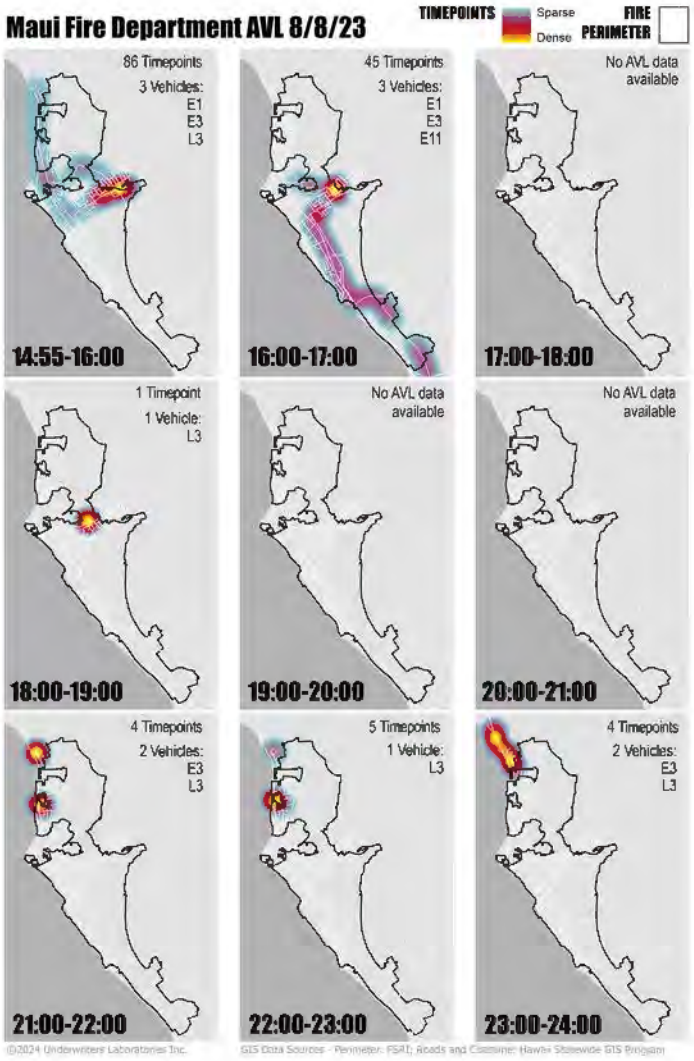


Figure 3.7.4.2.1 MFD AVL data aggregated to location within each hour, starting at the time of the Lahaina PM fire and through midnight. These maps are limited by the relatively sparse data provided for MFD units.

The location of MFD resources is mostly consistent with what personnel communicated, with the understanding that firefighters may be working a distance from their apparatus. This was especially common during the Lahaina AM fire suppression operations and early into the PM operations.

Furthermore, it is important to note that the MFD had a limited number of resources that were either AVL-enabled or where data was provided. The majority of resources assigned to the Lahaina PM fire on August 8, 2023, did not have AVL data included in the spreadsheet provided to FSRI, but were highly engaged in the most critical areas of rescue and fire suppression.

See Section 6.10 in the Appendix for a comparison of MFD, MPD, and Hawaiian Electric's AVL timepoints.

3.7.5 Assessing Electrical Power Status

There is no safe and reliable way for a firefighter to definitively tell if a downed powerline is energized by simply looking at it or using basic tools. Downed powerlines, energized or not, can appear identical. There might not be sparking or any other visual indicator of active current.

Firefighters are fire-safety specialists, not electrical hazard mitigation experts. For these reasons, all downed lines must be considered energized until confirmed safe by the utility company.

Downed powerlines pose a life-threatening risk to citizens and first responders. Electricity can travel through paths like water, conducting materials, and even short distances through air. Until a qualified representative from the utility company confirms a downed line has been de-energized, firefighters are trained to immediately establish a safety perimeter around the downed line (usually at least 100 feet, but the minimum safe distance depends on voltage and local regulations).

The IC then works with Central dispatch and the EOC to coordinate with the utility company to ensure power is shut off to the involved area.

As water conducts electricity, firefighters must be extremely cautious when fighting fires near downed powerlines, especially high-voltage lines. Many of the tools firefighters use through the course of fire attack conduct electricity and pose additional risk to responders (e.g., straight water streams and metal hand tools and ladders).

These tools must be used with extreme caution when downed lines are present. Until there is confirmation by a utility expert (who has advanced electrical detection and management tools), firefighters must maintain a heightened level of situational awareness for secondary hazards that could possibly conduct electricity, such as falling trees, swaying or leaning utility poles, additional downed lines, and damaged structures.

At 06:34 on August 8, 2023, crews responded to a grass fire located in the vicinity of a downed powerline near Ku‘ialua Road and Lahainaluna Intermediate School. The crews, joined by a private equipment operator's assets, protected structures and worked to contain the grass fire.

Fire attack operations were challenging due to the unknown status of the powerline, heavy wind conditions that caused the grass fire to spread towards and threaten structures, lack of air support due to the heavy wind conditions, and rocky topography impacted by the spreading grass fire. The fire was reported 90% contained at 08:34, but personnel still did not have confirmation regarding the status of the powerlines. MFD crews remained on scene maintaining the safety perimeter, extinguishing hotspots, and wetting down the area to reduce risk of fire spread.

At 09:35, the IC requested a status update for the requested "MECO" (Hawaiian Electric is formerly known as MECO) representatives.

At 10:35, F4 relayed that he was in contact with the Hawaiian Electric (MECO) representative in the EOC and he would make sure Hawaiian Electric knew about the snapped pole and downed lines. At the same time, the IC instructed L3 to reposition due to strong wind gusts, which increased the risk of additional lines falling.

At 12:06, the IC reported, "The fire is pretty much secure, we are standing by waiting for MECO because there are a lot of lines we aren't sure about. We want to wait until we can confirm with MECO." During this time, multiple additional utility poles snapped, causing wires to come down across houses and roads.

At 12:27, the following radio exchange occurred:

> *"Lahaina Command from BC5: Did MECO ever arrive and confirm it is de-energized?*
>
> *Lahaina Command: Negative they came by and they checked some of the lines and he said he was not able to confirm all of them, he said some of them were de-energized but he was not able to confirm all of them, then he left, so he said he was going to come back or send someone up here, so we are just standing by and we have a bunch more lines down.*
>
> *BC5: Do you need anyone else?*
>
> *E3: We are OK, we are informing all of the residents, we don't need anyone else."*

At 14:17, the IC (E3 Captain) notified Central that Hawaiian Electric (MECO) had arrived and was working on the powerlines. The IC confirmed with Central that the fire had been extinguished and MFD crews were returning to quarters, leaving the Hawaiian Electric (MECO) representative to address the downed lines.

According to Central, Hawaiian Electric (MECO) confirmed power to the area had been shut down at 16:11 (the Lahaina PM fire started at 14:55).

3.7.6 Private Equipment Operators

Private contractors providing heavy equipment have become integral in county and state wildfire management. The MFD and DLNR-DOFAW have formal and informal agreements with multiple private contractors to use dozers, loaders, excavators, and water tankers, which are needed to supplement the County of Maui's limited resources.

There are no requirements for private contractors to use PPE and no PPE is provided to private contractors for fire operations. This exposes private operators to potential respiratory and other physical injury. There are no formal standards or guidance in place regarding private operator PPE.

The lack of MFD compatible equipment added to the challenges of firefighting operations on August 8, 2023 (i.e., some private tankers did not have the necessary adapters, therefore, they were unable to fill fire engines when the municipal water supply was lost).

As mentioned in 3.5.3 of the Communications section, private heavy equipment operators rely on cellular service both for dispatch instructions and for operational coordination. During the August 2023 fires, cellular service was intermittent, unreliable, or unavailable.

The responding private assets relied on communications with Central dispatch and face-to-face communications with the MFD. Coupled with the loss of public water access, the inability to communicate via cell phone led to a lack of coordination and efficiency with private water tankers. At times during the Lahaina PM fire, MFD personnel relied on flagging down water tankers to initiate protective measures and structural firefighting.

3.7.7 ANALYSIS OF SYSTEM COMPONENTS

Despite reliance on private heavy equipment assets, no formal county or state training programs are in place for private heavy equipment operators. Lack of fire training response led to inconsistent and, at times, ineffective firefighting tactics.

Some private equipment operators have become familiar with fireground operations and MFD personnel, while other private operators may have limited or no experience operating on an emergency fire incident. This lack of training and collaboration pre-event creates a potential safety risk for the private operators and the first responders.

3.7.7 Mopup of Lahaina AM Fire

The Lahaina AM fire (Lat Long: 20.884723, -156.662991) burned in an open field north of Hoʻokahua Street and east (mauka) of Kuʻialua Street (Figure 3.7.7.1). The area is on a west (makai) facing slope of the West Maui mountains at approximately 300 foot elevation and 1.3 miles from the nearest access point to the coast (Pacific Ocean) at the end of Lahainaluna Road (Figure 3.7.7.2).



Figure 3.7.7.1 Google Earth image of Lahaina with highlighted area indicating Lahaina AM fire location where fire suppression resources were working.



Figure 3.7.7.2 Google Earth pre-fire image (July 9, 2016) of the area where the Lahaina AM fire burned. Red outline marks the ravine with walls made of large boulders that contained voids where tufts of dry vegetation and combustible trash were concealed. The area outlined is approximately five (5) acres.

3.7.7 ANALYSIS OF SYSTEM COMPONENTS



The mid-slope burn area includes a ravine with angled sides made from randomly stacked boulders of various sizes (Figure 3.7.7.3). Small tufts of dry vegetation and combustible human trash filled the voids created between the boulders. The ravine provides natural drainage, running east (mauka-higher elevation) to west (makai-lower elevation) toward the coast.



Figure 3.7.7.3 Post-fire image taken September 3, 2023, from near the top of the ravine southeast of the two-story home in the image at 8[redacted]Ho'okahua Street. Image shows unburned vegetation in rocky terrain. Inset: Viewpoint of the image in the photograph above.

3.7.7 ANALYSIS OF SYSTEM COMPONENTS



Many overhead electrical transmission lines extended over the area where the Lahaina AM fire burned, and several were directly over the ravine (Figure 3.7.7.4).



Figure 3.7.7.4 Post-fire image taken September 3, 2023, from near the east end (mauka) of the ravine southeast of the two-story home in the image at 7 ■Ku'ialua Street. Image shows unburned vegetation in rocky terrain. Inset: Viewpoint of the image above.

3.7.7 ANALYSIS OF SYSTEM COMPONENTS



Images from before the August 8, 2023, fire show the highly invasive non-native buffelgrass and haole koa dominating the area just behind the homes off of Ho‘okahua Street and on the southside of Lahainaluna Road, across from the intermediate school (Figure 3.7.7.5).

Live and dead fuel moistures are unknown as these measurements were not recorded, however, the vegetation was in a well-cured state with golden brown color, common for August. As indicated in Section 3.2, the leeward side of Maui was in Red Flag Weather (KBDI > 600, >20 mph winds, RH <45%).



Figure 3.7.7.5 Google Street View image (pre-fire, date unknown) looking south from Lahainaluna Road. Home in the image is addressed at 8[redacted]Ho‘okahua Street and was the structure nearest the Lahaina AM fire point of origin. Image shows buffelgrass and haole koa at the base of several utility poles supporting overhead electrical lines. Inset: Viewpoint of the image above.

3.7.7 ANALYSIS OF SYSTEM COMPONENTS

3.7.7.1 Role of Mopup in Wildland-Urban Interface Fires

The work effort after a vegetation fire has been knocked down is referred to as the mopup period. Mopup operations need to be thorough to prevent reignition and the spread of residual hotspots. Fire suppression resources should focus on ensuring that all fire is extinguished, using water to cool all hot spots and clearing the vegetation adjacent to the burn to mineral soil.

Firefighters often use handlines and sprayers mounted on water tankers (i.e., water tenders) to extinguish the fire. A control line around the fire is constructed using hand tools or heavy equipment machinery like dozers.

Mopup can be made difficult by certain types of fuels, challenging terrain, hot-dry-windy weather, slope aspect, time of day, and overhead fall hazards like trees and utility infrastructure. (All of these factors were present during the Lahaina AM fire.) Heavy fuel loads, underground fires (in roots or duff layers), poor visibility (from smoke, ash, or difficult view access), limited water supply, and hunger and fatigue of responders can likely pose additional challenges during mopup.

Fires burning in rocky terrain can be especially challenging due to void spaces where vegetation and other combustible material can hide. Low RH exacerbated by high winds can also frustrate mopup, as vegetation, especially fine fuels (often referred to as “one-hour fuels”) like grasses, rapidly dry and become more receptive to ignition. Also, vegetation on south- and west- (makai) facing slopes is susceptible to more drying from the sun’s radiation, which is more intense after noon.

Mopup operations during extreme fire weather conditions are often even more rigorous. They can involve activities, such as extending the perimeter of the mopup, increasing patrol and weather monitoring frequency, and using resources like thermal imaging cameras to detect hidden hot spots. These and other actions aid in reducing the likelihood of flare-ups in extreme conditions.

3.7.7.2 MFD Mopup Guidelines

MFD mopup guidelines are included within the Brush and Wildland Fires (E.O. 302.14) policy, which can be found in Section 6.12.16 of the Appendix. The mopup guidelines state the following:

A. On small fires, all fires should be extinguished in the mopup area, where quantities of burning materials are not so large as to make this impractical.

B. On large fires, completely mopup enough of the area adjacent to the line to be certain no fire can blow, spot, or roll over the fire line under the worst possible conditions.

C. The areas or perimeter of the fire with the greatest chance for spread (e.g., head, uphill, flanks, downwind, or special hazards) should be given the highest priority for initial mopup.

D. All smoldering material that is not put out should be spread well inside of the control line.

E. Eliminate all burned trees inside of the control line that could throw sparks over the control line.

F. Add Class A foam to water when possible for increased effectiveness of wetting the vegetation and charred fuels.

G. Determine the distance inside the control line to be overhauled.

H. During rehab of mopup crews, ensure at least two (2) firefighters remain in the area to monitor for re-ignition or spread of fire.

I. Schedule follow-up checks by crews to ensure the fire is contained, controlled, or extinguished inside of the control line.

3.7.7 ANALYSIS OF SYSTEM COMPONENTS

3.7.7.3 Analysis of MFD Mopup Actions

MFD firefighters performed a mopup of the Lahaina AM fire, according to their typical procedure. They remained on scene for more than seven (7) hours, applying copious amounts of water on to the burning vegetation while also constructing a containment line.

However, there was a portion of the fire that was inaccessible due to unstable overhead powerlines located directly over a ravine made of large boulders where void spaces could hide unburned vegetation and combustible trash.

See Phase One report (pages 91-93) and Section 3.7.5 for radio communications during the mopup period.

Firefighters left the scene when no smoke was visible and when they thought they were “certain no fire can blow, spot, or roll over the fire line under the worst possible conditions.” They performed as they had on previous fires where they experienced successful outcomes. They likely anticipated the same result on this fire.

A careful review of the MFD’s effort revealed that challenges that are often faced during mopup efforts of wildfires were present in this situation. Firefighters believed the fire was fully extinguished because no smoke was visible for several hours after beginning mopup operations.

However, the fire was in challenging terrain with void spaces created by rocks in the ravine, which was difficult to access due to the danger of unstable utility poles and steep slopes described above (Figure 3.7.7.2). Additionally, the presence of dust in the area could have obstructed their view. The extreme downslope winds stirred up dust clouds, making it difficult to see any remaining smoke (Figure 3.7.7.3.1).



Figure 3.7.7.3.1 Video image captured on August 8, 2023, at 09:07, taken from a vehicle traveling eastbound (mauka) on Lahainaluna Road. At the far east end (mauka), a dust cloud can be seen near the location where the Lahaina AM fire burned. Insert: Viewpoint looking east (mauka) on Lahainaluna Road.

The extreme weather conditions, cured fuel, time of day, slope aspect, and challenging terrain made mopup more difficult; all of these factors also increased the likelihood of flare-up conditions.

Wildland firefighting requires recognition and adjustment to weather conditions. These conditions may have not been recognized as critically important by the on-scene crews, whose training and experience are focused more on either structural fires or wildfires in less extreme conditions.

The MFD currently lacks established protocols to adjust operations accordingly. The firefighters operating at the Lahaina AM fire adhered to their training and carried it out completely. Additionally, the forecasts did not lead organizational leadership to implement any specialized operational strategies or instructions, potentially for the same reasons.

Additional fire suppression system factors that may have contributed to MFD resources leaving the scene when they did may be due to the lack of available resources and the need for crews to respond to other emergencies, such as the Upcountry fires. These fires, as well as widespread wind damage, drew down resources county-wide.

It may also be related to the following:

- The state's general lack of attention to addressing wildfire risk as described in Section 2.1.
- The absence of wildland firefighting training requirements and assigned performance standards at the county level.
- A possible lack of understanding and sensemaking of the weather forecasts as described in Section 3.2.
- A possible lack of precedent for adjusting operational strategies during extreme conditions as described in Section 3.7.1.
- A possible lack of experience working in these types of extreme conditions.

3.7.7.4 Comparison Analysis to Wildland Firefighting Mopup Best Practices

The National Wildfire Coordinating Group (NWCG) develops courses for wildland firefighting operations. Wildland Firefighter Training S-130 is the entry-level course required by many agencies around the country. Training includes instruction on Patrolling and Securing the Fireline (page 58).[160] It lists conditions that can lead to spot fires, including:

- Extremely dry weather
- Steep topography
- Heavy fuels
- Crown fires
- Whirlwinds or dust devils
- Torched-out, lone trees
- Wind across the fireline
- Punky logs and tree roots hidden beneath the fireline in the soil
- Snags
- Flashy fuels

Many of these conditions existed during the Lahaina AM fire. Addressing these conditions with adequate resources of the correct type is critical.

According to the MFD's Brush and Wildland Fires E.O. 302.14 (Appendix Section 6.12.16), the MFD's initial response to a reported brush fire consists of: one (1) Engine and one (1) Water Tender (Tanker). Response to a first alarm assignment to a brush fire consists of: two (2) Engines (Type 1), two (2) Wildland Units (Type 6), two (2) Water Tenders, one (1) Chief Officer, and one (1) water dropping helicopter.[161] The adequacy/inadequacy of these response packages will be assessed in the Phase Three report.

If the fire threatens state land (which it did) specialized wildland DLNR-DOFAW units can be added through dispatch. There is no record of DLNR-DOFAW units being requested during the first 48 hours of the Lahaina fires, and there is no record of DLNR-DOFAW offering resources.

DLNR-DOFAW units were already engaged on the Olinda Fire, but they maintain a practice of calling in more resources when mutual aid is requested. Had they been requested to assist with the Lahaina AM fire, or had they been clear and/or notified that state lands were threatened and self-dispatched, mopup may have been handled by wildfire-trained personnel using equipment designed to address the challenging conditions that existed (if DLNR-DOFAW resources were available).

This process was challenged by the lack of clarity and systems for identifying land ownership by dispatch during incidents and lack of protocols for notifying state or federal fire responders when their lands are burning or threatened.

In many parts of the United States, the length of time resources stay on scene to mopup and/or patrol is dependent on weather and fuel conditions. If dry, hot, and windy weather exists, fire resources remain on scene to patrol and mopup around the clock. In many cases, these resources will remain on scene until the weather changes to be more advantageous to fire suppression, which can be several days to several weeks.[162]

Remaining on scene to mopup for days to weeks is likely foreign to MFD firefighters, as well as response teams in other Hawai‘i counties. However, due to the flashy fuels, rocky terrain, and persistent dry, windy weather in the summer, keeping trained firefighters on scene to mopup until the weather changes may be necessary to prevent future flare ups.

In the case of the Lahaina AM fire, firefighters may have been able to remain on scene to check for small hidden fires after Hawaiian Electric secured and de-energized the overhead lines, provided they had the appropriate resources.

3.7.7.5 Vegetation Fire Suppression Operations

The Lahaina PM fire consisted of a wildfire-initiated urban conflagration flanked by fast-moving vegetation fires on the north and south (Figure 3.7.7.5.1).

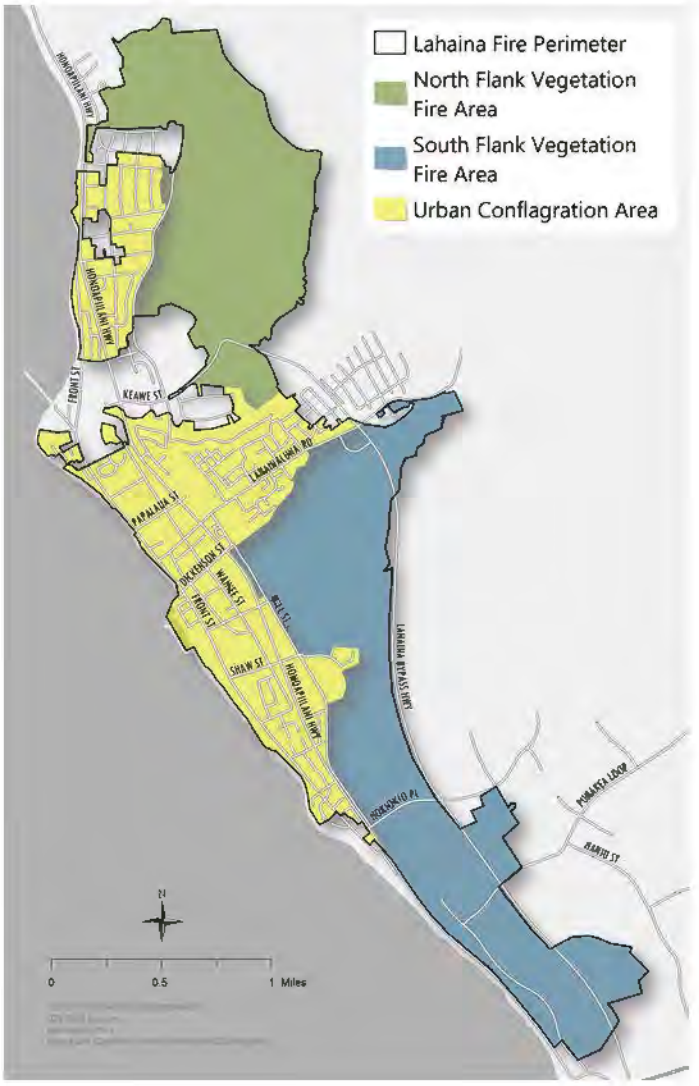


Figure 3.7.7.5.1 Map of Lahaina PM fire perimeter showing area of urban conflagration and vegetation fires on north and south flanks.

3.7.7 ANALYSIS OF SYSTEM COMPONENTS

As the fire moved from structure-to-structure, the fire's flanks widened as more vegetation was consumed.

The vegetation in the fields along the north and south flanks consisted mostly of the highly invasive, non-native buffelgrass and haole koa. On August 8, 2023, the vegetation was already well-cured. The hot, dry northeast winds continued to dry these vegetative fuels, making them even more receptive to fire.

The MFD's early engagement on the vegetation fire flanks was not possible with the resources assigned to the incident. The limited resources available for rescue and fire suppression were prioritized on the urban conflagration, where lives and property were immediately threatened. There were simply not enough MFD resources on the island to address the vegetation fires running along the flanks at the same time, and the lack of resources was compounded by the Upcountry fires where many MFD personnel and apparatus were already engaged.

Vegetation fires of this magnitude, and in these types of extreme conditions, would have demanded a considerable response, especially since aircraft were grounded due to high winds. The resources required to even attempt to narrow the vegetation fire's flanks were also beyond the MFD's capabilities.

Wildland apparatus initially assigned to the Lahaina PM fire consisted of: four (4) Type 6 engines, each staffed with two (2) firefighters from Type I engines, and one (1) water tender staffed with one (1) firefighter.

Two (2) dozers and multiple water tenders from private contractors also assisted. (See Section 3.7.6 regarding private contractor capabilities.) The Type 6 apparatus were equipped with only a few wildland hose packs and limited fire line construction hand tools. (Note: The MFD refers to Type 6 apparatus as "Wildland" and "Mini." The newest models are sometimes referred to as "Skeeter," the vehicle upfitter company name.)

Although the above represents what initially responded, what was actually available for the vegetation component of the fire changed as the incident progressed. For example:

- Wildland 3 (WL3) was burned an hour into the incident.
- WL6 was out of service for an extended period of time due to a utility pole falling on it.
- Mini1 was disabled for a short time due to damage sustained while rescuing E1 and E6 crews.
- Mini11's pump was reported as inoperable at 17:42 by E11.

If a similar WUI fire occurred in a moderately resourced CONUS area, the initial ground unit response may consist of:

- Five (5) Type 1 or Type 3 engines
- One (1) Type 6 engine
- Four (4) hand crews
- Two (2) hand crew superintendents
- One (1) water tender
- One (1) dozer

This initial response would likely be elevated to multiple alarms due to the weather and fuel conditions demanding more direct fire line engagement. Furthermore, if the fire department in that jurisdiction had limited resources, it is customary (and usually feasible) for CONUS fire departments to receive additional resources of a specific type upon request through mutual aid.

3.7.7 ANALYSIS OF SYSTEM COMPONENTS

Being an island in the middle of the Pacific, this is far from a reality for Maui, and all other Hawai‘i counties. As part of Phase Three, a standard of cover and CRA will examine the County of Maui’s resources against its fire and all-hazards risk profile.

The Lahaina PM fire’s vegetation component was equivalent to what is experienced in the CONUS during WUI fires. The threat to life and property is also similar. The resource limitations of state and county fire agencies to handle this crucial area are readily apparent and should be addressed urgently to avoid similar issues with vegetative fire suppression.

Lahaina PM Fire – Vegetation Fire Response Zones

As per the response map (see Figure 3.3.2.1), the MFD is primarily responsible for fire suppression of vegetation fires burning on county and private lands, and a large portion of state lands. The DLNR-DOFAW is generally responsible for state preserves, while federal agencies are responsible for fires on federal lands.

The vegetation portion of the Lahaina PM fire burned mostly on state lands to the north and private lands to the south. These areas are within the MFD’s response areas, making them responsible for fire suppression on both flanks. However, according to the response model, and consistent with the Mopup section, the DLNR-DOFAW could have assisted in the perimeter control objective. As mentioned in the Phase One report (page 42), the DLNR-DOFAW maintains a complement of specialized wildland firefighting apparatus that may have been able to engage on at least one (1) flank.

Federal wildland firefighting assets could have also been requested. Although using federal resources from the National Parks is uncommon, due to the severity of the wildfire threat, this should be considered for future WUI fires.



3.7.8 ANALYSIS OF SYSTEM COMPONENTS

3.7.8 Findings & Recommendations

59. **FINDING:** The MFD did not have an organizational pre-plan for an anticipated high wind or extreme fire weather event.	**RECOMMENDATION:** Ensure effective sensemaking of forecasts and real-time conditions through training and pre-planning. **RECOMMENDATION:** Implement organization-wide start-of-shift briefings to discuss extreme fire weather conditions. **RECOMMENDATION:** Ensure the ICS can scale up quickly, integrating additional support, including personnel normally serving in administrative roles or other functions (e.g., fire prevention, ocean safety, and training), as needed. Provide training and protocols for pre-deployment. **RECOMMENDATION:** Communicate anticipated environmental conditions, risks, and performance expectations across organizations. This includes the MPD, MEMA, County of Maui Department of Water Supply, DLNR-DOFAW, and Hawaiian Electric, who reacted to environmental conditions only after problems arose. **RECOMMENDATION:** Develop a system for ongoing situational awareness that includes continuous monitoring of weather forecasts, fuel moisture levels, and fire behavior through real-time data and predictive models.

3.7.8 ANALYSIS OF SYSTEM COMPONENTS

3.7.8 Findings & Recommendations

60. **FINDING:** With the impending forecast of severe fire weather, there was limited pre-deployment of additional public safety resources prior to the first fire event.	**RECOMMENDATION:** With the potential impact of hurricanes like Dora and Red Flag conditions, the MFD, MPD, DLNR-DOFAW, and their cooperators should consider deploying additional resources across Maui Nui. **RECOMMENDATION:** Identify fire apparatus, incident management, and law enforcement resources for upstaffing and pre-deployment when severe conditions are forecasted. **RECOMMENDATION:** Ensure sufficient fire apparatus, response vehicles, portable equipment, PPE, and radios are available to resource the pre-deployment of additional response units and overhead assets. Whenever possible, standardize the equipment loadout on similar apparatus/vehicles to facilitate use by callback personnel. **RECOMMENDATION:** Consider providing dedicated personnel and resources for staffing management and callback, on a daily basis and before/during major incidents, to make command-level resources readily available for strategic/tactical ICS roles.
61. **FINDING:** There appears to be a statewide culture of dismissing and/or under-recognizing wildfire risk. The underfunding and under-addressing of preparedness, planning, and mitigation efforts significantly impacts all parts of the system and fire outcomes. This cannot be overstated.	**RECOMMENDATION:** Establish a culture of respect for extreme conditions and the need for operational adjustment.

3.7.8 ANALYSIS OF SYSTEM COMPONENTS

3.7.8 Findings & Recommendations

62.	**FINDING:** DLNR-DOFAW resources, specialized wildfire equipment, and trained personnel were underutilized due to restrictive fire response zone guidelines.	**RECOMMENDATION:** Incorporate land ownership maps into incident reporting and tracking to ensure that state and federal agencies with response duties and wildland firefighting capacity are notified and activated. **RECOMMENDATION:** Review and revise master mutual aid agreements for all fire suppression resources on Maui Nui, including, but not limited to, the MFD, ARFF, DLNR-DOFAW, and National Park Services to ensure optimal readiness and response for multi-hazard disasters.
63.	**FINDING:** Densely populated and narrow roadways hindered both MFD and MPD movement during suppression (as well as evacuation and rescue) efforts. Apparatus positioning was not always optimal, due in large part to an overall lack of situational awareness about the location, severity, and trajectory of the fire(s).	**RECOMMENDATION:** Responding MFD units should have pre-determined plans and operating practices for specific areas with narrow streets, outlining alternative access points, water supply strategies, evacuation procedures, and addressing the needs of vulnerable populations. **RECOMMENDATION:** Place hardcopy maps, mapbooks, and pre-incident plans in all response vehicles to provide redundancy if cellular network communication is unavailable.
64.	**FINDING:** The uncertainty around the status of power in the area created numerous impacts on MPD and MFD response to the incident.	**RECOMMENDATION:** As previously mentioned, Hawaiian Electric should have a representative at the ICP (when established).
65.	**FINDING:** Private heavy equipment contractors lacked appropriate training, PPE, equipment, and communications.	**RECOMMENDATION:** Strengthen the coordination with private contractors and address limitations in training, equipment (including standardizing equipment to ensure compatibility with all fire suppression resources), PPE, and communication.

3.7.8 ANALYSIS OF SYSTEM COMPONENTS

3.7.8 Findings & Recommendations

66. **FINDING:** A portion of the mopup area was difficult to access and posed safety threats.	**RECOMMENDATION:** Include DLNR-DOFAW resources on initial response to vegetation and WUI fires. **RECOMMENDATION:** Ensure all personnel have the training to identify and establish safety zones and escape routes, and have protocols in place for communicating this to crews. **RECOMMENDATION:** Communicate the wildfire risk to all department members to set and/or reinforce expectations related to fire mopup procedures.
67. **FINDING:** MFD firefighters performed mopup as proven successful under typical conditions. However, under the severe weather conditions on August 8, 2023, this level of mopup appears to have been insufficient.	**RECOMMENDATION:** Revise policies, procedures, and trainings (E.O. 302.14) that address wildland firefighting (specifically mopup operations) to be in alignment with NWCG guidelines.[163] **RECOMMENDATION:** Implement schedules to manage responder fatigue, ensuring adequate rest periods and meals.
68. **FINDING:** MFD wildland firefighting training, equipment, and staffing should be commensurate with the level of wildfire risk faced by firefighters.	**RECOMMENDATION:** Conduct a comprehensive audit and gap analysis of existing MFD operating procedures/practices against relevant Occupational Safety and Health Administration (OSHA) regulations, National Fire Protection Association (NFPA) standards, fire service best practices, and NWCG standards/ guidelines to help ensure compliance with industry regulations and best practices. By conducting an audit and implementing recommended improvements, the MFD can create a safer working environment for its personnel and enhance the effectiveness of its firefighting and rescue efforts for all incident types. **RECOMMENDATION:** Review the implementation of the MFD's 36-hour rule for alignment with operational needs during disasters and major emergencies.

3.7.8 Findings & Recommendations

68. **FINDING (CONT.):** MFD wildland firefighting training, equipment, and staffing should be commensurate with the level of wildfire risk faced by firefighters.	**RECOMMENDATION:** Consider developing a WUI firefighting playbook to address the increasingly severe wildfire threat across Maui Nui. Look to departments that respond to WUI incidents for expertise and protocols, such as California.[164] **RECOMMENDATION:** Deliver training on, and provide a copy in all response vehicles, the *NWCG Incident Response Pocket Guide (IRPG), PMS 461*.[165] **RECOMMENDATION:** Provide additional wildfire and WUI firefighting training and experiences (such as shadowing incident management personnel in other areas) for MFD personnel. **RECOMMENDATION:** Continue providing medical monitoring and behavioral health support for responders and support personnel.
69. **FINDING:** Many initial attack resources were burned over due to fighting fire from a downwind position.	**RECOMMENDATION:** Train firefighters about the impact of wind on fire progression and fire suppression techniques as per evidence based information and best practices.
70. **FINDING:** Standard wildland firefighting operating procedures for the DLNR-DOFAW and MFD are not in alignment.	**RECOMMENDATION:** The DLNR-DOFAW and MFD should collaborate to update and integrate standard operating guidelines and training for wildland firefighting.

3.8 Evacuation

Rapid evacuation of a community during a natural or man-made disaster is difficult in the best of circumstances. With the addition of inclement weather, such as high winds and limited egress routes, it becomes especially difficult.

This confluence of challenges occurred during the Lahaina PM fire on August 8-9, 2023. High winds prompted rapid fire spread throughout the town, while several community egress options were blocked due to downed utility poles and trees and windblown debris. The complexities of the evacuation were further compounded by infrastructure issues and the dynamic nature of the emergency.

Coordinated and effective evacuations are crucial to achieving the goals of the Cohesive Strategy for public safety and reducing wildfire fatalities. Despite prevention efforts, some wildfires will necessitate evacuation. Efficient evacuations save lives and minimize wildfire impacts, particularly when rapid fire spread threatens people and structures.

The Cohesive Strategy emphasizes pre-planning and close coordination among local governments, emergency responders, law enforcement, community organizations, and the public to ensure well-developed and executed evacuation protocols. Pre-incident planning and preparation by response entities are vital for effective evacuations.

During a wildfire, timely communication of the advancing disaster, evacuation orders, and previously identified routes and assembly points ensures residents can make decisions on their own to evacuate safely and quickly, reducing congestion.

Effective evacuation procedures require multifaceted pre-incident planning built on several best practices:

- **Timely communication to the general public.** Necessitates timely and clear dissemination of evacuation orders through multiple channels (SMS text alerts, social media, local news, etc.) before, during, and after an emergency
- **Smooth traffic management.** Involves the establishment of designated and maintained evacuation routes that are well-publicized to the public and regularly drilled to prevent bottlenecks and ensure a smooth flow of evacuees
- **Clear interagency communications.** Requires the establishment of communications plans between rescue and IMTs, especially in cases of wide-spread communication network failures (See Section 3.5)
- **Adequate personnel and resources.** Ensures each team has the necessary resources to effectively handle an emergency incident at its probable scale
- **Coordination among agencies.** Ensures a unified and efficient response from agencies, with well-defined roles established on key teams, including fire, police, and emergency management

3.8.1 Population Density

According to the U.S. Census, Lahaina, a Census-Designated Place (CDP), had a population of approximately 12,906 as of 2022.[166] The County of Maui had a total population of 164,754 and is predominately (78.6%) urban.[167]

Lahaina's population density is 1,632 people per square mile, compared to 162/sq mi for the County of Maui, making the historic coastal town nearly 10-fold more densely populated than the County of Maui. This relatively high population density likely exacerbated the challenges encountered when residents tried to escape the fire.

3.8.1 ANALYSIS OF SYSTEM COMPONENTS

The area was further crowded by the number of tourists visiting Maui at the time—28,671 visitors in August 2023, according to the average daily census.

Risk to vulnerable populations in the Lahaina area is very high.[168] Both social and economic factors can adversely impact the ability of certain groups or demographic populations to prepare for, respond to, and recover from wildfire.

These vulnerable populations may exhibit limited mobility, or other medical conditions, exacerbated by stress or smoke, encounter cultural and institutional barriers, and/or have challenging access to resources.

Some specific examples of the increased challenges observed in vulnerable populations are provided here. Senior citizens and the disabled have greater sensitivity to both the air pollution and particulates generated by wildfire smoke.

Language barriers can hinder the ability to make preparations before a disaster, follow directions during an evacuation, or to access support after a disaster. Moreover, there are strong correlations among both race and/or ethnicity with health disparities and access to aid and/or resources.

Wildfires further disproportionately impact people with low incomes because of factors like substandard housing and a reduced ability to relocate or even evacuate.

3.8.2 Traffic Management and Egress Challenges

Several factors caused extensive congestion and traffic issues before the start of the fire on August 8, 2023. High winds downed utility poles and utility lines and toppled trees, while debris from vegetation and building materials blocked major traffic routes, creating numerous hazards for vehicles (Figure 3.8.2.1). This obstruction severely limited traffic flow in and out of Lahaina.



Figure 3.8.2.1 Several downed utility poles and powerlines in the northbound lane of Hwy-30 and Kapunakea Street. Photo taken August 8, 2023, at 16:52. Inset: Viewpoint of photo of downed utility poles and electrical lines at Hwy-30 and Kapunakea Street.

3.8.2 ANALYSIS OF SYSTEM COMPONENTS

The Hwy-30 and Kapunakea Street intersection was a major choke point before and during the fire. Due to downed utility poles and electrical lines on Hwy-30, vehicles were forced to use alternative routes on smaller streets and the Lahaina Cannery Mall parking lot to get north and south prior to the Lahaina PM fire.

As the PM fire progressed, traffic on Hwy-30 north of Kapunakea Street and Front Street over Kahoma Stream was restricted to northbound flow (Figures 3.8.2.2 and 3.8.2.3).

Many neighborhoods, especially those along Lahainaluna Road and surrounding areas, had narrow streets congested with multiple parked vehicles on both sides of the streets. Intense heat from burning structures and vehicles parked along the city streets further reduced options for safe passage, slowing traffic flow and complicating evacuation efforts (Figures 3.8.2.1-3.8.2.4).

As mentioned previously, addressing parking issues through community education and stricter enforcement of regulations could alleviate some of these problems in the future, providing clearer and quicker evacuation routes.

Even without these additional challenges blocking traffic flow, the Lahaina area had inherently limited access and egress routes, which became even more problematic during evacuations. The restricted road network was unable to handle the sudden surge in traffic as residents and tourists tried to navigate and evacuate the Lahaina area simultaneously.

These limited egress points meant any blockage, disabled vehicle, or accident could hinder residents' ability to evacuate quickly.

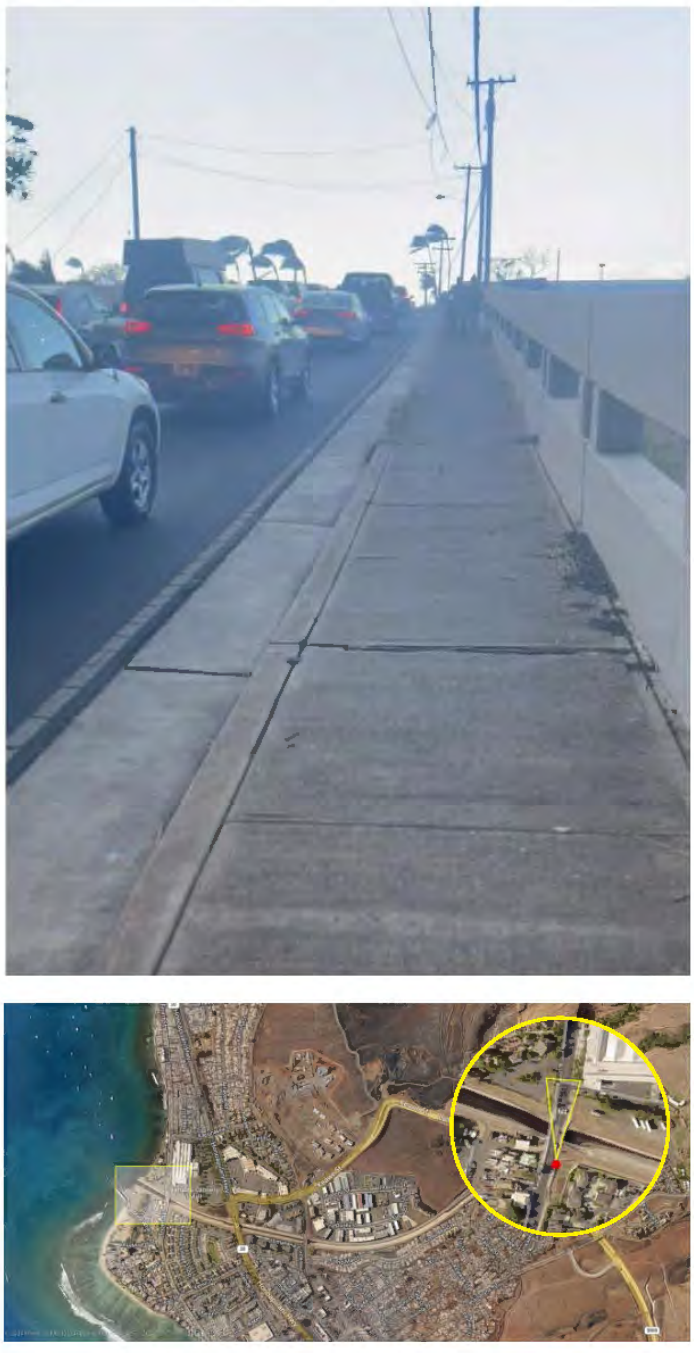


Figure 3.8.2.2 Northbound Front Street traffic over Kahoma Stream on August 8, 2023, at 17:05. Inset: Viewpoint of northbound Front Street traffic over Kahoma Stream on August 8, 2023, at 17:05.

3.8.2 ANALYSIS OF SYSTEM COMPONENTS

Safety issues arose for both emergency responders and pedestrians. Emergency vehicles struggled to navigate through parked cars and heavy traffic, while pedestrian safety was compromised, especially in areas lacking proper sidewalks or crosswalks.

The area's loss of power affected traffic signals, causing them to stop functioning and further hindering traffic flow. Without operational traffic signals, intersections rapidly became chaotic, slow, and dangerous, leading to severe traffic congestion.

Thick smoke and flames also reduced visibility, greatly obscuring drivers' ability to see and safely navigate the roads. This reduced visibility increased the risk of accidents and slowed evacuation efforts. Additional downed utility poles, powerlines, trees, and building materials, all scattered by the high winds, obstructed both primary and secondary egress routes.

This debris made many roads impassable and forced residents and emergency responders to find alternative, less direct routes. The high winds and subsequent fire damage led to the reports from some MPD officers of lost cellular connection. Some individuals reported GPS navigation systems were unreliable. These issues contributed to the chaotic and dangerous environment for evacuations, highlighting the critical need for improved emergency planning, infrastructure resilience, and public awareness.



Figure 3.8.2.3 Front Street at Hwy-30 on August 8, 2023, at 17:28 shows MPD vehicles redirecting southbound Hwy-30 traffic away from the fire, and vehicles on northbound Front Street merging onto northbound Hwy-30. Inset: Viewpoint looking south toward Front Street and Hwy-30 intersection.

3.8.2 ANALYSIS OF SYSTEM COMPONENTS

The MPD extended their night shift officers, who were due to be sent off duty, to help control traffic at key intersections. However, the extreme wind and heavy smoke from the fire further hampered efficient egress from the fire-ravaged areas of Lahaina and increased health and safety hazards for MPD officers.

Some old sugarcane roads (with different degrees of maintenance) on private and public lands, served as crucial alternative evacuation routes. Access to these dirt roads were mostly blocked by either locked gates or boulders, which were intended to prevent unauthorized use.

As the fire grew in intensity and consumed structure after structure down Lahainaluna Road, by 16:30 on August 8, 2023, the main westbound egress routes down Komo Mai Street and Lahainaluna Road were cut off by fire. Due to the quick actions of MPD officers and residents, alternative egress routes through locked gates and dirt roads enabled many residents to evacuate safely (Figure 3.8.2.4).

The route was accessed via the east end of Komo Mai Street using a small dirt road between 3[redacted] and 4[redacted] Komo Mai Street. This led to a path along the south bank of Kahoma Stream, which allowed traffic to flow eastbound onto Kanakea Loop (Figure 3.8.2.5).



Figure 3.8.2.4 Evacuation route used by residents exiting the Lahainaluna neighborhood as the fire burned through the Lahainaluna neighborhood. Route required breaking open three (3) locked gates (red circles), and driving on dirt roads to make access to Lahainaluna Road, and ultimately, the Lahaina Bypass.



Figure 3.8.2.5 Body-worn camera (BWC) images of a MPD officer captured August 8, 2023, at 16:27 and 16:28 on a private vacant lot north of 4[redacted] Komo Mai Street and south of Kahoma Stream. MPD officers and residents broke through the gate to travel on the dirt road to Kanakea Loop, and ultimately, out to the Lahaina Bypass via Lahainaluna Road. Inset: Viewpoint of BWC image of MPD officer assisting residents evacuating dirt road on a private lot on south side of Kahoma Stream.

3.8.2 ANALYSIS OF SYSTEM COMPONENTS



Egressing the neighborhood along Kanakea Loop proved challenging due to the westbound streets of Kahena, Kahako, and Ka‘akolu being cut off by fire. The only way out was through the County of Maui Department of Water Supply lot across from 1005 Kanakea Loop. MPD officers used their vehicles equipped with tow straps, and in some cases their own bodies, to open gates that were blocking the critical egress route (Figure 3.8.2.6).







Figure 3.8.2.6 BWC image capture of a MPD officer August 8, 2023, at 16:43,16:44, and 16:46 breaking through a locked gate securing the County of Maui Department of Water Supply Lot (Parcel No. 450310010000) on Kanakea Loop, directly across from 10[redacted] Kanakea Loop. Gate restricted access to the county lot, leading to a second gate that provided access to the Kelawea Mauka Makai Park parking lot, and ultimately, Lahainaluna Road. Inset: Viewpoint of MPD officers making access through the locked gate, securing the county lot in the west side (makai) of Kanakea Loop, across from 10[redacted] Kanakea Loop.

3.8.2 ANALYSIS OF SYSTEM COMPONENTS



Numerous vehicles followed one another from the Komo Mai Street dirt road to Kanakea Loop, through the County of Maui Department of Water Supply lot (Figure 3.8.2.7) and the Kelawea Mauka Makai Park parking lot, to eastbound Lahainaluna Road, and ultimately, to the safety of the Lahaina Bypass.

The direct intervention of MPD officers allowed for quicker evacuations and access to safer areas. The necessity of rapid access measures to open these gates highlighted a significant gap in the preparedness and planning for such emergencies. Ensuring these routes are maintained and accessible by emergency crews could vastly improve evacuation operations in future incidents.

Ensuring multiple, well-maintained evacuation routes are available and first responders have the necessary access to these routes is crucial. Pre-planned and regularly updated evacuation routes can mitigate delays and ensure smoother evacuations during emergencies.



Figure 3.8.2.7 BWC image captured on August 8, 2023, at 16:46 of a MPD officer within the County of Maui Department of Water Supply lot (Parcel No. 450310010000) just north of Kelawea Mauka Makai Park. MPD officers and residents broke through locked gates to exit the lot into the Kelawea Mauka Makai Park parking lot, then to Lahainaluna Road, and ultimately, to the Lahaina Bypass to escape the fire. Inset: Viewpoint of BWC image of MPD officer inside county lot residents used to travel through to escape the fire.

3.8.3 ANALYSIS OF SYSTEM COMPONENTS

3.8.3 MPD Preparedness

No evacuation pre-plan for Lahaina and the Lahainaluna neighborhood was provided by the MPD. The lack of an executable evacuation plan contributed to many of the challenges the MPD faced during the Lahaina PM fire.

While the MPD's night shift, which had been held over, handled traffic control, MPD day-shift officers were tasked with responding to numerous incidents and emergencies that arose both during the course of the fire and normal, daily activity.

Despite the escalating severity of the situation in Lahaina, no supplementary support or reinforcements were requested until the start of the Lahaina PM fire on August 8, 2023, increasing the strain on already limited resources and manpower. Despite the officers' efforts, the urgent need for proactive staffing and comprehensive pre-incident planning became critical with such an extremely rapid fire.

It's imperative for the MPD to prioritize the implementation of strategic preparedness measures to mitigate the impact of future disasters. These measures will ensure the readiness of equipment and facilities to withstand the impact of emergency situations like storms and wildfires, and the prospect of loss of power that follows.

3.8.4 MPD Actions

During the Lahaina PM fire, effective coordination of resources and accountability were necessary for managing evacuations, rescues, and supporting evacuation routes. However, the MPD faced numerous challenges in ensuring a coordinated response.

Due to the vast distances and limited access routes, any additional assistance or support from neighboring districts was at least 20 to 30 minutes away, which created logistical problems. This geographical constraint further underscored the urgency of the situation and emphasized the critical importance of efficient resource allocation and strategic planning in emergency response efforts.

Dispatch was notified about evacuation orders at 15:06. However, the MPD had already been evacuating residents who were in the immediate area of the AM fire toward the Lahaina Bypass, while the MFD and private equipment operator crews were firefighting.

Directing traffic around roadway obstructions was critical before the PM fire and the MPD were stationed at strategic traffic control points, managing the traffic flow in and out of Lahaina. During this time, utility poles were falling, powerlines were coming down, and airborne debris was flying around, making the environment dynamic and perilous.

Power status was also unclear, elevating the risks for both officers and residents. Once the PM fire began and evacuations were ordered, there were not enough officers in position to notify every resident, especially those in the Lahainaluna neighborhood, of evacuation orders ahead of the fast-moving fire.

MPD officers made an emergency field decision to send limited evacuation vehicle traffic on Lahainaluna Road in a "contra-flow" manner to the west toward Hwy-30 at 16:47. This action provided limited relief to the vehicle gridlock.

Working off one (1) primary radio channel limited the MPD's ability to communicate effectively. Relaying timely information proved challenging as events unfolded rapidly. At times, officers were forced to delay transmission while other officers had the channel open. Transmissions were often difficult to hear due to deafening winds and the sound of fire destruction.

3.8.4 ANALYSIS OF SYSTEM COMPONENTS

Throughout the fire, the MPD conducted rescues of citizens and others endangered by the fire, including managing search and rescue (SAR) operations and providing aid to people in distress. Collaboration with the MFD at this task-level ensured the safe evacuation of hundreds of residents, maintenance of evacuation routes, and assistance to those in need.

One (1) notable instance highlighting the importance of incident management occurred when the MPD captain ordered a recall at 18:15 of all officers not engaged in traffic posts back to the station. According to the MPD, this decision was made to address a lack of coordination and accountability within the response teams, establish a new structured evacuation plan, and reallocate resources.

While the decision to recall these officers provided the opportunity to regain command and control of MPD units, it deviated from NIMS-ICS best practices. This action was taken without coordination with the EOC or MFD, highlighting a missed opportunity for a unified ICS.

Ideally, the initial MPD captain would have assigned and tracked resources at a strategic level, allowing officers to operate effectively at the task-level. This approach would have ensured better coordination, accountability, and a unified response with the MFD.

Despite encountering coordination challenges, it is imperative for the MPD to align with and engage in evidence-based best practices to ensure a more effective response in future crises.

3.8.4.1 Automatic Vehicle Location Data – Apparatus Location

The positioning of MPD apparatus throughout the incident was communicated by MPD personnel during their TDs. Personnel assigned to each resource identified their location on a map and used the dispatch/communications record to verify their location in most cases.

For apparatus equipped with AVL capabilities, location was also verified using the data provided by the County of Maui.

The AVL heatmaps in Figure 3.8.4.1.1 display MPD resource location over time. The warmer the color, the more timepoints recorded in that location. Each one (1) hour time period displaying a heat signature represents a collection of units with their associated timepoints within a geographic area. The limitation of the heatmap is, at times, there were no units with timepoint data for the hour period, or there was only one (1) or a few units with only one (1) or a few timepoints.

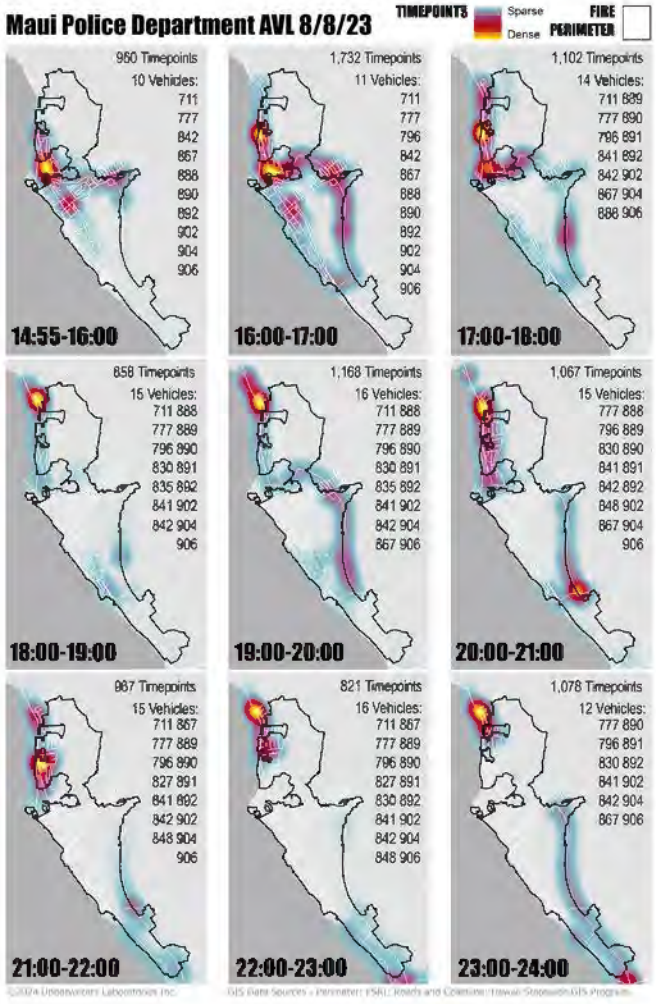


Figure 3.8.4.1.1 MPD AVL data aggregated to location within eaach hour, starting at the time of the Lahaina PM fire and through midnight.

3.8.5 ANALYSIS OF SYSTEM COMPONENTS

The location of MPD resources is mostly consistent with what personnel communicated. This was especially common during the Lahaina AM fire suppression operations and early into the PM operations.

Furthermore, it's important to note that, like the MFD, some MPD vehicles assigned to Lahaina may not have been AVL-enabled or data was not provided.

See Appendix 6.10 for a comparison of MFD, MPD, and Hawaiian Electric's AVL timepoints.

3.8.5 MFD Actions

During the Lahaina PM fire, the MPD and MFD performed their primary roles independently, with the MPD focusing on evacuation and the MFD on fire suppression. While there was no formal unified command structure, individual MPD officers and MFD personnel worked together on the ground to notify, evacuate, and make rescues.

The MFD concentrated on combating the fire, utilizing their resources and personnel to attempt to control the blaze and prevent it from spreading. However, the MFD also played a role in evacuating residents, particularly in areas where the fire posed an immediate threat.

Along with police officers, MFD crews went door-to-door, assisted in directing vehicles and citizens away from harm, and placed individuals in fire apparatuses for immediate safety. The MFD also used additional support vehicles for evacuations in the Front Street area and along the sea wall.

3.8.6 Resident Communications During Evacuations

Due to the loss of power and unreliable cellular networks, MPD officers began alerting Lahaina residents of the fire's imminent danger using vehicles equipped with public address (PA) systems and sirens.

The effectiveness of vehicle-mounted PA systems to alert residents of evacuations was dramatically impacted by several factors, including wind noise, limited ability of residents to hear within their homes (especially older residents with diminished hearing), and the directional nature of PA systems.

These systems are designed to project sound in a specific direction, meaning that if the vehicle is not oriented correctly, the sound may not reach all intended areas. These factors underscore the limitations of relying solely on vehicle-mounted PA systems for emergency alerts and the need for other communications channels in the event of full network failure.

Strong wind noise also drowned out the sound of PA systems, making it difficult for residents to hear evacuation orders. Wind noise is particularly problematic in open areas or streets where sound dispersion occurs. Studies have shown gusty, 15-30 mph winds can cause a reduction of a few decibels per 100 yards.[169]

Residents inside their homes faced additional challenges. With windows and doors closed to block out the wind, their ability to hear external announcements was greatly reduced. The insulating properties of buildings, especially modern homes with energy-efficient windows and solid doors, also decreased sound transmission from outside.

Additionally, the diminished hearing of older residents posed a significant challenge. Many elderly individuals suffer from age-related hearing loss, which can affect their ability to hear PA announcements clearly, even if they are nearby. Hearing loss affects approximately 33% of people over the age of 65, with high-frequency sounds, like those from PA systems, being particularly hard to hear.

Inaccessible roads due to downed trees and electrical lines prevented police vehicles from reaching certain areas, leaving those residents without direct audio alerts. Physical barriers also severely limited the distribution of emergency communications, necessitating alternative methods for reaching isolated populations.

The factors listed above made it impossible to notify everyone, especially those west (makai) of where the fire started and all the way to the ocean.

3.8.7 Rescue Operations

During the Lahaina PM fire, the MPD and MFD undertook numerous rescue operations, assisting those unable to evacuate on their own, including elderly residents and those with limited mobility, and rescuing people from the sea wall and the area around the aquatic center.

During the firefight, MFD companies evacuated numerous citizens from the fire's path. For example, the crew of L3, during their initial fire attack on Lahainaluna Road, encountered a family of seven (7), including a baby, trapped by the rapidly advancing flames. The firefighters placed the family in the safety of their cab, and coordinated with BC5 to transfer them to a secure area above the fire, away from immediate danger.

In another instance, L3 provided refuge for a victim who remained with them for an extended period of time until a safe location and transfer could be completed (see Phase One report, pages 103-108). Throughout the operation, MPD and MFD units rescued numerous individuals and families, guiding them to safe zones or the civic center, which served as a temporary shelter (see Phase One report, pages 151-157, 159-173, 179, 213-216).

3.8.8 Resident Response to Evacuation Efforts

The speed of the fire, extreme winds, blocked roads, and limited access points prevented the MPD from getting into all impacted neighborhoods and informing people of the imminent danger. For residents, the situation was confusing and unprecedented, making it difficult for individuals to know what action(s) to take.

As the fire moved, officers worked quickly to evacuate these critical areas. Some residents refused to leave their homes, despite evacuation orders, which endangered their lives and may have delayed the evacuation process for others.

During TDs, MPD officers cited repeated issues of complacency, and a lack of awareness or understanding of the fast-approaching danger posed by the fire. Negotiating these situations required the MPD to prioritize public safety and community evacuation over the dangers and delays created when individuals resisted evacuation directives.

Many residents believed that a fire had never substantially affected Lahaina or Maui before and trusted the MFD's past successes protecting Lahaina, leading to a false sense of safety by some residents.

As mentioned previously, the diminished cell service and loss of electrical power during the fire further complicated matters, as many residents did not receive evacuation notices, and did not hear PA announcements.

In TDs with residents from all parts of Lahaina (including areas that were not immediately impacted by the fire in the Lahainaluna neighborhood), 57% said they were not instructed to evacuate and those who did evacuate were urged to do so by friends or neighbors.

3.8.8 ANALYSIS OF SYSTEM COMPONENTS

Although MPD officers were driving around and making PA announcements about evacuating the area, many respondents commented they could not hear what was being said over the PA. Some heard the announcements, but stated there were no instructions for which routes to take or where to go (Appendix Section 6.3).

However, 79% said they encountered the MPD on August 8, 2023, with most encounters occurring in traffic situations while evacuating residences and businesses (Appendix Section 6.3).

Some residents also faced physical or logistical challenges, such as limited mobility or lack of transportation, which prevented them from evacuating promptly.

Overall, these factors highlight the critical need for community education and better communication strategies to ensure residents understand the importance of evacuation and are equipped to respond appropriately in future emergencies as part of a comprehensive and effective emergency preparedness plan.

3.8.9 Evacuation Reflection

Even with the evacuation challenges highlighted, thousands of Lahaina residents and visitors managed to escape to safety, a testament to the actions of emergency services personnel and every-day people helping each other through the disaster.

The situation in the Lahainaluna neighborhood was particularly tense, where the PM fire spread very rapidly. While an exact count is unclear, a majority of the population was able to evacuate, though some, unfortunately, did not make it out of the area.

The severe weather preceding the disaster likely caused many people to be at home during the fire. And since the fire took place primarily in the after-noon, many people were awake, alert, and able to evacuate. In the eastern (mauka) section of Lahaina, the 2022 U.S. Census (Block Groups 1-4, Tract 314.05) reports a population of 6,442.[170] [171] [172] [173]

The night of August 8, 2023, brought new challenges, especially for the residents of the Wahikuli neighborhood. As flames approached in the darkness, first responders were tasked with waking sleeping inhabitants and guiding them to safety. The urgent knocks on doors and sirens became a lifeline for many who might otherwise have slept through the encroaching danger.

Many residents who lived in this area decided to evacuate well ahead of the fire making it to this location. Of an estimated population of more than 3,000[174] [175] in this northern section of Lahaina, five (5) residents were lost.

3.8.10 Fatalities

The fires that occurred on August 8-9, 2023, on Maui resulted in an unprecedented loss of life and property damage. A total of 102 fatalities have been confirmed in Lahaina, with two (2) additional individuals still reported missing by the MPD.[176]

This section is intended to provide context and insight into the fatalities. Data presented in this section was compiled from:

- The MPD's Preliminary After-Action Report
- Data produced by the MPD
    - Driver's licenses on the victims (limited)
    - Victim home addresses and recovery notes
- Resident TDs
- Media reports

3.8.10 ANALYSIS OF SYSTEM COMPONENTS

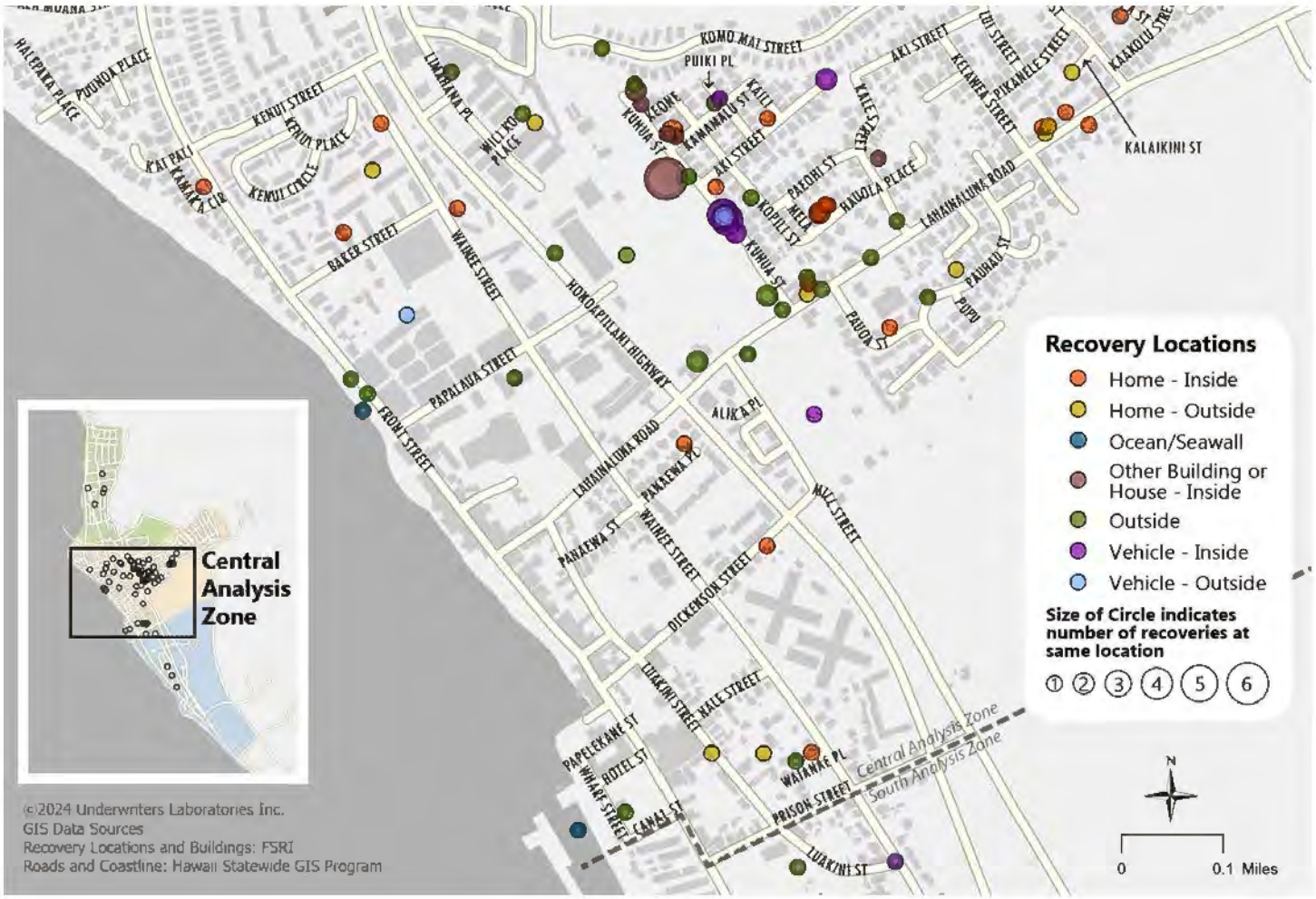


Figure 3.8.10.1 Recovery locations and descriptions of fire fatalities for the central analysis zone.

Several characteristics of victims were documented from the available data sources, including age, gender, home address, location recovered, whether there was evidence indicating the person was attempting to evacuate, and other circumstances around their death (Appendix Section 6.13).

- The average age of the victims was 65 years old
- The median age of the victims was 68 years old
- The age of the victims ranged from 7 to 97 years old

The largest number of fatalities, 82 (80%), took place in the central part of Lahaina, the area bounded by Kahoma Stream to the north and Dickenson Street to the south (Figure 3.8.10.1). This area experienced rapid initial fire spread and the least available evacuation time. See the Phase One report (pages 45-83) for additional details on where and when the fire progressed.

Eleven (11%) fatalities occurred south of Dickenson Street and five (5%) fatalities occurred north of Kahoma Stream (Figures 3.8.10.2 and 3.8.10.3). Four (4%) victims died later due to injuries sustained during the fire.

3.8.10 ANALYSIS OF SYSTEM COMPONENTS

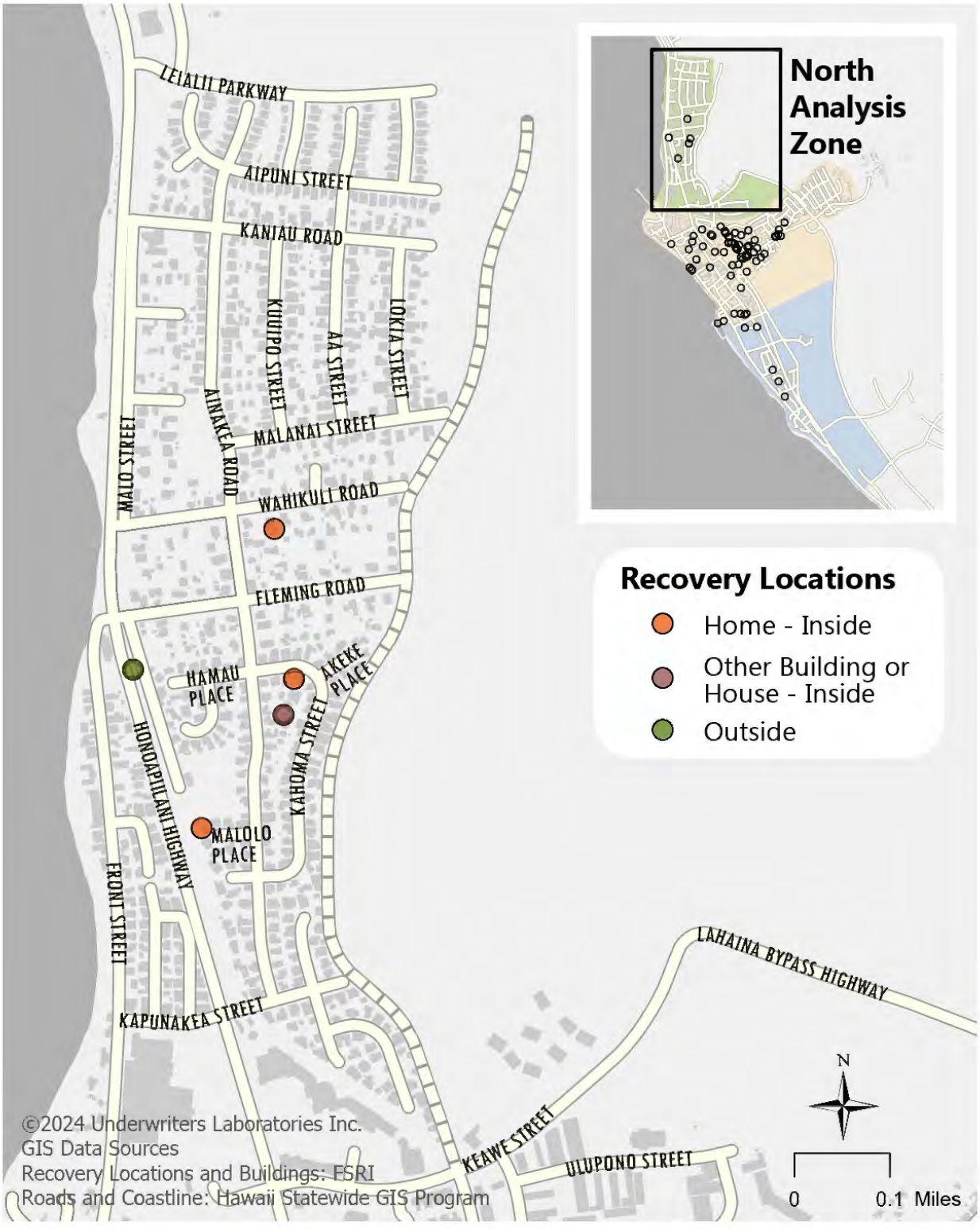


Figure 3.8.10.2 Recovery locations and descriptions of fire fatalities in the north.

3.8.10 ANALYSIS OF SYSTEM COMPONENTS

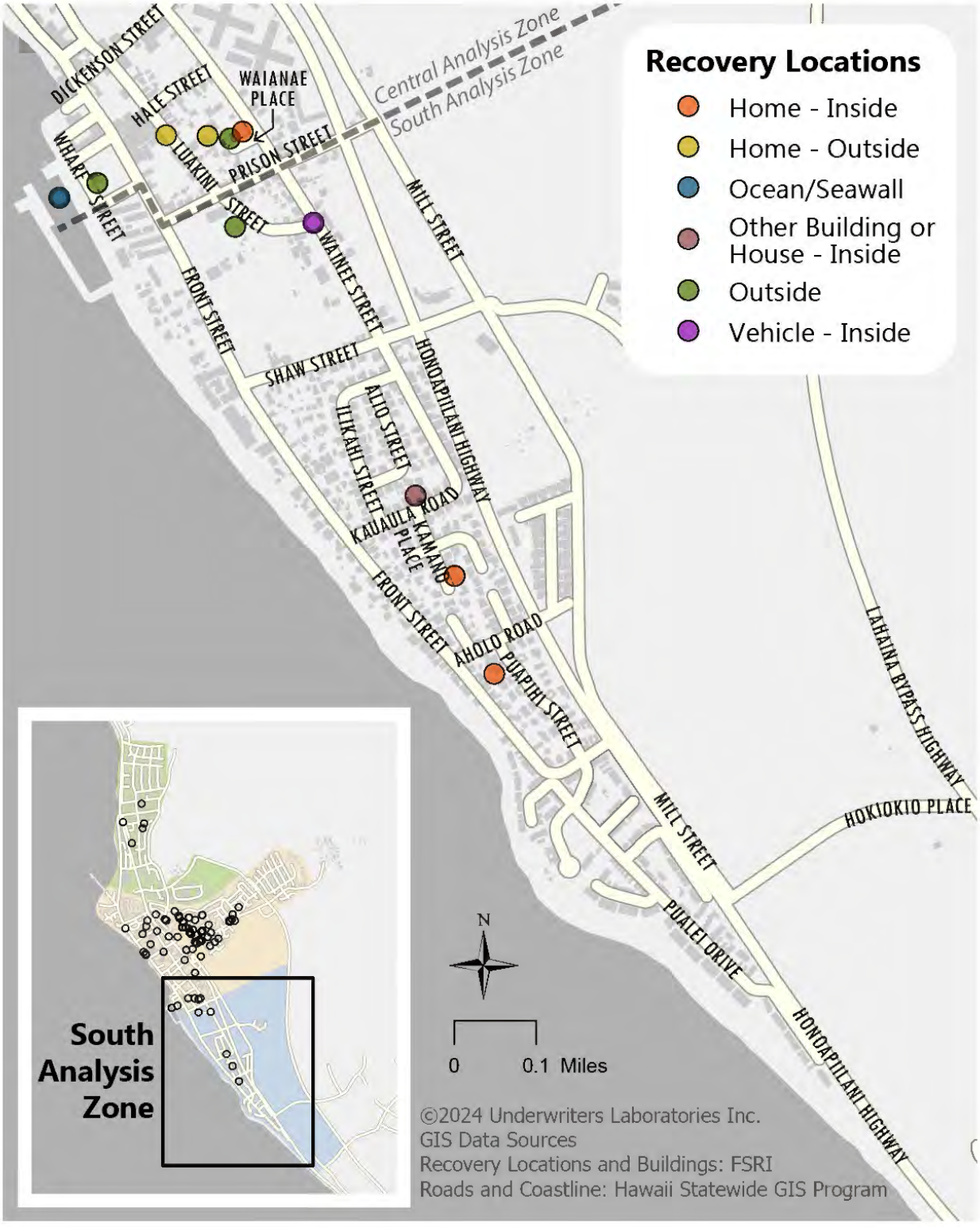


Figure 3.8.10.3 Recovery locations and descriptions of fire fatalities in the south.

3.8.10 ANALYSIS OF SYSTEM COMPONENTS

Most fatalities, 37 (36%), were found in or just outside their homes (Table 3.8.9.1). Twenty-seven (26%) were located outside. Fourteen were located in buildings or houses that did not match their reported home address. Many were located in or right outside vehicles (17).

Based on available reporting of the circumstances of each victim, it appears that at least 65 of the 102 people (64%) were attempting to evacuate when they were overcome by the fire. Those who were found in or just outside their home were not classified as attempting to evacuate.

For those who were evacuating, examining the distance between the victims' home addresses and the locations where they were recovered yields an average evacuation distance of 0.15 mi (800 ft).[177] This suggests that those who were able to evacuate could not make it very far.

The following section utilizes the available data to examine the evacuation circumstances for all 102 victims. The amount of data is not the same for each person and, in some cases, context-informed assumptions are made, such as where they were when they became aware of the fire and how they ultimately got to where they were recovered.

Table 3.8.10.1 Summary of fatalities with respect to location found.

Summary of Fatality Recovery Locations		
Recovery Location	**Count**	**Percentage of Total**
Home – Inside	28	27
Home – Outside	9	9
Vehicle – Inside	15	15
Vehicle – Outside	3	3
Outside	27	26
Other Building or House – Inside	14	14
Ocean/Seawall	2	2
Hospital	4	4

For each person, we also examined the fire progression data from the Phase One report to begin to understand the speed at which the fire approached and the evacuation challenges the victims likely experienced. As a baseline for fire progression from Phase One, the Lahaina PM fire ignited at 14:55, jumping the Lahaina Bypass at approximately 15:21. The first homes along Lahainaluna Road began to ignite at 15:30.

There were three (3) clusters of fatalities located in the Lahainaluna neighborhood. The first was at the Hale Mahaolu Eono independent-living apartment complex at 8[redacted] Kelawea Street. Seven (7) residents were among the fatalities. Six (6) were recovered on the facility property and one (1) evacuated to the area of Lahainaluna Road and Kuhua Street and was recovered there (Figure 3.8.10.4).

The average age of those who did not evacuate this complex was 86. This complex was very close (approximately 200 feet to the closest point) to the first structures that ignited after the fire jumped the Lahaina Bypass. The MFD initially positioned several units to try to stop the fire's progression near the intersection of Kalena Street and Lahainaluna Road, but were unsuccessful. MPD officers worked to evacuate the complex, but were forced to fall back

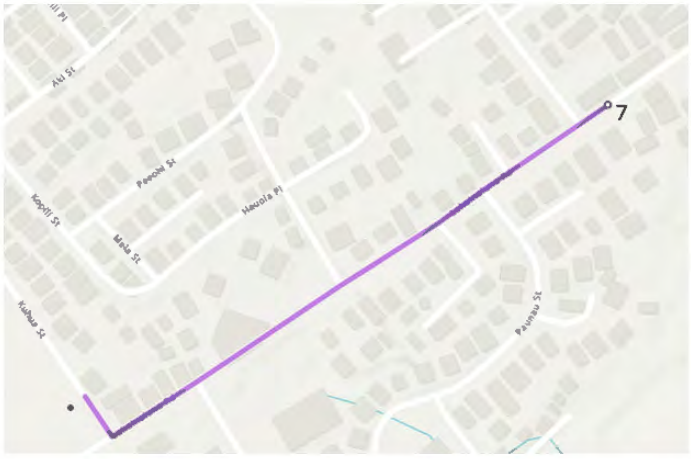


Figure 3.8.10.4 Evacuation path of the resident of the Hale Mahaolu Eono independent-living apartment complex at 8[redacted] Kelawea Street who was recovered on Kuhua Street.

at 16:08. At 16:43, a dispatch record stated, “Hale Mahaolu fully engulfed.”

The second cluster of fatalities was located inside 8[redacted] Kuhua Street. Six (6) people sought refuge inside a structure described in MPD documents as a “quonset hut.” This lightweight prefabricated structure of corrugated, galvanized steel with a semi-circular cross-section faced Kuhua Street. The remainder of Kuhua Street was lined with a security fence that residents described as well-reinforced due to previous vandalizations of the mill property that ran along most of the western side (makai) of Kuhua Street (Figure 3.8.10.5).



Figure 3.8.10.5 Front of 8[redacted] Kuhua Road from Google Street View (Sept 2011).

Based on resident reports and media stories, a large tree came down blocking Kuhua Street just south of Aki Street, and a utility pole came down across Kuhua Street just north of Aki Street. All six (6) victims lived on Kopili Street and likely traveled north on Kopili Street, then west on Aki Street to Kuhua Street, where they became trapped, unable to go north or south without hitting an obstruction (Figure 3.8.10.6).

Once the fire spread to the Kuhua Street and Aki Street area at approximately 16:42, when a 911 caller advised the fire was getting closer to Kuhua



Figure 3.8.10.6 Potential egress routes for fatalities recovered from 8[redacted] Kuhua Street.



Figure 3.8.10.7 August 11, 2023, satellite image of 8[redacted] Kuhua Street and surrounding area.

Street and Aki Street, they were left with no evacuation route. Unfortunately, the structure did not resist the fire and was burned out, along with the six (6) victims (Figure 3.8.10.7).

The third cluster of fatalities was located in front of 8[redacted]-8[redacted] Kuhua Street. There were ten (10) victims located inside or just outside of vehicles. MPD records describe a car crash at this location and satellite images show at least two (2) cars involved in an accident, and possibly two more vehicles 75 feet further down Kuhua Street toward Lahainaluna Road.

3.8.10 ANALYSIS OF SYSTEM COMPONENTS

The Dychmans were found in a vehicle in front of 8[redacted] Kuhua Street. They possibly evacuated from Puiki Place. The other vehicles were in front of the neighboring home, 8[redacted] Kuhua Street.

This address is where two (2) of the victims (Terri Thomas and Dale Richter) were reported to have lived. Tony Takafua, Salote Tone, Fa'aoso Tone, and Malui'fonua Tone were presumably evacuating from 9[redacted] Kuhua Street in their car headed south on Kuhua Street toward Lahainaluna Road. Juan Deleon and Ediomede Castillo were presumably evacuating from their home at 3[redacted] Keone Street in their car, headed south on Kuhua Street toward Lahainaluna Road (Figure 3.8.10.8).

It is not known what time they all reached this area. However, they were able to get past the area on the corner of Aki Street and Kuhua Street. The fire first reached the area of Kuhua Street and Lahainaluna Road at 15:57. At 16:25, homes were reported to be on fire in this area. The vehicles in front of 8[redacted] Kuhua Street were consumed by fire, while the vehicle in front of 8[redacted] does not appear to have been consumed by the fire (Figure 3.8.10.9).



Figure 3.8.10.8 Potential egress routes for those recovered in vehicles in front of 8[redacted]-8[redacted] Kuhua Street.



Figure 3.8.10.9 August 11, 2023, satellite image of 8[redacted]-8[redacted] Kuhua Street and surrounding area.

3.8.10 ANALYSIS OF SYSTEM COMPONENTS



3.8.10.1 List of Victim Evacuation Circumstances

Louise Abihai was 97 years old and was reportedly found inside her home at the Hale Mahaolu Eono independent-living apartment complex at 8[redacted] Kelawea Street. It is presumed that she did not, or was not able, to evacuate.[178] MPD officers worked to evacuate the complex, but were forced to fall back at 16:08. At 16:43, a dispatch record stated, “Hale Mahaolu fully engulfed.”

Laurie Allen was 65 years old and reportedly succumbed to her injuries at Straub Medical Center in Honolulu on September 29, 2023. She reported that she had delayed her own evacuation until the Sagudang family could gather their things and join her. When they were ready, she apparently followed their two (2) cars down the road until a falling tree branch forced them to abandon their cars and climb into hers, but she was unable to find a way forward. Allen presumably got out of the car and fled 100 yards (91 meters) across a field of burning grass (possibly in the area of Lahainaluna Road and Mill Street where Conchita Sagudang was reportedly recovered). A police officer and firefighter reported that they met her, and she was taken to an emergency shelter.[179] [180] [181] At 16:09, the MPD advised the fire was reaching Mill Street. At 16:24, the MPD advised, “We might have one (1) fatality. Homes rear of Mill Street,” indicating fatal conditions at that area. At 16:37, the MPD reported having a 65-year-old female with burns to her body.

June Anbe was 78 years old and was reportedly found inside her home at the Hale Mahaolu Eono independent-living apartment complex at 8[redacted] Kelawea Street. It is presumed that she did not, or was not able, to evacuate.[182] MPD officers worked to evacuate the complex, but were forced to fall back at 16:08. At 16:43, a dispatch record stated, “Hale Mahaolu fully engulfed.”

Angelica Baclig was 31 years old and was reportedly found inside an industrial building at 8[redacted] Kuhua Street. It was reported that she was recovered with Junmark Quijano, Adela Villegas, Justin Recolizado, Maria Victoria Recolizado, and Eugene Recolizado. At 15:57, a 911 caller advised the fire reached Kuhua Street and Lahainaluna Road. At 16:42, another 911 caller advised the fire was getting closer to Kuhua Street and Aki Street, which is adjacent to the industrial building.

Narciso Baylosis, Jr. was 67 years old and was reportedly found at 2[redacted] Lahainaluna Road next to the Shell Gas Station. He presumably departed his home in a vehicle with Vanessa Baylosis and possibly traveled down Pauoa Street to Lahainaluna Road. They may have turned left on Lahainaluna Road and drove west past Mill Street. At 16:09, the MPD advised the fire was reaching Mill Street.[183] At 16:24, the MPD advised, “We might have one (1) fatality. Homes rear of Mill Street,” indicating fatal conditions at that area.

3.8.10 ANALYSIS OF SYSTEM COMPONENTS



Vanessa Baylosis was 67 years old and was reportedly found at 2[redacted] Lahainaluna Road next to the Shell Gas Station. She presumably departed her home in a vehicle with Narciso Baylosis Jr. and traveled down Pauoa Street to Lahainaluna Road. They may have turned left on Lahainaluna Road and drove west (makai) past Mill Street. At 16:09, the MPD advised the fire was reaching Mill Street.[184] At 16:24, the MPD advised, "We might have one fatality. Homes rear of Mill Street," indicating fatal conditions at that area.

Melva May Benjamin was 71 years old and was reportedly found outside at 9[redacted] Puiki Place. She presumably departed her home with partner Edward Sato in their vehicle and traveled east (mauka) on Aki Street, turning left on Puiki Place.[185] At 16:25, a house in the 300 block of Aki Street was reported as on fire. At 16:58, a third-party 911 caller advised a house was on fire on Puiki Place.

Luz Bernabe was 64 years old and was reportedly found inside her home at 3[redacted] Hauola Place with Lydia Coloma and Salvador Coloma. It is presumed that she did not, or was not able, to evacuate. At 15:57, a 911 caller advised the fire reached Kuhua Street and Lahainaluna Road, which is to the south and west of this location.

Maurice Buen was 79 years old and was reportedly found across Waine'e Street from Lahaina Surf Apartments (10[redacted] Waine'e Street), where he was reported to have lived.[186] At 16:24, the MPD was evacuating this area. At 16:44, the MPD reported the Hale Ohana Apartments, below Hwy-30 and Kenui Street, was engulfed in flames.

Buddy Carter was 85 years old and was reportedly found adjacent to his home at 2[redacted] Kamaka Circle—unknown if inside or outside. At 17:59, the MPD reported multiple buildings fully engulfed in this area.

Kirk Carter was 44 years old and reportedly succumbed to his injuries at Straub Medical Center in Honolulu on September 19, 2023. It is unknown where he started his evacuation. The house he apparently lived in survived the fire, but he arrived at Safeway with burns.[187] The fire was in the area of Nahale Place after 22:00.

Ediomede Castillo was 35 years old and was reportedly found inside a vehicle in front of 8[redacted] Kuhua Street. He and Juan Deleon were apparently evacuating from their home at 3[redacted] Keone Street in their car, headed south on Kuhua Street toward Lahainaluna Road. It was reported that they appeared to have been involved in a car crash in front of 8[redacted] Kuhua Street with at least one other vehicle. The fire first reached the area of Kuhua Street and Lahainaluna Road at 15:57. At 16:25, homes were reported to be on fire in this area.

3.8.10 ANALYSIS OF SYSTEM COMPONENTS



Rex Cole was 64 years old and was reportedly found across the street from his home in the area of 6[redacted] Luakini Street (Liberty Apartments). It was reported that he was seen walking near the Banyan tree, which is further from his home on Front Street.[188] The first report of fire near the Banyan tree was 16:24. Structures were reported on fire in this area at 17:44.

Lydia Coloma was 70 years old and was reportedly found inside her home at 3[redacted] Hauola Place with Luz Bernabe and Salvador Coloma. It is presumed that she did not, or was not able, to evacuate.[189] [190] At 15:57, a 911 caller advised the fire reached Kuhua Street and Lahainaluna Road, which is just beyond this location.

Salvador Coloma was 77 years old and was reportedly found inside his home at 3[redacted] Hauola Place with Luz Bernabe and Lydia Coloma. It is presumed that he did not, or was not able, to evacuate. At 15:57, a 911 caller advised the fire reached Kuhua Street and Lahainaluna Road, which is to the south and west of this location.

Allen Constantino was 25 years old and was reportedly found inside his home at 9[redacted] Kuhua Street with Letcia Constantino. It is presumed that he did not, or was not able, to evacuate. The fire first reached the area of Kuhua Street and Lahainaluna Road at 15:57. At 16:25, homes were reported to be on fire in this area.

Leticia Constantino was 56 years old and was reportedly found inside her home at 9[redacted] Kuhua Street with Allen Constantino. It is presumed that she did not, or was not able, to evacuate. The fire first reached the area of Kuhua Street and Lahainaluna Road at 15:57. At 16:25, homes were reported to be on fire in this area.

Theresa Cook was 72 years old and was reportedly found in the ocean by the Coast Guard. It was reported that she was last seen by the Banyan tree on foot.[191] [192] The first report of fire near the Banyan tree was 16:24. Structures were reported on fire in this area at 17:44.

Juan Deleon was 45 years old and was reportedly found inside a vehicle in front of 8[redacted] Kuhua Street. He and Ediomede Castillo were presumably evacuating from their home at 3[redacted] Keone Street in their car, headed south on Kuhua Street toward Lahainaluna Road. They appear to have been involved in a car crash in front of 8[redacted] Kuhua Street with at least one other vehicle. The fire first reached the area of Kuhua Street and Lahainaluna Road at 15:57. At 16:25, homes were reported to be on fire in this area.

3.8.10 ANALYSIS OF SYSTEM COMPONENTS



Marilou Dias was 60 years old and was reportedly found inside her home at 14[redacted] Komohana Place. It is presumed that she did not, or was not able, to evacuate. The fire was reported by the MPD to be in this area after 21:30.

Virginia Dofa was 90 years old and was reportedly found inside her home at the Hale Mahaolu Eono independent-living apartment complex at 8[redacted] Kelawea Street. It is presumed that she did not, or was not able, to evacuate.[193] MPD officers worked to evacuate the complex, but were forced to fall back at 16:08. At 16:43, a dispatch note said, “Hale Mahaolu fully engulfed.”

Bette Jo Dyckman was 73 years old and was reportedly found inside her vehicle in front of 8[redacted] Kuhua Street with Robert Dyckman. Together, they presumably evacuated from 9[redacted] Puiki Place in their pickup truck. They may have made their way south and west (makai) to Kuhua Street. The fire first reached the area of Kuhua Street and Lahainaluna Road at 15:57. At 16:25, homes were reported to be on fire in this area.

Robert Dyckman was 74 years old and was reportedly found inside his vehicle in front of 8[redacted] Kuhua Street with Bette Jo Dyckman. Together, they presumably evacuated from 9[redacted] Puiki Place in their pickup truck. They may have made their way south and west (makai) to Kuhua Street. The fire first reached the area of Kuhua Street and Lahainaluna Road at 15:57. At 16:25, homes were reported to be on fire in this area.

Jeanne Eliason was 57 years old and was reportedly found inside a home at 5[redacted] Ka‘akolu Place. She lived close to where the fire began on Ka‘akolu Place. It is unknown if she evacuated to this location. At 19:38, the MPD reported the fire jumped Shaw Street and was entering this neighborhood.

Keyiro Fuentes was 14 years old and was reportedly found in his bedroom at 8[redacted] Ka‘akepa Street. According to his family, Keyiro was home alone. The fire progressed quickly from where it first ignited (14:55) to this location at approximately 15:37, where the MFD reported homes on fire in this area. This was 16 minutes after the fire jumped the Lahaina Bypass. A resident video at 16:32 shows homes on this street on fire.[194]

Alfredo Galinato was 79 years old and was reportedly found adjacent to 1[redacted] Komo Mai Street. It appears he evacuated his home on Kopili Street on foot to Komo Mai Street. At 16:07, the MPD reported the flames reaching Komo Mai Street.[195] [196]

3.8.10 ANALYSIS OF SYSTEM COMPONENTS



Douglas Gloege was 59 years old and was reportedly found outside behind a Subway restaurant. He presumably evacuated with partner Rebecca Rans on foot from 3[redacted] Paeohi Street and made it to the area of 9[redacted] Honoapi‘ilani Highway (Subway Restaurant).[197] [198] At 16:22, a 911 caller advised the fire was right behind the Subway.

Donna Gomes was 71 years old and was reportedly found in or near her home at 3[redacted] Lahainaluna Road with Coleen Jones.[199] The fire first reached the area of Kuhua Street and Lahainaluna Road at 15:57. At 16:08, the MFD was working to extinguish homes reported to be on fire in this area.

Michael Gordon was 68 years old and was reportedly found inside his home at 6[redacted] Waine‘e Street. It is presumed that he did not, or was not able, to evacuate. At 18:00, a civilian video shows fire moving through this area.

George Hall III was 67 years old and was reportedly found in or near a McDonalds. He lived across the street at 8[redacted] Waine‘e Street. At 17:44, the post office up the street from the McDonalds was reported to be on fire.

Carole Hartley was 60 years old and was reportedly found outside her home at 3[redacted] Hauola Place. She was seemingly unable to escape.[200] At 15:57, a 911 caller advised the fire reached Kuhua Street and Lahainaluna Road, which is just south of this location.

Claudette Heermance was 68 years old and reportedly died on March 28, 2024, following 119 days of hospice care. She apparently left her senior housing complex on Waine‘e street on her mobility scooter and headed to Front Street. She was badly burned when she was found by paramedics.[201]

Roxanne Ibara-Hinao was 68 years old and was reportedly found inside her home at 10[redacted] Waine‘e Street. It is presumed that she did not, or was not able, to evacuate. At 16:44, the MPD reported buildings on fire in this area.

Rafael Imperial was 63 years old and was reportedly found in the area of 9[redacted] Kuhua Street near where he presumably lived at 8[redacted] Kopili Street. The fire first reached the area of Kuhua Street and Lahainaluna Road at 15:57. At 16:25, homes were reported to be on fire in this area.

Buddy Jantoc was 78 years old and was reportedly found in his home at the Hale Mahaolu Eono independent-living apartment complex at 8[redacted] Kelawea Street. It is presumed that he did not, or was not able, to evacuate.[202] MPD officers worked to evacuate the complex, but were forced to fall back at 16:08. At 16:43, a dispatch note said, “Hale Mahaolu fully engulfed.”

3.8.10 ANALYSIS OF SYSTEM COMPONENTS



Coleen Jones was 59 years old and was reportedly found in or near her home at 3[redacted] Lahainaluna Road with Donna Gomes. The fire first reached the area of Kuhua Street and Lahainaluna Road at 15:57. At 16:08, the MFD was working to extinguish homes reported to be on fire in this area.

Morris Kaita was 74 years old and was reportedly found inside his home at 2[redacted] Panaewa Street. It is presumed that he did not, or was not able, to evacuate. At 16:14, the MPD advised there was fire in the median and they could no longer safely stay in this location.

Richard Kam was 88 years old and was reportedly found in the area of 5[redacted] Lahainaluna Road. This is the area where the first homes caught fire at approximately 15:28.

Mark Kaminsky was 59 years old and was reportedly found across the street from his presumed home in the area of the Sly Mongoose Bar/Restaurant. There were reports of fire in this area beginning 16:22 through 16:53.

Paul Kasprzycki was 76 years old and was reportedly found in the rubble of a large furniture store on Limahana Place. It was reported that he ditched his bike and sought shelter in this building.[203] [204] There were reports of fire in this area beginning 16:22 through 16:53.

Valerie Kauffman was 78 years old and was reportedly found in her apartment complex at 10[redacted] Wainee Street, outside of a building. At 16:44, the MPD reported buildings on fire in this area.

Albert Kitaguchi was 62 years old and was reportedly found inside his home at 1[redacted] Wahikuli Road. It is presumed that he did not, or was not able, to evacuate. At 22:25, the MPD reported a fire in this area.

Joseph Lara was 86 years old and was reportedly found outside of his purple 2003 Ford Ranger pickup truck at the Outlets of Maui parking structure. He apparently lived at 7[redacted] Paunau Street and could have been trying to go north on Front Street before he was stuck in the traffic.[205] [206] There were a few reports of fire reaching this area between 16:59 and 17:44.

Poomaikai Losano was 28 years old and was reportedly found inside 8[redacted] Kale Street. He was reported to live on Hauola Place, which intersects Kale Street.[207] Spot fires were reported in this area at 15:40 and houses were reported on fire at approximately 16:25.

3.8.10 ANALYSIS OF SYSTEM COMPONENTS



Bibiana Lutrania was 58 years old and was reportedly found inside a burned vehicle with her 82-year-old stepmother, Revelina Baybayan Tomboc, in the same area as a car accident at 8[redacted] Kuhua Street. They presumably traveled from their home on Mela Street via Kopili Street and Aki Street. The fire first reached the area of Kuhua Street and Lahainaluna Road at 15:57. At 16:25, homes were reported to be on fire in this area.

Rogelio Mabalot was 68 years old and was reportedly found outside in a field behind 1[redacted] Prison Street, very far from his known home address of 9[redacted] N Laalo Place.[208] A civilian video shows fire progressing through this area at 16:00.

Michael Mahnensmith was 80 years old and was reportedly found outside his home at 2[redacted] Wili Ko Place. There were reports of fire in this area beginning 16:22 through 16:53.

Lynn Manibog was 74 years old and was reportedly found outside in the area of Lahainaluna Road and Kuhua Street, just west (makai) of Glenn Yoshino. She presumably evacuated from 3[redacted] Pauwala Place with Glenn Yoshino. The fire first reached the area of Kuhua Street and Lahainaluna Road at 15:57.

Douglas Matsuda-Boucher was 65 years old and was reportedly found outside his home at 6[redacted] Luakini Street. It is presumed that he did not, or was not able, to evacuate. A civilian video shows fire progressing through this area at 16:00.

John Joseph McCarthy III was 74 years old and was reportedly found inside his home at 2[redacted] Dickenson Street. It is presumed that he did not, or was not able, to evacuate. At 16:36, the MPD advised that this area was fully engulfed in fire.

Michael Misaka was 61 years old and was reportedly found in the doorway of 9[redacted] Kuhua Street, a block from his known home at 9[redacted] Puiki Place. (It was reported that he was recovered close to Leticia Constantino, Allen Constantino, and Rafael Imperial). The fire first reached the area of Kuhua Street and Lahainaluna Road at 15:57. At 16:25, homes were reported to be on fire in this area.

Antonia Molina was 63 years old and was reportedly found inside her home at 7[redacted] Pauoa Street. It is presumed that she did not, or was not able, to evacuate.[209] At 16:08, the MFD was fighting structures on fire in this area.

Michael Morinho was 61 years old and was reportedly found inside his home at 3[redacted] Hauola Place. It is presumed that he did not, or was not able, to evacuate. At 15:57, a 911 caller advised the fire reached Kuhua Street and Lahainaluna Road, which is just south of this location.

3.8.10 ANALYSIS OF SYSTEM COMPONENTS



Tim Nakamoto was 69 years old and was reportedly found inside his home at 8[redacted] Kaili Place. It is presumed that he did not, or was not able, to evacuate. At 16:25, houses were reported to be on fire in this area.

Todd Nakamura was 61 years old and was reportedly found in the driveway of 8[redacted] Kopili Street. He presumably evacuated from 4[redacted] Aki Street in his vehicle, which was found at Paeohi Street and Mela Street. At some point, he apparently left his vehicle and fled west (makai) to Kopili Street. At 16:25, homes were reported to be on fire in this area.

David Nuesca Jr. was 59 years old and was reportedly found inside his home at 1[redacted] Malolo Place. It is presumed that he did not, or was not able, to evacuate.[210] At 22:09, a civilian video captured fire progressing through this area.

Carolyn Ono was 73 years old and was reportedly found outside 7[redacted] Paunau Street. She presumably evacuated from 4[redacted] Pāʻūʻū Place. At 16:08, the MFD was fighting structures on fire in this area.

Matsuyuki Osato was 83 years old and was reportedly found inside his home at 8[redacted] Kuhua Street. It is presumed that he did not, or was not able, to evacuate. The fire first reached the area of Kuhua Street and Lahainaluna Road at 15:57. At 16:25, homes were reported to be on fire in this area.

Pablo Pagdilao III was 75 years old and was reportedly found outside in the area of 9[redacted] Front Street. He presumably evacuated to Front Street, but he could not evacuate to safety.[211] There were a few reports of fire in this area between 16:59 and 17:44.

Tau Ponali was 66 years old and was reportedly recovered from outside of 1[redacted] Waineʻe Street. This is closer to the origin of the fire than her home at 6[redacted] Front Street. There were multiple reports of fire in this area between 16:36 and 16:53.

Bernard Portabes was 75 years old and was reportedly found outside near Kale Street and Lahainaluna Road. He apparently evacuated from 4[redacted] Hauola Street to the area of Kale Street and Lahainaluna Road, one (1) block west (makai) and one (1) block south. Fire was reported in this area at 15:56.

Gwendolyn Puou was 83 years old and was reportedly found outside, across from 8[redacted] Kuhua Street (there were several cars in this area, and outside 8[redacted] Kuhua Street, where several people were recovered.) She possibly evacuated from 8[redacted] Mela Street, west (makai) to Kopili Street, left on Aki Street, and west (makai) on Kuhua Street. At 15:57, a 911 caller advised the fire reached Kuhua Street and Lahainaluna Road. At 16:42, another 911 caller advised the fire was getting closer to Kuhua Street and Aki Street.

3.8.10 ANALYSIS OF SYSTEM COMPONENTS



Felimon Quijano was 60 years old and was reportedly found with Glenda Yabes inside a home at 9[redacted] Kuhua Street. Joel Villegas (another relative) was also reportedly found in the vicinity. It is unknown what their relation to the house was, as they apparently lived together at 3[redacted]1 Hauola Place with other relatives. The MFD reported the fire was reaching this area around 16:25.

Junmark Quijano was 30 years old and was reportedly found inside an industrial building at 8[redacted] Kuhua Street with Angelica Baclig, Adela Villegas, Justin Recolizado, Maria Victoria Recolizado, and Eugene Recolizado. At 15:57, a 911 caller advised the fire reached Kuhua Street and Lahainaluna Road. At 16:42, another 911 caller advised the fire was getting closer to Kuhua Street and Aki Street.

Sharlene Rabang was 78 years old and reportedly succumbed to her injuries at an unnamed hospital on September 4, 2023. She presumably evacuated and traveled to a family member's home on O'ahu.[212]

Rebecca Rans was 57 years old and was reportedly found outside behind a Subway restaurant with Douglas Gloege. They apparently evacuated on foot from 3[redacted]Paeohi Street and made it to the area of 9[redacted] Honoapi'ilani Highway (Subway Restaurant).[213] [214] At 16:22, a 911 caller advised the fire was right behind the Subway.

Alfred Rawlings was 84 years old and was reportedly found inside his home at the Hale Mahaolu Eono independent-living apartment complex at 8[redacted] Kelawea Street. It is presumed that he did not, or was not able, to evacuate.[215] MPD officers worked to evacuate the complex, but were forced to fall back at 16:08. At 16:43, a dispatch note said, "Hale Mahaolu fully engulfed."

Eugene Recolizado was 50 years old and was reportedly found inside an industrial building at 8[redacted] Kuhua Street. Eugene, Maria Victoria, and Justin Recolizado apparently left home as a family and drove down Aki Street, turning right on Kuhua Street. At some point, they presumably left their car and went into 8[redacted] Kuhua Street (industrial building/ Quonset Hut) to seek shelter. They were apparently found alongside Junmark Quijano, Adela Villegas, and Angelica Baclig.[216] At 15:57, a 911 caller advised the fire reached Kuhua Street and Lahainaluna Road. At 16:42, another 911 caller advised the fire was getting closer to Kuhua Street and Aki Street.

3.8.10 ANALYSIS OF SYSTEM COMPONENTS



Justin Recolizado was 11 years old and was reportedly found inside an industrial building at 8[redacted] Kuhua Street. Eugene, Maria Victoria, and Justin Recolizado left home as a family and drove down Aki Street, turning right on Kuhua Street. At some point, they presumably left their car and went into 8[redacted] Kuhua Street (industrial building/Quonset Hut) to seek shelter. They were apparently found alongside Junmark Quijano, Adela Villegas, and Angelica Baclig.[217] At 15:57, a 911 caller advised the fire reached Kuhua Street and Lahainaluna Road. At 16:42, another 911 caller advised the fire was getting closer to Kuhua Street and Aki Street.

Maria Victoria Recolizado was 51 years old and was reportedly found inside an industrial building at 8[redacted] Kuhua Street. Eugene, Maria Victoria, and Justin Recolizado left home as a family and drove down Aki Street, turning right on Kuhua Street. At some point, they presumably left their car and went into 8[redacted] Kuhua Street (industrial building/Quonset Hut) to seek shelter. They were apparently found alongside Junmark Quijano, Adela Villegas, and Angelica Baclig.[218] At 15:57, a 911 caller advised the fire reached Kuhua Street and Lahainaluna Road. At 16:42, another 911 caller advised the fire was getting closer to Kuhua Street and Aki Street.

Dale Ann Ritcher was 66 years old and was reportedly found inside a vehicle in front of his presumed home at 8[redacted] Kuhua Street. Ritcher and Terri Thomas were presumably evacuating together with their dogs. They appear to have been involved in a car crash at this location. The fire first reached the area of Kuhua Street and Lahainaluna Road at 15:57. At 16:25, homes were reported to be on fire in this area.

Rodolfo Rocutan was 76 years old and was reportedly found outside, across from 3[redacted] Lahainaluna Road. He presumably evacuated from 4[redacted] Pā‘ū‘ū Place to Paunau Street, to the left on Lahainaluna Road. Fire was reported in this area at 15:56.

Lee Rogo was 76 years old and was reportedly found outside the Old Lahaina Courthouse Building (6[redacted] Wharf Street). Spot fires were reported in this area as early as 16:24 and structure fires were reported at 17:44.

Conchita Sagudang was 75 years old and was reportedly found near the intersection of Lahainaluna Road and Mill Street. She presumably evacuated with her son, Danilo Sanubang, and Laurie Allen. Each was apparently in their own vehicle. They reportedly drove toward Lahainaluna Road until a falling tree branch forced them to abandon their cars and climb into Allen’s vehicle. Allen apparently couldn’t find a way forward. Ms. Sagudang is believed to have run with Allen toward Mill Street. At 16:09, the MPD advised the fire was reaching Mill Street.[219] At 16:24, the MPD advised, “We might have one fatality. Homes rear of Mill Street,” indicating fatal conditions at that area.

3.8.10 ANALYSIS OF SYSTEM COMPONENTS



Danilo Sagudang was 55 years old and was reportedly found outside at Kuhua Street and Lahainaluna Road against a fence and in front of a vehicle with Joseph Schilling. He presumably evacuated with his mother, Conchita Sagudang, and Laurie Allen. Each was apparently in their own vehicle. They reportedly drove toward Lahainaluna Road until a falling tree branch forced them to abandon their cars and climb into Allen's vehicle. Allen apparently couldn't find a way forward. Mr. Sagudang apparently made his way down Lahainaluna Road to Kuhua Street.[220] The fire first reached the area of Kuhua Street and Lahainaluna Road at 15:57.

Edward Sato was 76 years old and was reportedly found outside with Melva May Benjamin on Puiki Place, just past Kamamalu Street. Sato and Benjamin presumably departed their home in their vehicle. They likely traveled east (mauka) on Aki Street and turned left on Puiki Place.[221] At 16:25, a house in the 300 block of Aki Street was reported on fire. At 16:58, a third party 911 caller advised a house was on fire on this street.

Joseph Schilling was 67 years old and was reportedly found outside at Kuhua Street and Lahainaluna Road against a fence and in front of a vehicle with Danilo Sagudang. He apparently lived at the Hale Mahaolu Eono independent-living apartment complex on Lahainaluna Road.[222] The fire first reached the area of Kuhua Street and Lahainaluna Road at 15:57.

Anthony Simpson was 43 years old and was reportedly found inside, across the street from his apparent home at 9[redacted] Kuhua Street. He reportedly lived at the same address as Ediomede Castillo and Juan Deleon.[223] The fire first reached the area of Kuhua Street and Lahainaluna Road at 15:57. At 16:25, homes were reported to be on fire in this area.

James Smith was 79 years old and was reportedly recovered from the seawall. He likely evacuated from his reported home at 7[redacted] Waine'e Street to the area of 9[redacted] Front Street. There were a few reports of fire in this area between 16:59 and 17:44.

Leslie Smith was 80 years old and was reportedly found inside her home at 3[redacted] Kamano Place. It is presumed that she did not, or was not able, to evacuate. There were reports of fire in this area at 20:46.

Jonathan Somaoang was 76 years old and was reportedly found outside behind 3[redacted] Lahainaluna Road. He likely evacuated from his apparent home at 7[redacted] Pupu Place. He may have then proceeded north on Pauoa Street and turned left on Lahainaluna Road. At 16:08, the MFD was working to extinguish homes reported to be on fire in this area.

3.8.10 ANALYSIS OF SYSTEM COMPONENTS



Floyd St. Clair was 75 years old and was reportedly found in his vehicle at the dead-end of Aki Street with Janet St. Clair. They presumably evacuated from their reported home at 9[redacted] Puiki Place, likely turning on Aki Street. In their attempt to evacuate, they reportedly drove toward the direction of the fire. At 16:25, homes were reported to be on fire in this area.

Janet St. Clair was 75 years old and was reportedly found in her vehicle at the dead-end of Aki Street with Floyd St. Clair. They presumably evacuated from their reported home at 9[redacted] Puiki Place, turning on Aki Street. In their attempt to evacuate they reportedly drove toward the direction of the fire. At 16:25, homes were reported to be on fire in this area.

Tony Takafua was seven (7) years old and was reportedly found outside a vehicle at Kuhua Street and Lahainaluna Road. Tony Takafua, Salote Tone, Fa‘aoso Tone, and Malui‘fonua Tone were likely evacuating from 9[redacted] Kuhua Street in their car headed south on Kuhua Street toward Lahainaluna Road. They appear to have been involved in a car crash in front of 8[redacted] Kuhua Street with at least one (1) other vehicle and possibly more.[224] [225] The fire first reached the area of Kuhua Street and Lahainaluna Road at 15:57. At 16:25, homes were reported to be on fire in this area.

Freeman Tam Lung was 80 years old and was reportedly found outside in the area of 9[redacted] Front Street. He presumably evacuated from 7[redacted] Luakini Street toward Front Street. There were a few reports of fire in this area between 16:59 and 17:44.

Terri Thomas was 62 years old and was reportedly found inside a vehicle in front of her home at 8[redacted] Kuhua Street with Dale Ann Richter. Thomas apparently lived with Dale Ann Richter and was presumably evacuating with their dogs. They appear to have been involved in a car crash at this location. The fire first reached the area of Kuhua Street and Lahainaluna Road at 15:57. At 16:25, homes were reported to be on fire in this area.

Carlo Tobias was 54 years old and was reportedly found inside his home at 14[redacted] Kahoma Street. It is presumed that he did not, or was not able, to evacuate. At 21:46, the MPD reported structures on fire in this area.

Revelina Tomboc was 81 years old and was reportedly found inside a vehicle in the same area as the car accident, 8[redacted] Kuhua Street, along with her stepdaughter, Bibiana Lutrania. They reportedly traveled from their reported home on Mela Street via Kopili Street and Aki Street.[226] The fire first reached the area of Kuhua Street and Lahainaluna Road at 15:57. At 16:25, homes were reported to be on fire in this area.

3.8.10 ANALYSIS OF SYSTEM COMPONENTS



Fa‘aoso Tone was 70 years old and was reportedly found inside a vehicle at Kuhua Street and Lahainaluna Road. Fa‘aoso Tone, Tony Takafua, Salote Tone, and Malui‘fonua Tone were presumably evacuating from 9[redacted] Kuhua Street in their car headed south on Kuhua Street toward Lahainaluna Road. They appear to have been involved in a car crash in front of 8[redacted] Kuhua Street with at least one (1) other vehicle.[227] [228] The fire first reached the area of Kuhua Street and Lahainaluna Road at 15:57. At 16:25, homes were reported to be on fire in this area.

Malui‘fonua Tone was 73 years old and was reportedly found inside a vehicle at Kuhua Street and Lahainaluna Road. Malui‘fonua Tone, Tony Takafua, Salote Tone, and Fa‘aoso Tone were presumably evacuating from 9[redacted] Kuhua Street in their car headed south on Kuhua Street toward Lahainaluna Road. They appear to have been involved in a car crash in front of 8[redacted] Kuhua Street with at least one (1) other vehicle.[229] [230] The fire first reached the area of Kuhua Street and Lahainaluna Road at 15:57. At 16:25, homes were reported to be on fire in this area.

Salote Tone was 39 years old and was reportedly found inside a vehicle at Kuhua Street and Lahainaluna Road. Salote Tone, Tony Takafua, Fa‘aoso Tone, and Malui‘fonua Tone were presumably evacuating from 9[redacted] Kuhua Street in their car headed south on Kuhua Street toward Lahainaluna Road. They appear to have been involved in a car crash in front of 8[redacted] Kuhua Street with at least one (1) other vehicle.[231] [232] The fire first reached the area of Kuhua Street and Lahainaluna Road at 15:57. At 16:25, homes were reported to be on fire in this area.

Franklin Trejos was 68 years old and was reportedly found inside his vehicle in an open area east (mauka) of Mill Street and south of Lahainaluna Road with the remains of a friend’s golden retriever. Trejos apparently tried to help others and save his home.[233] [234] The fire was reported in this area at 16:13.

Nicholas Turbin was 71 years old and was reportedly found inside a home at 13[redacted] Kahoma Street. He had a reported address of 8[redacted] Puiki Place, which was in the middle of the area where fire was moving fast. It is unknown if he was at this address or evacuated to here. At 21:28, the MPD reported the fire to be in this area.

Linda Vaikeli was 69 years old and was reportedly found inside her home at 10[redacted] Waine‘e Street. It is presumed that she did not, or was not able, to evacuate.[235] At 16:44, the MPD reported buildings on fire in this area.

3.8.10 ANALYSIS OF SYSTEM COMPONENTS



Angelita Vasquez was 88 years old and was reportedly found inside her home at the Hale Mahaolu Eono independent-living apartment complex at 8[redacted] Kelawea Street. It is presumed that she did not, or was not able, to evacuate.[236] MPD officers worked to evacuate the complex, but were forced to fall back at 16:08. At 16:43, a dispatch note said, “Hale Mahaolu fully engulfed.”

Adela Villegas was 53 years old and was reportedly found inside an industrial building at 8[redacted] Kuhua Street with Angelica Baclig, Junmark Quijano, Justin Recolizado, Maria Victoria Recolizado, and Eugene Recolizado. Villegas reportedly lived with Angelica Baclig, Junmark Quijano, and Joel Villegas. At 15:57, a 911 caller advised the fire reached Kuhua Street and Lahainaluna Road. At 16:42, another 911 caller advised the fire was getting closer to Kuhua Street and Aki Street.

Joel Villegas was 55 years old and was reportedly found in the area of 9[redacted] Kuhua Street (far end of Kuhua Street approaching Komo Mai Street). Villegas reportedly lived with Angelica Baclig, Junmark Quijano, and Adela Villegas. The fire was reported to have reached this area around 16:25.

Leroy Wagner was 69 years old and was reportedly found inside his home at 7[redacted] Paunau Street. It is presumed that he did not, or was not able, to evacuate.[237] At 16:08, MFD was fighting structures on fire in this area.

Clyde Wakida was 74 years old and was reportedly found inside his home at 2[redacted] Puapihi Place. It was reported that he was trying to protect his home, and as such, did not evacuate.[238] Fire was reported in this area at 20:37.

Glenda Yabes was 48 years old and was reportedly found with Felimon Quijano inside a home at 9[redacted] Kuhua Street. Joel Villegas (another relative) was also apparently found in the vicinity. It is unknown what their relation to the house was, as they reportedly lived together at 3[redacted] Hauola Place with other relatives. It is unknown if they evacuated to this address. The fire was reported to have reached this area around 16:25.

Todd Yamafuji was 68 years old and was reportedly found inside a vehicle at the intersection Luakini and Waine‘e. He likely evacuated from his home at 6[redacted] Luakini Street and traveled south to the intersection of Waine‘e. A civilian video shows fire moving through this area around 17:52.

Glenn Yoshino was 75 years old and was reportedly found in the area of Lahainaluna Road and Kuhua Street, just east (mauka) of Lynn Manibog. He likely evacuated from 3[redacted] Pauwala Place (presumably with Lynn Manibog). The fire first reached the area of Kuhua Street and Lahainaluna Road at 15:57.

3.8.11 ANALYSIS OF SYSTEM COMPONENTS

3.8.11 Findings & Recommendations

71. **FINDING:** Unified coordination of evacuation procedures among the MPD, MFD, and other agencies may have facilitated more efficient egress of residents.	**RECOMMENDATION:** Create, review, and implement an interagency comprehensive evacuation plan based on risk and resources. Integrated emergency response plans involving local, state, and federal agencies, as well as non-governmental organizations, should be developed, with regular joint training exercises to ensure smooth coordination during actual emergencies. **RECOMMENDATION:** The MPD should regularly train for wildfire evacuations, familiarizing themselves with evacuation procedures and protocols. This training enhances response capabilities and ensures a swift and organized evacuation process when wildfires threaten communities.
72. **FINDING:** During the evacuations, there were lapses in coordination and communication that could have reduced efficiency.	**RECOMMENDATION:** Pre-plan evacuation routes. Effective evacuations during a wildfire, such as the Lahaina PM fire, require planning, coordination, and adherence to best practices. A key aspect is comprehensive pre-event planning, which involves identifying evacuation routes (including unnamed dirt roads), establishing communication protocols, and conducting drills to ensure readiness. **RECOMMENDATION:** Sufficient personnel are needed to manage traffic, provide assistance to evacuees, and maintain public safety. Adequate staffing levels enable timely and orderly evacuations, reducing the risk of congestion and confusion. **RECOMMENDATION:** Create and implement comprehensive traffic management plans that account for limited access and egress routes, including pre-planned alternate routes and strategies to manage congestion.

3.8.11 Findings & Recommendations

72. **FINDING (CONT.):** During the evacuations, there were lapses in coordination and communication that could have reduced efficiency.	**RECOMMENDATION:** Ensuring gates blocking potential evacuation routes are equipped with standardized locks and that emergency responders have the necessary keys or access codes is also vital. **RECOMMENDATION:** Develop comprehensive support systems for residents who need to evacuate—especially those with access and functional needs—including temporary housing, transportation assistance, and access to essential services. By addressing these key areas, the Maui community can improve its preparedness for future wildfires and other emergencies, ensuring better protection of lives and property. **RECOMMENDATION:** Volunteer training programs, such as those for Community Emergency Response Teams (CERT), should be expanded to assist with evacuation efforts and provide support during emergencies. Additionally, specific evacuation plans for vulnerable populations, including the elderly, disabled, and those without transportation, should be created, with community support networks established to assist these individuals during evacuations. Engage community organizations and CERT teams to provide additional support in evacuation efforts.
73. **FINDING:** While some Body-Worn Cameras (BWC) were activated (in keeping with the current policy), several files provided by the County of Maui were unreadable.	**RECOMMENDATION:** Update the MPD's G.O. 304.12 policy to have BWCs activated upon dispatch and include a quality-control program to ensure all equipment is functioning properly and producing usable audio visual assets (Appendix Section 6.12.17). **RECOMMENDATION:** The MPD should follow G.O. 304.12 (Appendix Section 6.12.17).

3.8.11 ANALYSIS OF SYSTEM COMPONENTS

3.8.11 Findings & Recommendations

74. **FINDING:** MPD officers experienced difficulty hearing radio traffic due to the wind and noise from the fire.	**RECOMMENDATION:** Issuing radio earpieces to all officers will enhance communication, allowing them to stay informed and coordinate effectively during incidents. Officers should receive training on the proper use and maintenance of these earpieces to maximize their benefits.
75. **FINDING:** The alert systems in place did not adequately inform residents of inherent dangers.	**RECOMMENDATION:** Developing and implementing multiple alert systems, including sirens, radio broadcasts, and door-to-door notifications, can ensure that evacuation orders reach all residents, especially when cell service and electrical power are lost. **RECOMMENDATION:** Expand community engagement and preparedness efforts with public awareness campaigns that emphasize the importance of evacuation and the risks of staying behind during wildfires, encouraging residents to have a personal evacuation plan that includes considerations for pets and family members with special needs. **RECOMMENDATION:** Educate the public about evacuation procedures and safe routes, and the importance of establishing family evacuation plans and having prepared “go-bags.” Regular drills and informational sessions can reinforce this knowledge, while localized communication networks, such as neighborhood watch groups or community liaisons, can assist in disseminating information.

3.8.11 ANALYSIS OF SYSTEM COMPONENTS

3.8.11 Findings & Recommendations

76.	**FINDING:** MPD officers encountered barriers to roads that could have been (and eventually were) used as alternate egress routes and lacked equipment to navigate these barriers.	**RECOMMENDATION:** Perform annual status checks of emergency gates throughout the community. **RECOMMENDATION:** Equip police vehicles with disaster response kits, including appropriate PPE, to be able to facilitate evacuations and remove barriers from potential escape exits, such as chain link fences, gates, and boulders. **RECOMMENDATION:** The MFD to establish new policy/General Order for the provision of fire- and disaster-related emergency tools for patrol, such as bolt cutters, tow straps, etc.

4.0 Fire Impact on the Built Environment



The Lahaina PM fire's rapid spread to residential, commercial, and industrial structures ultimately caused it to become an urban conflagration. The speed of the fire's progression was influenced by various factors, including winds and receptive fuels (vegetative and structural). The Red Flag Weather, especially the hurricane force winds blowing downslope into a densely developed Lahainaluna subdivision, quickly accelerated the fire's progression to the coastline.



This section explains the impact the built environment, vegetation, and the fire suppression efforts of firefighters and residents had on the fire's progression, and connects this experience to codes, standards, guidelines, and national best practices.

Mitigating risk in the built environment—the human-made surroundings that provide the setting for human activity—is crucial for fire management and the Cohesive Strategy.

Ignition-resistant structures and communities can help mitigate fire risk and decrease demands on emergency firefighting response, protecting homes and reducing overall impact by slowing fire progression and creating buffer zones. Coordinated efforts are required among homeowners, developers, local governments, land managers, planning departments, and emergency services.

Emphasis should be placed on best practices like enforcing defensible space (an area around a building in which vegetation, debris, and other types of combustible fuels have been treated, cleared, or reduced to slow the spread of fire to and from the building) and using fire-resistant building materials.

In resilient landscapes, integrating land-use planning, natural resource management, and community design helps reduce fire spread between wildlands and developed areas.

For fire-adapted communities, ignition-resistant structures and robust defensible space strategies enhance safety against rapid fire advancement by helping control fire spread and protecting properties. Improving wildfire response capabilities involves lowering fire intensity and ensuring accessibility for firefighters. This approach also safeguards critical infrastructure, ensuring continuous operation during wildfires and supporting broader landscape management efforts.

4.1 Lahaina Built Environment

Lahaina's built environment has a number of characteristics that likely contributed to the devastation caused by the fires that occurred on August 8-9, 2023.

When all three (3) ignition mechanisms (ember attack, direct flame contact, and radiant heat) act in unison in a built-environment conflagration, any weak point in the building envelope (the physical barrier that separates the interior and exterior of a building) makes the entire structure, and surrounding ones, vulnerable to fire spread.

In the following sections, we will explore how a variety of factors within the built environment of Lahaina, including building construction, structure separation, building coverage, and adjacent vegetation, played interconnected roles in the devastation of the August 2023 fires.

4.1.1 Building Construction

As reported in the Phase One report, both Lahaina's residential and commercial regions are densely packed areas with narrow streets. Many of the structures in Lahaina were constructed in the 1960s and 1970s, or earlier.

Several of the resident structures in the north and south (particularly those built in the 1980s and before) had at least some masonry components. Wood construction was used in roofs and other portions of the structures, but there were a fair number of block walls still standing in the older residential areas.

While many homes in Lahaina had some type of wildfire-resistant components included in their construction, such as Class A roofs and/or noncombustible wall material, the majority of housing stock in Lahaina was constructed, at least partially, using older materials and architectural designs that may have contributed to the fire's spread. For example, older buildings, especially those constructed prior to the common use of central air conditioning systems, were designed for cooling and ventilation by easy airflow, which make such structures particularly vulnerable to ember, or even direct flame, entry. These design features include louvered windows and open eaves.

Local codes[239] require newer construction to have high-wind protection elements, which might have helped decrease the fire's spread caused by the gale-force winds that preceded the fire. However, there is no evidence the structures in the Lahaina area were constructed explicitly with wildfire prevention in mind.

Other factors also contributed to the fire's devastation, such as surrounding vegetation; population, vehicle, and building density; and building exposure. For example, the areas surrounding the built environment are covered with highly flammable invasive grasses.[240]

Based on real estate and appraisal data the housing stock before the fire in Lahaina was approximately 80% single-family residential construction and multi-family housing units, such as duplexes, low-rise condominiums, and multi-structure apartment complexes. The dominant era of construction for this housing stock was the 1960s to the 1980s, although some newer residential structures of all types were built using current building codes. Commercial construction included retail primarily in the downtown area along Front Street, the Lahaina Business Plaza off Kupuohi Street, shopping centers at Keawe Street and Hwy-30, and a few other areas in central Lahaina.

Foundations consisted of a mixture of raised and slab. Homes were elevated to reduce the intrusion of water and facilitate natural ventilation. In some cases, this under-building area was used for storage with minimal skirting.

Wall construction included concrete masonry unit (CMU) block walls, wood panel siding, concrete fiber board, stucco, and, less commonly, vinyl or aluminum siding.

Most of the roofing was composed of common asphalt shingles, although a number of structures throughout Lahaina had roofs constructed using tile, metal, and wood shake.

4.1.2 Building and Fire Codes

Building codes regulated the construction and materials of buildings relevant for resistance to exterior fire hazards. See Section 3.4.1 for more information on codes and standards at the time of the fire.

At the time of the fire, the County of Maui's fire code addressed exterior vegetation determined to pose a fire hazard. This code language requires the removal of flammable vegetation within 30 feet of buildings or structures.[241] See Section 3.3.8 for more information on policy changes relating to vegetation management.

4.1.3 Structure Separation

Structure separation distance is the distance between two structures, either on the same parcel or between parcels. Setbacks are the distances between structures and property lines. Aerial imagery can be used to measure the distance between roof lines of structures (Figure 4.1.3.1).



Figure 4.1.3.1 Example of distance measurement capabilities with aerial imagery and potential reference point for set back and separation distances.

For structures with eaves, which is typical for structures in Lahaina, the separation distance between roof lines is less than the separation distance between exterior walls. The separation distances reported in this analysis are conservatively low (underestimates) of the true separation distance.

Residential structures in Lahaina were separated by as little as six (6) feet, and in many cases, the distance between primary and accessory structures was even less. This continuity of fuel contributed to the easy spread of fire throughout Lahaina.

See Section 3.4.1 for more information on planning, codes, and standards.

4.1.4 Building Density

According to the 2020 Decennial Census, the number of housing units for the Lahaina Census County Division (CCD) is 12,410,[242] with approximately 4,180 housing units in Lahaina.[243] See Section 3.4.1.2 for more information related to building density.

4.1.5 Vegetation Adjacent to the Built Environment

Following the abandonment of sugar plantations on Maui in the 1950s, several invasive grass species spread rapidly, including plants native to Africa, such as guinea grass, buffelgrass, and molasses grass, which are particularly fire-prone.[244] About a quarter of Maui's landscape is dominated by non-native grasses,[245] which surround many of the built environments within the county.

4.1.6 Wildfire Risk

The USDA Forest Service, under the direction of Congress, developed "Wildfire Risk to Communities,"[246] a free, easy-to-use website with interactive maps, charts, and resources to help communities understand, explore, and reduce wildfire risk. It was created to help community leaders, such as elected officials, community planners, and fire managers. The tool is built from a variety of nationally consistent data, including vegetation and fire-behavior fuel models, topography, recent weather patterns, and long-term simulations of large wildfire behavior.

The current "Wildfire Risk to Communities" tool classifies Lahaina as having a very high wildfire risk—greater than 98% of all communities in the U.S.[247] The risk to homes on the landscape in Lahaina is very high, which represents the potential consequence of fire to residential structures. This considers wildfire likelihood and intensity, which represent hazard, and a generalized susceptibility for all homes. The classification assumes all homes that encounter wildfire will be damaged, and the degree of damage is directly related to wildfire intensity.

Risk-reduction zones are based on wildfire likelihood, flammable vegetation, and populated areas. The four zones are: wildfire transition, direct exposure, indirect exposure, and minimal exposure.

Wildfire transition zones are areas where flammable vegetation may expose homes to wildfire. Direct exposure zone hazards include adjacent flammable vegetation, embers, and nearby structures. Indirect exposure zone hazards include embers and building-to-building ignition. Minimal exposure zones are not likely to be subjected to wildfire. Based on currently available data, the majority (86%) of buildings in Lahaina are in the indirect exposure zone and 13% are in the direct exposure zone, while only 1% are considered to be in the minimal exposure zone.

192

4.2 Built Environment Analysis Methodology

FSRI utilized maps developed by the Pacific Disaster Center (PDC) and FEMA, in conjunction with an evaluation of damage assessment data compared against pre- and post-fire imagery, to create an accurate map reflecting the actual structural damage caused by the Lahaina PM fire.

Post-fire imagery includes those presented in the Phase One report and other open sources (e.g., EagleView), as well as ground- and air-based images captured during FSRI's field work, which was primarily collected between August 24-September 4, 2023.

Pre-fire imagery was used to understand the condition of adjacent vegetation and the built environment. Because some of this imagery was taken up to two (2) years prior to the fire, it only provides an estimate for potential conditions at the time of the fire.

A team from the University of Hawai'i, National Disaster Preparedness Training Center used a 360-degree panoramic camera to collect street view imagery of Lahaina.[248] They developed a tool that matches pre-fire Google Street View imagery with the post-fire imagery collected in October 2023 (Figure 4.2.1).



Figure 4.2.1 Screen capture of University of Hawai'i, National Disaster Preparedness Training Center tool. Map on the left shows the exact location, the lower right image is before the fire and the upper right image is after the fire.[249]

4.2 FIRE IMPACT ON THE BUILT ENVIRONMENT

FSRI personnel surveyed the incident area and captured video and photographic evidence depicting fire spread and damage in the built environment. This field work was primarily conducted after rescue and recovery efforts were underway/completed that necessitated altering the scene—a known limitation of the analysis presented here. The burned area of Lahaina has been divided into three (3) distinct zones—Central, South, and North—reflecting the general direction of fire's progression.

Within each zone, areas consisting of structures that suffered the full spectrum of damage, from total loss to undamaged, were identified. Each of these areas were then analyzed by referencing data on the fire's progression, using both the Phase One report and pre- and post-fire imagery to pinpoint the key factors that contributed to the fire's movement.

Data collection efforts were particularly focused on the structures that survived immediately adjacent to those that were destroyed in order to understand factors that may have contributed to structure survivability in this urban conflagration.

It should be noted that priority actions taken immediately post-fire were search and rescue and recovery, which required the alteration of factors relevant for the analysis conducted in this work (e.g., clearing roadway of vehicles, demolishing unsafe structures, etc.). Additionally, the incident area was not secure from residents who may have re-entered after evacuating. The analysis presented here is based on the best-available data and information.

This work is not an origin-and-cause investigation, which is in the purview of the County of Maui aided by the ATF. The analysis presented here focuses on fire progression in the built environment, including spread from vegetation to built environment fuels and between built environment fuels.

4.2.1 Structure Damage Classification Map

Shortly after the fire, multiple groups provided maps of impacted and damaged structures. PDC and FEMA released fire damage assessment maps early in the morning on August 10, 2023, which showed the estimated fire perimeter and structure status (destroyed, heavy damage, light damage, and undamaged).[250] The most recent PDC map is dated August 23, 2023 (Phase One report, Figure 4.1.3).

The New York Times published a map on August 12, 2023, (four days after the fire) based on the analysis of satellite images by Planet Lab that indicated structures visibly damaged or destroyed.[251] Subsequently, several research groups have attempted to use artificial intelligence (AI) to analyze satellite and other remote sensing data to determine structure damage.[252]

FEMA conducted a Geospatial Damage Assessment by reviewing pre- and post- incident imagery, assigning damage classifications (No Visible Damage, Affected, Major, Minor, and Destroyed) to each structure in the imagery. There is specific description for flood damage and general guidance for non-flood damage, including fire.

This dataset is generally more robust than others that solely use remote sensing data and computer vision. A limitation of this dataset is that it uses point locations for structures instead of structure shapes, which better convey the spatial size and distribution of structure damage.

4.2 FIRE IMPACT ON THE BUILT ENVIRONMENT

As a result, FSRI conducted an independent review of the available structure damage datasets and determined there were discrepancies between the assigned damage classification and evidence collected in Phase One, including ground-based, post-fire imagery and technical discussions with citizens and emergency responders.

To establish an updated record of structure damage, FSRI built a map starting with the Building Footprint shapes found online at the REST service,[253] dated October 2022. Although the complete origination information of the REST service shapes is not known, the polygons offer a more detailed and accurate representation than OpenStreetMap structures (the other potential source) and have been reviewed and coded by FSRI.

Figure 4.2.1.1 is the structure damage assessment based on data available and current understanding that combines information gleaned from previously published datasets with ground truth from Phase One evidence.

For this analysis four (4) damage classifications were used: Destroyed, Wind Damage, Fire Damaged, and No Visible Damage; the three (3) classifications for damage magnitude used in FEMA classifications (Major, Minor, and Affected) were combined to focus classification on the source of the damage (Fire or Wind Damaged).

The current damage classification dataset was used to produce a map with color-coded structures based on the damage classification. This visual depiction of the spatial structure damage data allows for the identification of transition from “destroyed” to “damaged” to “no visual damage”—these locations warrant additional review and analysis included in this report.

“Destroyed” indicates the structure is a total loss or damaged to such an extent that repair is not feasible. “Wind damage” indicates the structure sustained damage from wind, but there was no visible evidence of fire damage. Examples of wind damage include missing roof covering and broken windows with no visible evidence of thermal exposure.

“Fire Damaged” indicates a structure that sustained fire damage, but was not destroyed. For instance, when a structure sustained both wind and fire damage, it was classified as “ Fire Damaged.”

Structures with no visible damage were classified as such.

Further analysis will be conducted in Phase Three of this work.

Table 4.2.1.1 Comparison between FEMA and FSRI structure damage datasets.

	FEMA GSDA	FSRI
Total # Structures	**2807**	**3335**
Destroyed	**1791**	**2117**
Damaged	**283**	**431**
No Visible Damage	**733**	**787**

4.2 FIRE IMPACT ON THE BUILT ENVIRONMENT

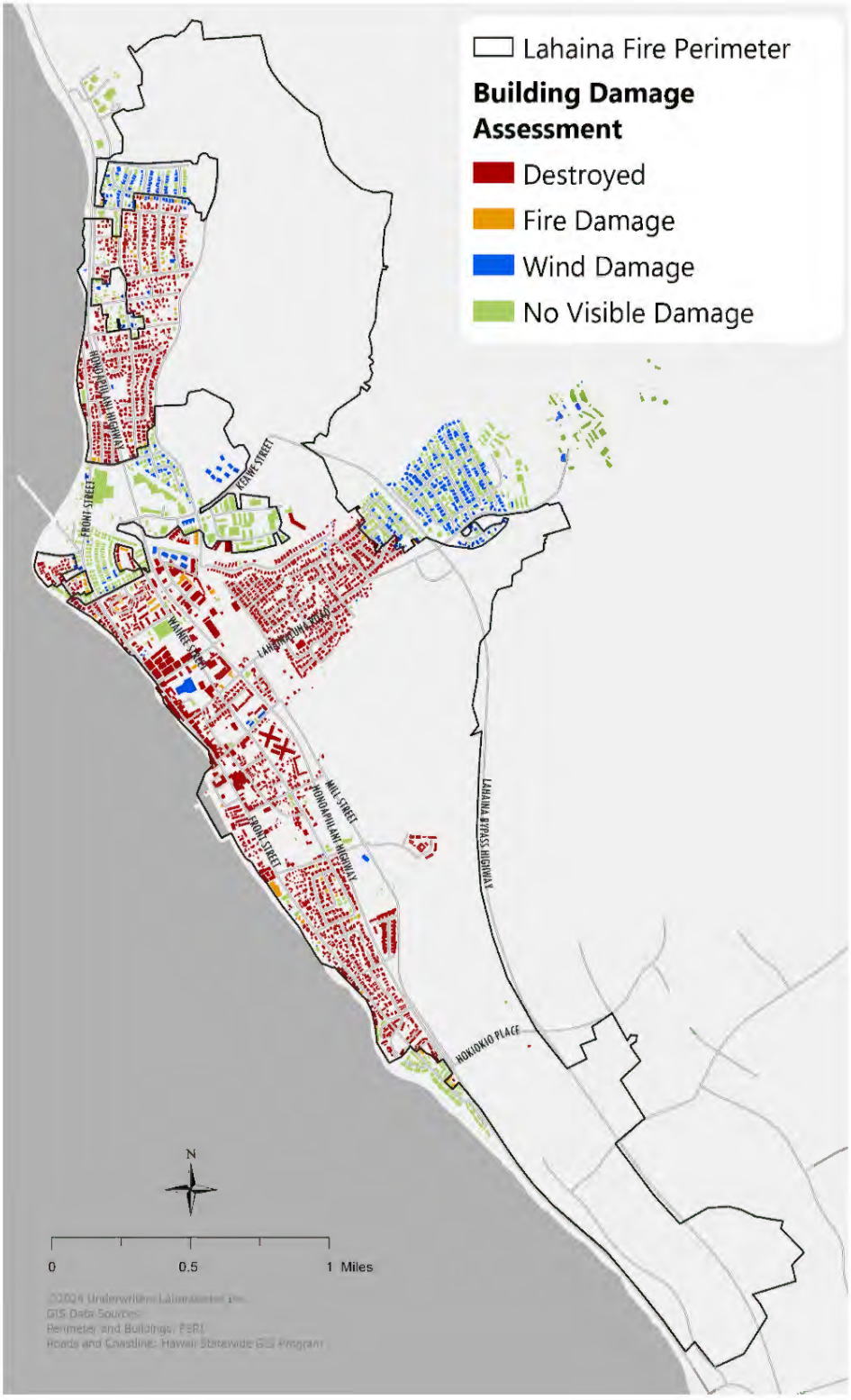


Figure 4.2.1.1 Structure damage assessment map of Lahaina as a result of the August 8-9, 2023 fire.

4.2.2 FIRE IMPACT ON THE BUILT ENVIRONMENT

4.2.2 Vehicles

Vehicles are an often overlooked, yet meaningful contributor, to the fuel load in the built environment. The expected number of vehicles and their impact on parking and evacuation were previously discussed in the context of Infrastructure (Section 3.4).

FSRI conducted a visual survey using post-fire aerial imagery captured August 11-13, 2023, to create a dataset of vehicle locations and damage classification (Figure 4.2.2.1). It is evident from the imagery (and as reported) that vehicles, both destroyed and undestroyed, were moved at some point during or after the incident.

Despite this limitation, the dataset provides insight on the contribution of vehicles to the fuel load in the built environment. A more detailed ground-based assessment of each vehicle's condition was also conducted by insurance investigators.

The data collected with this effort includes make, model, year, location/direction, and damage imagery. As per Table 6.4.1 (Subpoena No. 2024-046), FSRI has requested this information, but has not yet received it. This information can be useful in further analyzing vehicle impact on fire progression.

4.2.3 Roadways

Roads and streets were discussed previously in the Infrastructure and Evacuations sections. In the context of fire progression, roads may be considered a fuel break. Asphalt, concrete, gravel, and dirt roads can serve as fuel breaks to help stop the spread of wildfire. However in Lahaina, the number of vehicles and narrow road widths did not create sufficient discontinuity in fuel to hinder the wind-driven fire spread.



4.2.3 FIRE IMPACT ON THE BUILT ENVIRONMENT

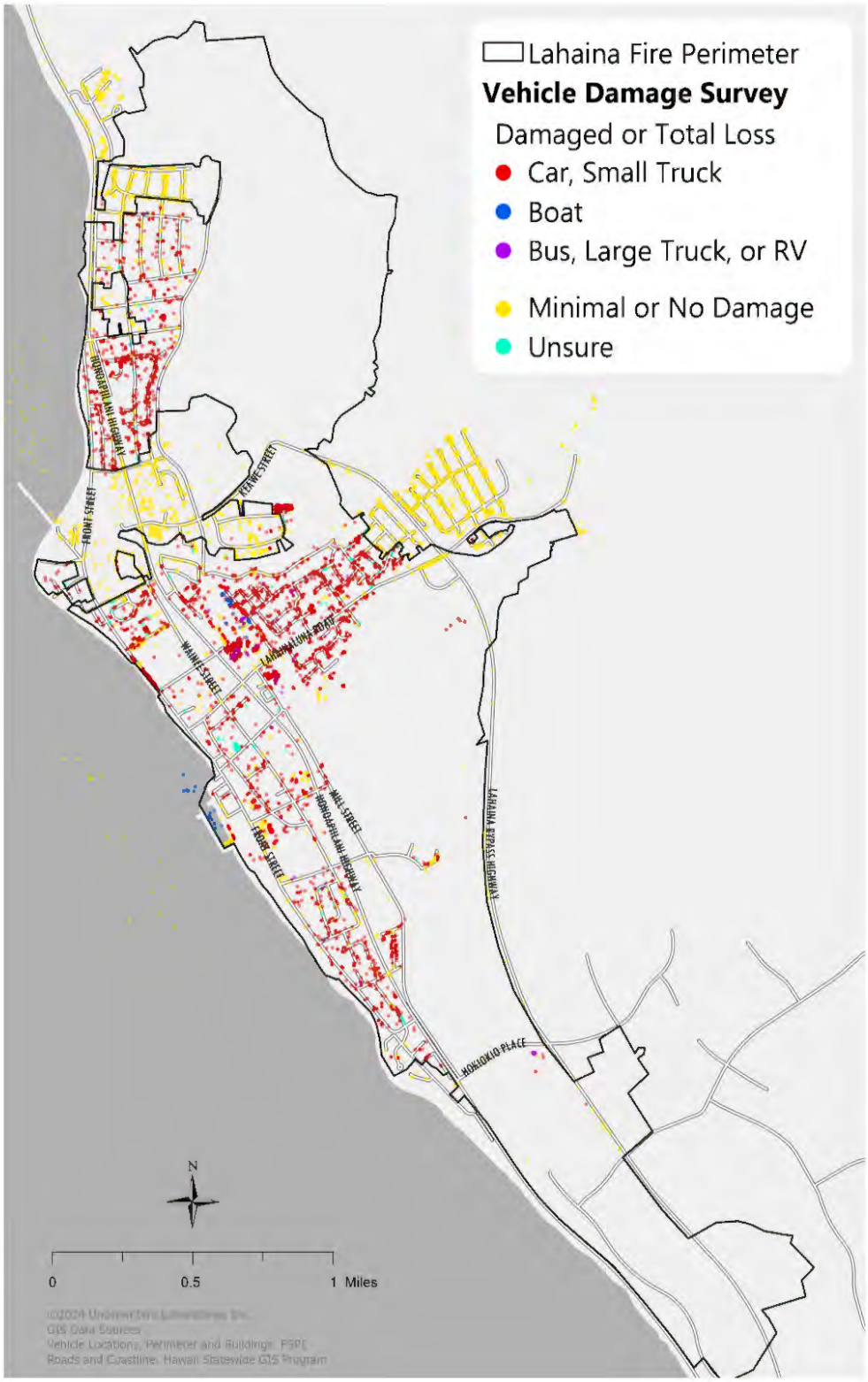


Figure 4.2.2.1 Overview of incident area with location of vehicles identified in aerial imagery captured August 11-13, 2023.

4.3 Fire Spread in the Built Environment

4.3.1 Structure Damage and Fire Spread Analysis

Unlike other natural disasters, damage from wildfires is typically binary (e.g., a structure is either completely destroyed or there is no visible damage with relatively few instances of partial damage). Where a structure, or a group of structures, falls within this damage classification, evidence may be available to reveal the impact of defensive actions taken by citizens and/or emergency responders,[254] changes in fire behavior (e.g., wind shift), and/or structural features (e.g., design, materials, construction).[255]

Destroyed structures are most often void of combustibles (which burned) that can serve as physical evidence. The transition from “destroyed” to “undestroyed” indicates a change in fire behavior (exposure) and/or wildfire-resistance (hardening) of structures.

In the built environment, fire spread needs to be considered at the structure, parcel, and community scale.[256] In the simplest terms, fire spreads from fuel package (source) to fuel package (target), by radiant heat, flame contact, and/or embers.

In the built environment anything combustible is potential fuel, including fences, vehicles, household belongings, vegetation, and structures. The distance over which the different mechanisms (radiant heat, direct flame contact, and embers) will impact fire spread depends on several factors, including the material and amount of fuel burning, wind strength and direction, and susceptibility of adjacent fuels to ignition. Fuel continuity can span across jurisdictional and property boundaries, making mitigation and hazard reduction a community effort. The fire spread analysis reported here focuses on plausible, evidence-based explanations for how the Lahaina PM fire spread from grassland to structures and between structures. Where evident, defensive actions (both civilian and emergency responder) are considered.

Evidence described in the Phase One report corroborates a predominantly easterly (mauka) wind impacting the fire during August 8, 2023, with damage patterns and radio traffic indicating strong winds. Notable, distinct shifts in wind direction were also identified on several occasions.

With this analysis, we attempted to address the following questions:

1. **Prior to the fire, what types of fuels (structures and vegetation) existed? Specifically, what construction types, occupancy class, and common building materials and/or features used contributed to embers entering the structure and starting a fire.**
2. **Did the high winds cause structural damage thus contributing to fire spread?**
3. **From what direction did the fire enter the area? What did it impact first, and how did it spread from there?**
4. **What role did structure to structure spacing play in fire spread? What role did vegetation near structures play in fire spread?**
5. **How did the fire spread through structures differ from when it burned in the vegetation on the north and south?**
6. **What role did resident firefighting and MFD and MPD fire suppression have on structures surviving, or at least sustaining less damage?**
7. **What role did the fire have on victim survivability?**
8. **What form of heat transfer was in play to enhance fire spread?**

4.3.2 Central, South, and North Zones

The area within the burn perimeter was divided into three (3) zones—Central, South, and North—for the purpose of this analysis (Figure 4.3.2.1). These divisions mark the general fire spread direction.

The fire started in the east end (mauka) of the Central zone and burned west (makai) to the coastline. As the fire's flanks widened, it progressed first to the south and then to the north.

The map in Figure 4.3.2.1 shows the boundaries of each zone and the parcels within these areas. Specific structures or clusters of structures within these areas were selected for analysis because they contain a transition in damage classification. Post-fire analysis of completely destroyed structures often provides limited insights on the fire behavior and factors that impacted it. These areas offer evidence of fire behavior (what burned) and other factors that may have contributed to the transition (e.g., defensive actions).

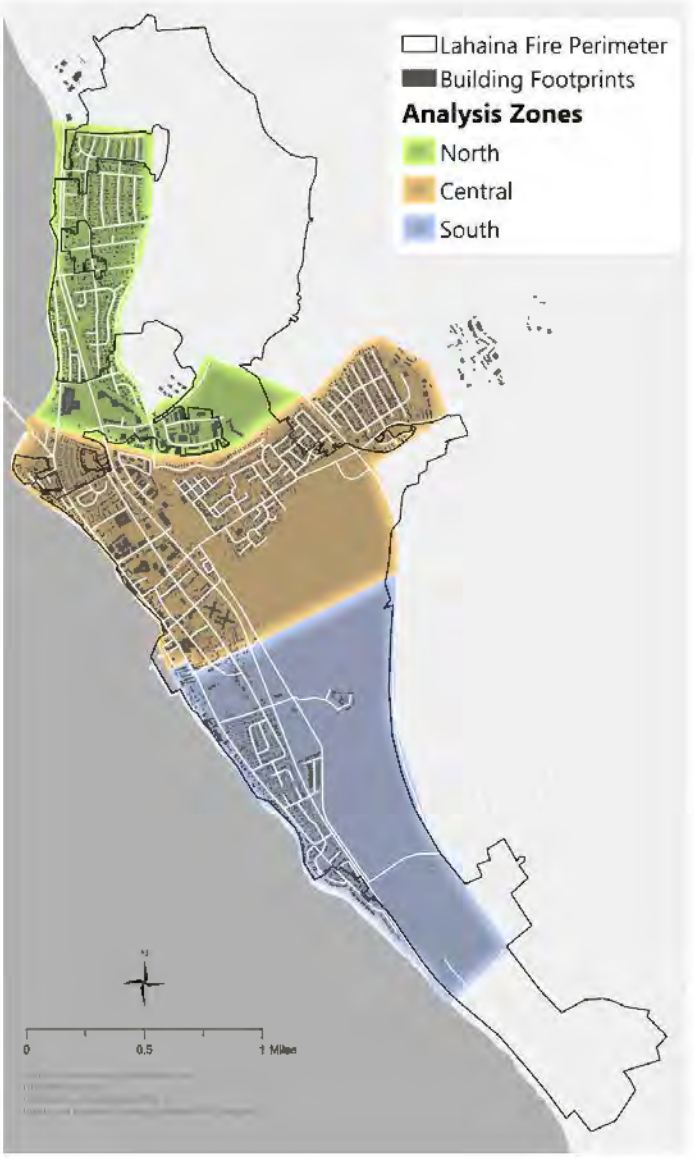


Figure 4.3.2.1 Overview map of Lahaina depicting North, Central, and South zones.

4.3.3 FIRE IMPACT ON THE BUILT ENVIRONMENT

4.3.3 Central Zone

The Central zone is the incident area south of Kahoma Stream and north of Canal Street and Prison Street (Figure 4.3.2.1).

Within the Central zone, six (6) areas of interest were identified for analysis:

- Kuhua Street and Paunau Street (near Lahainaluna Road)
- Kelawea Mauka III subdivision east (mauka) of Lahaina Bypass
- Kahoma Subdivision
- Opukea Apartments
- Kahoma Village
- West (makai) of Front Street between Ala Moana Street and Kamaka Circle

4.3.3.1 Kuhua Street and Paunau Street (near Lahainaluna Road)

The Kuhua Street and Paunau Street area is predominantly residential and located at the western end (makai) of the Kelawea Mauka III subdivision (Figure 4.3.3.1.1). This area suffered a high concentration of civilian fire deaths during the Lahaina PM fire. It was also where MFD units E1 and E6, and their crews, were burned over.


Kamaka Circle
Kenui Rd
Kenui Rd
Hinau St
Will To Pl
Umalahi Pl
Honoapiilani Hwy
Waiola St
Waiola St
Piapaa St
Lahainaluna Rd
Lahainaluna Rd
Lahainaluna Rd
Honoapiilani Hwy
Lahaina Center
Kaahumanu St
Kauhale St
Kauhale St
Kauhale

4.3.3 FIRE IMPACT ON THE BUILT ENVIRONMENT

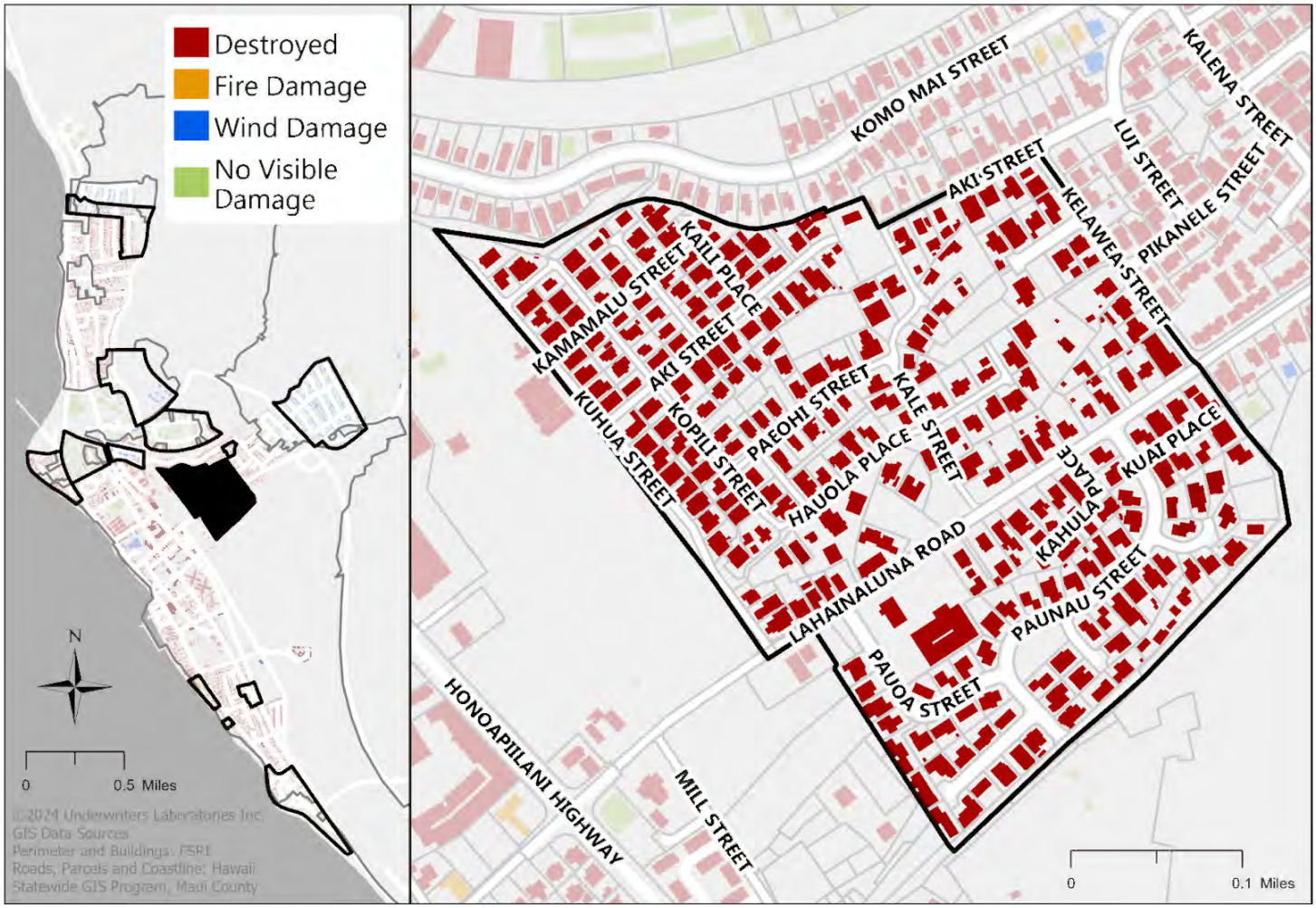


Figure 4.3.3.1.2 Damage classification assessment map of Kelawea Community analysis area.

The neighborhood is bound on the west (makai) by a large industrial area that had once been the Pioneer Sugar Mill, and was originally constructed as employee housing for the mill. All of the structures in this area were destroyed (Figure 4.3.3.1.2).

The area is made up of a very high density of houses, auxiliary structures, sheds, cars, shrubs, grasses, and other items stored on residents' properties (see Section 3.4.1.2). Some structures were so densely located that their roofs were just a few feet apart (Figure 4.3.3.1.3).

Plans for the original homes in this community (Figure 4.3.3.1.4) show they were designed to be less than 1,000 feet^2. Figure 4.3.3.1.5 shows that by 2022, additional structures had filled the empty spaces between these original structures, causing very little separation distance between buildings.

4.3.3 FIRE IMPACT ON THE BUILT ENVIRONMENT



Figure 4.3.3.1.3 EagleView image taken August 26, 2021 showing the high community density.

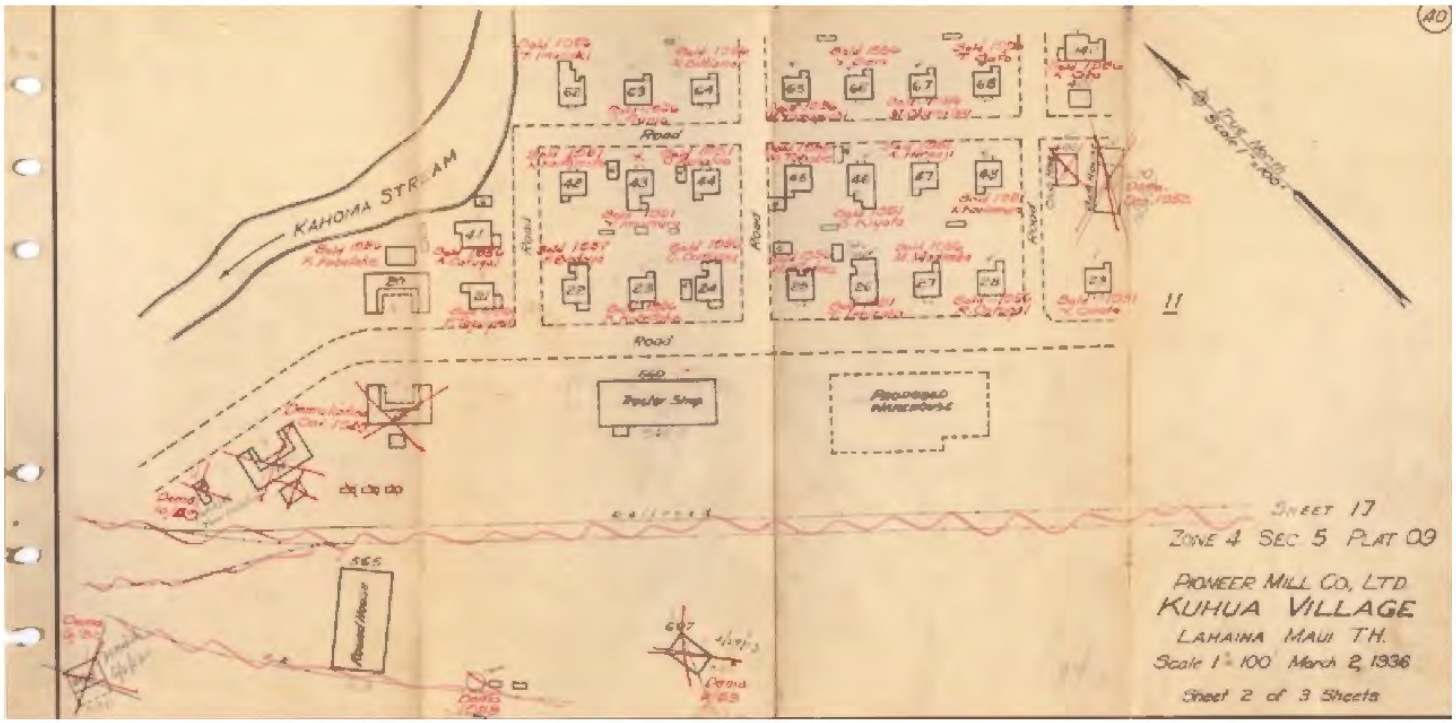


Figure 4.3.3.1.4 Historical planning document showing the northern area of Kahua St in 1936.

4.3.3 FIRE IMPACT ON THE BUILT ENVIRONMENT



Figure 4.3.3.1.5 Pre-fire aerial imagery captured August 2021 of the area along Kuhua Street depicted in FIgure 4.3.3.1.4.

Many factors have influenced this trend over the years, including increased housing costs, multigenerational living, and lack of zoning and/or enforcement.

The first homes within the neighborhood to catch fire were on Lahainaluna Road across from Kalena Street at approximately 15:28. At 15:38, multiple 911 callers indicated their homes, fences, and sheds were on fire near Paunau Street (4[redacted] and 4[redacted] Pā‘ū‘ū Place). At 15:40, an MPD officer (499) advised of fire in the brush at 4[redacted] Kauhi Place, approximately 1,000 feet west (makai) of the structure fires the MFD was working on.

Due to the close proximity of many homes within the area, as well as the addition of many ladder fuels (vegetation and structures that allow a fire to climb up from the ground level landscape), such as vehicles, fences, trees, shrubs, sheds, propane tanks, and additional outbuildings, the fire spread rapidly ahead of suppression efforts.

Spot fires were also burning around and in homes as embers from numerous burning fuels were carried by strong winds ahead of the structure fires.

With many structures on fire, the smoke thickened, and the plume could be seen making its way all the way to the ocean. The heavy wind drove the smoke to the ground, limiting the visibility of those in the path.

The fire continued to spread quickly west (makai) on Lahainaluna Road. At 15:41, MFD command advised of several houses catching fire west (makai) on Lahainaluna Road, toward Kelawea Street. At 15:42, command confirmed the fire was all the way down to Kelawea Street.

At 15:48, a 911 caller stated her yard was on fire at 4[redacted] Pauwala Place. At 15:56, an MPD officer indicated that the fire had reached the transformer area, across from the intersection of Lahainaluna Road and Kuhua Street. One (1) minute later, another 911 caller advised that the fire was starting up at Lahainaluna Road and Kuhua Street.

4.3.3 FIRE IMPACT ON THE BUILT ENVIRONMENT

E1, E6, WL6, and RE1 were operating on Pauoa Street, south of Lahainaluna Road. They declared emergency traffic (i.e., critical life safety radio communications that take priority over all other transmissions) at 16:17, and at 16:22, they became trapped by a combination of the advancing fire and other vehicles trying to evacuate. Video from the firefighters on the scene shows many structures on fire in the area and embers being driven through their location by strong winds.

The interval from first home ignition to the emergency conditions experienced by the MFD was approximately 49 minutes. During this time, the fire had spread at least 1,800 feet down Lahainaluna Road to the firefighters' position on Pauoa Street. This is likely the time Kuhua Street also became untenable for unprotected civilians.

Due to the fire's intensity, firefighters were forced out of their apparatus while they were wearing firefighting PPE and SCBA. The firefighters also shared that their water application was having no impact on the fire conditions and that it was hot enough for their hoseline to burn through.

At 16:24, Officer 401 radioed, "We might have one (1) fatality, homes rear of Mill Street." This indicates that IDLH fire conditions had progressed to the area of Mill Street and Hwy-30. This location is further west (makai) than the firefighters and just south of Kuhua Street.

No structures survived in this area due to the extreme fire conditions (Figure 4.3.3.1.6). All three (3) fire spread mechanisms—embers, radiant heat transfer, and direct flame contact—played important roles in the speed at which the fire spread within the neighborhood.



Figure 4.3.3.1.6 Post-fire aerial imagery (captured August 11-13, 2023) of Kuhua Street in the Kelawea Community.

4.3.3 FIRE IMPACT ON THE BUILT ENVIRONMENT

In this area, there were two (2) ways to evacuate to Hwy-30: via Lahainaluna Road and via Komo Mai Street. There were trees down and sections of roofs down in the road on Aki Street, west (makai) of Kelawea Street, which blocked people from using Komo Mai Street as an exit.

A large mango tree also fell on Kuhua Street, just south of Aki Street (described during a 911 call at 16:41), which blocked an exit to Lahainaluna Road (Figure 4.3.3.1.7). The roads were narrow and further clogged with many parked cars. The smoke would have been thick and blinding due to the high winds driving the smoke towards the ground, at or below eye-level. See Section 3.8.2 for more information on Traffic Management and Egress Challenges.

The fire and smoke conditions straight down Lahainaluna Road would have been untenable, particularly for civilians trapped in their vehicles and/or without protection from the hot and toxic gasses from the fire.

Fifty citizens perished in this area or after exposure to conditions in this area (Figure 4.3.3.1.8). Fifty-five of those killed in the fire had addresses in the neighborhood. Many people narrowly escaped and there are many stories of neighbors helping neighbors to escape the fast spreading urban conflagration. For more information on the circumstances surrounding the fatalities, see Section 3.8.10.



Figure 4.3.3.1.7 Map showing egress route at 16:41 after the fire cut off the westbound exits via Komo Mai Street and Lahainaluna Road. Orange dots represent the location of the fallen trees and debris blocking Kuhua and Aki Streets. Red dots represent locked gates that police officers and residents forcibly opened to gain access to alternative egress routes depicted by the yellow lines.

4.3.3 FIRE IMPACT ON THE BUILT ENVIRONMENT

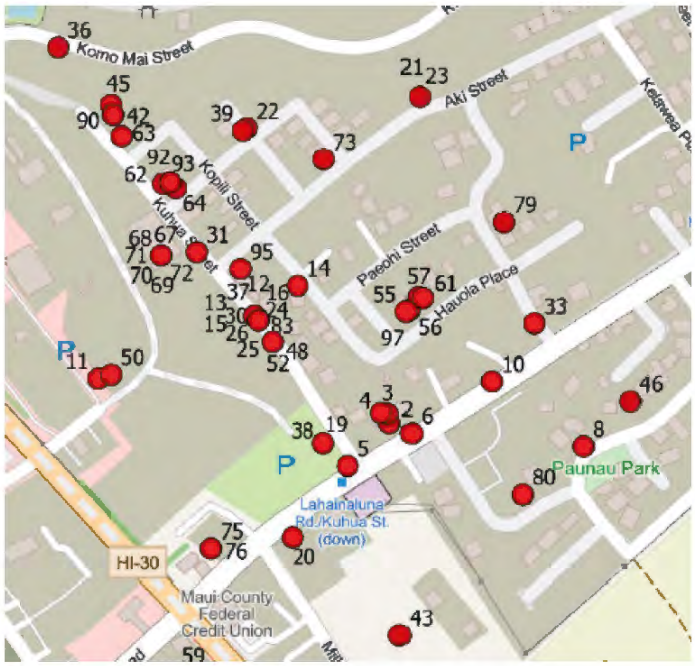


Figure 4.3.3.1.8 Fatality locations in this area as provided by the MPD.

4.3.3.2 Kelawea Mauka III subdivision east (mauka) of Lahaina Bypass

The Kelawea Mauka III subdivision is a group of approximately 300 structures, mostly residential homes, east (mauka) of the Lahaina Bypass (Figure 4.3.3.2.1). The average year of construction for this subdivision is 1985 with some newer construction and additions as recent as the 2010s.

The area of origin is just behind the homes on Hoʻokahua Street, but does not appear to have damaged any of the structures. Several residents indicated they engaged in firefighting activities, including fighting spot fires and defending structures. Without these actions it is likely structures would have ignited and resulted in similar destruction that occurred west (makai) of the bypass. Most of these structures were outside of the fire perimeter, but many sustained damage due to high winds before and during the fire. Of the 276 properties,162 (59%) have visible damage due to wind (Figure 4.3.3.2.2).



Figure 4.3.3.2.1 Post-fire aerial imagery Kelawea Mauka III subdivision, east (mauka) of Lahaina Bypass.

4.3.3 FIRE IMPACT ON THE BUILT ENVIRONMENT

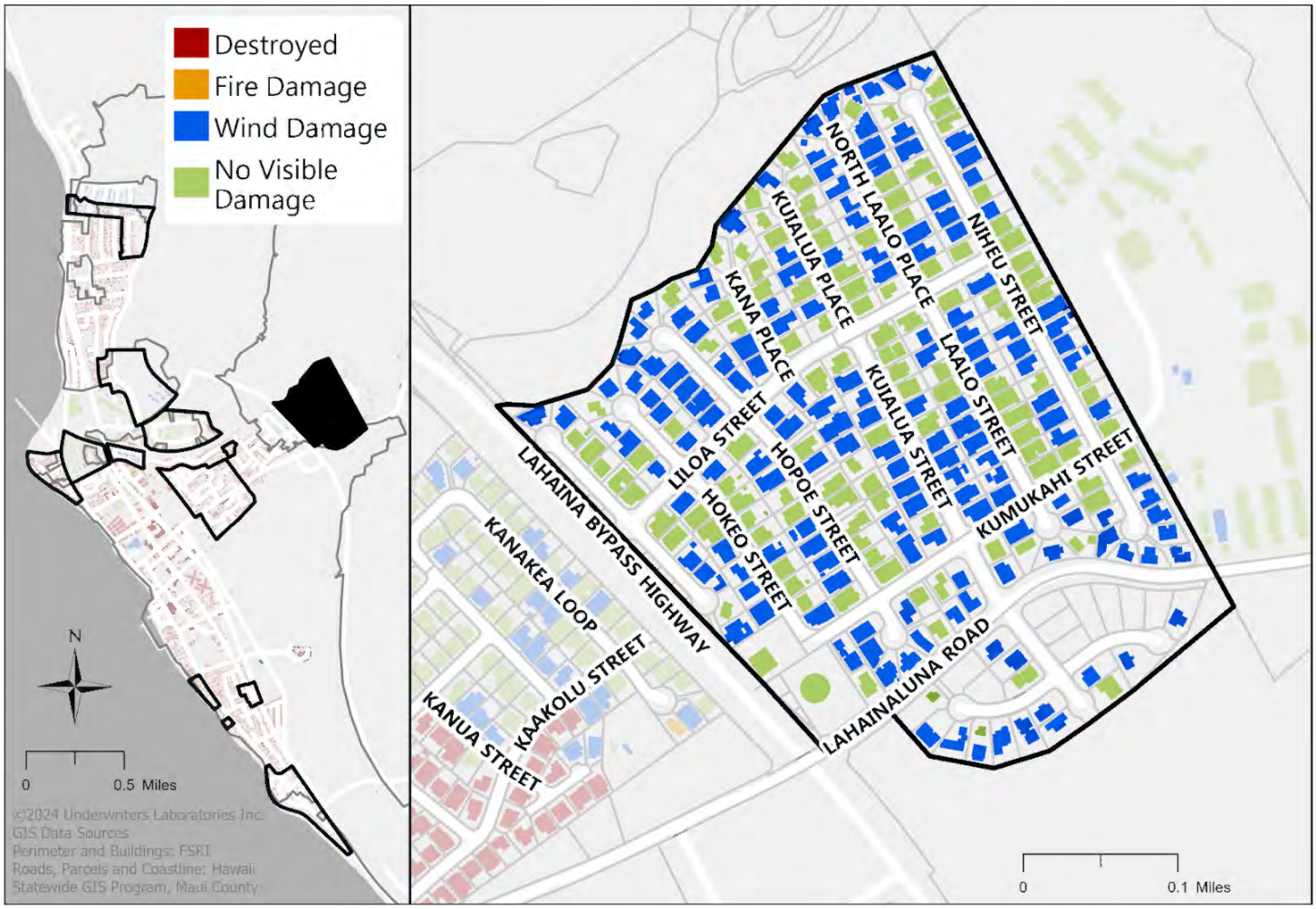


Figure 4.3.3.2.2 Damage classification assessment map of Kelawea Mauka III subdivision analysis area.

Residents living west (makai) of the bypass, off of Kanakea Loop and Ka‘akolu and Kanua Streets, also engaged in fire suppression efforts. Those living in the cul-de-sac of Kanakea Loop used garden hoses and hand tools to extinguish the grass fire located on the north end of Kelawea Mauka Makai Park. Others cooled spot fires, and used water curtains, in an attempt to protect their homes from the radiant heat.

The most common wind damage was to roof coverings (displaced or totally removed) and/or roof-mounted solar panels. According to the County of Maui assessor data, the most common roof material used within the Kelawea Mauka III subdivision was metal (44%), composite shingle (34%), and wood shake (17%).

The magnitude and orientation of roof damage from high winds is typically impacted by several factors, including average wind gust speed, wind direction, and vulnerability (roof shape, covering material and attachment, and age).

Based on aerial imagery, approximately 84% of properties in the subdivision had roof-mounted PV panels, which may have increased the susceptibility of these structures to wind damage.[257]

4.3.3 FIRE IMPACT ON THE BUILT ENVIRONMENT

Figure 4.3.3.2.3 shows examples of wind damage in the Kelawea Mauka III subdivision, including loss of roof covering and structural components.

These structures are located outside of fire plume and thermal exposure, which may affect the susceptibility of roof coverings to wind damage and wind-borne debris that can cause damage. Additionally, the construction (age, materials, etc.) and location of these structures is not necessarily representative of all structures impacted during the incident.

Given these caveats, this sample of wind damaged structures provides insight into the plausible damage to other structures before and during the fire, which would subsequently impact their vulnerability to fire damage, particularly for entry of airborne embers.



Figure 4.3.3.2.3 Example of wind damage in the Kelawea Mauka III subdivision—(bottom left) damaged roof sheathing and (bottom right) loss of roof covering.

4.3.3 FIRE IMPACT ON THE BUILT ENVIRONMENT

4.3.3.3 Kahoma Subdivision

The Kahoma subdivision, in the area of Lu‘i Street at Komo Mai Street, features relatively new construction compared to the Kelawea Mauka III subdivision (Figure 4.3.3.3.1). The homes along Komo Mai Street were constructed in or after 2017. Komo Mai Street was used as an evacuation route out of the Lahainaluna subdivision. MPD officers 4B10 and 4B30 operated in the area coordinating evacuations.

Shortly before 16:00, reports came in that structures on Kalena Street and Lu‘i Street near Komo Mai Street were on fire. Civilian video shows fire spreading west (makai) along Komo Mai Street at 18:14 (Phase One report, Figures 4.3.1.14-17).



Figure 4.3.3.3.1 Pre- and post-fire aerial imagery of homes that survived the fire on Komo Mai Street and Lu‘i Street. Annotations depict separation distances between perimeter structures and nearest destroyed structure.

4.3.3 FIRE IMPACT ON THE BUILT ENVIRONMENT

Five (5) structures at the corner of Komo Mai Street and Lu‘i Street were not destroyed, while all adjacent ones were destroyed (Figure 4.3.3.3.2). The western-most (makai) home that was not destroyed—3[redacted] Komo Mai Street—was impacted by the adjacent (downwind) structure, including what appears to be discoloration of the fiber cement siding and damage to windows on the fire-exposed side of the structure (Figure 4.3.3.3.3).



Figure 4.3.3.3.2 Damage classification assessment map of Kahoma subdivision analysis area.



Figure 4.3.3.3.3 Damage classification assessment map to 3[redacted] Komo Mai Street from (destroyed) 3[redacted] Komo Mai Street; approximately 24 foot separation distance. Top left image shows both addresses, top right indicates the radiant heat vector in the generally opposite direction of fire spread. Bottom images show discoloration of fiber cement siding and deformation of vinyl window frames.

4.3.3 FIRE IMPACT ON THE BUILT ENVIRONMENT

Based on the incident timelines (see Phase One report), MFD units E3, L3, and other personnel were in the area of Luʻi Street and Komo Mai Street from approximately 16:00 to 19:00 on August 8, 2023. During this time, firefighting units implemented structure defense tactics, including fire suppression and exposure protection (Figure 4.3.3.3.4). These defensive actions were likely the primary reason that these structures were not destroyed.

Several of the structures in the subdivision sustained damage due to wind, including uplift and removal of roof shingles. Fences were also damaged, possibly due to a combination of wind and defensive actions taken by MFD units at the scene.



Figure 4.3.3.3.4 Isolated fire damage to 3[redacted] Komo Mai Street. Spot fire (ember ignition) caused localized damage, but did not spread to the structure, likely due to defensive actions.

Potential contributing factors in undestroyed structures

Newer construction homes:

- **As buildings age, they naturally degrade, which can create openings and penetrations in the structure's envelope, creating pathways for ignition.**
- **Newer homes tend to have fewer additional structures and vegetation on their parcels, which creates less opportunity for fuel continuity, limiting fire spread.**

Suppression efforts and defensive actions:

- **L3 deployed an aerial master stream, but reported, due to wind, the water application had limited effectiveness.**
- **E3 was deployed in the area protecting structures and putting out spot fires.**

4.3.3.4 Opukea Apartments – Limahana Circle

The Opukea apartment complex comprises seven (7) apartment buildings and one (1) office/amenity building along and south of Kahoma Stream (Figure 4.3.3.4.1). The complex was built in 2008 and construction features include stucco exterior walls and composition shingle roofs.

Within the complex, several structures were destroyed, including two (2) apartment buildings and the office/amenity building, while the remaining five (5) apartment buildings sustained wind damage, but were not destroyed (Figure 4.3.3.4.2).



Figure 4.3.3.4.1 Pre-fire aerial imagery (captured August 10, 2021) of Opukea Apartments.

4.3.3 FIRE IMPACT ON THE BUILT ENVIRONMENT



Figure 4.3.3.4.2 Damage classification assessment map of Opukea apartment complex analysis area.

Radio traffic from MFD unit RE11 at 16:49 on August 8, 2023, indicates fire was impacting the complex:

"I've got a view of Opukea. It's being impacted on the cars, on the outside, extending to the building; it needs to get evacuated."

Based on fire progression, the vehicles and Based on fire progression, the vehicles and buildings being referenced are most likely those that back up to Komo Mai Street and the east (mauka)-most apartment building.

At this point in the incident, most of the structures on Komo Mai Street (other than those described in Section 4.3.3.3) were burning and generating embers that were likely capable of spreading fire over the 150-foot distance to resident vehicles and 40 to 50 feet further from the vehicles to the east (mauka)-most apartment building (Figure 4.3.3.4.3).

4.3.3 FIRE IMPACT ON THE BUILT ENVIRONMENT



Figure 4.3.3.4.3 Distance between nearest destroyed structure on Komo Mai Street, destroyed vehicles, destroyed apartment building, and undestroyed apartment building.

After 18:00, the crew from U3B responded to this area to assist with evacuation and suppress small fires in the area. The crew recalled that all buildings were intact, but there was fire activity around the building with limited visibility.

While conducting searches of the buildings, U3B crew used fire extinguishers to put out spot fires around and inside units where exterior doors had been left open, likely during evacuation. Upon completion of the search, U3B crew gathered civilians who were sheltering in place and evacuated north across Kahoma Stream to the Walgreens parking lot and then to the Civic Center shelter.

A photo of one of the destroyed apartment buildings (Figure 4.3.3.4.4) provides additional information on their construction style and materials, which may be assumed common for the other apartment buildings within the complex.

The first floor exterior walls are concrete masonry block (CMU) blocked with stucco cladding, while upper floors were constructed with gypsum sheathing and similar stucco cladding.



Figure 4.3.3.4.4 Destroyed apartment building showing CMU block exterior wall construction (first floor) and noncombustible sheathing with stucco finish coat and fiber cement siding.

4.3.3 FIRE IMPACT ON THE BUILT ENVIRONMENT



These noncombustible exterior wall materials likely contained the fire within the burning structures and reduced exposure to adjacent buildings. Additionally, the 40- to 50-foot separation distance between the burning buildings, and nearby structures, could also have been a contributing factor in why fire did not spread to the adjacent apartment buildings.

The non-destroyed structures within the complex were those closest to, or along, Kahoma Stream, just west (makai) of the point where the fire jumped the stream and spread north (Phase One report, Figure 4.3.1.13).

The combination of fire spread direction (north), potentially caused by wind direction, and the effect of the eastern (mauka)-most apartment building creating an ember cast shadow, were also likely contributing factors as to why those apartment buildings were not destroyed.

However, these surviving structures sustained substantial wind damage, including detachment of roof coverings, as well as the removal of roof sheathing (Figure 4.3.3.4.5) and broken windows (Figure 4.3.3.4.6), which could create potential pathways for embers into the structures.



Figure 4.3.3.4.5 Wind damage to undestroyed apartment buildings, including significant roof covering (composition shingle) loss and roof sheathing.

4.3.3 FIRE IMPACT ON THE BUILT ENVIRONMENT



Figure 4.3.3.4.6 Broken window on third floor of eastern (mauka) side of apartment building, likely caused by windborne debris.

There is evidence of some firebrand/ember ignitions of ornamental vegetation (Figure 4.3.3.4.7), but a notable lack of spot fires in grasses in the community, compared to spot fires in the grasses adjacent to Kahoma Stream.

This evidence suggests the ember exposure was sufficient, but most fuels in the apartment complex, including vegetation, were not receptive to ignition. The lack of ignition in the vegetation may be attributed to the apparent lushness caused by irrigation.



Figure 4.3.3.4.7 Ornamental vegetation (palm bracts) ignited by embers and burned without igniting adjacent vegetation.

4.3.3 FIRE IMPACT ON THE BUILT ENVIRONMENT



Figure 4.3.3.5.1 Pre-fire aerial imagery (captured August 10, 2021) of Kahoma Village before the fire.

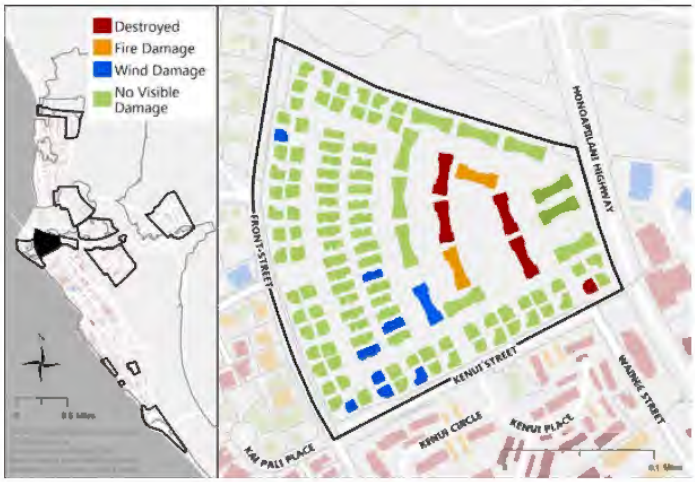


Figure 4.3.3.5.2 Damage classification assessment map of Kahoma Village analysis area.

4.3.3.5 Kahoma Village

Kahoma Village is a 20.5-acre master planned community comprising 32 single family homes, 69 courtyard single family homes, and 102 villas (townhomes) across 17 buildings (Figure 4.3.3.5.1). The development was built between 2017 and 2020. One (1) of the courtyard homes and four (4) townhomes were destroyed by fire; two (2) townhomes sustained fire damage and nine (9) buildings sustained wind damage (Figure 4.3.3.5.2).

All of the buildings were constructed using modern materials, including asphalt shingle roofs and non-combustible wall sheathing, and maintained green vegetation landscape. The village was further protected by a concrete barrier wall, which extended along the full east (mauka) side of the village, along Hwy-30 between Kenui Street and Kahoma Stream (Figure 4.3.3.5.3).

4.3.3 FIRE IMPACT ON THE BUILT ENVIRONMENT



Figure 4.3.3.5.3 Concrete barrier wall along Hwy-30.

Notably, this was the side of the village that received the bulk of the ember exposure from the fire to the east (mauka), driven by westerly (makai) winds. Although all of the grasses along the concrete barrier wall had burned, the homes behind the wall did not appear to have any thermal damage.

There was one (1) single family home (2[redacted] Kahoma Village Loop) that was ignited by embers on the southeast corner of the village (Figure 4.3.3.5.4). The house fire was recorded by Central at 16:44:56. MPD BWC footage shows the house's roof on fire at 17:41 and water being applied from the Kenui Street side (Figure 4.3.3.5.5).

The MFD, with support from private tankers, kept the fire from extending to adjacent structures. There was no thermal damage to the home to the east (mauka), even though this house was only approximately 14 feet away from the neighboring home.



Figure 4.3.3.5.4 Destroyed single family home at 2[redacted] Kahoma Village Loop from the front (north).



Figure 4.3.3.5.5 Body worn camera image captured by an MPD officer on August 8, 2023, at 17:41:23, showing the house fire in Kahoma Village.

4.3.3 FIRE IMPACT ON THE BUILT ENVIRONMENT

As the fire was spreading quickly from east (mauka) to west (makai), including burning the entire Front Street apartment complex across Kenui Street to the south, there were resources in Kahoma Village, protecting homes from ember ignitions. Numerous residents remained in Kahoma Village throughout the entire incident and shared stories with FSRI team members of extinguishing spot fires.

The MPD had several officers in Kahoma Village evacuating residents and suppressing spot fires. The MFD also had several units suppressing spot fires and extinguishing fires around Kahoma Village. During the post-incident walkthrough, evidence of ember damage was found on patio furniture in backyards of several houses.

In addition to the house, four (4) townhome buildings located in the center of the village were destroyed (buildings 11, 12, 14, 15). There is no recorded evidence as to when these structures ignited.

These fires likely ignited after the MFD and the MPD relocated their resources north to support evacuations in the Wahikuli Area. With the MFD supporting operations further north, the fire eventually stopped spreading without intervention.

Examining the areas around the townhouse buildings that survived provides useful insights, pointing out how construction and design features can impact the fire-susceptibility of a particular structure.

Building 13 was damaged (melted window trim, cracked windows, dried out shrubs, and melted vinyl fence) by adjacent Buildings 12 and 14, but did not ignite (Figure 4.3.3.5.7). Building 14 (destroyed) caused damage to windows and a vinyl fence (Figure 4.3.3.5.8 and Figure 4.3.3.5.9).



Figure 4.3.3.5.6 Destroyed single family home from the rear on the other side of the concrete wall.



Figure 4.3.3.5.7 Aerial imagery of distances between Building 13 (damaged), Building 12 (destroyed), and Building 14 (destroyed).



Figure 4.3.3.5.8 Ground-based photograph of space between Building 13 (shown on the left of the image) and Building 14 (shown on the right), showing damaged windows and heat damaged/dried (but not ignited) vegetation.

4.3.3 FIRE IMPACT ON THE BUILT ENVIRONMENT



Figure 4.3.3.5.9 Ground-based photograph of space between Building 13 (shown on the left of the image) and Building 14 (shown on the right).

Building 13 was approximately 20 feet away from Building 12, which was also a total loss. Each townhouse building had vinyl fenced-in backyards, which could be as close as 10 feet from one another (Figure 4.3.3.5.9). The combustible materials (e.g., outdoor furniture) between the buildings measured 12 feet between their vinyl fences (Figure 4.3.3.5.9).

Building 16 was damaged (melted window trim, cracked windows, bubbled paint, dried out shrubs, melted vinyl fence) but did not ignite (Figure 4.3.3.5.11). Building 16 was located approximately 16 feet from Building 15, which was destroyed (Figure 4.3.3.5.12). Several vehicles were also destroyed. Those vehicles were approximately 22 to 30 feet from the nearest window opening in the building.



Figure 4.3.3.5.10 Photograph of space between Building 12 (shown on the right of the image) and Building 13 (shown on the left), showing minimal damage to the vinyl fence.

4.3.3 FIRE IMPACT ON THE BUILT ENVIRONMENT

Examining these buildings post-fire highlighted some trends:

- There were multiple locations where vinyl windows were the potential weak link for fire spread from structure-to-structure. Cracked windows and warped vinyl frames were seen even where there was no or little thermal damage to siding or roofing. Windows were double-paned with plain glass; when window glass cracking occurred in these surviving structures, only the outer pane cracked and the inner remained intact.
- The shrubs located between all of the townhouse buildings show signs of drying out without signs of ignition. If these shrubs were not maintained, they could have ignited and acted as ladder fuel that helped spread the fire to more structures.
- There was little evidence of large amounts of embers down wind from the four (4) townhouse buildings. The wind may have died down when these structures burned, suggesting that they might have ignited late on August 8, 2023, or early August 9, 2023.

4.3.3.6 West (Makai) of Front Street Between Ala Moana Street and Kamaka Circle

The area along and west (makai) of Front Street to the beach between Ala Moana Street and Kamaka Circle has mixed construction, including single-family residential housing, ADUs, multi-family residential housing (condominiums), and places of worship (Figure 4.3.3.6.1). This area is the western (makai)-most point of the fire perimeter and damage to the built environment (Figure 4.3.3.6.2).



Figure 4.3.3.4.11 Thermal damage (window) to the front of Building 16, across from Building 15 (destroyed).



Figure 4.3.3.5.12 Distance between Building 15 (undestroyed) and Building 16 (destroyed) and several vehicles lost during the fire.



Figure 4.3.3.6.1 Post-fire aerial imagery of Ala Moana Street to Kenui Street.

4.3.3 FIRE IMPACT ON THE BUILT ENVIRONMENT



Figure 4.3.3.6.2 Damage classification assessment map of Front Street to the beach between Ala Moana Street and Kamaka Circle analysis area.

The mix of construction included structures from the early 1900s to 2022 and a range of building materials. These structures are situated west (makai) of Kahoma Village (leeward during the wind-driven fire event), which provided a buffer for fire spread from the east (mauka).

The first report of fire in this area was at 19:49, when MPD officer T34 reported multiple houses on fire south of Ala Moana along Front Street. Shortly after (at 19:51) they stated, “The back of 11[redacted] Front is on fire, coming from Māla Wharf, guess it jumped Ala Moana from the back.”

A private driveway off Ala Moana Street (Figure 4.3.3.6.3) is generally a line of demarcation between destroyed and surviving structures. West (makai) side of the driveway homes were destroyed all the way to the ocean, including the Lahaina Jodo Mission.

Two buildings, 4[redacted] Ala Moana Street and 5[redacted] Ala Moana Street, were damaged by a destroyed accessory structure in the backyard of 4[redacted] Ala Moana Street. The accessory structure was most likely ignited by embers, due to the lack of continuous fire spread. The destroyed burning accessory structure

4.3.3 FIRE IMPACT ON THE BUILT ENVIRONMENT

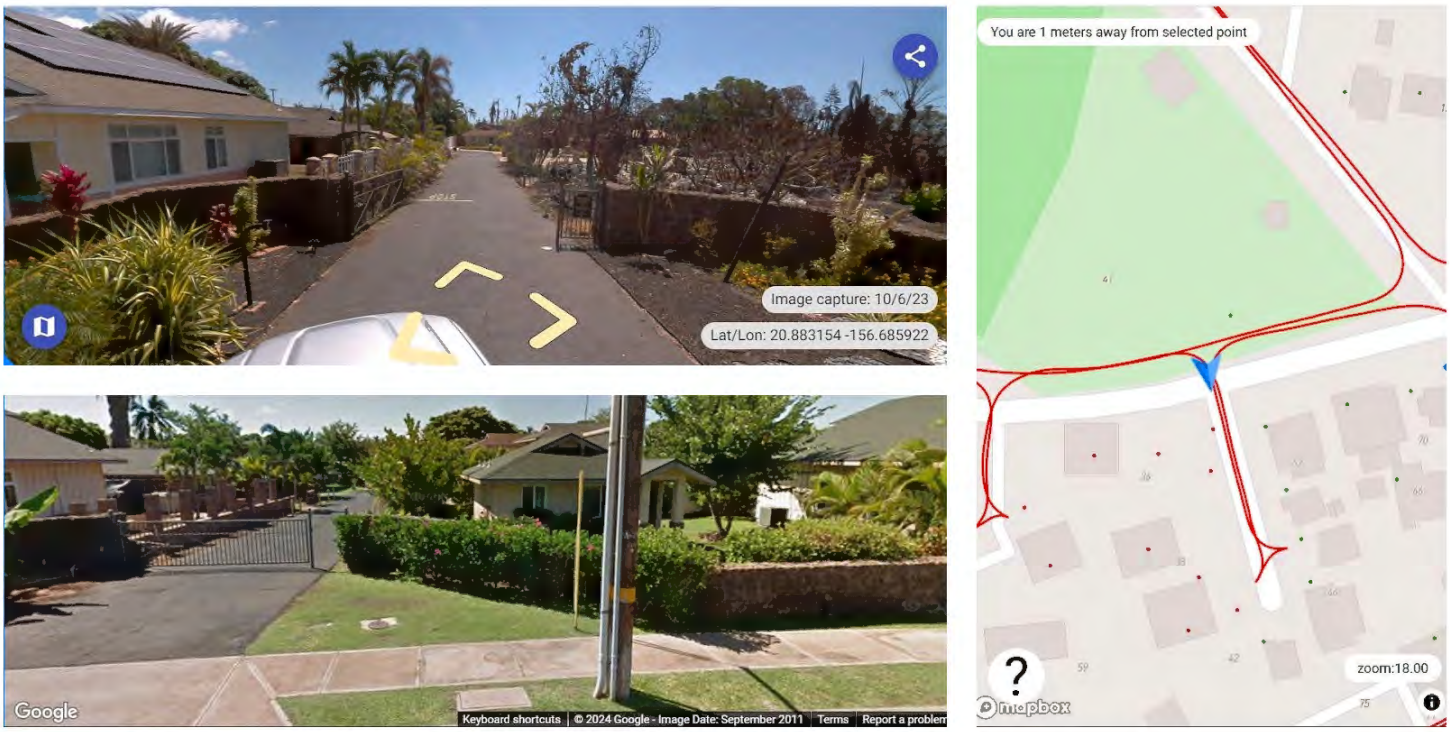


Figure 4.3.3.6.3 Pre- and post-fire Google Street View imagery of Ala Moana Street private driveway. This road is a demarcation of destruction, nearly all of the structures on the ocean (makai) side are destroyed.

caused damage to both 4[redacted]Ala Moana Street (burned fascia and broken windows) and 5[redacted] Ala Moana Street (burned fascia and a damaged storage container) (Figure 4.3.3.6.4).

The distance between the destroyed and adjacent structures was less than six (6) feet. However, there are masonry walls between the accessory structure and the surrounding buildings. These walls likely provided some level of containment/resistance that limited the fire's spread to other structures on the parcel.

E11 reported being in this area and recalled extinguishing a fire on Ala Moana where an ohana dwelling (accessory structure) had ignited. The crew patrolled this area, suppressing spot fires and protecting structures.

There is evidence that defensive actions (connected residential hoses flaked out in the area) to suppress the burning structure and/or protect adjacent structures, which could have been a contributing factor to why the fire did not spread further on the parcel.

4.3.3 FIRE IMPACT ON THE BUILT ENVIRONMENT



Figure 4.3.3.6.4 Destroyed accessory structure at 4[redacted] Ala Moana Street (top left). The burning structure caused damage to 4[redacted] Ala Moana Street (top right and bottom left) and 5[redacted] Ala Moana Street (bottom right).

During the post-fire damage survey, FSRI team members spoke with a resident of an undestroyed home. The resident stated they returned to the home on Wednesday, August 9, 2023, after evacuating the day before. They found both electricity and water utilities were turned off and that a structure in the backyard was burning (Figure 4.3.3.6.5). The resident was able to suppress the fire before it spread to any adjacent structures.

Slightly further south, the burning structures on Lahilahi Place caused damage to the rear side exposures at 11[redacted] and 11[redacted] Front Street, 20 to 40 feet away. The vinyl siding and window frames were damaged by the radiant heat, but did not ignite (Figure 4.3.3.6.6). A garden hose found behind 11[redacted] Front Street may have been used by the residents described above to protect these structures from ignition.



Figure 4.3.3.6.5 Post-fire aerial imagery (captured August 13, 2023) of the area of Puunoa Place.

4.3.3 FIRE IMPACT ON THE BUILT ENVIRONMENT



Figure 4.3.3.6.6 Destroyed structure on Lahilahi Place caused damage to the rear side of 11■ (top) and 11■ (bottom) Front Street structures.



Figure 4.3.3.6.7 Post-fire aerial imagery of 1■ Kamaka Circle (damaged), surrounded by destroyed structures.

At the south end of this analysis area, an isolated structure at 1■ Kamaka Circle was impacted, but survived, while adjacent structures were all destroyed (Figure 4.3.3.6.7). On the southeast (or "B") side of the structure, there is approximately 30 feet of foliage and a fence, and the adjacent structure (1■ Kamaka Circle) is approximately 50 feet away.

There is evidence of ground fire in the vegetation, potentially from embers, but limited fire spread. The dense, lush (apparently well-watered) foliage and fence may have provided some shielding of the radiant heat from the burning adjacent structure, a contributing factor for the reduced thermal exposure (Figure 4.3.3.6.8).

4.3.3 FIRE IMPACT ON THE BUILT ENVIRONMENT



Figure 4.3.3.6.8 Vegetation and fence on "B" side exposure of 1[redacted] Kamaka Circle.

The burning structure and vehicles at 2[redacted] Kamaka Circle impacted 1[redacted] Kamaka Circle (approximately 12 feet) on the northeast side and caused damage to window frames and glass, exterior vinyl, and the thatch roof covering (Figure 4.3.3.6.9).



Figure 4.3.3.6.9 Close-up images of the structure at 1[redacted] Kamaka Circle, showing that the extent of damage varied by multiple factors. Yellow arrow indicates the vinyl window frame that was impacted by radiant heat and fell out. Red arrow indicates ember ignition of wooden deck for what appears to be an outdoor shower.

The entire window sash in the exposed side fell out onto the ground, leaving an open path for flame or embers to enter the structure. However, this window was oriented opposite the prevailing wind direction, which may have provided some level of protection for this opening. The ember exposure was sufficient to cause ignition of wooden deck boards for what appears to be an outdoor shower.

Given the separation distance and likely wind direction, the mechanism of heat transfer was radiation; the masonry wall would have provided some shielding (shadowing) from the source and reduced the thermal impact. The exposure was sufficient to cause deformation of vinyl window frames that fell outward.

In addition to the thermal exposure from adjacent burning structures, there was considerable ember exposure evident at this location. The hot tub cover and sun shade had numerous burn marks from embers that were energetic enough to pyrolyze these materials after they landed. Ember size characteristics, such as size and shape, can be measured based on the burn marks they leave,[258] such as those shown in Figure 4.3.3.6.10.



Figure 4.3.3.6.10 Ember damage of a hot tub cover reveals the noticeable size variation of embers encountered during the fire.

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT

4.3.4 South Zone

The South zone is the incident area south of Canal Street and Prison Street (Figure 4.3.2.1). Within the Central zone, four (4) areas of interest were identified for further analysis:

- 400 Block of Front Street
- 400 Block of ʻĀlīʻō Street and Waineʻe Street
- 300 Block of Front Street
- Puamana Community

4.3.4.1 400 Block of Front Street

The 400 block of Front Street is an oceanfront section of Front Street that features commercial and residential structures (Figure 4.3.4.1.1). Six (6) of the seven (7) primary structures in this area survived the fire on the west (makai) side between Shaw Street and Kauaʻula Road, while all other structures adjacent to this analysis area were destroyed (Figure 4.3.4.1.2).



Figure 4.3.4.1.1 EagleView image of the 400 block of Front Street showing the survival of six (6) primary structures on the west (makai) side of the street.

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT



Figure 4.3.4.1.2 Damage classification assessment map of the 400 block of Front Street analysis area.

Many structures on this block were originally constructed in the 1950s and 1960s, though several new structures were built between 2009 and 2020.

Fires were reported in this area beginning at 16:58, when an unidentified MPD Officer advised the fire was near a shelter for the unhoused located east (mauka) of the Lahaina Recreation Center on Shaw Street.

A civilian video recorded at 18:47 near Shaw Street and Front Street shows both 1[redacted] Shaw Street (Salvation Army Building) and another structure on fire just north on Front Street (Phase One report, Figures 4.3.1.22 and 4.3.1.23).

At 19:11, MPD Officer 6B40 advised there was zero visibility by the Shops at 505 mall and that the 400 block of Front Street was impassable.

At 19:38, on the eastern (mauka) end of Shaw Street near the highway, MPD Officer 4Z20 advised the fire “jumped” Shaw Street to the south and was extending into the surrounding neighborhood (Phase One report, Figure 4.3.1.20).

At 20:29, a civilian photo shows the fire impacting structures in the area of Hwy-30 and ‘Aholo Road (Phase One report, Figure 4.3.1.34) south of the 300 block of Front Street.

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT

At 20:37, an unidentified MPD officer advised the fire was starting to cross over into the structures at Aulike Street, which runs slightly parallel to Mill Street. By this time, the fire was one (1) structure north and to the east (mauka) of Lahaina Shores Beach Resort (4[redacted] Front Street), a six-story condominium.

By 20:46, MPD Officer 4A40 advised there were a few houses engulfed on Aulike and Leoleo Streets, which is along the 300 block, east (mauka) of Hwy-30.

The Lahaina PM fire likely impacted the 400 block of Front Street initially from the north through structure-to-structure spread. As the fire continued, it spread south through structures between Hwy-30 and Front Street, radiant heating and embers from the east (mauka) likely impacting structures through prevailing northeasterly winds.

There has been no confirmed evidence that fire suppression operations were conducted in this area.

This grass fire encroached on the highway at ‘Aholo Road (south end of the 300 Block) a couple of hours after the fire was first reported to have crossed Shaw Street at the north end of the 400 block. This fire front may have contributed to both structure-to-structure spread from the south and the embers cast from the south and east (mauka).

These visual signs of damage suggest winds impacting this area were predominantly from the east (mauka), laying trees and poles to the west (makai) and driving spot fires in the same direction (Figure 4.3.4.1.3).

Downed utility poles can be seen along Mill Street to the east (mauka) of the Lahaina Aquatic Center and Boys & Girls Clubs of Maui (Figure 4.3.4.1.4). One (1) of these poles hit and damaged the roof of the Boys & Girls Clubs of Maui (Figure 4.3.4.1.4).



Figure 4.3.4.1.3 The orientation of wind impacting the 400 block of Front Street in Lahaina can be visualized in the grass fields on either side of Mill Street, around the Lahaina Aquatic Center and Boys & Girls Clubs of Maui (middle). Representative damage to trees oriented towards the west (makai) (bottom). Spot fire damage in the softball field, where the heel of the fire can be identified towards the east (mauka), indicating spread to the west (makai)—assuming flat terrain on the grass field (top).

The vegetation fire spreading from north to south near the Boys & Girls Clubs likely caused fire spotting on the west (makai) softball field (Figure 4.3.4.1.3, bottom) later in the day.

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT



Figure 4.3.4.1.4 Utility pole south of Mill Street that hit and damaged the roof of the Boys & Girls Clubs of Maui.

Structure-to-structure fire spread from the north was interrupted at the Lahaina Shores Beach Resort (Figure 4.3.4.1.5). The Shops at 505, immediately north of this structure, were completely destroyed, resulting in notable radiant heat damage to the balconies and windows of the condominium on the north side (Figures 4.3.4.1.7 and 4.3.4.1.8).

The bulk of the damage to the condominium includes bubbling and flaking of paint on its balconies, which is more severe along the upper two (2) floors. Windows, screens, and patio furnishings were also damaged on the second through sixth floors on the western (makai)-side rooms. Screen and window damage is only noted on the fifth floor in the eastern (mauka)-side rooms (Figures 4.3.4.1.7-4.3.4.1.8).

Also on the fifth floor, the door to an western (makai)-side room appears to have been opened with smoke/fire damage above the sliding glass door indicating smoke emanated from this compartment (Figure 4.3.4.1.9). The sliding glass door is more heavily damaged than the others on floors above and below. This damage does not appear to have spread on the exterior of the structure, except as noted, indicating the fire likely came from within the interior.

Several screens on the sliding doors dropped from their frame. Cracked glass in windows and doors was noted, but did not appear to cause large pieces of glass to fall out. There was also some radiant damage to furnishings on the sixth-floor balcony, though these items did not appear to ignite.

Tall, lush vegetation was present between the condominium and shopping mall, particularly at the eastern (mauka) and central portions. This vegetation potentially provided some protection from radiant heating and possible ember attack and did not ignite, protecting the condominium from significant damage.

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT







Figure 4.3.4.1.5 Lahaina Shores Beach Resort (4[redacted] Front Street) in southern Lahaina. Top panel depicts the street location and robotic street imagery before and after the fire. (bottom left) Overall view of structure from southeast (note fenced area in bottom left where trash bins and materials are typically stored) (bottom right). View from northeast beyond the destroyed Shops at 5[redacted] Front Street.

No radiant heat damage was noted for any of the east (mauka) facing portions of the surviving structures or vehicles on the 400 block of Front Street. There was some indication of embers and potentially radiant heating impacting fuels between the street and structures on these properties.

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT

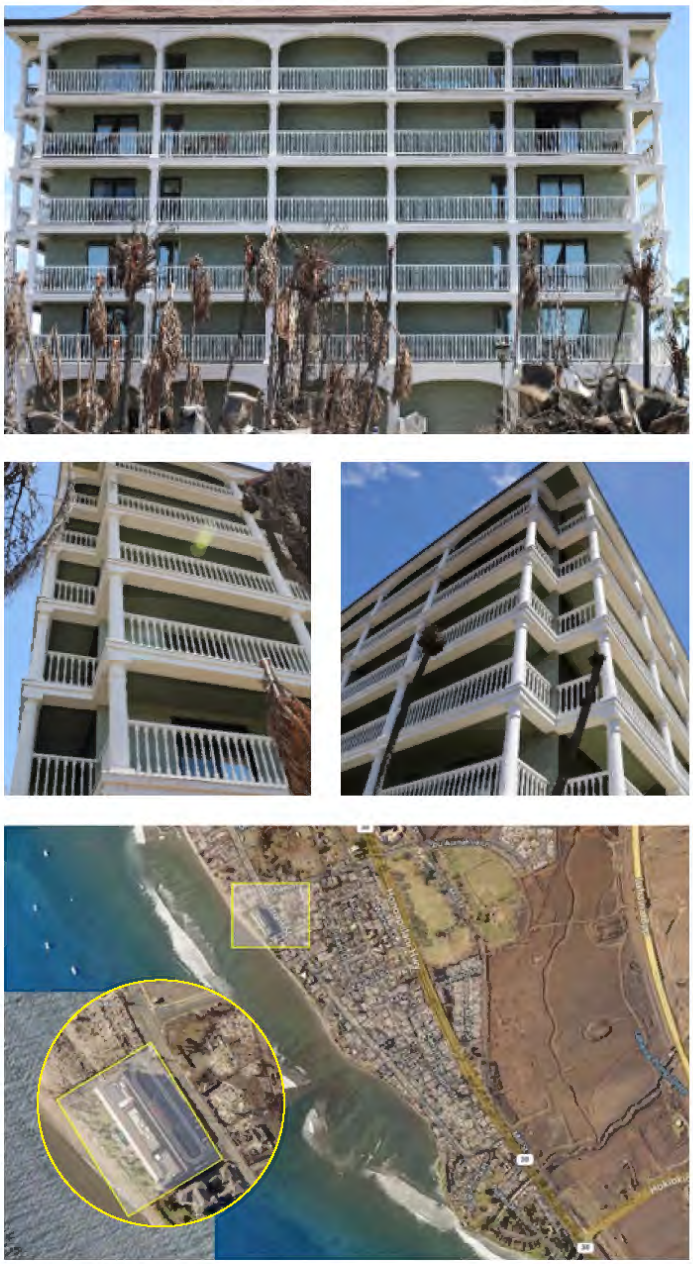


Figure 4.3.4.1.6 Radiant heat damage to the north end of the Lahaina Shores Beach Resort (4[redacted] Front Street). More severe bubbling to the paint is noted on the western (makai) portion of the structure (middle right) compared to that on the east-mauka (middle left) for the bottom four (4) floors, though more bubbling is noted on the fifth and sixth floors on the west (makai). Larger amounts of lush vegetation between the eastern (mauka) portions of the building compared to the western-side (makai) may have aided in locally reducing radiant heat impacting the north face of this structure. Inset: Viewpoint showing the area depicted in the photographs above.

A garbage can/disposal area in the southeast parking lot of 4[redacted] Front Street was ignited and destroyed everything inside the fence (Figure 4.3.4.1.5, Figure 4.3.4.1.10).

This fire was likely ignited through embers impacting the combustibles stored in this area, which may have been enhanced by radiant heating from the structures across the street. This fire subsequently impacted the railing on the north end of 4[redacted] Front Street, but either self-extinguished or had water applied from a nearby garden hose and did not further spread to the structure.

Spot fires were noted in the front lawn of 4[redacted] Front Street, but these also did not spread further to the structure or vehicles (Figure 4.3.4.1.11).

Remnants of embers were also noted in the open garage of 4[redacted] Front Street, but no receptive fuel bed was encountered, so they did not spread fire into this structure (Figure 4.3.4.1.12).



Figure 4.3.4.1.7 Increased window damage on the lower floor windows on the west-makai (right) compared to the east-mauka (left). Cracking is noted on the second and fourth floor windows with screens partially dropped on the third and fourth floors for the rooms on the west (makai).

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT



Figure 4.3.4.1.8 Close up of window damage on the second floor windows on the west (makai) room of 4[redacted] Front Street.



Figure 4.3.4.1.9 Close up of the open compartment on the fifth floor and thermal damage to furnishings on the sixth floor of 4[redacted] Front Street.







Figure 4.3.4.1.10 Ember and/or radiant heat ignited and destroyed the 475 Front Street garbage can/disposal area, which subsequently damaged a light post and the wood railing/fence on the northwest corner of 4[redacted] Front Street. Inset: Viewpoint showing the area depicted in the photograph above.

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT



Figure 4.3.4.1.11 Ember-created spot fires in the front lawn of 4[redacted] Front Street (top). Bottom panel shows the map location and street image before and after the fire at 4[redacted] Front Street.



Figure 4.3.4.1.12 Debris in the open garage of 4[redacted] Front Street. Inset: Viewpoint showing the area depicted in the photograph above.

The furthest south surviving structure on this block was 4[redacted] Front Street, which shared an entry from Front Street with the 4[redacted] Front Street structures that were destroyed. The south/southeast facing portions of 4[redacted] Front Street were substantially impacted by radiant heat from the fire in the 4[redacted] Front Street structures.

While some bubbling and flaking of the paint on the first floor and slight warping of the metal fascia trim was noted, the most substantial damage was observed on the south-facing windows, particularly on the first floor (Figure 4.3.4.1.13).

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT

The five (5) double-pane windows on the first floor of the structure (closer to the larger 4[redacted] Front Street structure) had the outer pane cracked and with several large pieces of glass that dropped out.

However, in all cases, the inner pane remained intact. Considering the orientation of these windows relative to prevailing winds, and evidence of embers landing near these windows with enough energy to char footwear left outside, these panes remaining intact may have been important to limit embers from entering into the house.

The windows in this structure were in aluminum frames, which are less likely to warp than vinyl frame windows that were commonly found in other structures, which may have been important in the survival of the glass panes in these windows.

Even though the structures on the west (makai) side of the 400 block of Front Street were adjacent to the coast with no addressed structures to the west (makai), post-fire damage assessment suggests fire spread through vegetation to the west (makai) of several of these structures, which was likely responsible for some thermal damage to these properties (Figure 4.3.4.1.14).

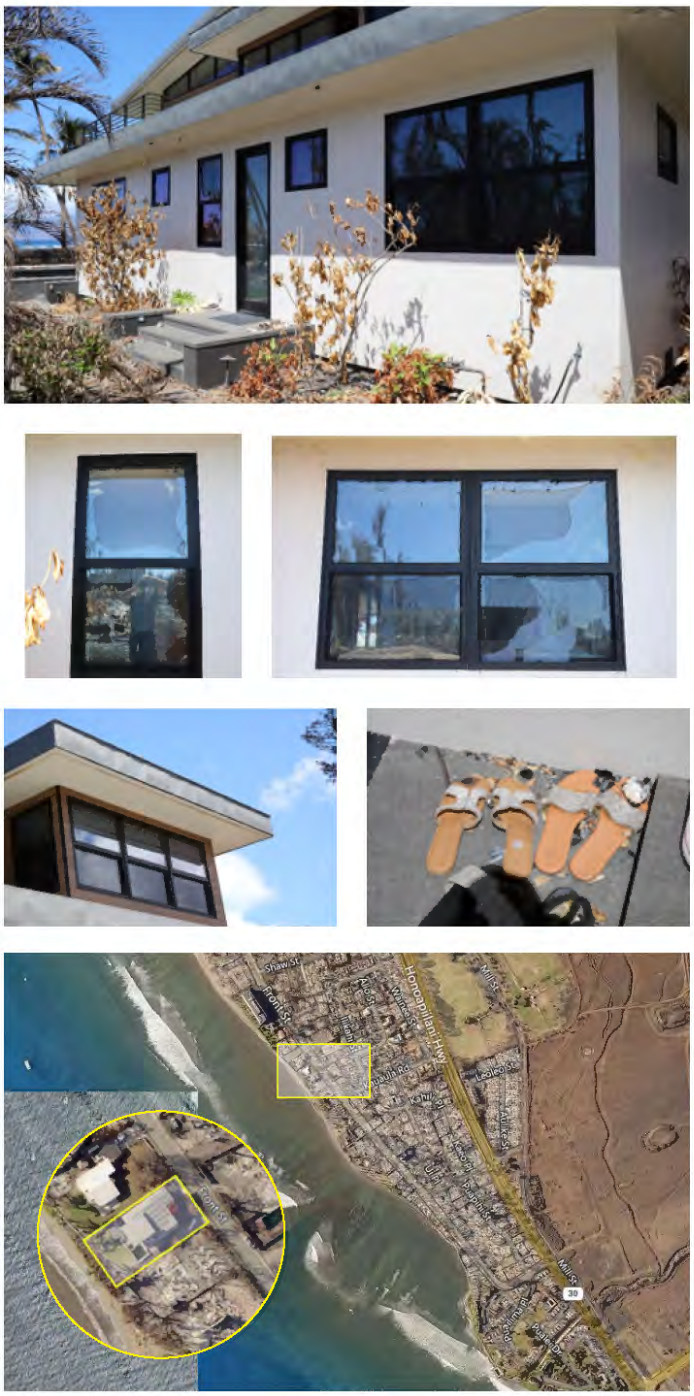


Figure 4.3.4.1.13 Window damage on the south side of 4[redacted] Front Street. Ember damage to shoes on doorstep indicates energetic embers were present in the area, which could have increased risk for ignition of interior combustibles had windows completely failed. Inset: Viewpoint showing the area depicted in the photographs above.

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT

A vegetation fire propagated along the west (makai) side of the low stone wall border to the west (makai) of several properties in this area, with indications of crossing into the backyard of 4[redacted] and 4[redacted] Front Street at a gap in the wall (between these two (2) property lines) and when palm trees crossover low to the wall toward the ocean (Figure 4.3.4.1.15-4.3.4.1.16).

The prevailing easterly (mauka) winds may aid fire propagation along the northwest orientation of these property lines. But intermittent shifts in wind direction, or obstructions caused by local vegetation and breaks in the fence, could have supported embers moving back to the east (mauka) as seen by the wood fence damage to the east (mauka) of this wall at the 4[redacted]-4[redacted] Front Street property line (Figure 4.3.4.1.16), the ignition of the accessory structure in the northwest corner of the 4[redacted] Front Street property, and the ignition of an outdoor chair near the rear patio door/window assembly of this structure.



Figure 4.3.4.1.14 Overhead view of 4[redacted]-4[redacted] Front Street showing potential path of fire progression along a low stone wall west (makai) of the property lines and then east (mauka) along 4[redacted]-4[redacted] property line wood fence, into an accessory structure and a chair by on the patio of 4[redacted] Front Street (see Figures 4.3.4.1.15, 4.3.4.1.16, 4.3.4.1.17, 4.3.4.1.18).









Figure 4.3.4.1.15 Vegetation and fence fire west (makai) of the low stone walls along 4[redacted] and 4[redacted] Front Street. The vegetation fire remained west (makai) of the stone wall other than at the 4[redacted]-4[redacted] property line, where a gap is present.

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT



Figure 4.3.4.1.16 Vegetation fire west (makai) of the property line for 4■ Front Street appears to cross into the backyard at the 4■-4■ Front Street property fence line and near large trees proximate to the wall. Note destroyed accessory structure to the left of the bottom, right image.

The fire in the accessory structure resulted in the burning of synthetic turf in the backyard of the property to the north (4■ Front Street), which spread toward the west (makai) and northwest with limited spread to the east by the noncombustible patio around the pool (Figure 4.3.4.1.17).

An outdoor chair fire in close proximity to the patio door/window assembly glass resulted in failure of the outer pane of a full-length, fixed window, while the inner pane remained intact (Figure 4.3.4.1.18).

In this specific instance, the glass near this fire was tempered (as can be seen by the many small pieces of glass after failure). This type of glass can withstand more intense fire exposure prior to failure compared to plain (annealed) glass,[259] which is common in other window failures noted in this section.

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT






Shaw St
Front St
Kaiholo St
Kaiholo Pl
Kahili St
Kahili Pl

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT

4.3.4.2 400 Block of ʻĀlīʻō and Waineʻe Street

The 400 block of ʻĀlīʻō and Waineʻe Street features primarily residential homes abutting maintained, grassy playing fields (Figure 4.3.4.2.1). A cluster of ten (10) structures survived the fire to the west (makai) of Hwy-30 in between Ilihaki Street (to the north) and just south of Kauaʻula Road (Figure 4.3.4.2.2).

Many of the structures in this area were constructed in the 1970s with masonry exterior walls and wood shake roofing (though most of the surviving structures had composite or metal roofing). For these legacy structures, tall openings were designed in the masonry walls to allow for doors and windows. Spaces around these openings were typically clad with wood siding.

The structures south of Kauaʻula Road are part of the 300 block, but are in the last row of structures alongside the playing fields to the east (mauka) of Hwy-30 with the rest of the 400 block. As such, they were included in this group for analysis (Figure 4.3.4.2.3).



Figure 4.3.4.2.1 EagleView image of the 400 block of Waineʻe and ʻĀlīʻō Streets, showing a cluster of ten (10) surviving structures located west (makai) of Hwy-30 (see text for further details).

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT



Figure 4.3.4.2.2 Damage classification assessment map of the 400 block of ʻĀlīʻō and Waineʻe Street analysis area.

The fire progression timeline described for the 400 block of Front Street (Section 4.3.4.1) likely applies to this section of the same block farther east (mauka). The most relevant emergency radio traffic to establish the timeline for the 400 block of ʻĀlīʻō and Waineʻe Streets comes from MPD Officer 4Z20, who was on the eastern (mauka) end of Shaw Street near Hwy-30 at 19:38 and advised at 19:38 the fire had "jumped" Shaw Street to the south and was extending into the neighborhood (Phase One report, Figure 4.3.1.20).

As the fire extended into this section of the block, radiant heat transfer from structure-to-structure increased the risk of fire spreading from the north in the structures along Waineʻe, ʻĀlīʻō, and ʻIlikahi Streets. At 20:46, MPD Officer 4A40 advised there were a few houses on fire on Aulike and Leoleo Streets. Leoleo Street is located east (mauka) of Hwy-30, and parallels Kauaʻula Road, just south of this analysis area.

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT



Figure 4.3.4.2.3 Surviving cluster of structures along the 400 block of ʻĀlīʻō Street and Waineʻe Street including east (mauka)-west (makai) separation distances on (top right) pre-fire image and (bottom right) post-fire image. Inset: Viewpoint showing area depicted in photographs above.

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT

At this location, there are concrete walls on both sides of Hwy-30 near Leoleo Street, which potentially blocked radiant heat transfer and embers moving along the ground. However, the prevailing easterly (mauka) winds may have supported moving airborne embers above concrete walls and toward the 400 (and 300) block of homes west (makai) of Hwy-30.

This section of the 400 block was likely impacted by fires moving through structures from the north and the south. The fire did progress on either side of this cluster of surviving structures, along the east (mauka) side of Waine‘e Street and the west (makai) side of ‘Ālī‘ō Street. These destroyed structures likely impacted the surviving structures through radiant heating, though from a distance across these streets.

The fuel break created by the well-maintained green grass fields, along the width of Hwy-30 and the height of the nearby concrete wall, provided a fuel break from the south flank vegetation fire.

The northmost structure that did not burn in this group of surviving structures is 4[redacted] ‘Ālī‘ō Street (Figure 4.3.4.2.4), which sustained structural damage to the roof and eaves along the northside and northwest corner. The property to the north of this lot, 4[redacted] ‘Ālī‘ō Street, is approximately 12 feet from the corner of this roof. Heavy charring at the northwest end gradually decreased by about two-thirds toward the northeast end where paint remains on the soffit (Figure 4.3.4.2.5).

The soffit and roof deck above the eaves burned completely through, but the fire did not continue to propagate.

This structure is one of the few that noted more extensive damage to the eaves/roof than to the windows, which showed no indications of damage, possibly due to the relatively large eaves extending the roofline well past the windows, the presence of a heavy screen between the exposure and the windows, and/or the design of the louvered windows that allowed glass more flexibility to expand when heated without creating enough stress to fracture.



Figure 4.3.4.2.4 Northernmost surviving structure in the cluster of homes along the 400 block of ‘Ālī‘ō Street and Waine‘e Street was located at 4[redacted] ‘Ālī‘ō Street.

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT

The grass around the 4[redacted] and 4[redacted] ʻĀlīʻō Street properties was heavily charred—Figures 4.3.4.2.4 (left) and 4.3.4.2.5 (second to top).

These grass fires may have been ignited either by fire brands blown to the west (makai) from destroyed properties to the east (mauka), which could have found a receptive fuel bed in the dry grasses or through failure of the wooden fence along the property lines.

Several separate starts appear to begin in the grass where smoldering sections of the wood fence (which sits on top of a low block wall) on the 4[redacted] ʻĀlīʻō Street property lines came off there posts and landed in the dry grass along the length of 4[redacted] ʻĀlīʻō Street (Figure 4.3.4.2.6) and west (makai) yard of 4[redacted] ʻĀlīʻō Street (Figure 4.3.4.2.7).

However, neither of these structures ignited from these grass fires that propagated very near the structures.

Under the eaves on the west (makai), north, and east (mauka) of the 4[redacted] ʻĀlīʻō Street structure, a wide concrete pathway separated the structure from the grass, which provides an ample buffer to keep the grass fire from reaching the structure.

To the south, the grass was very near the wooden portion of the walls and louvered windows, but the fire did not propagate to the structure. Shifts in wind and/or water from a nearby hose may have aided reducing this spread to the structure. In the west (makai) yard of 4[redacted] ʻĀlīʻō Street, dried grasses ignited, yet islands of unburned grass remained where sprinklers had been set out.



Figure 4.3.4.2.5 Eave and roof damage to the structure at 4[redacted] ʻĀlīʻō Street.

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT







Figure 4.3.4.2.6 Grass fire to the south of 4[redacted] ʻĀlīʻō Street appears to have ignited in multiple locations where charred sections of the fence from the 4[redacted]4[redacted]ʻĀlīʻō Street property line landed in dry grass. While it propagated near the wooden structure on the southside of 4[redacted]ʻĀlīʻō Street, it did not transition to the structure.

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT



Figure 4.3.4.2.7 Grass fire in the northwest yard of 4[redacted] ʻĀlīʻō Street appears to have been ignited where charred sections of the fence from the 4[redacted]-4[redacted] ʻĀlīʻō Street property line landed in dry grass, which then backed up to the fence and gate connected to the structure. Sprinklers were distributed throughout the yard, including in the center of this section of undamaged grass.

The grassfire appeared to back up toward the gate and spread along the gate toward the house. However, the fence broke off the post because it was weakened through mass loss due to the fire. The fire did not continue to propagate along the fence after this point.

In several of the properties in this cluster, there was some localized ignition of landscaping materials that did not propagate to the structure (Figure 4.3.4.2.8).

A small fire appears to have started at the southwest corner of the front porch on 4[redacted] ʻĀlīʻō Street. This fire did not propagate from what appears to be a single item ignited despite a number of other combustible materials in the area, possibly aided by a garden hose in the area (Figure 4.3.4.2.10).



Figure 4.3.4.2.8 Localized ignition of landscaping materials in the backyards of (top) 4[redacted] ʻĀlīʻō Street and (bottom) 4[redacted] Waineʻe Street, including a section of deeply charred dimensional lumber that does not appear connected to any other structures in the immediate vicinity.

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT



Figure 4.3.4.2.9 Viewpoint depicting the area shown in Figures 4.3.4.2.5 through 4.3.4.2.8.

To the south of this cluster of surviving structures, 6[redacted], 6[redacted] and 6[redacted] Kāhili Place were all destroyed by the fire. While the structures along Kāhili Place were located close to the northwest property lines, the surviving structures along Kaua‘ula Road had relatively deep backyards, separating the structures from the south property lines (Figure 4.3.4.2.3 and 4.3.4.2.12).

The 7[redacted] and 7[redacted] Kaua‘ula Road properties had sheds, outdoor structures/furnishings, and combustible materials in the south yard that were ignited by fires from the south. At 7[redacted] Kaua‘ula Road, these exterior fires propagated all the way to under an overhang at the south side of the structure (Figure 4.3.4.2.13).

The south yard fire consumed a portion of the rear deck, some outdoor furnishings, and a number of other belongings located near the exterior of the structure, but the only indication of fire impact on the south side of this structures through radiant heat is melting and deformation of a plastic gutter in the southwest corner.



Figure 4.3.4.2.10 A spot fire near the southwest corner of the 4[redacted] ‘Āli‘ō Street porch was confined to a small area, possibly through water application from the garden hose on the porch. Insert: Viewpoint of 4[redacted] ‘Āli‘ō Street.

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT



Figure 4.3.4.2.11 South Zone—Kaua'ula Road showing the area shown in Figures 4.3.4.2.12 and 4.3.4.2.13.



Figure 4.3.4.2.12 Deep yards to the south of (top) 6[redacted] and (bottom) 7[redacted] Kaua'ula Road separated these surviving structures from destroyed structures to the south. A shed in the southeast corner of 7[redacted] Kaua'ula Road was destroyed, yet this fire did not appear to create thermal damage on the main structure.



Figure 4.3.4.2.13 Exterior fire in the south yard of 7[redacted] Kaua'ula Road destroyed outdoor furnishings and structures up to the corner of the main residential structure. However, these fires did not spread to the south of the residence and appeared to result only in damage to the plastic gutter in the southwest corner.

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT

The west side (makai) of 6[redacted] Kaua‘ula Road is approximately 12 feet from the destroyed structure on 5[redacted] Kaua‘ula Road (Figure 4.3.4.2.16), and suffered heavy thermal damage from radiated heat. The facia was heavily charred on the outer layer, though did not appear to propagate through its thickness or into the roof (Figure 4.3.4.2.14).







Figure 4.3.4.2.14 West (makai) side of 6[redacted] Kaua‘ula Road was severely impacted by radiant heat from the destroyed structure at 5[redacted] Kaua‘ula Road, located 12 feet to the west (makai). Heavy charring was noted in the fascia board at the end of the eave and plastic conduit melted, exposing a penetration through the exterior wall for AC access. Windows and screens on the sliding glass patio door were also damaged. Inset: Viewpoint showing the area depicted in the photographs above.



Figure 4.3.4.2.15 West (makai) side of 6[redacted] Kaua‘ula Road withstood extensive damage to windows, including three (3) casement style windows where frames were severely warped and both panes of glass failed and dropped out of the frame. The interior screen remained in place for all three (3) windows, and appears to have blocked some materials from entering the structure.

An air conditioning unit was heavily damaged along with the conduit around refrigerant lines along and through the structure. This melted plastic component uncovered a penetration through the exterior wall that could provide a pathway for embers that might reach this area. The windows on the west (makai) facing side of 6[redacted] Kaua‘ula Road experienced extensive damage (Figure 4.3.4.2.15).

Two (2) windows in the middle of the structure had both panes of plain glass fail and fall out of the deformed frame. In both cases, the window screens remained intact and appear to have limited the ingress of some debris including some material that appeared hot enough to stick to the screen. These windows and screens were oriented opposite the prevailing wind direction, which may have also provided some level of protection for this opening.

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT

A wood fence between the two (2) structures was also severely damaged and eventually fell toward 6[redacted] Kaua‘ula Road (Figure 4.3.4.2.16).

Several panels of the wood fence between the property line fence and the 6[redacted] Kaua‘ula Road structure were destroyed by fire, but the last panel that remained attached to the structure was still largely intact. Had fire continued along this fence, it would have come in direct contact with the structure.

While the walls of this structure are stucco, which would have provided some resistance to direct spread, the fence continues directly below wood eaves on the roof and is closely located near two (2) windows that were already deformed by radiant heat from the destroyed structure on 5[redacted] Kaua‘ula Road.

Near this cluster of surviving structures, two (2) additional properties addressed on the 400 block of ‘Ālī‘ō Street, were damaged, but survived the fire (Figure 4.3.4.2.17).

4[redacted] ‘Ālī‘ō Street sustained radiant heat damage on the north side to the structure eaves and gable vent, along with furnishings, belongings, garbage cans, and a large support beam in the covered parking area (Figure 4.3.4.2.18).

The parking area created a large distance from the destroyed structure at 4[redacted] ‘Ālī‘ō Street to the windows in this structure, which showed no visual signs of thermal damage. Much less damage was observed on the south side of the structure, where only softening and deformation of plastic trim around the windows was noted.

The distance between 4[redacted] ‘Ālī‘ō Street and the structures to the north and south were similar (approximately 17 feet). However, the structure to the north was two (2) stories, which likely provided more fuel and increased flux to 4[redacted] ‘Ālī‘ō Street compared to the single story structure to the south.



Figure 4.3.4.2.16 A wood fence connecting the west (makai) side of 6[redacted]Kaua‘ula to the wood fence on the 6[redacted]-5[redacted]property line was destroyed up to the easternmost (mauka) panel that was connected to the structure. Had fire continued along this fence, it could have directly exposed wood eave structure and increased heat flux to the already damaged window immediately south of the fence.

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT

The distance between 4[redacted] ʻĀlīʻō Street and the structures to the north and south were similar (approximately 17 feet). However, the structure to the north was two (2) stories, which likely provided more fuel and increased flux to 4[redacted] ʻĀlīʻō Street compared to the single story structure to the south.

Sprinklers were noted at several locations throughout the property, which may have improved survivability of the structure through increased moisture in the grass and/or protection before/during fire approach to the structure.

There were no visual indications of thermal damage to the west (makai), north, or east sides (mauka) of 4[redacted] ʻĀlīʻō Street, which is situated on a corner lot at the intersection of ʻIlikahi Street and ʻĀlīʻō Street. However, the south exterior wall, proximate to the destroyed structure at 4[redacted] ʻĀlīʻō Street, was severely damaged. Deep charring of wood eaves and siding are noted, along with considerable paint bubbling (Figure 4.3.4.2.19).





Figure 4.3.4.2.17 Surviving structures at 4[redacted] and 4[redacted] ʻĀlīʻō Street, dimensioned from the pre-fire image (top) superimposed on the post-fire image (bottom right). Inset: Viewpoint showing the area depicted in the photographs above.

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT

Windows were deeply charred and glass was broken in at least one (1) pane. Four (4) of the sliding glass window assemblies had glass from the fixed sash fall completely out of the frame (moving sash may have been partially protected by a screen that was present between the destroyed structure and the window).

A window treatment in a bedroom and outdoor lamp in the garage showed signs of deformation due to heating, but no interior materials appeared to have ignited. The timing of these window failures relative to other structure fires in the area and shifting winds all impacted the relative risk created by these openings.



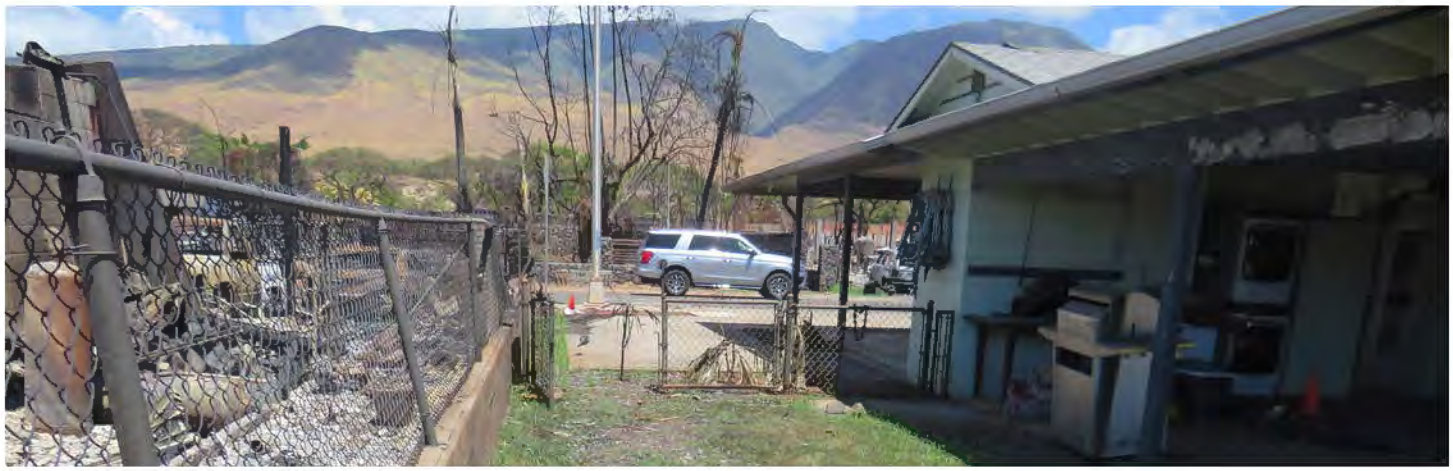






Figure 4.3.4.2.18 Radiant heat damage to the structure and household belongings at 4[redacted] ʻĀlīʻō Street was noted primarily on the north side.

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT



These large openings in the building envelope would have provided relatively easy access for embers to enter and accumulate inside this structure if enough energetic materials were transported to this area after the windows failed.

Figure 4.3.4.2.19 Radiant heat damage to the structure at 4[redacted] ʻĀlīʻō Street was noted only on the south side. Windows were severely damaged across the entire exterior wall, including four (4) windows where both panes failed and/or sashes fell out. Window screens over the sliding sash were less damaged than the fixed sashed with no screens.

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT

Typical openings in buildings for entrance/egress (doors), venting of living spaces (windows), and venting of attic/roof spaces can provide a route for embers and/or flames to enter a structure if they are not appropriately closed or covered.

The orientation of windows and doors (open, closed, ajar) or roof/attic venting (screened or unscreened) for the destroyed structures cannot be determined after the fire.

However, in the post-fire analysis, the condition of some window openings in surviving structures that could provide a route for entry through open/broken glass and/or screens were noted. For the examples shown in Figure 4.3.4.2.20, these openings were facing structures that also survived, which would likely result in a lower radiant heat and ember exposure than if oriented upwind from destroyed structures.



Figure 4.3.4.2.20 Examples of open/broken windows and/or screens in this cluster of surviving homes.

4.3.4.3 300 Block of Front Street

The 300 block of Front Street primarily features residential homes (Figure 4.3.4.3.1). Two (2) structures (3[redacted] and 3[redacted] Front Street) on the west (makai) side of this section of the block, south of Kaua‘ula Road, survived (Figure 4.3.4.3.2).



Figure 4.3.4.2.20 Examples of open/broken windows and/or screens in this cluster of surviving homes. (Figure 4.3.4.3.1 continues on page 254.)

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT



Figure 4.3.4.3.1 Surviving structures at 3[redacted] and 3[redacted] Front Street, including approximate separation distances determined from pre-fire images (left), which were superimposed on post-fire images (right).



Figure 4.3.4.3.2 Damage classification assessment map of analysis area.

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT

Both 3[redacted] Front Street (built 1953) and 3[redacted] Front Street (built 1981) were constructed with wood siding over framed construction and a composite shingle roof. Other structures on this block were built between 1933 and 2016, most of which were frame constructed with wood or stucco exterior, though one structure was masonry.

Civilian video and emergency responder reports described in the Phase One report are limited with respect to this area of Lahaina. The timeline of events described for the 400 block of Front Street in section 4.3.4.1 also encompasses this group of houses just to the south.

The fire likely impacted the 300 block of Front Street from the north and south through structure-to-structure fire spread.

As the fire continued to spread south, radiant heating and embers from burning structures east (mauka) of Front Street would likely have impacted these structures through prevailing easterly (mauka) winds. They were also at risk for impact from smoldering and/or flaming fires and potential embers produced from vegetation along the beach at the western edge (makai) of 3[redacted] Front Street.

The post-fire damage assessment documented the impact of winds that resulted in damage to the roof of the main and secondary structure on 3[redacted] Front Street (Figures 4.3.4.3.3 and 4.3.4.3.4).

The heaviest wind damage was noted on the east (mauka)-northeast facing aspects of the roof on the primary structure and southeast facing aspects of the roof on the secondary structure. Much of the displaced roofing material was located in the west (makai) yard of this property. This damage is consistent with strong winds from the east (mauka).



Figure 4.3.4.3.3 Strong winds removed shingles and tar paper from the roof of 3[redacted] Front Street (top) and deposited much of this material in the west (makai) rear yard (middle).

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT

The destroyed structures at 3[redacted] Front Street are the closest buildings to both 3[redacted] and 3[redacted] Front Street. Portions of 3[redacted] Front Street were 35 to 52 feet from 3[redacted] Front Street. The main residence and structure by the pool at 3[redacted] Front Street were ~54 feet and ~17 feet, respectively, from 3[redacted] Front Street (Figure 4.3.4.3.1).

Dense, tall, and lush vegetation was planted between these structures along a block half wall (Figure 4.3.4.3.4 - 4.3.4.3.5). The vegetation likely aided in shielding 3[redacted]Front Street from some of the radiant energy from the fire at 3[redacted]Front Street, while also blocking some of the airborne embers. The block half wall would have also reduced these mechanisms of fire spread, particularly for embers moving along the ground under the force of wind.



Figure 4.3.4.3.4 Tall, lush vegetation was planted along block walls on either side of the driveway to 3[redacted] Front Street, which may have provided protection to the 3[redacted] and 3[redacted] Front Street lots. The block wall south of 385 Front Street also influenced the ember movement. Note pile up in corner of wall (bottom left) and wind driven burn scar in grass around the wall toward the front of the structure showing the likely path of ground based embers deflected towards the north and away from the open garage (bottom right).

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT

Immediately to the north of 3[redacted] Front Street, the structures at 3[redacted] Front Street were completely destroyed. The main portion of the structure on 3[redacted] Front Street was more than 55 feet from the 3[redacted] Front Street. Despite being a longer distance than the destroyed structure to the south, the radiant heat exposure on the north side of 3[redacted] Front Street was sufficient to crack the glass in several windows and deform portions of the vinyl window frame material.

In all cases, it appears that only the outer pane of the windows were cracked and the inner pane remained intact (Figure 4.3.4.3.6). Paint on the wood siding was bubbled in a few locations, but no thermal damage was visible on the roof.

A wooden fence running perpendicular from the property line wall/fence to 3[redacted] Front Street was heavily damaged in the fire (Figure 4.3.4.3.7). A portion of the northmost panel was consumed and could have provided a pathway for fire propagation between structures. However, the fence became dislodged and came off the next support post.

There were no obvious signs that this fence panel was forcibly removed by human intervention. However, this possibility cannot be ruled out at this time. In previously published wildfire investigations, it has been shown that combustible fences can act as a “wick,” allowing fire to travel between different structures or between structures and nearby vegetation.[260]

This displaced fence panel may have interrupted the fire spreading from the north to 3[redacted] Front Street.







Figure 4.3.4.3.5 The east (mauka) facing exterior wall of 3[redacted] Front Street did not have any indication of radiant heat damage and there were relatively limited signs of embers along the ground. Tall, lush vegetation plated along a block half-wall between 3[redacted] and 3[redacted] Front Street was still standing, including some plants that remained green at the time of the post-fire analysis. Inset: Viewpoint showing the area depicted in the photographs above.

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT













Figure 4.3.4.3.6 Window damage along the north wall of 3■ Front Street.



Figure 4.3.4.3.7 Burnt, charred, and broken wooden fence from the 3■-3■ Front Street property line directly connected to the structure at 3■ Front Street. Wooden fences can act as a "wick," carrying fire from one structure to the next. The northernmost panel was disconnected from the rest of the fence, removing this mechanism of fire spread.

A wooden fence that physically connected the 3■ Front Street property line and the exterior wall of the 3■ Front Street structure also appeared to have been ignited by embers that landed in the dead leaves near the block half-wall base. While several pickets and rails were consumed in this spot fire, the support post for the gate appears to have been broken off and leaned against the structure.

As discussed above, wooden fences have been shown to provide a pathway for fire to spread along a continuous fuel to a structure, so the physical break provided by removing this gate from the path likely interrupted this mechanism of fire spreading to 3■ Front Street (Figure 4.3.4.3.8).

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT

Based on inspection of the physical damage to the post, the orientation of the gate and fence, and the char marks on the portion of the post remaining in the ground, it is likely the broken support post was caused by the gate being forced open while burning or smoldering was occurring in the area.

If an individual (emergency responder, resident, or passer-by) were present to force this gate open, they may have conducted other defensive actions to mitigate the risk to this property. While this possibility cannot be ruled out, at the time of this report, there are no confirmed reports of such activities.

Embers with enough energy to char the lawn were notably present in the front and side yards of 3[redacted] Front Street. Several areas of scorched grass were noted in the yard to the east (mauka) of the structure, inside the front block half wall (Figure 4.3.4.3.9).

Burned areas appeared to be typically located closer to the east (mauka) and north wall and northeast corner, though there was one (1) spot very near the southeast corner of the structure that did not spread to the residence.

Accumulation of embers was also found in the open garage and side yard between the garage and block wall between this property and the driveway to 3[redacted] Front Street (Figure 4.3.4.3.10). Embers collected in these areas did not have enough energy to ignite the combustibles present and eventually cooled down or burnt out.



Figure 4.3.4.3.8 Gate and post moved away from burning fence pickets that interrupted the continuous wooden fuel from the 3[redacted]-3[redacted] property line to the east (mauka) wall of 3[redacted] Front Street. The charred end of the post remaining in the ground is indicated by the red arrow in the bottom right image.

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT

The block wall between the entrance to the 3[redacted] Front Street driveway and 3[redacted] Front Street east (mauka) yard (Figure 4.3.4.3.11) may have played an important role in reducing some of the ember accumulation in the open garage and under the primary structure.

There is evidence of embers piling up in the corner of this wall and those that went around the wall were deflected toward the north (Figure 4.3.4.3.11).

The foundation of the residential structure at 3[redacted] Front Street is elevated from ground level, allowing access to the underside of the structure from three (3) sides. However, the east (mauka) yard is higher than on the others, limiting access to the underside of the structure from the address (front) side oriented towards the prevailing wind direction (Figure 4.3.4.3.11).

If enough embers could pile up and come into contact with a receptive fuel bed, such as dried leaves and vegetation, a spot fire could ignite under the house.

For this structure, it is possible that the block walls and elevated east (mauka) yard limited ember accumulation (and accumulation of a receptive fuel bed) under the residence. However, this mechanism of fire spread may have been present in other similar structures with different orientation relative to ember spread or different protection provided by landscaping.



Figure 4.3.4.3.9 Multiple burn scars on grass in the east (mauka) yard of 3[redacted] Front Street, particularly along the east (mauka) and north block half wall. One (1) spot formed near the southeast corner of the residence (bottom right), but did not extend to the structure.



Figure 4.3.4.3.10 Embers accumulated in both the side yard and open garage area but did not have enough energy (individually or accumulated) to create sustained ignition of combustibles. There are some indications of localized burning/melting, such as a tine on the plastic rake, but these did not spread.

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT



Figure 4.3.4.3.11 Vegetation fire to the west (makai) of 3[redacted] Front, largely confined west (makai) of the low block wall at the edge of the grass yard.

These two structures were adjacent to the coast with no structures to the west (makai). However, vegetation between the structures and the beach was involved in the fire. In particular, vegetation west (makai) of 3[redacted] Front Street was ignited and largely consumed (Figure 4.3.4.3.11).

The low block wall to the west (makai) of 3[redacted] Front Street appears to have provided an effective buffer between this vegetation fire and the west (makai) yard of this structure.

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT



Figure 4.3.4.4.1 Post-fire aerial imagery (captured August 13, 2023) of the north (top) and central (bottom) sections of Puamana community in southern Lahaina.

4.3.4.4 Puamana Community

The Puamana neighborhood is bordered by Hwy-30 to the east (mauka), by Front Street to the north (as it turns mauka to intersect with Hwy-30), and the Pacific Ocean mauka and to the south (Figure 4.3.4.4.1).

Structures in the Puamana community consist of multifamily dwellings and open parking structures (roof and supports only). Within the community, there is a transition from destroyed to undestroyed structures (Figure 4.3.4.4.2). Residential structures contain between two (2) and six (6) housing units, with two (2) and four (4) unit structures being the most common (Figure 4.3.4.4.3).

Nearly all units in the community were built between 1968 and 1973, though 1[redacted] Pualei Drive was constructed in 1985. All structures were frame constructed with cast walls, plywood exterior siding, and wood shake roof shingles. For several structures, a cast wall was also present as an exterior wall.

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT

The Puamana community was impacted in the early morning hours of August 8, 2023, with multiple reports of downed utility infrastructure due to strong winds.

As described in the Phase One report, Hawaiian Electric received a report from the MPD at approximately 05:51 on August 8, 2023, that a stretch of poles fell onto Hwy-30 south of Lahaina near Hōkiokio Place. The MPD reported several more poles down in this location at approximately 06:13.

Hawaiian Electric personnel observed eight (8) poles down in the Puamana area by Hwy-30, south of Hōkiokio Place, around 09:45. These poles were located some distance away from the highway and were not blocking traffic flow.

As late as 18:28, a civilian photo taken from Pualei Drive shows continued strong winds blowing palm tree fronds westward-makai (Phase One report Figure 4.3.1.21).



Figure 4.3.4.4.2 Damage classification assessment map of the Puamana Community analysis area.

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT

Hawaiian Electric personnel observed eight (8) poles down in the Puamana area by Hwy-30, south of Hōkiokio Place, around 09:45. These poles were located some distance away from the highway and were not blocking traffic flow.

As late as 18:28, a civilian photo taken from Pualei Drive shows continued strong winds blowing palm tree fronds westward-makai (Phase One report Figure 4.3.1.21).

The post-fire damage assessment in Puamana documented the impact of winds that resulted in uprooting of several trees in this area, with the fallen trees most often oriented westward (makai) or northwestward (Figure 4.3.4.4.4).

Additionally, roof damage to 1[redacted] Pualei Drive appears on a southeasterly facing (mauka) ridge that would have been impacted by easterly (mauka) winds (Figure 4.3.4.4.5). However, at least one (1) tree near 1[redacted] Pualei Drive fell oriented toward the southeast, possibly impacted by varying wind direction and velocity. The relative timing of the tree damage and the fire reaching Puamana has not been established.

Based on the evidence available, the fire likely impacted the Puamana community from the north through structure-to-structure spread, as well as through dry vegetation along roadways and from the east (mauka) from embers created by south flank vegetation fire along and to the east (mauka) of Hwy-30.

At 18:28, civilian video showed heavy smoke moving east (mauka) to west (makai) north of the community (Phase One report, Figure 4.3.1.21), though it appears fire had not yet impacted structures in this area.



Figure 4.3.4.4.3 Example construction features of Puamana community built between 1968 and 1973.

By 21:01, MPD Officer 4B30 advised the fire was within 200 yards of Hōkiokio Place. MPD Officer W2 advised the fire had jumped Hōkiokio Place at 22:29, and Command assigned MFD unit E11 and a private tanker to take the Lahaina Bypass and check on the status of Hōkiokio Place.

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT



Figure 4.3.4.4.4 Trees downed by wind facing west (makai)-northwest in the vicinity of 6[redacted] and 7[redacted] Puakukui Place. Red arrows identify the approximate location and orientation of fallen trees. The overview image (top left) is oriented with north facing towards the bottom. Inset: Viewpoint showing the area depicted in the photographs above.

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT

At 22:41, E11 advised Command the fire had jumped Hōkiokio Place and was making its way west (makai) toward Puamana. E11 reported the tanker needed to refill at Hōkiokio Road and E11 would advise further. The location of this transmission (Phase One report, Figure 4.3.1.40) roughly coincides with the end of the charred grass on the bank east (mauka) of Mill Street (Figure 4.3.4.4.1) and the fenceline fire west (makai) of Hwy-30, which was impacting Puamana.

At 23:01, MPD Officer 4B30 advised the fire was moving slowly south and was nearing Puamana. At approximately 00:49 on August 9, 2023, officers advised the fire had now moved eastbound (mauka) of the Lahaina Bypass.

North of Kaua‘ula Stream (the concrete drainage just south of, and roughly parallel to, Puapake Place from Hwy-30 to the ocean), there were three (3) residential structures in this community that were not destroyed. North of Puamana, from ‘Aholo to Front Street, all structures between Hwy-30 and the ocean were destroyed—except one (1) relatively isolated structure at 2[redacted] Front Street.


Hokiokio Pl
Lahaina Bypass
Lahaina Pump Ditch
Mill St
Aukele St
Pualei Dr
Pualei Pl
Waiaka Pl
Waiaka Loop
Waiaka Pl
Waiaka Pl
Waiaka Pl

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT

The northernmost surviving structure in Puamana—3[redacted] Pualoke Place—is next to a sweeping 90-degree corner of Front Street, providing a long distance from the destroyed structures to the northeast (Figure 4.3.4.4.6).

There is also lush vegetation along Front Street that may have provided some shielding from radiant heat and absorption of energy through dehydration (Figure 4.3.4.4.7).

This surviving structure is also immediately adjacent to the destroyed structure at 2[redacted] Front Street. There was no apparent damage from radiation heat to 3[redacted] Pualoke Place, most likely due in some part to the tall, leafy vegetation standing between the two (2) structures (Figure 4.3.4.4.7).

The grass surrounding 3[redacted] Pualoke Place was also green and healthy, preventing the fire from spreading along the ground. The westernmost (makai) corner of this structure does not have any apparent radiant heat damage from the other adjacent destroyed structure at 3[redacted] Pualoke Place.



Figure 4.3.4.4.6 Three (3) surviving structures in the north part of Puamana (3[redacted], 4[redacted], and 5[redacted] Pualoke Place).

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT

The rear porches of 3[redacted] Pualoke Place had notable deposition of soot, ash, and burned particles/embers that self-extinguished. These materials were not energetic enough to ignite the combustibles present on the porches (outdoor furnishings, decorations, dry leaves, etc).

The westernmost (makai) surviving structures in the Puamana community—4[redacted] and 5[redacted] Pualoke Place—are immediately west (makai) and across from destroyed structures at 3[redacted] and 5[redacted] Pualoke Place. The width of Pualoke Place and a parking structure near the homes appear to have reduced any radiant heat from the west (makai), as there is no apparent radiant heat damage on this side of the structures.

However, the north end of 4[redacted] Pualoke Place (unit 4[redacted]) was heavily damaged by radiant heat from the destroyed 3[redacted] Pualoke Place, including bubbling of paint on the first and second floor and melted gutters and plastic vent covers on the second floor (Figure 4.3.4.4.8).

There was also extensive damage to windows (glass cracking, frame warping) on the north side of the structure, including a large double pane (plain glass) window on the northwest corner that fell out from the frame. The vertical blinds inside this window appeared to have some warping possibly due to radiant heat, but they remained intact without charring.

Very little soot was noted inside this window. Prevailing winds were typically easterly (off-shore), so this opening may not have been in the path to receive embers from 3[redacted] Pualoke Place or other structures/vegetation fires further east (mauka).

The tree standing to the east (mauka) of unit 4[redacted] is deeply charred on several west (makai) and southwest aspects of large branches (Figure 4.3.4.4.8, top left), which is likely from embers blown



Figure 4.3.4.4.7 Vegetation surrounding 3[redacted] Pualoke Place, including address-side view showing vegetation along Front Street (to the right of the structure) and rear view showing standing leafy vegetation immediately behind the rear porches of the surviving structure.

into fissures, openings, or scars. This damage suggests embers with enough energy to create a smoldering fire in wood were present in this area.

All residential structures between Pualoke Place and Kaua‘ula Stream and west (makai) of Hwy-30 were destroyed. The concrete drainage may have helped limit additional spread from the north, particularly for structures southwest (makai) of Pualei Drive (Figure 4.3.4.4.9).

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT



Figure 4.3.4.4.8 Damage to the north end of 4[redacted] Pualoke Place immediately adjacent to the destroyed structure at 3[redacted] Pualoke Place. A tree to the east (mauka) of the structure sustained deep charring, likely from embers gathering in cracks, fissures, or scars in the tree bark (top left). Window damage on the north structure wall (top right) ranges from single pane cracking to vinyl frame warping (middle left) to complete pane fallout (middle center). Plastic vent cover and gutters melted and fell. Paint bubbled and peeled across most of the surface. No apparent indication of charring or damage to wood shake roofing materials or wood wall substrate (top right and middle right). Grass remained green between the destroyed and damaged structure. Garden hose noted at the corner of the structure (bottom left). Inset: Viewpoint showing area shown in the photographs above.

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT

South and east of Kaua‘ula Stream, a vegetation fire in the brush and duff surrounding a fenceline along Hwy-30 likely contributed to the destruction of structures to the northeast of Pualei Drive (Figure 4.3.4.4.10).

Extensive burning and charring is noted in the vegetation between Puakukui Place and Hwy-30 all the way to the location where Pualei Drive shifts east (mauka) and then runs adjacent to Hwy-30. At this location east (mauka) of Mill Street, the charred grass also appears to terminate, possibly due to either water application from the E11 with the private tanker and/or shifting winds.

The underbrush appears more completely consumed farther north (closer to Kaua‘ula Stream), likely due to a combination of longer burn times as the fire moved south, as well as radiant heat from consumed structures across Puakukui Place. Structure numbers 2[redacted], 4[redacted], 5[redacted], and 6[redacted], all of which were immediately adjacent to the fenceline or across Puakukui Place from the fenceline, were destroyed. 7[redacted] Puakukui Place, along with 1[redacted] and 1[redacted] Pualei Drive, were also separated from the fenceline by Puakukui Place, but did not ignite. Spot fires in light fuels on the west (makai) side of the road and parking structures did ignite in a few locations, but did not continue to these structures (Figure 4.3.4.4.11).

Along the northeast side of Pualei Drive, structures 9[redacted], 1[redacted], and 1[redacted] did not sustain any damage despite their proximity to the destroyed structures along Puakukui Place. A relatively large open field, pool, and pool house between the structures resulted in limited radiant heat damage to the east (mauka) side of the surviving buildings. The northeast exterior wall of 8[redacted] Pualei Drive was impacted by radiant heat from the destroyed structure across Puakukui Place that was approximately 40 feet (compared to more than 100 feet to 4[redacted] Puakukui to the east).



Figure 4.3.4.4.9 Kaua‘ula Stream running through Puamana provided a physical separation between the northern section (where structures were destroyed between Hwy-30 and the coast) and the rest of the community (where destroyed structures were limited to the area between Hwy-30 and Pualei Drive).



Figure 4.3.4.4.10 Images along Hwy-30 and Mill Street indicating the southern termination of the grass fire on the bank east (mauka) of Mill Street coincides with the southern end of damaged vegetation along fence line west (makai) of Hwy-30. Approximate location of E11 radio transmission at 22:41 roughly coincides with this area (See Phase One report, Figure 4.3.1.40). Yellow siren provides a common orientation in each picture. Vegetation appears more heavily consumed around the drainage but remains more dense (yet damaged) further south until this transition to green foliage.

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT



Figure 4.3.4.4.11 Spotting across Puakukui Place in front of structures (top left) 1[redacted] and (top right) 1[redacted]. Embers found a receptive fuel bed to ignite, but not sustain burning through the green grass. Inset: Viewpoint showing above images.

1[redacted] Pualei Drive is the southernmost structure destroyed in Puamana (Figure 4.3.4.4.12). While, structures immediately adjacent to the north, west (makai), and south were not destroyed, 1[redacted] Pualei Drive (northwest) received extensive thermal radiation damage, including bubbled paint, melted plastic conduit and vent covers (some vent covers fell off), and broken windows (Figure 4.3.4.4.13).

One (1) broken window was boarded up prior to documentation, so someone had accessed the area prior to the analysis. For the windows that were visible, at least one pane of the double pane windows remained intact. Horizontal blinds behind some of these windows appear warped, possibly due to radiant heating, though no charing/melting was noted behind the window.

1[redacted] Pualei Drive is situated closer to the destroyed structure than 1[redacted] Pualei Drive, but radiant heat damage on this structure was limited to paint bubbling with no visible damage to windows or other components. This difference in damage between the two (2) nearby structures may suggest the wind at the time that 1[redacted] Pualei Drive was burning may have directed flames more toward the northwest than south or that more fuel was present in the northern part of the structure than the south.

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT





Figure 4.3.4.4.12 1[redacted] Pualei Drive is the farthest south structure destroyed in Puamana. It is bounded by 1[redacted] Pualei Drive to the northwest and 1[redacted] Pualei Drive to the south and parking structures to the west (makai). Inset: Viewpoint shows the area appearing in the photograph above.



Figure 4.3.4.4.13 Radiant heating damage on the southeast side of 1[redacted]Pualei Drive. Window damage includes cracking and drop out of some panes, melting and deformation of frames and screens, and potentially deformation of blinds behind windows due to transmitted radiant heating. Damage was noted to plastic vent covers and charring of fascia board on the end of the roof line. Inset: Viewpoint showing the area depicted in the photographs above.

4.3.4 FIRE IMPACT ON THE BUILT ENVIRONMENT

As described earlier, the orientation of windows and doors or roof/attic venting for the destroyed structures in Puamana cannot be definitively determined in the post-fire analysis. However, images collected from the surviving structure shows some windows may have been left partially open. For example, a louvered window was found partially open with debris and ash build up, but a screen was in place that appeared to keep the material from entering the structure (Figure 4.3.4.4.14).

Other windows through this community were found open or potentially broken, though it is possible these were opened after the fire but prior to images being collected (Figure 4.3.4.4.15). Several of these windows did not have screens behind them, which if left open, would have allowed direct entry of embers that may impact the structures if they were present at this orientation.



Figure 4.3.4.4.14 Louvered windows left partially ajar where debris collected, including charred remains of possible embers. An intact screen behind this window kept these materials from entering the structure and possibly igniting interior contents.



Figure 4.3.4.4.15 Examples of open/broken windows on surviving structures in Puamana.

4.3.5 North Zone

The North zone boundary is the incident area north of Kahoma Stream (Figure 4.3.2.1). Within the North zone, three (3) areas of interest were identified for further analysis:

- Lahaina Business Park—adjacent to Kahoma Stream and east (mauka) of Kuhua Street
- Keawe Street Apartments at the Villages of Leialiʻi Construction Site and surrounding neighborhood
- Northern-most damaged and destroyed buildings in the zone.

4.3.5.1 Lahaina Business Park

The Lahaina Business Park is a mixed-use, commercial complex that sits in a loop created by Kupuohi Street and Ulupono Street (Figure 4.3.5.1.1). Access to the business park is from Keawe Street on the northwest corner of the loop. Kuhua Street borders the west side (makai) and Kahoma Stream runs the entire southern boundary of the park.

4.3.5 FIRE IMPACT ON THE BUILT ENVIRONMENT

On the east (mauka) and north sides of the park is an undeveloped open field consisting of unmanaged vegetation (buffelgrass and haole koa). Three (3) structures were destroyed (Figure 4.3.4.1.2) in addition to numerous vehicles and adjacent fuels.

The business park comprises many businesses, including a gas station, grocery store, church, warehouses, an adventure park, liquor store, numerous retail stores, and a newer apartment building (Kaiāulu o Kupuohi apartment complex). The apartment complex, located on the east side (mauka) of the park, was five (5) stories high with



Figure 4.3.5.1.1 Post-fire aerial imagery of Lahaina Business Park.

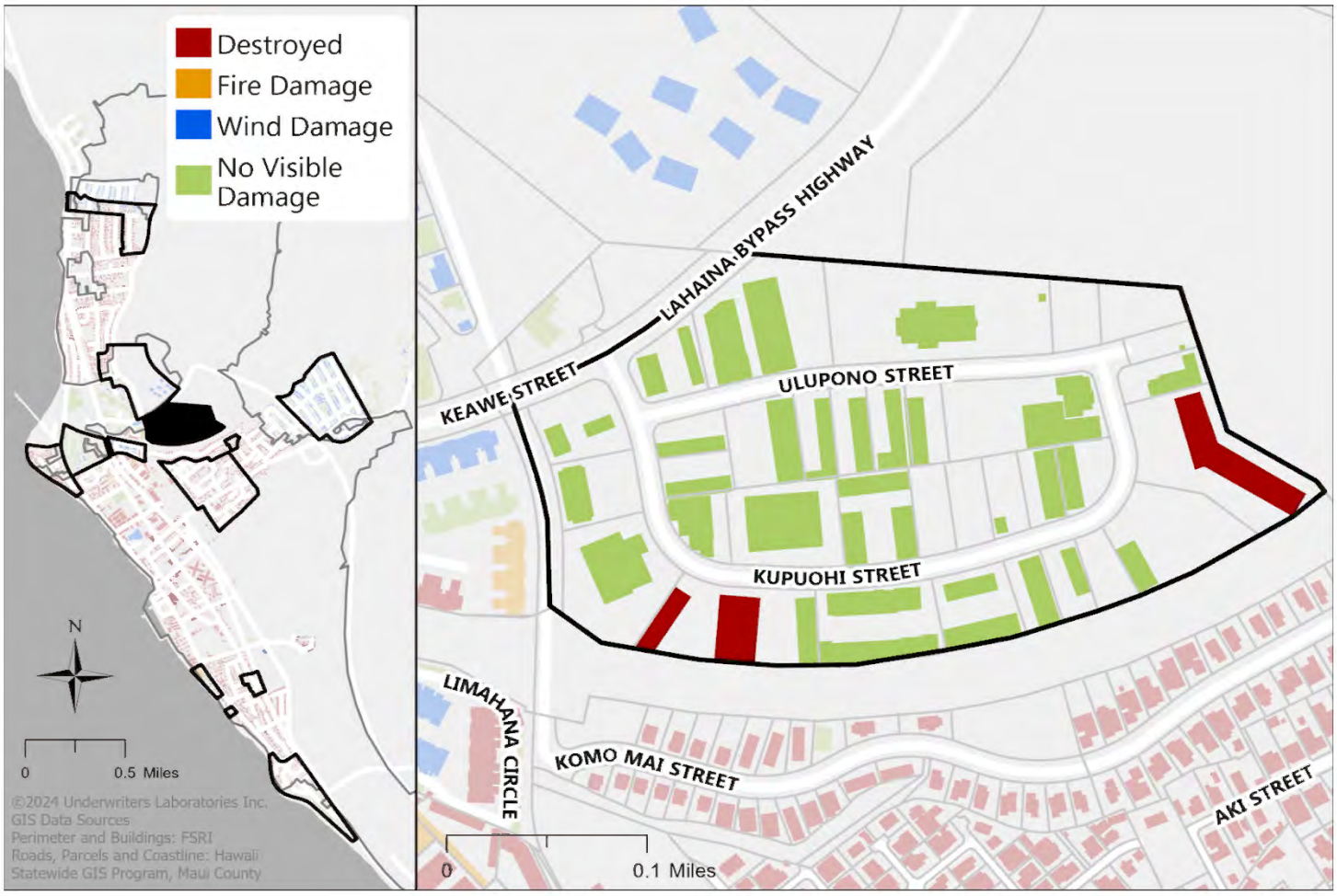


Figure 4.3.5.1.2 Damage classification assessment map of the Lahaina Business Park analysis area.

4.3.5 FIRE IMPACT ON THE BUILT ENVIRONMENT

89 apartments (Figure 4.3.5.1.3). The apartment complex and two commercial structures were destroyed by the fire.

The first evidence of the fire impacting the business park occurred at 16:43 on August 8, 2023, when Command advised E11 of a vacant lot on fire in the business park, exposing the warehouses (Figure 4.3.5.1.4). E11 had egressed down Komo Mai Street, where the fire was engulfing homes on the west (makai) end of the street, and was looking for a defensive position to slow the spread of the fire.

They relocated into the business park and began to extinguish the grass fires adjacent to 2[redacted] Kupuohi Street (Figure 4.3.5.1.5 and 4.3.1.6).



Figure 4.3.5.1.3 Kaiāulu o Kupuohi Apartment complex prior to the August 8, 2023, fire (Source: https://www.civilbeat.org/2024/04/a-low-income-housing-complex-is-ready-to-rebuild-after-lahaina-fire-it-just-needs-36m/)



Figure 4.3.5.1.5 Grasses burned along Kahoma Stream and behind 2[redacted] Kupuohi Street (Tamura's Fine Wine & Liquors).



Figure 4.3.5.1.4 Grasses burned looking east (mauka) toward the Kaiāulu o Kupuohi Apartment complex.



Figure 4.3.5.1.6 Grass lot burned at 2[redacted] Kupuohi Street, one of the first fires reported on the north side of Kahoma Stream.

4.3.5 FIRE IMPACT ON THE BUILT ENVIRONMENT

At 17:22:25, MPD Officer 4SA2 radioed, “Island Grocery Depot, rear area catching on fire, towards Minit Stop gas station, and 1[redacted] Kupuohi Street, truck fully engulfed.” RE11 was also in this area and extinguished a brush fire to the rear of 4[redacted] Kupuohi Street (Figure 4.3.5.1.7). The fire was stopped at the rear of where 4[redacted] Kupuohi Street and the Minit Stop building come together.

At 17:41:56, MPD officer 4SA2 notified Central of a vehicle engulfed in fire in the parking lot of 1[redacted] Kupuohi Street (Figure 4.3.5.1.8 and Figure 4.3.5.1.9).

Between 19:13:30 and 20:00:09, RE1 advised Command there was an “ember wash” (airborne and ground traveling embers) exposing the Island Grocery Depot and a warehouse in the area. Unit E11 was fighting a truck fire next to the warehouses on Kupuohi Street. E3 attempted to engage the fire near the Church of Jesus Christ of Latter-day Saints building at 8[redacted] Ulupono Street (Figures 4.3.5.1.10, 4.3.5.1.11, and 4.3.5.1.12).



Figure 4.3.5.1.8 Trailer and building materials ignited by embers (1[redacted] Kupuohi Street).



Figure 4.3.5.1.9 Vehicles consumed by fire in the parking lot of 1[redacted] Kupuohi Street.



Figure 4.3.5.1.7 Location where the brush fire spread stopped behind 4[redacted] Kupuohi Street.



Figure 4.3.5.1.10 Large spot fire west (makai) of the church (8[redacted] Ulupono Street).

4.3.5 FIRE IMPACT ON THE BUILT ENVIRONMENT

By 20:00, the visibility in the area of the business park had worsened and units began to reposition to extinguish the fire that was now spreading in the brush toward Keawe Street and the Lahaina Bypass.

Several factors led to many of the buildings in the Lahaina Business Park surviving the fire. First, during the initial few hours of the fire the business park was not in the primary direction of fire spread. Secondly, the park was separated from the original fire neighborhood by the Kahoma Stream (an 80-foot wide concrete waterway with a 20-foot gravel road on either side).

The business park was also elevated above Kahoma Stream with a concrete wall, running short lengths on both banks of the stream. There was dry vegetation along this wall, which may have contributed to the fire extending up into other brush areas in the business park.

Thirdly, the building construction consisted of mostly metal roof buildings with metal or concrete walls. Lastly, there was no direct flame spread or radiation hazards across the long distance of the stream. The only mechanism to spread fire to these structures was embers transport. The presence of MFD units in this area allowed them to control the fire's size north of Kahoma Stream, which, in turn, diminished the amount of embers that traveled downwind, limiting their ability to ignite other structures.

This activity allowed MFD units to suppress numerous spot, vehicle, building material, and structure fires before they spread (Figures 4.3.5.1.13, 4.3.5.1.14, 4.3.5.1.15, 4.3.5.1.16, 4.3.5.1.17, 4.3.5.1.18, and 4.3.5.1.19).



Figure 4.3.5.1.11 Vehicles consumed by fire west (makai) of the church (8[redacted] Ulupono Street).



Figure 4.3.5.1.12 Additional vehicles consumed by fire west (makai) of the church (8[redacted] Ulupono Street).



Figure 4.3.5.1.13 Materials storage area burned by embers (1[redacted] Kupuohi Street).

4.3.5 FIRE IMPACT ON THE BUILT ENVIRONMENT



Figure 4.3.5.1.14 Materials storage area burned by embers (1[redacted] Kupuohi Street).



Figure 4.3.5.1.15 Dumpster fire to the west (makai) of 2[redacted] Kupuohi Street.



Figure 4.3.5.1.16 Box truck consumed by fire behind 1[redacted] Kupuohi Street.



Figure 4.3.5.1.17 Car consumed by fire next to 2[redacted] Kupuohi Street..



Figure 4.3.5.1.18 Vehicles consumed by fire in the middle of Emerald Plaza Place (near 1[redacted] Kupuohi Street).

.



Figure 4.3.5.1.19 Van consumed by fire with thermal damage to 1[redacted] Kupuohi Street.

The two (2) warehouse buildings that burned (Figure 4.3.5.1.20 and Figure 4.3.5.1.21) had several open vents that may have allowed embers to enter the structure and ignite combustible materials. These buildings were also on the southwestern edge of the business park where large wind-borne plumes of embers likely traveled from nearby engulfed homes on the other side of the Kahoma Stream.

The ignition of the Kaiāulu o Kupuohi apartment complex (Figure 4.3.5.1.22) and the vehicle lot on the northeast corner of the business park (Figure 4.3.5.1.23) began later in the incident. There were no reports of the building or vehicle fires on MPD or MFD radio, so they likely ignited between the time units evacuated north of the Lahaina Civic Center and the following morning.

4.3.5 FIRE IMPACT ON THE BUILT ENVIRONMENT



Figure 4.3.5.1.20 Emerald Plaza Building A consumed by fire.

The first known resident video of the apartment complex on fire was recorded at 05:35 on August 9, 2023. At this time, the north wing of the building was on fire. The fire spread to the south and completely destroyed the structure within two (2) days, according to news reports (Figure 4.3.5.1.24).



Figure 4.3.5.1.21 Emerald Plaza Building B and C consumed by fire.



Figure 4.3.5.1.22 Kaiāulu o Kupuohi Apartment complex consumed by fire.



Figure 4.3.5.1.23 Lot of vehicles consumed by fire in the northeast corner of the business park.



Figure 4.3.5.1.24 Kaiāulu o Kupuohi Apartment complex continuing to burn following the August 8, 2023, fire.[261]

4.3.5 FIRE IMPACT ON THE BUILT ENVIRONMENT

4.3.5.2 Keawe Street Apartments at the Villages of Leialiʻi Construction Site and surrounding neighborhood

The Keawe Street Apartments at the Villages of Leialiʻi construction site is an approximately 50-acre construction site near Keawe Street and the Lahaina Bypass (Figure 4.3.5.2.1). Keawe Street borders the south end of the construction site and Oil Road borders the west side (makai).

Just west (makai) of Oil Road are residential homes from Keawe Street, north to Kahoma Street (Figure 4.3.5.2.2). Undeveloped open fields consisting of unmanaged vegetation (buffelgrass and haole koa) are situated on the east (mauka) and north sides of the construction site.



Figure 4.3.5.2.1 Post-fire aerial imagery of the Keawe Street Apartments at the Villages of Leialiʻi construction site and surrounding neighborhood.

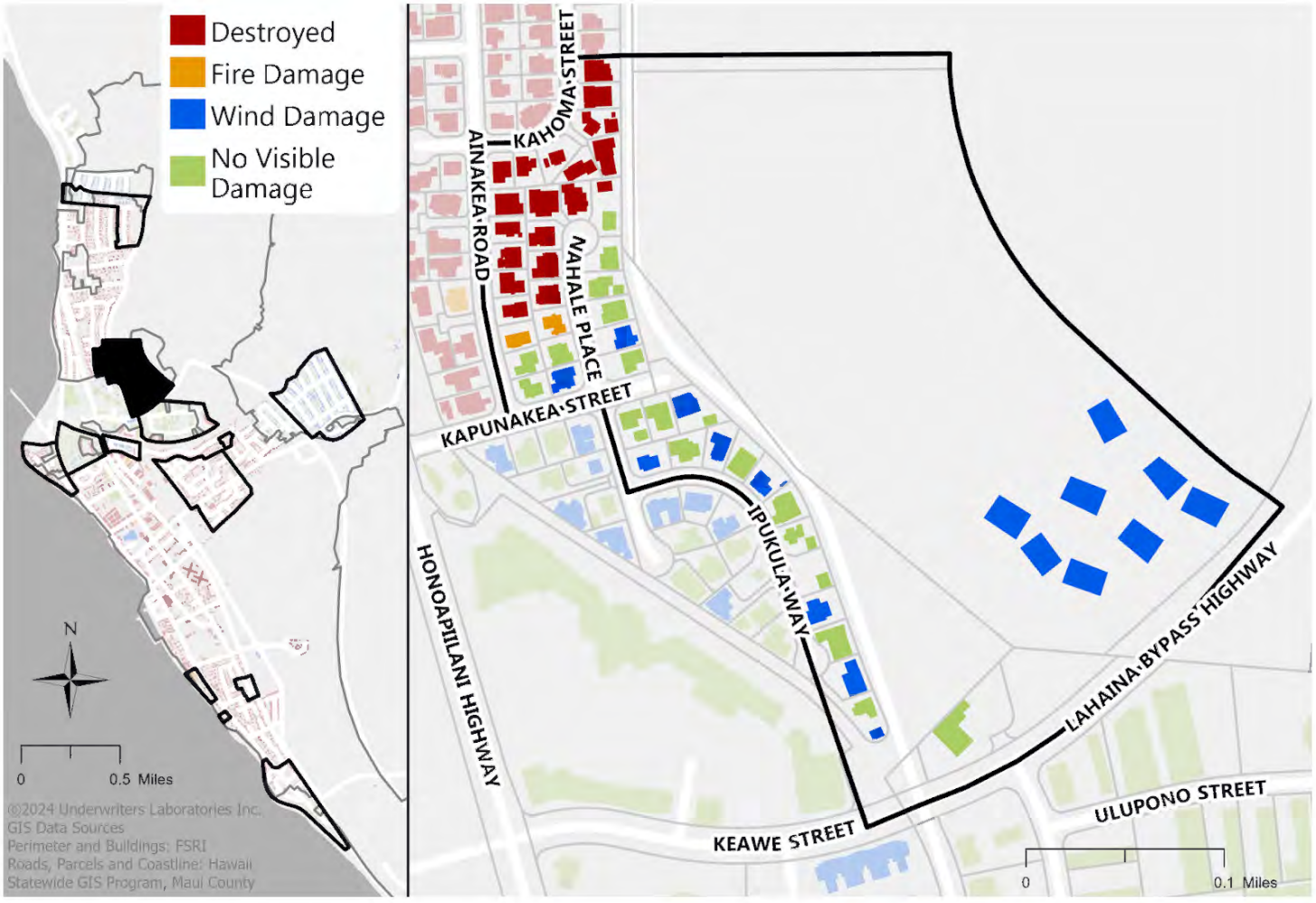


Figure 4.3.5.2.2 Damage classification assessment map of the Keawe Street Apartments at the Villages of Leialiʻi analysis area.

4.3.5 FIRE IMPACT ON THE BUILT ENVIRONMENT

The entire construction site had been cleared to mineral soil prior to the fire. Eight (8) apartment buildings were in some state of construction prior to August 8, 2023, with two (2) concrete foundations completed and several others were being prepared. High winds impacted the construction site, resulting in notable wind damage (Figure 4.3.5.2.3), but there was no observable fire damage.

Grasses had been removed to make way for the construction, creating a fuel break that offered some protection to nearby homes, the Lahaina Gateway Shopping Center located west (makai) of the homes, and the Cannery Mall located further west (makai) (Figure 4.3.5.2.4 and 4.3.5.2.5). The Cannery Mall was an important refuge area for civilians, firefighters, and police officers during the fire.

Without this fire break, the fire department would have been challenged to keep the fire from spreading into homes and the shopping centers located to the west (makai).

Around 20:00 on August 8, 2023, the fire had spread over the area surrounding Kahoma Stream and into the grasses east (mauka) of Lahaina Business Park. It also began to spread over the Lahaina Bypass and Keawe Street, heading north. MFD units were able to extinguish the fire spread between the Lahaina Business Park and the construction site, but the fire was still able to spread to the north along the east side (mauka) of the construction site.

At 20:43, E3 advised they were trying to scalp the brush in this area, utilizing the construction site as a buffer. They requested a bulldozer, but Command responded that acquiring one would take hours—an example of the challenges the MFD encountered when attempting to secure access to heavy equipment that could have made a dramatic impact in limiting the spread of the northern flank vegetation fire. With little water available for fire suppression, the fire was able to spread into the Wahikuli neighborhood, north of the construction site.



Figure 4.3.5.2.3 Wind damaged apartments at the construction site.

4.3.5 FIRE IMPACT ON THE BUILT ENVIRONMENT



Figure 4.3.5.2.4 Pre-fire aerial imagery (taken July 2021-December 2022) of the Keawe Street Apartments at the Villages of Leialiʻi construction site prior to construction and surrounding neighborhood (Source: Microsoft).



Figure 4.3.5.2.5 Pre-fire imagery (August 2021) depicting invasive grasses up to community before construction site.

4.3.5 FIRE IMPACT ON THE BUILT ENVIRONMENT

A resident living on Nahale Street captured numerous videos showing how the grass fire extended to a vehicle located on the northwest corner of the construction site, where it jumped Oil Road and into the homes on Kahoma Street (Phase One report, pages 71-78) (Figure 4.3.5.2.6 and Figure 4.3.5.2.7).

From there, the fire spread west (makai) toward the ocean, southwest toward Kapunakea Street, and then northwest toward Fleming Road. Due to the protection provided by the construction site, actions taken by both residents and the MFD, and a shift in wind direction, some of the homes located on Nahale Street and at the southern end of ‘Ainakea Road, as well as all the structures located between Kapunakea Street (north), Oil Road (east - mauka), Keawe Street (south), and Hwy-30 (west - makai), survived the fire.

Figure 4.3.5.2.8 provides an overhead view of the northwest corner of the construction site, highlighting the interface where the fire stopped. Structure-to-structure fire spread that started from this location spread south until it reached the top of Nahale Street.

Figure 4.3.5.2.9 shows 12[redacted] Nahale Street on left (destroyed) and 12[redacted] Nahale Street on right (survived). An ancillary structure on the property was destroyed by fire, but the fire did not extend to the house. The fire did not propagate further south on the east side of Nahale Street, in part, due to the distance between structures, defensive actions taken by a neighbor to stop the fire, and a shift in wind direction.



Figure 4.3.5.2.6 Car located at edge of construction site that supported the fire jumping Oil Road from the east-mauka (right to left).



Figure 4.3.5.2.7 Resident video of car on fire at the northeast end of the construction site with heavy winds driving the fire toward 13[redacted] Kahoma Street.



Figure 4.3.5.2.8 Overhead view of the area at the northwest corner of the construction site, highlighting the interface where the fire stopped. To the north, the fire stopped at the top of Nahale Street (Source: EagleView).

4.3.5 FIRE IMPACT ON THE BUILT ENVIRONMENT

On the west side (makai) of Nahale Street, the fire propagated further south and destroyed 12[redacted] Nahale Street, but 12[redacted] Nahale Street survived (Figure 4.3.5.2.10). The fence separating the structures was burned, and 12[redacted] Nahale Street was damaged (windows cracked and paint bubbled) due to radiant heat. However, the fire did not extend through the main structure.

The structure to the rear of 12[redacted] Nahale Street (12[redacted] ʻAinakea Road) also survived the fire (Figure 4.3.5.2.11), though it also sustained radiant heat damage from the structure next door at 12[redacted] ʻAinakea Road, including blistered paint and cracked windows (Figure 4.3.5.2.12).



Figure 4.3.5.2.9 12[redacted]Nahale Street on the left and 12[redacted]Nahale Street on the right.



Figure 4.3.5.2.10 12[redacted]Nahale Street on the left and 12[redacted]Nahale Street (destroyed) on the right.





Figure 4.3.5.2.11 (Left) Post-fire aerial image with annotated distance, 39 feet, between (destroyed) 12[redacted]ʻAinakea Road and (damaged) 12[redacted]ʻAinakea Road. (Right) Ground-based image of separation between destroyed and damaged structures.

4.3.5 FIRE IMPACT ON THE BUILT ENVIRONMENT



Figure 4.3.5.2.12 Northeast corner of 12[redacted] 'Ainakea Road with blistering paint from radiant heat exposure (indicated by red arrow).



Figure 4.3.5.2.14 12[redacted] 'Ainakea Road (Front view, oriented west).



Figure 4.3.5.2.15 12[redacted] 'Ainakea Road (side view, oriented north).



Figure 4.3.5.2.16 12[redacted] 'Ainakea Road (rear view, oriented northeast).



Figure 4.3.5.2.13 Post-fire aerial imagery of 12[redacted] 'Ainakea Road with distances to adjacent (destroyed) buildings.

Diagonally across 'Ainakea Road is 12[redacted] 'Ainakea Road. This house survived even though structures on all four (4) sides of it were destroyed (Figure 4.3.5.2.13-4.3.5.2.16). The side of the house facing north toward 12[redacted] 'Ainakea Road had blistered paint and cracked windows, but it showed no signs of ignition.

The other sides of the house were further from the neighboring homes that were destroyed. There also appeared to be maintained green vegetation that provided a buffer to the front and rear of the home and a concrete wall/fence that helped shield the home on all sides.

4.3.5 FIRE IMPACT ON THE BUILT ENVIRONMENT

4.3.5.3 Northeast Damage Assessment (Lokia,Kanaiu, ‘Aipuni)

In the North zone, structures between Kaniau Road and ‘Aipuni Street were the northernmost structures to be destroyed by the fire (Figure 4.3.5.3.1). Only 13 of the 31 structures on the north side of Kaniau Road survived the fire, with most of the surviving structures grouped toward the west (makai) end of this road (Figure 4.3.5.3.2).



Figure 4.3.5.3.1 Aerial imagery of the North Zone, between Kaniau Road and ‘Aipuni Street, which is the most northern area of Lahaina affected by the August 2023 Maui fires.

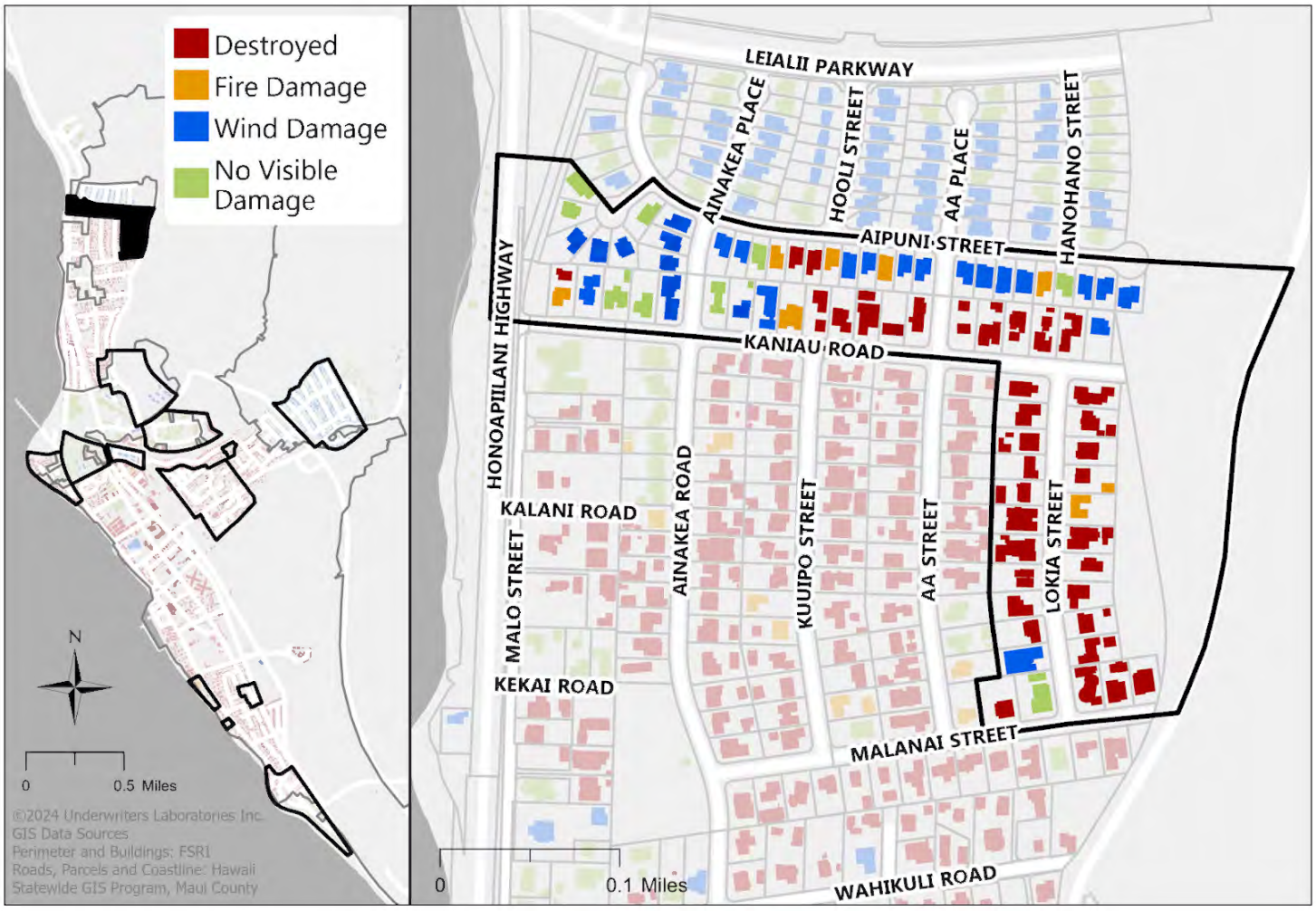


Figure 4.3.5.3.2 Damage classification assessment map of analysis area.

4.3.5 FIRE IMPACT ON THE BUILT ENVIRONMENT

The north property line of the Kaniau Road structures is shared with the south property line of the ‘Aipuni Street structures, yet 22 of the 24 structures along ‘Aipuni Street survived, as well as 16[redacted], 16[redacted], and 16[redacted] ‘Ainakea Road and all six (6) of the structures addressed off Wahinoho Way.

Properties along Lokia Street between Malanai Street and Kaniau Road were the easternmost (mauka) destroyed and fire-damaged structures in this zone. Two (2) of the 18 structures east (mauka) of Lokia Street survived, while three (3) out of the 13 structures addressed on the west side (makai) of this street survived.

Kaniau Road and Lokia Street are part of the Wahikuli neighborhood. Initial construction of these lots was completed between 1972 and 1981, with a mix of masonry and frame construction employing stucco, wood, or masonry exterior walls. The homes also had a variety of roof covering materials including composite, wood, metal, masonry (concrete tile, ceramic), and composite shingle.

Accessory structures (approximately 500 to 600 square feet each) were built on 13 of these lots between 1984 and 2004 (10 frame construction, 3 masonry) with similar exterior wall and roofing materials.

All structures on the Hawaiian Homes lots addressed along ‘Aipuni Road were constructed in 2006, with some additions constructed on a few properties (typically on the south side of these structures) over the years.

Fire began impacting this portion of Lahaina in the late evening of August 8, 2023. At 20:29, RE14 advised the fire was north of Oil Road and making its way into Wahikuli. MPD Officer 4Z20 advised the fire had crossed Wahikuli Road and was headed north at 22:54.

At 23:39, the MFD Support Group Leader advised the brush was on fire above Malanai Street, and the fire was making its way to Kaniau Road, impacting several homes in that area.

At 01:10 on August 9, 2023, U3B headed back to Leialiʻi from Kāʻanapali. U3B recalled two (2) engines using handlines fed by unit T3. MPD officer 401 radioed that the fire was slowly surrounding Leialiʻi Village at 01:54.

At 04:18, U5 was requested to return to the Leialiʻi Parkway area of Hawaiian Homes. A U5 officer recalled that when they arrived at Leialiʻi, they saw a MFD apparatus already working in the area.

The U5 crew stretched a 1 ½” handline to the rear of the houses near the cul-de-sac of ‘Aipuni Street. They were joined by another engine and wildland unit.

At 04:34, U3B/Support Group advised T3 to bring all personnel and report to Leialiʻi Parkway so they could pull lines from Hawaiian Homes (the homes off ‘Aipuni Street) to the Wahikuli side to stop radiant heat from igniting more homes.

At 04:58, Command directed all units to relocate to Leialiʻi Parkway to assist with structure protection and triage in Hawaiian Homes. RE1 crew recalled spending the morning extinguishing fires and hot spots in and around the structures along ‘Aipuni Street in the Hawaiian Homes area, including exposure protection to 7[redacted] ‘Aipuni Street.

RE14 responded to ‘Aipuni Street and a RE14 officer recalled seeing at least three (3) engines along ‘Aipuni Street putting out fires within and around ‘Aipuni Street.

4.3.5 FIRE IMPACT ON THE BUILT ENVIRONMENT

The E1/Mini1 crew recalled driving around ‘Aipuni Street into the cul-de-sac. They pulled a handline between houses and extinguished hot spots in the backyard that backed up to the houses on Kaniau Road (most of the houses on Kaniau Road had burned and were smoldering).

At 06:30, U5 reported they had gone through the backyards of Hawaiian Homes with E1/Mini1 and the area looked good.

This section of the North zone was likely to have been impacted by vegetation fires on both the east (mauka) and west (makai) of the community and by fires moving through structures from the south.

As structures east (mauka) of Lokia and Aa Streets ignited, radiant heating and embers would likely have impacted structures to the west (makai) and north through prevailing winds.

Homes east (mauka) of Lokia Street and those on the eastern (mauka) end of Kaniau Road and E ‘Aipuni Place abut grassland. The north flank vegetation fire, progressing from south to north in this grassland area, began impacting the North zone between 20:00 and 22:00 and continued to spread throughout the night of August 8, 2023, into the morning of August 9, 2023.

When the vegetation fire crossed over Oil Road, it continued to spread west (makai) to the eastern (mauka) property lines of these lots (Figure 4.3.5.3.3). Some of the structures on these properties were buffered by gardens, maintained (e.g., mowed and/or watered) lawns, and fences. Four (4) structures on the eastern (mauka) border of this area survived the fire with varying levels of damage.

Two (2) structures on the east side (mauka) of Lokia Street were damaged by the fires, but survived (Figure 4.3.5.3.4), including an accessory structure on 16[redacted] Lokia Street located to the far east (mauka) of the property (Figure 4.3.5.3.5) and the structure at 16[redacted] Lokia Street (Figure 4.3.5.3.6). Both had notable damage to the windows, some of which were boarded up from the inside.

The structure at 16[redacted] Lokia Street was elevated from the ground and was buffered by a garden to the east (mauka) of the property line fence. The southwest corner of the fence appeared to have caught fire at some point, but was broken out and burning was stopped.

Hoses were noted near the garden, which may have been used during the fire or may have been used to water and maintain the garden, providing a buffer of fuels with increased moisture and reduced burning potential.



Figure 4.3.5.3.3 Fire in the grassland along the eastern edge (mauka) of the northern zone crossed over Oil Road to the eastern edge (mauka) of properties on Lokia Street and Kaniau Road. The north flank vegetation fire remained east (mauka) of Oil Road between ‘Aipuni Street and Leiali‘i Parkway, after which the fire moved back west (makai). Note: North is to the right on these images.

4.3.5 FIRE IMPACT ON THE BUILT ENVIRONMENT



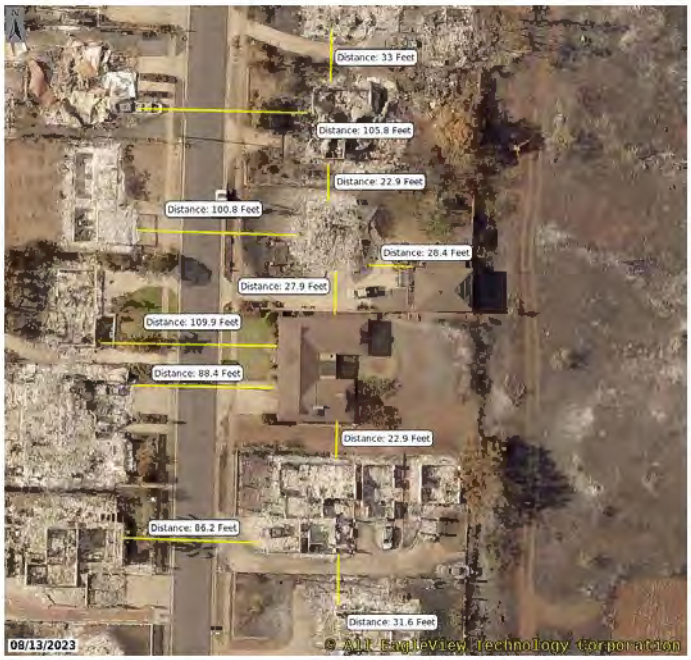


Figure 4.3.5.3.4 Structure spacing along Lokia Street in the vicinity of the surviving structures on the east side (mauka) of the street, abutting the grassland fire.

The vegetation fire in the grassland propagated into the east (mauka) yard of 16[redacted]Lokia Street, but had limited impact on the structure itself. A sprinkler was noted in the east (mauka) yard in the vicinity of where the vegetation fire ended.

This sprinkler may have applied water during the fire either in preparing the property for the oncoming fire or prior to the fire to maintain the grass in this area (Figure 4.3.5.3.7). Regardless of when water was applied, fire-spread toward the structure was halted.





Figure 4.3.5.3.5 The surviving accessory structure at 16[redacted]Lokia Street was near the eastern (mauka) property line, but was buffered from the grassland by a garden (note intact hoses and stone landscaping separating from the grass) and a fence. The structure was elevated such that the damaged windows were a longer distance from the burning vegetation than a single-story structure. Charred sections of fence were broken away from the posts and burning was stopped. Broken windows were boarded up from the inside by the time images were collected.

4.3.5 FIRE IMPACT ON THE BUILT ENVIRONMENT



Figure 4.3.5.3.6 The 16[redacted] Lokia Street structure did not appear damaged by the grass fire to the east (mauka) sides (top left) or destroyed structure west (makai) of Lokia Street (top right). The structure was heavily damaged from radiant heating from the destroyed structure to the south (bottom left) and north (bottom, right).

Structures at 1[redacted] Kaniau Road and 1[redacted] E ‘Aipuni Place both survived, despite the grass fire progressing to the edge of these lots (Figure 4.3.5.3.3). The 1[redacted] Kaniau Road property had a maintained grass yard and concrete driveway between the structure and grass fire to the east (mauka), which helped restrict the vegetation fire from propagating directly to the structure.

The home at 1[redacted] E ‘Aipuni Place was separated from the grass fire by a vinyl fence, which may have stopped embers and flames for a period of time prior to pickets softening, deforming, and falling out along much of the southern and eastern (mauka) sections.



Figure 4.3.5.3.7 (top) Overhead view of 16[redacted] Lokia Street lot with approximate location of sprinkler that may have been used to prepare the property for the fire and/or defend the property during the fire.

4.3.5 FIRE IMPACT ON THE BUILT ENVIRONMENT

Firefighters were working in this area throughout the morning of August 9, 2023, specifically operating near the cul-de-sac of ‘Aipuni Street around 04:18. Their actions could have stopped the spread of this fire towards the structures on ‘Aipuni Street.

The northern spread of the grass fire on the west side (makai) of Oil Road may have been slowed near Kaniau Road by a dirt path (free of vegetation) that connects the dead end of Kaniau Road with Oil Road, creating a discontinuity in the vegetation. Additionally, Oil Road also shifts toward the east (mauka) in this area, away from the residential area.

A vegetation fire also impacted structures on the west (makai) end of Kaniau Road. A single residential structure (accessory structure at 1[redacted] Kaniau Road) was destroyed by this fire, despite being surrounded by at least two (2) surviving structures to the north, east (mauka), and south with no fire damage noted to the west (makai) of Hwy-30 (Figure 4.3.5.3.8).

Tall grasses on the northeast corner of Kaniau Road and Hwy-30 would likely have provided a receptive fuel bed for embers that may have gathered there. If these grasses had dried out to the state shown in Figure 4.3.5.3.9, they would have more easily ignited the green, mowed lawns in the surrounding properties west (makai) of this location.

Fire traveling along the railroad tracks that parallel Hwy-30 between Kapunakea Street and Leiali‘i Parkway could have carried embers or flames to this location and ignited dry grasses. Embers may also have reached these grasses if they were carried by wind down Kaniau Road.

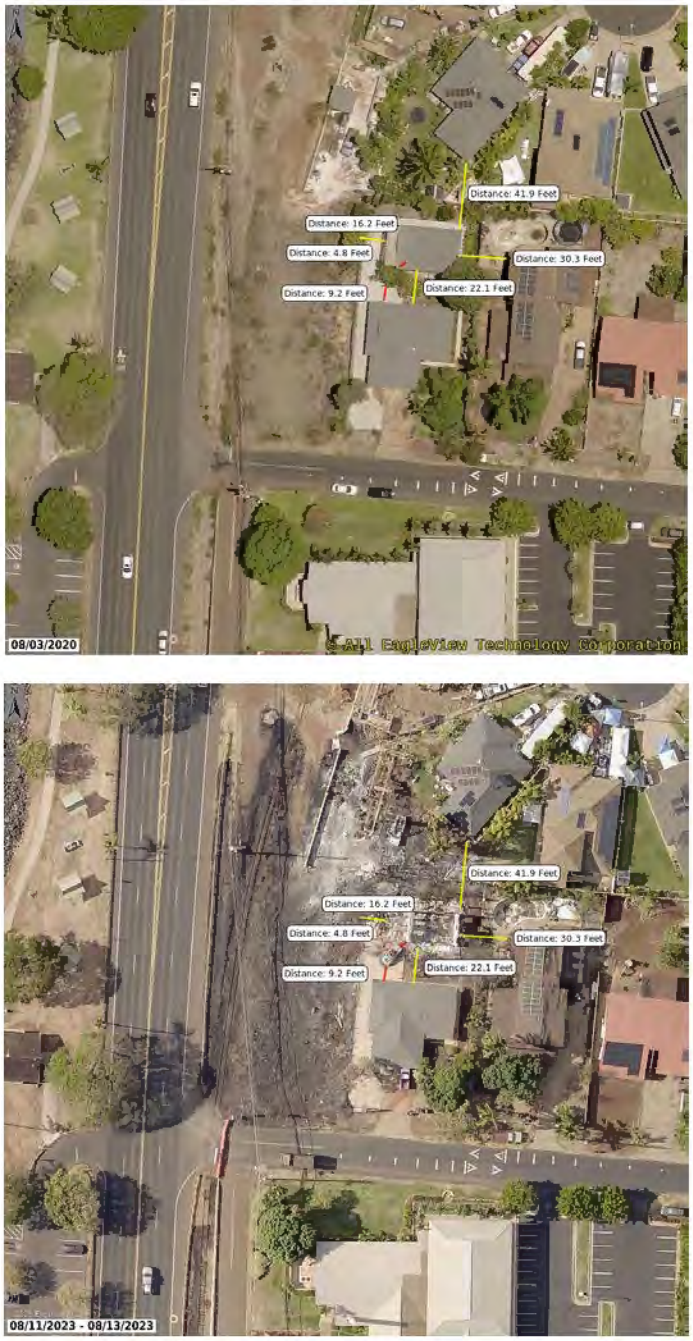


Figure 4.3.5.3.8 Structure spacing near destroyed accessory structure at 1[redacted] Kaniau Street.

4.3.5 FIRE IMPACT ON THE BUILT ENVIRONMENT

The prevailing winds were typically from the east (mauka)/southwest, which could have driven fires along the tracks toward the north (particularly in areas where a concrete barrier between Hwy-30 and Malo Street might have restricted embers from blowing further to the west-makai).

However, wind shifts were noted throughout the timeline of the fire, so it cannot be ruled out that embers from the grass fire north of Leialiʻi Parkway could have been blown toward the southwest, which may have propagated the fire to the south along the railroad tracks.

While the accessory structure on the 1[redacted] Kaniau Road was destroyed by the fire, windows in the north side of the primary structure that was 20 to 25 feet to the south were damaged and spot fires were noted in outdoor furnishings to the west (makai) of this structure (Figure 4.3.5.3.10).

A vehicle between these two (2) structures was destroyed by the fire and may have played an important role in heat transfer to/from the vegetation and/or structure fire. The most extensive window damage was noted on the northwest corner, which was closest to the destroyed vehicle. However, damage to plastic molding on the windows was also noted on the west side (makai), proximate to the vegetation fire.

None of the other structures in this part of the North zone had visible damage from radiant heat. This relatively isolated fire was likely contained by defensive actions conducted by citizens and MFD personnel.



Figure 4.3.5.3.9 Tall dry grasses are noted on the northeast corner of Kaniau Road and Hwy-30 in August 2020 (top), which could have provided a receptive fuel bed for fires fires along the railroad tracks or embers moving down (makai) Kaniau Road to ignite these grasses in August 2023 and travel to structures in the immediate vicinity (bottom). Note: North is to the left of these images.

4.3.5 FIRE IMPACT ON THE BUILT ENVIRONMENT



Figure 4.3.5.3.10 The primary structure at 1■ Kaniau Road, in close proximity to the destroyed secondary structure and vehicle, had damaged windows, particularly close to the vehicle fire and ember damage to outdoor furnishings that did not extend to the structure.

A garden hose was stretched from a hose bib on a structure in 1■ Kaniau Road and remained deployed near 1■ Kaniau Street. Conversations with local residents revealed neighbors used a pump to control the fire that was progressing along a plastic fence on the north property line. A pump was located next to a swimming pool in the south yard of 1■ Kaniau Road (Figure 4.3.5.3.11).

Defensive actions that appeared to utilize a residential swimming pool were also noted on the west side (makai) of Lokia Street, near the south end of the road where it intersects Malanai Street (Figure 4.3.5.3.12).

4.3.5 FIRE IMPACT ON THE BUILT ENVIRONMENT

The structure at 15[redacted] Lokia Street survived, despite being in close proximity to the destroyed structure at 15[redacted] Lokia Street (Figure 4.3.5.3.13). The partially closed front, wood gate to this lot ignited and a vehicle was destroyed behind the stone wall. However, this fire did not spread further to the structure.

Additional spot fires were noted along the north and south fences, particularly in the southwest corner where the property line is shared with the north yard of the destroyed structure at 2[redacted] Malanai Street.

These fires consumed some household outdoor furnishings, but did not spread to the structure. Evidence suggests this property was defended, in part, by using a battery system to power a submersible pump to apply water from the residential pool through a garden hose stretched around the structure.

The defense of this structure most likely improved the survivability of nearby structures, including the five (5) structures immediately to the west (makai) of this lot on Aa Street. Additionally, during data collection for this analysis, conversations with residents in the area indicate water from this pool was later used by some returning to the area in the days following the fire to put out spot fires on their properties and neighbors' properties.

Once the north flank vegetation fire crossed Oil Road near Kahoma Street, the fire continued to spread structure-to-structure as an urban conflagration, eventually moving from the south to the north in this area. At the same time, structure-to-structure fire spread and embers also moved the fire from the east (mauka) to the west (makai).



Figure 4.3.5.3.11 Water resources from 1[redacted]Kaniau Road were utilized to help control the fire from propagating farther east (mauka) from 1[redacted]Kaniau Road. Garden hose was deployed from a hose bib with the terminal end remaining at the next lot. Neighbors reportedly used the pump to control a fire along the plastic fence at the north property line of this lot.

4.3.5 FIRE IMPACT ON THE BUILT ENVIRONMENT

This northern/northwestern spread continued to the edge of the Wahikuli neighborhood to the north of Kaniau Road and the Hawaiian Homes lots to the south of ‘Aipuni Street. As noted previously, MFD intervention throughout the early morning hours of August 9, 2023, were critical in stopping the progress of the fires.

The northernmost destroyed structures in Lahaina were addressed at 8[redacted] and 9[redacted] ‘Aipuni Street (Figure 4.3.5.3.14).

Structures to the east (mauka) and west (makai)—1[redacted] and 7[redacted] ‘Aipuni Street—of these destroyed structures were damaged by the fire through radiant heat transfer, but survived, due, in part, to defensive actions conducted by firefighters and citizens.

Two (2) outbuildings in the south yard of 1[redacted] ‘Aipuni Street, along the property line shared with 8[redacted] and 9[redacted] Kaniau Road, were destroyed by the fire. The fire did not propagate to the rear of 1[redacted] ‘Aipuni, but paint bubbling was identified on the south porch along with vinyl trim melting on a window assembly and cracking of an outer pane.

The west side (makai) of the structure was more heavily damaged, particularly deformed window frames and broken window glass along with the deformation of window blinds on the interior of the structure (Figure 4.3.5.3.15). Considering the roofline of the destroyed structure at 9[redacted] ‘Aipuni was approximately 10 feet from the roofline of 1[redacted] ‘Aipuni, the amount of damage noted to the west side (makai) of this structure could have been more severe if it were not for defensive actions undertaken by firefighters and citizens.

The radiant heat impacting this structure may also have been reduced if the prevailing west (makai)/ northwest winds had pushed flames and smoke plumes away from this structure.



Figure 4.3.5.3.12 Structure spacing near surviving structures on the west side (makai) of the south end of Lokia Street.

4.3.5 FIRE IMPACT ON THE BUILT ENVIRONMENT

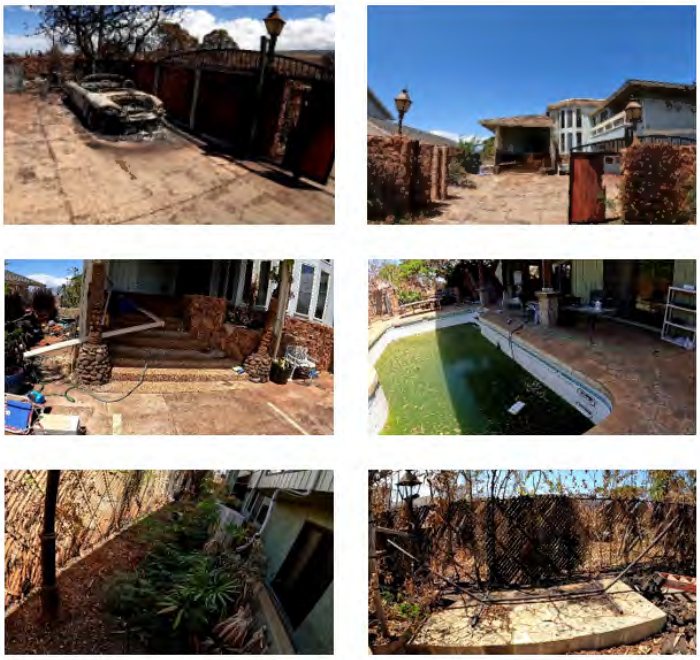
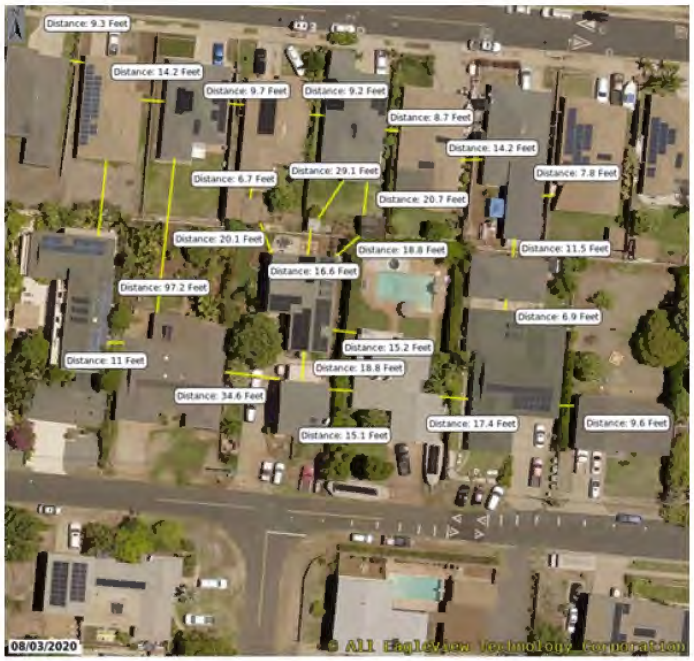


Figure 4.3.5.3.13 The 15[redacted] Lokia Street lot experienced fire damage to the front entrance gate and destroyed a vehicle, but did not extend to the structure (top). The structure appears to have been defended, in part, by pumping water from the pool in the rear of the structure, powered by a battery system (middle). Damage to fences on the north and south sides of the properties (bottom), showing the end of the hose from the pump in the pool and along with a bucket (bottom left).



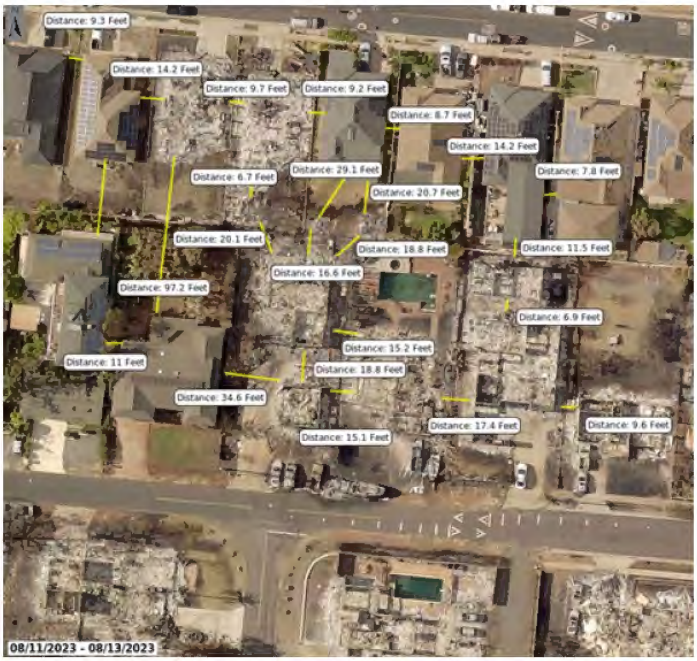


Figure 4.3.5.3.14 Structure spacing near surviving structures on the north side of Kaniau Street and south side of ‘Aipuni Street.

4.3.5 FIRE IMPACT ON THE BUILT ENVIRONMENT



Figure 4.3.5.3.15 West side (makai) of 1[redacted] 'Aipuni showing melted plastic components, damaged/broken window assemblies, and deformed window blinds likely caused by radiant heat transfer.

4.4 FIRE IMPACT ON THE BUILT ENVIRONMENT

4.4 Findings & Recommendations

77. **FINDING:** Numerous stakeholder organizations (state, county, community, HWMO) have collaborated to evaluate wildfire risk per West Maui CWPP.	**RECOMMENDATION:** Hold a statutory organization accountable for executing the preparedness plans commensurate with the risk identified through these efforts. **RECOMMENDATION:** Adopt and enforce contemporary codes and standards for building construction in wildfire prone areas.
78. **FINDING:** Codes and standards exist for addressing fire hazards of exterior vegetation (16.04D Subsection 10.13.10), but they require enhancement based on risk and current guidelines.	**RECOMMENDATION:** Update, implement, and enforce fuel management and defensible space around structures.
79. **FINDING:** Some vegetation adjacent to structures survived where the structure was not destroyed.	**RECOMMENDATION:** Additional research is necessary to understand the potential for lush, well-watered, and well-maintained vegetation to provide benefits (e.g., radiation shielding) that is not outweighed by the hazard.
80. **FINDING:** Ember penetration through building envelopes, including roofs, vents, and windows, is a common pathway for building ignition.	**RECOMMENDATION:** Buildings should be constructed and maintained to resist ember intrusion. This will include construction features (vents, roofs, etc.). **RECOMMENDATION:** Adopt stronger WUI codes (e.g., ICC International Wildland-Urban Interface Code[262] and NFPA 1140: Standard on Wildland Fire Protection[263]) or WUI Structure/Parcel/Community Hazard Mitigation Methodology[264] guidance.
81. **FINDING:** Window and doors were left open prior to evacuation.	**RECOMMENDATION:** Residents and citizens should be educated on the importance of closing building openings as an important component of preparation for, and departure from, a home during an evacuation —part of a “Ready, Set, Go: Close Before you Go” campaign.

4.4 FIRE IMPACT ON THE BUILT ENVIRONMENT

4.4 Findings & Recommendations

82. **FINDING:** Age of construction is not a primary indicator of structure survival (correlation not causation).	**RECOMMENDATION:** Ensure properties and areas around structures are well-maintained, despite the structures' age (i.e., newer structures are not exempt).
83. **FINDING:** Defensive actions appear to have lessened fire impact in the built environment.	**RECOMMENDATION:** Identify fire suppression strategies and tactics commensurate with resources and infrastructure capabilities and availability. Preplan based on these limitations and local conditions.
84. **FINDING:** Fuel breaks, such as Kahoma Stream, Kaua'ula Stream, Keawe Street Apartments at the Villages of Leiali'i construction site, and grass athletic fields by the Boys and Girls Club/Lahaina Recreation Center, appear to have impacted fire progression.	**RECOMMENDATION:** Investigate zoning changes to incorporate fuel breaks in areas within the community to slow fire progression and to act as safe refuge areas for evacuating residents.

5.0 Summary

In the United States of America, the destruction and loss of life caused by the Maui fires of August 8-9, 2023, are unprecedented in modern times.

Recognizing the complexity of this incident, FSRI used a systems analysis methodology to comprehensively examine the many contributing factors to the August 2023 fire event in Lahaina. It is vital to reiterate, as demonstrated throughout this report, that no single factor, or set of factors, is directly responsible for the tragic outcome.

The pre-conditions for these fires have been in the making for decades, stemming from the changing landscape of Maui Nui, more frequent extreme weather events, and the increased frequency of vegetation-fueled fires. It is important to note these same conditions exist across the State of Hawai‘i, in countless other locations throughout the United States, and around the globe.

The risk of wildfire in Maui was extensively documented in the years leading up to August 2023. Many recommendations from these reports were not addressed, potentially due to the complications of implementation, competing policy priorities for scarce resources, and—it appears—the cost of taking these recommended actions. Residents' and policymakers' perceptions of risk, roles, and responsibilities also likely contributed to years of inaction.

Responsibility for fire protection has almost exclusively been left to the MFD. In fact, response data from the past decade suggests that, overall, the MFD has been very successful at extinguishing wildfires, even with the increased frequency of these events. At the same time, the 2018 Lahaina fire during Hurricane Lane exemplified what was possible, and was, by many accounts, a harbinger of the August 2023 tragedy.

At time of publication, the official origin-and-cause report on the August 2023 Maui fires has not been released by the County of Maui. Stating the obvious, however, if the Lahaina fires had not started in the first place, then the subsequent destruction of Lahaina on August 8-9, 2023, would not have happened.

The State of Hawai‘i is among a handful of states at moderate to high risk for almost the full range of natural disasters, including drought, earthquakes, fires, hurricanes, landslides, tsunamis, and volcanic eruptions. Historical records strongly suggest that weather conditions in Maui Nui and across the Hawaiian Islands are changing, contributing to an increased frequency of wildfires.

This pattern, combined with the decline of agriculture and an increasing prevalence of unmanaged vegetative fuels, helped set the stage for the August 2023 fires around Maui.

The vulnerabilities of the County of Maui's infrastructure were exposed on August 8, 2023. Extreme winds toppled numerous utility poles and downed overhead electrical wires, which ignited the dry grass along Lahainaluna Road resulting in the start of the Lahaina AM fire. The subsequent degradation of other critical systems (e.g., roads, water, and telecommunications) would also contribute significantly to the challenges faced by emergency responders to control the Lahaina PM fire.

The Lahaina AM fire burned in rocky terrain with vegetation growing in hidden void spaces with downslope winds blowing in excess of 60 miles per hour. These were extreme conditions that the MFD had never experienced or trained for. All the factors for the AM fire to resist extinguishment were in alignment. Dry vegetation, low RH, wind, time of day, and slope aspect created optimal conditions to support fire at 14:55 when the PM fire was reported.

5.0 SUMMARY

The Lahaina PM fire jumped the Lahaina Bypass and ignited the first structures along Lahainaluna Road—essentially the transition point from a wildfire to an urban conflagration.

Tragically, the first area of Lahaina to be impacted by the fire was also the most densely populated, providing the fire with ample fuel from tightly-packed burning structures and vehicles, along with exposing a high concentration of residents to toxic smoke, fast-moving flames, and waves of burning embers. Exacerbating the conditions were downed trees and utility poles, and other materials blown off structures, blocking roads and resulting in significant evacuation challenges.

During the first few hours, the fire's rapid progression through the Lahainaluna neighborhood resulted in all MFD resources being overrun by fire. Even before the hydrants lost pressure, the firefighters were simply overmatched by the numerous structure fires igniting almost simultaneously around them. Several fire apparatus were destroyed during this same period and there was also a Mayday that demanded the attention of command and other resources.

Resource limitations are a common theme across all of the agencies and organizations responsible for preparing for and responding to the August 8-9, 2023, fires throughout Maui.

Without question, these—and other— responders worked in the most challenging circumstances one can imagine; many lives were saved as a result of their actions. Trying to put themselves between the constantly-changing fire front(s) and vulnerable residents, the operating positions that many MFD units and MPD officers took were extremely dangerous and often untenable.

As with many other crisis events, communication challenges—with the public and among responders —played a major role throughout this incident. Incident management lacked unified coordination amongst assisting agencies and overhead personnel to fill critical operational roles.

These baseline resource limitations, however, especially given the Upcountry fires and additional service demands from the severe weather, proved insurmountable. At the end of the day, there simply were not enough firefighters, police officers, and functional firefighting apparatus/equipment.

The lack of available resources due to three (3) other Maui wildfires happening at the same time, fires burning on other Hawaiian islands, and the extreme weather restricting the movement of resources from island to island, impacted what could have been done to limit the spread of the fast-moving Lahaina PM fire.

The effectiveness of emergency evacuations, and their attendant plans and planning functions, is an open question for many types of disasters. Experience suggests that, once a major incident is underway, it can be difficult to evacuate residents amid dynamic and changing conditions.

Extreme conditions across both the natural and built environments during these days in August 2023 combined to create a complex set of circumstances that overwhelmed many systems that are often taken for granted in local jurisdictions around the United States.

The need for additional fire-prevention and fire-suppression resources throughout Maui Nui will be addressed in Phase Three of this report series. This phase will yield a forward-looking report to help answer the question, "How do we prevent this from happening again?"

5.0 SUMMARY

The Phase Three report will include the following discrete, albeit interrelated, elements:

Standards of Cover Analysis
A comprehensive, independent Standards of Cover (SOC) analysis will assess the deployment and performance of the MFD and will quantify the MFD's ability to deliver the capabilities described in National Fire Protection Association (NFPA) 1710—Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments.

This assessment will be conducted utilizing state-of-the-art dynamic deployment modeling software that considers the activity level of MFD emergency units and the interaction of these units with the county's emergency ambulance transportation provider, along with current/potential mutual-aid partners.

Community Risk Assessment
A comprehensive Community Risk Assessment (CRA) for the County of Maui will evaluate and enumerate natural, technological, and societal contributors to the health and safety of county residents, businesses, and visitors. The CRA will be conducted in accordance with NFPA Standard 1300—Standard on Community Risk Assessment and Community Risk Reduction Plan Development.

This assessment will benefit from the active involvement of local residents and businesses in community-centered discussions of risk perception, societal and cultural contributors to risk, and the impact of multiple factors in the county's overall fire and all-hazards risk profile.

Community Risk Reduction Plan
Based on the CRA, a comprehensive Community Risk Reduction (CRR) plan will be developed—in concert with the local community—that provides realistic strategies to increase the resiliency of Maui residents, businesses, and visitors. This plan will describe actions that can be taken by individuals, community organizations, governmental agencies, and other groups to mitigate risk, prepare to actively address hazards, and make long-term progress on addressing overall risk in the community.

The CRR planning process will recognize the vital cultural and historic attributes of Maui communities by including residents and local businesses at every stage.

Fire and Building Code Review
A comprehensive independent review of the efficacy of current fire and building codes in Maui will be performed, including the present status of code implementation, education, and enforcement. This assessment is intrinsically related to the CRR planning outlined previously, and is an essential element of any long-term strategy to address risk in Maui Nui and across the State of Hawai‘i.

The entire FSRI team joins the survivors of this tragedy in mourning the loss of Maui residents.

From the very start of this comprehensive independent analysis, FSRI has desired to work collaboratively with state, county, and federal officials, community members, and other interested parties. We appreciate the cooperation received from so many individuals/organizations and sincerely hope for continued collaboration in Phase Three.

6.0 Appendix (See full list spreadsheet here)

6.1 Full List of Findings and Recommendations

Reference Section	Relevant Department	Actionable Areas	Finding	Recommendations
2.0 Analysis of Background	• State of HI	Policy, Organizational	**1. Lack of state policy-making and investment addressing Cohesive Strategy components.**	**1.** Pursue integrated solutions using a multidisciplinary team to address the entire system of factors that influence wildfire risk and outcomes, including land use and subdivision planning, agriculture, forestry and environmental protection, emergency response, economists and tax experts, and policy-makers. Use the existing and established plans and studies as starting points for discussion and action. **2.** Learn from states that already have existing advanced wildfire-fighting policies and procedures in place that are more mature in their work on wildfire prevention, preparedness, and response.
2.0 Analysis of Background	• State of HI	Policy, Organizational	**2. Statewide wildfire prevention is led by the non-profit Hawaii Wildfire Management Organization (HWMO) without state funding.**	**1.** Establish dedicated and sustained funding for HWMO to support the coordination and implementation of wildfire prevention and preparedness efforts, especially for communities and land stewards.
2.0 Analysis of Background	• State of HI	Policy	**3. Lack of standardized and consistent wildfire data collection and report submissions to federal organizations.**	**1.** Standardize wildfire data collection process for all counties and require Incident Status Summary, Form 209 completion for wildfires meeting reporting criteria. **2.** Leverage the impending release of the National Emergency Response Information System (NERIS) to institutionalize fire reporting while ample resources are available and focused to onboarding and supporting fire agencies in this new federal program.
2.0 Analysis of Background	• MFD • MPD	Policy, Organizational	**4. The MFD and MPD did not initiate an AAR for the 2018 Lahaina Fire. MEMA did not finalize an AAR for the same incident.**	**1.** MEMA, the MFD, and the MPD should create policies that include incident parameters requiring an AAR to ensure learnings are documented and changes required for improvement are implemented.
3.2 Weather	• MFD • MPD • NWS • MEMA	Policy, Organizational, Preparedness	**5. Actionable extreme weather forecasts were provided to fire chiefs and emergency managers prior to the August 2023 fires. However, adjusting staffing for extreme weather events and their resultant risk of extreme fire behavior was not standard.**	**1.** Assign a point of contact within the MFD who is tracking weather conditions, and is disseminating that information to the rest of the department and across partner agencies. **2.** Establish standard operating procedures for Red Flag and severe fire weather warning conditions, to include: preparing and pre-positioning supplies, equipment, vehicles, and personnel in high-risk areas; ensuring clear and open lines of communication within and among agencies to optimize for rapid and coordinated deployment of resources; and communicating with the public to aid residents in translating the forecasted conditions and risks into evacuation readiness. The California Fire Weather Annual Operating Plan is a good place to start developing a Hawai‘i plan.
3.2 Weather	• State of HI • NWS	Research, Policy, Preparedness	**6. There is little perceptible difference between Hawai‘i Red Flag criteria and a typical summer day, which may have contributed to the emergency manager’s response to the forecast.**	**1.** Engage federal partners to assist in refining Red Flag criteria to be commensurate with appropriate fire danger that is actionable by policymakers, emergency managers and responders, and the public.
3.2 Weather	• NWS • HI-EMA	Policy, Organizational, Preparedness	**7. NWS-Honolulu fire weather forecast briefings to fire and emergency managers should occur on a more frequent basis.**	**1.** Engage policymakers, emergency managers and responders, and the public with more frequent fire weather forecast briefings. This will elevate understanding of the weather, while informing the community of the risk.

6.1 APPENDIX

Reference Section	Relevant Department	Actionable Areas	Finding	Recommendations
3.2 Weather	• State of HI • NWS	Equipment, Organizational, Preparedness	**8. A lack of RAWS in West Maui, and other high wildfire risk areas, limits the capability to determine where Red Flag conditions may locally exist. The lack of resolution of fire weather data and monitoring yields uncertainty at the local level due to fire weather forecasts and Red Flag Warnings being based on data collected at the Honolulu airport, which is on O'ahu (not Maui). It does not represent the conditions observed in the diverse and numerous microclimates across all high fire risk areas across the state, including Lahaina, and therefore, serves as a point of reference (or inference, at best) for other regions.**	**1.** Install and fund the maintenance for a strategic set of RAWS that can provide information with resolution across the microclimates of high fire risk locations in the state.
3.3 Vegetative Fuel	• State of HI	Policy, Organizational, Preparedness	**9. A lack of vegetation management programs, including policy, regulation development and enforcement, and funding support to address vegetation management needs across the variety of landowner types contributed to a prevalence of unmanaged vegetation on the wildland and urban areas impacted by the August 8, 2023, fire.**	**1.** Develop comprehensive vegetation management programs that address the many types of land ownership and risk-reduction needs, to include thinning vegetation, removing invasive species, and creating strategic fuel breaks: - On public lands, funding for vegetation management must be commensurate with the personnel, equipment, and maintenance costs needed to strategically and consistently reduce risk. - On private lands, a combination of tax incentives and penalties for active land management, as well as a robust and proactive defensible space code inspection and enforcement programs are needed. - Such programs must be funded and staffed at a level appropriate to adequately ensure risk-reduction measures are implemented and effectively mitigate the potential for fire ignition and rapid spread through unmanaged lands. **2.** Establish specific governmental authorities, responsibilities, and goals for the management of vegetative fuels. (Currently, authority to address vegetation hazards is covered by a vague responsibility by the mayor and fire chief to address any number of hazards). **3.** Establish a system of penalties to address owners of agricultural land who are not participating in active agriculture or vegetation management. **4.** Develop programs that support coordination and implementation of an "All Hands, All Lands" approach, where vegetation management strategies and projects reduce risk across land ownerships, according to topography and anticipated fire behavior, rather than in fragmented or siloed parcels. **5.** Implement and expand use of targeted grazing for non-native forage grass removal and fuels reduction at landscape scale.

6.1 APPENDIX

Reference Section	Relevant Department	Actionable Areas	Finding	Recommendations
3.3 Vegetative Fuel	• State of HI	Policy, Organizational, Preparedness	**10. Fire risk and protective measures are not generally considered or integrated into land use planning, ordinances, or permitting processes to ensure adequate defensible space or consistent management of vegetative fuels in and around communities.**	**1.** Require integrated land use planning through zoning regulation that requires vegetation management in high-risk areas. **2.** Educate homeowners on how to create defensible space around their properties, and require them to maintain these spaces. **3.** Incorporate community-scale, maintained green spaces that are multi-use and could act as fuel breaks and public safe refuge areas.
3.3 Vegetative Fuel	• State of HI	Policy, Organizational, Preparedness	**11. The existing landowner and land steward risk-reduction programs, which include best practices for vegetative fuels management, have limited capacity and have not been invested in by the government at a level that meets the current need.**	**1.** Provide land steward and community education regarding vegetation management best practices. Invest in, and grow, the existing programs of Firewise USA(TM) and educational programs for land stewards offered by existing groups, such as those already led (but underfunded) by the HWMO, University of Hawai'i, and their established partners.
3.3 Vegetative Fuell	• State of HI	Policy, Organizational, Preparedness, Research	**12. There is no adequate system for monitoring fuel loads, fuel moisture, and other relevant characteristics.**	**1.** Improve monitoring of fuels and utilize drones, satellite imagery, and ground-based monitoring systems to detect and assess vegetative fuel loads, fuel moisture, and high fire risk conditions. **2.** Establish an information dissemination system to fire and emergency managers to communicate high-risk locations and periods.
3.3 Vegetative Fuel	• State of HI	Policy, Organizational, Preparedness, Research	**13. There is a need for additional public and private investment in long-term ecosystem restoration and sustainable land management practices that promote healthy ecosystems, maintain active agriculture, reduce fire risk, and control erosion.**	**1.** This investment can be accomplished as key components of integrated land use planning, financial incentive and assistance programs, and land steward education (all described above). **2.** Invest in watershed partnerships, conservation groups, and other existing ecosystem conservation and agricultural initiatives. **3.** Invest in and bolster plant material supply chain for bulk seed production to support adequate fuel conversion and post-fire mitigation. For example, these programs could include common native seed collection, plant propagation, and outplanting.
3.4.1 Planning, Zoning, and Codes	• County of Maui	Policy, Prevention, Organizational, Preparedness	**14. At the time of the fire, zoning in some areas of Lahaina was not commensurate with the modern built environment, environmental risks, and population growth.**	**1.** Review and adjust zoning laws to better reflect the actual occupancy levels in Lahaina. **2.** Implement stricter enforcement to ensure compliance with occupancy limits. **3.** Enforce building codes and zoning regulations that require sufficient road width and access points in new developments to ensure better planning for future developments. **4.** Increase the availability of off-street parking solutions to reduce the reliance on narrow streets for vehicle parking. **5.** Emergency responders should have pre-determined plans, as well as uniquely adapted equipment (if available), tactics, and strategies for specific areas with narrow streets, outlining alternative access points, water supply strategies, and evacuation procedures.

6.1 APPENDIX

Reference Section	Relevant Department	Actionable Areas	Finding	Recommendations
3.4.1 Planning, Zoning, and Codes	• County of Maui	Policy, Prevention, Organizational	**15. At the time of the fire, the County of Maui was enforcing the 2006 edition of the International Residential Code and International Building Code.**	**1.** Review and ensure adoption process meets requirements of state statute (HRS 107-28).
3.4.2 Road Networks	• MFD • MPD	Preparedness, Training, Equipment, Operational	**16. Emergency responders did not have ready capability to unlock emergency gates at various locations, including schools, to facilitate evacuations. They were often forced to rely on a third-party response for such access.**	**1.** The MPD and MFD should develop an assessment of its ability to access local utilities (Hawaiian Electric), flood control, waterworks, farms, resorts and public facilities (ex. private and public schools), flood control roads and gates, agricultural roads and gates, harbor areas, etc.) for emergencies. Create a system of universal lock security access that is available to all emergency responders and landowners.
3.4.2 Road Networks	• MPD • County of Maui	Preparedness, Policy, Preparedness, Operational	**17. Severe congestion due to parked cars along neighborhood streets hindered evacuation and response efforts.**	**1.** The MPD and county authorities should assess the parking needs and challenges within neighborhoods. This may include evaluating factors, such as population density, housing types, availability of off-street parking, street width, proximity to commercial areas or public transportation, and existing parking issues.
3.4.2 Road Networks	• MPD • County of Maui • MEMA	Preparedness, Policy, Organizational, Operational	**18. Limited written traffic plans or guidelines for emergencies and escalating incidents.**	**1.** Develop a pre-incident plan for the MPD to manage traffic during a wildfire that involves coordinating efforts to ensure public safety, facilitate evacuation if necessary, and maintain traffic flow in affected areas. Update MPD G.O. 405.1 Traffic Section and G.O. 405.7 Traffic Direction and Control to include instruction on wildfire evacuation. **2.** Implement and enforce strict no-parking zones on critical streets and encourage the use of off-street parking solutions to reduce the number of vehicles parked on narrow streets. **3.** Where possible, redesign traffic flow in congested areas, including implementing one-way street systems, to optimize vehicle movement. **4.** Residents in areas with narrow streets should be educated on fire safety procedures, importance of clear buffer zones/ defensible spaces, and evacuation plans to ensure a more coordinated response.
3.4.2 Road Networks	• County of Maui • MPD • MFD	Preparedness, Operational	**19. Roadways and evacuation routes were not adequately maintained prior to August 8, 2023, to sustain effective evacuation efforts during the fire event.**	**1.** Identify, name, map, and provide signage on dirt roads that serve as alternate egress/evacuation routes so residents and emergency responders refer to them by the same name. **2.** Inspect and maintain dirt roads annually. Modernize, standardize, and maintain barriers on dirt roads to help ensure they can be used during emergencies. **3.** Where feasible, widen roads to accommodate more parking, traffic, and provide room for emergency vehicles.
3.4.3 Water	• State of HI • Maui Water	Operational	**20. The County of Maui Department of Water Supply was seemingly in compliance with the Water System Design Standards for the State of Hawai‘i in August 2023.**	**1.** Given the increasing threat of wildfires and wildfire-initiated urban conflagrations, it may be necessary for the State of Hawai'i to revisit its design standards and guidelines for storage and distribution systems that could be used for firefighting purposes.

6.1 APPENDIX

Reference Section	Relevant Department	Actionable Areas	Finding	Recommendations
3.4.3 Water	• Maui Water	Operational, Equipment	**21. No pumps are used outside of the water production facilities to provide pressure in the system. Both systems had uninterrupted electrical power during the August 2023 fires and produced water at capacity for the duration of the fire.**	N/A
3.4.3 Water	• Maui Water	Operational, Equipment	**22. The amount of drinking water in storage tanks at the beginning of the August 2023 fires seemingly met standard design requirements as required by the Water System Design Standards for the State of Hawai'i.**	N/A
3.4.3 Water	• Maui Water	Operational, Equipment	**23. As per the Phase One report (pages 237-239), the water supply monitoring system failed at 15:30 (3:30 p.m.) on August 8, 2023, and no storage tank data was recorded for the duration of the fire event. Once this data connection was lost, the County of Maui Department of Water Supply did not know how much stored water was available for firefighting during the fire.**	**1.** Develop, install, and maintain a resilient drinking water tank level monitoring system for the Lahaina and Māhinahina storage and distribution systems that can be monitored from the County of Maui EOC and other locations.
3.4.3 Water	• Maui Water	Operational	**24. As homes and other structures were damaged and destroyed by fire, household plumbing (e.g., plastic and other piping) inside of the buildings failed, allowing unrestricted flow of water from one (1) or more locations in each home or structure, resulting in water freely flowing from more structures and diminishing the overall water pressure and flow in the fire area.**	N/A
3.4.3 Water	• Maui Water	Operational, Training, Equipment	**25. As per the Phase One report (page 239), County of Maui Department of Water Supply employees were unable to enter the fire area to assist firefighters due to multiple factors, including traffic congestion and the danger presented by the fire. Firefighters did not have the time, training, or tools to shut off water.**	**1.** Develop a plan to coordinate with the County of Maui Department of Water Supply to address water system needs at the incident command post (ICP).
3.4.3 Water	• Maui Water	Operational	**26. Due to the hydraulics of the drinking water storage and distribution system, and given the excessive demand caused by the flow from damaged/destroyed structures, water was not provided with sufficient volume and sufficient pressure (i.e., the system could not meet the required demand) for use in firefighting for the entire August 2023 fire event.**	**1.** Perform a hydraulic analysis of both the Lahaina and Māhinahina storage and distribution systems. Use the results of this analysis to design larger and/or multiple interconnected pipes between the two (2) drinking water storage and distribution systems. Consider the use of pumps, as appropriate, to supplement pressure and volume. Determine pressure and volume limits for a major fire event that stakeholders understand and can operate to.

6.1 APPENDIX

Reference Section	Relevant Department	Actionable Areas	Finding	Recommendations
3.4.3 Water	• Maui Water	Operational	**27. Water quality and cost concerns make it impractical to size a drinking water treatment, storage, and distribution system to accommodate the firefighting demands for a urban conflagration event similar to the one that occurred in August 2023.**	**1.** Provide alternate means of firefighting water supply for extreme events. This may include portable pumps to draw water from public and private pools, ponds, and other bodies of water (including sea water), large diameter hose equipped apparatus, sites, or connections for marine vessels to draw water from the Pacific Ocean, and other means.
3.4.4 Electrical	• Hawaiian Electric	Organizational, Operational	**28. Hawaiian Electric (in partnership with the MFD and MPD) did not have an adequate staffing plan to prepare for the wildfire conditions of August 8, 2023.**	**1.** Hawaiian Electric should work closely with the MFD and MPD to develop a staffing plan in preparation for high fire danger days. The plan should include implementing spotters and an artificial intelligence-enabled camera network, which can assess vulnerable areas of the infrastructure so failure points can be addressed quickly; operating a dedicated phone line to the MFD and MPD to communicate power and repair status; and assigning a representative to the ICP.
3.4.4 Electrical	• Hawaiian Electric • MFD • State of HI	Prevention, Policy	**29. A lack of electrical utility vegetation abatement regulations and enforcement may have contributed to vegetation at the base of utility poles and near transmission lines, creating a receptive fuel source for arcing electrical wires.**	**1.** Hawaiian Electric should continue to work closely with the PUC to execute the Climate Adaptation Transmission and Resilience Program and develop a long-term investment plan to protect infrastructure from high wind events and wildfire. The plan should include immediate vegetation management and enforcement requirements, a phased approach for undergrounding transmission lines in vulnerable areas, strategic replacement of bare overhead wires with covered conductors, and a Public Safety Power Shut-off program.
3.4.4 Electrical	• Hawaiian Electric • County of Maui • State of HI	Prevention, Policy	**30. Hawaiian Electric did not have a Public Safety Power Shut-Off program in place at the time of the fire.**	**1.** Establish a Public Safety Power Shut-Off and communication protocol in collaboration with the community. Shutting off power to vulnerable areas of the grid reduces the chance of ignition due to electrical infrastructure failure.
3.4.4 Electrical	• Hawaiian Electric • Maui Water	Preparedness, Policy, Organizational, Operational	**31. The lack of execution of a Hawaiian Electric pre-event organizational plan led to having to staff more field positions during the event to address problems with electrical and water infrastructure.**	**1.** Hawaiian Electric to prepare a staffing plan that is coordinated with the pre-event incident action plan (IAP).
3.5 Communications	• MFD • MPD	Preparedness, Organizational, Operational	**32. Central Dispatch ("Central") was limited by the availability of equipment and personnel.**	**1.** Expand Central's surge capacity by increasing the terminals/necessary equipment for call taking and dispatching operations and consider training personnel (including members from the MFD or MPD) to serve as "call takers" capable of transferring emergency 911 calls, and managing the non-emergency/administrative calls. **2.** Complete a comprehensive study of Central Dispatch to assess staffing, workloads, and technology to identify any gaps or additional resource needs to help ensure resilient communication during major emergencies and disasters.
3.5 Communications	• MFD • MPD • County of Maui • MEMA	Organizational, Policy, Operational	**33. Central Dispatch, and many other responding personnel, were deeply affected by this incident.**	**1.** Continue providing opportunities for individuals and crews to meet for a "report back/debrief." Ensure members know warning signs for PTS, PTSD, depression, suicide, and related impacts on personnel mental health. Provide access to Employee Assistance Programs (EAP) and peer support networks—encourage use when warning signs are present.

6.1 APPENDIX

Reference Section	Relevant Department	Actionable Areas	Finding	Recommendations
3.5 Communications	• MFD • MPD	Organizational, Operational	**34. Dispatchers were responsible for monitoring multiple large fires and other associated events. Most of the dispatchers were experienced, but all dispatchers were overwhelmed and some expressed lack of adequate knowledge, ready access to needed information, and concern about the safety of the instructions they were providing callers. There were persistent communication challenges between Central, the MPD's Department Operations Center (DOC), and the EOC.**	**1.** Staff a MFD fire officer and a MPD officer at the rank of lieutenant (or higher) in Central Dispatch to aid with operational monitoring, EOC/DOC coordinations, incident tracking, communications, and assistance with command decisions when the EOC is activated.
3.5 Communications	• MFD • County of Maui • State of HI Organizational, Operational	Equipment, Organizational, Operational	**35. Private equipment operators primarily communicate with response entities and field personnel using personal cell phones.**	**1.** Create a formal communication plan for private contractors to use during emergency situations that includes resilient hardware and appropriate training.
3.5 Communications	• County of Maui • State of HI	Preparedness, Organizational, Operational	**36. Many residents did NOT receive a text notification from the county regarding the high winds and high fire danger.**	**1.** Assess the resiliency of communication systems and establish redundant public alert program and warning processes, including best practice messaging guidance.
3.5 Communications	• Hawaiian Electric • County of Maui • State of HI	Preparedness, Organizational, Operational	**37. Only one (1) siren from the All-Hazard Outdoor Warning Siren System was operable within the burn perimeter of the Lahaina area on August 8, 2023.**	**1.** Implement a statewide sustainable program for the All-Hazard Outdoor Warning System, which includes functioning hardware resilient against mass communications failure, regular maintenance, public education, additional resources and staffing.
3.5 Communications	• County of Maui • State of HI • MEMA	Preparedness, Operational	**38. The All-Hazard Outdoor Warning Siren System had not been utilized for warning of WUI fires prior to August 8, 2023. As of the publication date of this report, MEMA has implemented a process for activating sirens for wildfires.**	N/A
3.5 Communications	• MFD • MPD • MEMA • County of Maui	Preparedness, Policy, Organizational, Operational	**39. Even when people were told to evacuate and conditions seemed obvious that evacuation was necessary, many refused because there did not appear to be official notification that danger was imminent.**	**1.** Engage the community to provide additional public education regarding the importance of what to do in an emergency and to heed all evacuation instructions.
3.6 Incident Management	• MFD	Policy, Organizational, Operational	**40. Although there were opportunities for the MFD to provide staff support for the battalion chief(s) managing the incident, a formal command team was not established. The ICs were overwhelmed with the demands of the event and possessed limited situational awareness during a rapidly expanding emergency, which included a mayday; these factors contributed to challenges with tactical decision-making throughout the Lahaina PM fire.**	**1.** Review and modify the dispatch algorithm to reflect the resource availability. **2.** Provide the resources and training necessary to establish and maintain effective support for the initial incident commander (IC). **3.** Within MFD Hazard Zone Command SOG, include requirements for all chief officer engagement within the incident command structure for large complex incidents.

6.1 APPENDIX

Reference Section	Relevant Department	Actionable Areas	Finding	Recommendations
3.6 Incident Management	• MFD • MPD • Hawaiian Electric • Maui Water	Policy, Organizational, Operational	**41. The MFD and MPD never connected to establish a unified command.**	**1.** The MFD, MPD, and other assisting and cooperating agencies should include guidance within their respective incident management SOGs on when unified command should be considered and how it could be established.
3.6 Incident Management	• MFD • MPD	Organizational, Operational	**42. Available public safety resources were inefficiently utilized. This resulted in the failure to establish and scale an effective incident management organization during the first 24 hours of the incident.**	**1.** Provide sufficient staffing to establish and maintain an effective incident management organization, while maintaining the capacity to conduct unit-level tactical actions. Once established, develop a robust incident action plan (IAP). An IAP should outline objectives, strategies, and tactics for managing the incident, including evacuation procedures, traffic management, and resource allocation. Communicating the IAP to all responding personnel and stakeholders ensures a shared understanding of roles, responsibilities, and priorities.
3.6 Incident Management	• MFD • MPD	Policy, Organizational, Operational	**43. There was no comprehensive plan for the MPD's wildfire response.**	**1.** Develop a comprehensive plan in coordination with the MFD for MPD's response to a wildfire that prioritizes public safety, efficient evacuations, and effective traffic management.
3.6 Incident Management	• MPD	Policy, Organizational, Operational	**44. Limited sharing of critical information occurred between field operations units, the MPD Department Operations Center (DOC), and the EOC.**	**1.** Review and update policies and develop new processes for information flow between MPD Command Personnel on site, command staff, dispatch, and the EOC. **2.** All commanders, captains, and above should receive training on activation of the DOC and a Department Operations Center quick reference guide should be developed for commanders to be utilized for any crisis.
3.6 Incident Management	• MPD	Policy	**45. The MPD Natural and Man-Made Disaster Plan, G.O. 411.4, does not include wildfire incidents.**	**1.** Update policy to include plans specifically related to wildfires.
3.6 Incident Management	• MFD • MPD • MEMA	Preparedness, Policy	**46. There was limited pre-event incident action planning for anticipated events or incidents by the MFD, MPD, and MEMA.**	**1.** The MFD, MPD, and MEMA should update the current policies and procedures regarding pre-event planning (including preparing pre-event incident action plans), staffing, and equipment.
3.6 Incident Management	• MFD • MPD • MEMA	Policy, Preparedness, Organizational	**47. There were no written procedures or guidelines for Continuity of Operations (COOP).**	**1.** The County of Maui, MPD, and MFD to prepare Continuity of Operations Plans (COOP) that outline procedures to ensure essential functions can continue during and after various types of emergencies or disruptions.
3.6 Incident Management	• MEMA • HI-EMA	Preparedness, Organizational	**48. Communication was limited between MEMA and HI-EMA EOC.**	**1.** Additional resources are needed to have a persistent durable communication link prior to, and during, a major emergency or disaster event.
3.6 Incident Management	• MEMA	Preparedness, Operational	**49. Given the known conditions forecasted for the County of Maui on August 8, 2023, agency representatives self-reported to the EOC throughout the day, but full activation of the EOC did not occur until 16:30.**	**1.** Under similar conditions, and given appropriate resources, consider full activation earlier to aid collaboration between all relevant emergency support functions.

6.1 APPENDIX

Reference Section	Relevant Department	Actionable Areas	Finding	Recommendations
3.6 Incident Management	• MEMA	Preparedness, Policy, Organizational, Operational	**50. MEMA does not have a sufficient budget/personnel allocation to effectively and sustainably perform the wide range of preparedness, response, and recovery missions assigned to it.**	**1.** EOCs fulfill essential functions during emergencies and must be properly staffed and operationalized with (A) qualified overhead personnel to perform emergency management-related functions and (B) designated representatives from all cooperating/involved agencies/organizations to provide subject matter expertise, resource coordination/tracking, and immediate information relays to ICs in the field.
3.6 Incident Management	• MEMA	Organizational, Training, Operational	**51. During the EOC activation on August 8, 2023, there was a lack of clarity regarding the roles and responsibilities among MEMA personnel.**	**1.** Provide clearly defined roles and responsibilities for each staff member during EOC activations. Staff members should be trained and fully competent to fulfill their designated role. MEMA should also ensure staff training for secondary roles and responsibilities for when personnel are expected to shift to a different position (e.g., when vacancies occur).
3.6 Incident Management	• MEMA	Training, Operational	**52. Some MEMA personnel were unfamiliar with the software platform used for documentation and incident tracking during EOC activations.**	**1.** Ensure all personnel are fully trained and proficient with use of the designated EOC software program (WebEOC or any other software program designated by the MEMA Administrator). **2.** Ensure all MEMA EOC personnel understand the NIMS-ICS requirements for documentation during EOC activations.
3.6 Incident Management	• MEMA	Operational	**53. The EOC was overcrowded and personnel had to find alternative work locations.**	**1.** MEMA should examine the needs for the physical location and expand the EOC.
3.6 Incident Management	• MFD • MPD	Policy, Operational, Equipment	**54. Both the MPD and MFD were unable to maintain personnel accountability for officers, firefighters, and crews during the Lahaina PM fire.**	**1.** MPD roll calls should be initiated by dispatch and/or command staff as needed to maintain accountability. A policy should be established with defined roll call procedures. **2.** Ensure sufficient resources are available to support MFD Cs and division/group/unit-level supervisors with all functions of command/management, including personnel accountability. **3.** Adoption and consistent use of a common and resilient AVL platform on all MPD, MFD, and cooperators' (e.g., DOFAW, ARFF, and EMS) vehicles would assist dispatchers and command officers with personnel accountability and incident management.
3.6 Incident Management	• MFD	Operational, Training	**55. The MFD sponsors a Type 3 IMT that was not used August 8-9, 2023.**	**1.** Consider pre-deploying the Type 3 IMT when severe weather and/or fire danger conditions are forecasted. **2.** Enhance training and expand participation to include personnel from multiple disciplines, reinforcing the value of an all-hazards IMT and fostering collaboration across agencies. Consider securing training and experiences for Ocean Safety personnel to be able to perform in specific IMT overhead roles.
3.6 Incident Management	• Hawaiian Electric	Policy, Operational	**56. Hawaiian Electric should be at the incident command post (ICP), or tied in closely with the incident commander if an ICP is not established, to inform command of safety issues, other coordination opportunities, and act as a liaison to their organization.**	**1.** Create and follow a protocol to embed Hawaiian Electric representatives in the incident command post (when established) as liaisons.

6.1 APPENDIX

Reference Section	Relevant Department	Actionable Areas	Finding	Recommendations
3.6 Incident Management	• MFD • MPD	Operational, Equipment	**57. The MPD and MFD did not deploy or use the mobile command vehicle as per MPD G.O. 304.11. Deployment and use of the vehicle in Lahaina before the PM fire may have initiated the unified command organization that was absent throughout the PM fire.**	**1.** Follow G.O. 304.11 to ensure the mobile incident command vehicle is used for appropriately sized incidents, such as the Lahaina PM Fire. **2.** Deploy the mobile command vehicle at planned events to exercise the deployment process and equipment.
3.6 Incident Management	• MFD • MPD	Policy, Operational	**58. There were no established unit identifiers for off-duty MPD officers or supplemental MFD units.**	**1.** Create a call sign procedure for identification of off-duty MPD officers who self-deploy and MFD personnel assigned to supplemental MFD units. The existing MPD G.O. 301.5 policy should be revised regarding the establishment of call signs for incoming off-duty officers and self-deploying officers. The MFD should establish a policy to standardize identification of staffed supplemental resources.
3.7 Fire Supression	• MFD • MPD • MEMA • Maui Water • DLNR-DOFAW • Hawaiian Electric	Preparedness, Policy, Organizational	**59. The MFD did not have an organizational pre-plan for an anticipated high wind or extreme fire weather event.**	**1.** Ensure effective sensemaking of forecasts and real-time conditions through training and pre-planning. **2.** Implement organization-wide start-of-shift briefings to discuss extreme fire weather conditions. **3.** Ensure the ICS can scale up quickly, integrating additional support, including personnel normally serving in administrative roles or other functions (e.g., fire prevention, ocean safety, and training), as needed. Provide training and protocols for pre-deployment. **4.** Communicate anticipated environmental conditions, risks, and performance expectations across organizations. This includes the MPD, MEMA, County of Maui Department of Water Supply, DLNR-DOFAW, and Hawaiian Electric, who reacted to environmental conditions only after problems arose. **5.** Develop a system for ongoing situational awareness that includes continuous monitoring of weather forecasts, fuel moisture levels, and fire behavior through real-time data and predictive models.
3.7 Fire Supression	• MFD • MPD • DLNR-DOFAW • Hawaiian Electric • Maui Water	Preparedness, Policy, Operational, Equipment	**60. With the impending forecast of severe fire weather, there was limited pre-deployment of additional public safety resources prior to the first fire event.**	**1.** With the potential impact of hurricanes like Dora and Red Flag conditions, the MFD, MPD, DLNR-DOFAW, and their cooperators should consider deploying additional resources across Maui Nui. **2.** Identify fire apparatus, incident management, and law enforcement resources for upstaffing and pre-deployment when severe conditions are forecasted. **3.** Ensure sufficient fire apparatus, response vehicles, portable equipment, PPE, and radios are available to resource the pre-deployment of additional response units and overhead assets. Whenever possible, standardize the equipment loadout on similar apparatus/vehicles to facilitate use by callback personnel. **4.** Consider providing dedicated personnel and resources for staffing management and callback, on a daily basis and before/during major incidents, to make command-level resources readily available for strategic/tactical ICS roles.

6.1 APPENDIX

Reference Section	Relevant Department	Actionable Areas	Finding	Recommendations
3.7 Fire Supression	• MFD • MPD • County of Maui • State of HI • HI-EMA • MEMA	Preparedness, Prevention, Policy, Organizational, Training, Operational	**61. There appears to be a statewide culture of dismissing and/or under-recognizing wildfire risk. The underfunding and under-addressing of preparedness, planning, and mitigation efforts significantly impacts all parts of the system and fire outcomes. This cannot be overstated.**	**1.** Establish a culture of respect for extreme conditions and the need for operational adjustment.
3.7 Fire Supression	• MFD • MPD • DLNR-DO-FAW	Preparedness, Policy, Organizational, Operational	**62. DLNR-DOFAW resources, specialized wildfire equipment, and trained personnel were underutilized due to restrictive fire response zone guidelines.**	**1.** Incorporate land ownership maps into incident reporting and tracking to ensure that state and federal agencies with response duties and wildland firefighting capacity are notified and activated. **2.** Review and revise master mutual aid agreements for all fire suppression resources on Maui Nui, including, but not limited to, the MFD, ARFF, DLNR-DOFAW, and National Park Services to ensure optimal readiness and response for multi-hazard disasters.
3.7 Fire Supression	• MFD • MPD • County of Maui	Preparedness, Policy, Operational	**63. Densely populated and narrow roadways hindered both MFD and MPD movement during suppression (as well as evacuation and rescue) efforts. Apparatus positioning was not always optimal, due in large part to an overall lack of situational awareness about the location, severity, and trajectory of the fire(s).**	**1.** Responding MFD units should have pre-determined plans and operating practices for specific areas with narrow streets, outlining alternative access points, water supply strategies, evacuation procedures, and addressing the needs of vulnerable members of the community. **2.** Place hardcopy maps, mapbooks, and pre-incident plans in all response vehicles to provide redundancy if cellular network communication is unavailable.
3.7 Fire Supression	• MFD • MPD • Hawaiian Electric	Policy, Operational	**64. The uncertainty around the status of power in the area created numerous impacts on MPD and MFD response to the incident.**	**1.** As previously mentioned, Hawaiian Electric should have a representative at the ICP (when established).
3.7 Fire Supression	• MFD • DLNR-DO-FAW	Policy, Operational, Equipment, Training	**65. Private heavy equipment contractors lacked appropriate training, PPE, equipment, and communications.**	**1.** Strengthen the coordination with private contractors and address limitations in training, equipment (including standardizing equipment to ensure compatibility with all fire suppression resources), PPE, and communication.
3.7 Fire Supression	• MFD • DLNR-DO-FAW	Policy, Operational, Training	**66. A portion of the mopup area was difficult to access and posed safety threats.**	**1.** Include DLNR-DOFAW resources on initial response to vegetation and WUI fires. **2.** Ensure all personnel have the training to identify and establish safety zones and escape routes, and have protocols in place for communicating this to crews. **3.** Communicate the wildfire risk to all department members to set and/or reinforce expectations related to fire mopup procedures.
3.7 Fire Supression	• MFD	Policy, Operational, Training	**67. MFD firefighters performed mopup as proven successful under typical weather conditions. However, under the severe weather conditions on August 8, 2023, this level of mopup appears to have been insufficient.**	**1.** Revise policies, procedures, and trainings (E.O. 302.14) that address wildland firefighting (specifically mopup operations) to be in alignment with NWCG guidelines. **2.** Implement schedules to manage responder fatigue, ensuring adequate rest periods and meals.

6.1 APPENDIX

Reference Section	Relevant Department	Actionable Areas	Finding	Recommendations
3.7 Fire Supression	• MFD	Policy, Operational, Training	**68. MFD wildland firefighting training, equipment, and staffing should be commensurate with the level of wildfire risk faced by firefighters.**	**1.** Conduct a comprehensive audit and gap analysis of existing MFD operating procedures/practices against relevant Occupational Safety and Health Administration (OSHA) regulations, National Fire Protection Association (NFPA) standards, fire service best practices, and NWCG standards/guidelines to help ensure compliance with industry regulations and best practices. By conducting an audit and implementing recommended improvements, the MFD can create a safer working environment for its personnel and enhance the effectiveness of its firefighting and rescue efforts for all incident types. **2.** Review the implementation of the MFD's 36-hour rule for alignment with operational needs during disasters and major emergencies. **3.** Consider developing a WUI firefighting playbook to address the increasingly severe wildfire threat across Maui Nui. Look to departments that respond to WUI incidents for expertise and protocols, such as California. **4.** Deliver training on, and provide a copy in all response vehicles, the NWCG Incident Response Pocket Guide (IRPG), PMS 461. **5.** Provide additional wildfire and WUI firefighting training and experiences (such as shadowing incident management personnel in other areas) for MFD personnel. **6.** Continue providing medical monitoring and behavioral health support for responders and support personnel.
3.7 Fire Supression	• MFD	Policy, Training, Operational	**69. Many initial attack resources were burned over due to fighting fire from a downwind position.**	**1.** Train firefighters about the impact of wind on fire progression and fire suppression techniques as per evidence based information and best practices.
3.7 Fire Supression	• MFD • DLNR -DO-FAW	Policy, Training, Operational	**70. Standard wildland firefighting operating procedures for the DLNR-DOFAW and MFD are not in alignment.**	**1.** The DLNR-DOFAW and MFD should collaborate to update and integrate standard operating guidelines and training for wildland firefighting.
3.8 Evacuation	• MFD • MPD	Policy, Training, Operational	**71. Unified coordination of evacuation procedures among the MPD, MFD, and other agencies may have facilitated more efficient egress of residents.**	**1.** Create, review, and implement an interagency comprehensive evacuation plan based on risk and resources. Integrated emergency response plans involving local, state, and federal agencies, as well as non-governmental organizations, should be developed, with regular joint training exercises to ensure smooth coordination during actual emergencies. **2.** The MPD should regularly train for wildfire evacuations, familiarizing themselves with evacuation procedures and protocols. This training enhances response capabilities and ensures a swift and organized evacuation process when wildfires threaten communities.

6.1 APPENDIX

Reference Section	Relevant Department	Actionable Areas	Finding	Recommendations
3.8 Evacuation	• MFD • MPD • County of Maui	Preparedness, Policy, Operational	**72. During the evacuations, there were lapses in coordination and communication that could have reduced efficiency.**	**1.** Pre-plan evacuation routes. Effective evacuations during a wildfire, such as the Lahaina PM fire, require planning, coordination, and adherence to best practices. A key aspect is comprehensive pre-event planning, which involves identifying evacuation routes (including unnamed dirt roads), establishing communication protocols, and conducting drills to ensure readiness. **2.** Sufficient personnel are needed to manage traffic, provide assistance to evacuees, and maintain public safety. Adequate staffing levels enable timely and orderly evacuations, reducing the risk of congestion and confusion. **3.** Create and implement comprehensive traffic management plans that account for limited access and egress routes, including pre-planned alternate routes and strategies to manage congestion. **4.** Ensuring gates blocking potential evacuation routes are equipped with standardized locks and that emergency responders have the necessary keys or access codes is also vital. **5.** Develop comprehensive support systems for residents who need to evacuate–especially those with access and functional needs–including temporary housing, transportation assistance, and access to essential services. By addressing these key areas, the Maui community can improve its preparedness for future wildfires and other emergencies, ensuring better protection of lives and property. **6.** Volunteer training programs, such as those for Community Emergency Response Teams (CERT), should be expanded to assist with evacuation efforts and provide support during emergencies. Additionally, specific evacuation plans for vulnerable populations, including the elderly, disabled, and those without transportation, should be created, with community support networks established to assist these individuals during evacuations. Engage community organizations and CERT teams to provide additional support in evacuation efforts.
3.8 Evacuation	• MPD	Policy, Operational, Equipment	**73. While some Body-Worn Cameras (BWC) were activated (in keeping with the current policy), several files provided by the County of Maui were unreadable.**	**1.** Update the MPD's G.O. 304.12 policy to have BWCs activated upon dispatch and include a quality-control program to ensure all equipment is functioning properly and producing usable audio visual assets. **2.** The MPD should follow G.O. 304.12.
3.8 Evacuation	• MPD	Equipment, Training	**74. MPD officers experienced difficulty hearing radio traffic due to the wind and noise from the fire.**	**1.** Issuing radio earpieces to all officers will enhance communication, allowing them to stay informed and coordinate effectively during incidents. Officers should receive training on the proper use and maintenance of these earpieces to maximize their benefits.

6.1 APPENDIX

Reference Section	Relevant Department	Actionable Areas	Finding	Recommendations
3.8 Evacuation	• County of Maui • MEMA	Preparedness, Policy, Equipment, Operational	**75. The alert systems in place did not adequately inform residents of inherent dangers.**	**1.** Developing and implementing multiple alert systems, including sirens, radio broadcasts, and door-to-door notifications, can ensure that evacuation orders reach all residents, especially when cell service and electrical power are lost. **2.** Expand community engagement and preparedness efforts with public awareness campaigns that emphasize the importance of evacuation and the risks of staying behind during wildfires, encouraging residents to have a personal evacuation plan that includes considerations for pets and family members with special needs. **3.** Educate the public about evacuation procedures and safe routes, and the importance of establishing family evacuation plans and having prepared “go-bags.” Regular drills and informational sessions can reinforce this knowledge, while localized communication networks, such as neighborhood watch groups or community liaisons, can assist in disseminating information.
3.8 Evacuation	• MFD • MPD	Preparedness, Policy, Equipment, Operational	**76. MPD officers encountered barriers to roads that could have been (and eventually were) used as alternate egress routes and lacked equipment to navigate these barriers.**	**1.** Perform annual status checks of emergency gates throughout the community. **2.** Equip police vehicles with disaster response kits, including appropriate PPE, to be able to facilitate evacuations and remove barriers from potential escape exits, such as chain link fences, gates, and boulders. **3.** The MFD to establish new policy/General Order for the provision of fire- and disaster-related emergency tools for patrol, such as bolt cutters, tow straps, etc.
4.0 Built Environment	• MFD • County of Maui • State of HI	Prevention, Preparedness, Policy	**77. Numerous stakeholder organizations (state, county, community, and HWMO) have collaborated to evaluate wildfire risk per West Maui CWPP.**	**1.** Hold a statutory organization accountable for executing the preparedness plans commensurate with the risk identified through these efforts. **2.** Adopt and enforce contemporary codes and standards for building construction in wildfire prone areas.
4.0 Built Environment	• MFD • County of Maui • State of HI	Prevention, Preparedness, Policy	**78. Codes and standards exist for addressing fire hazards of exterior vegetation (16.04D Subsection 10.13.10), but they require enhancement based on risk and current guidelines.**	**1.** Update, implement, and enforce fuel management and defensible space around structures.
4.0 Built Environment	• MFD • County of Maui • State of HI	Research, Prevention, Policy	**79. Some vegetation adjacent to structures survived where the structure was not destroyed.**	**1.** Additional research is necessary to understand the potential for lush, well-watered, and well-mainted vegetation to provide benefits (e.g., radiation shielding) that is not outweighed by the hazard.
4.0 Built Environment	• MFD • County of Maui • State of HI	Prevention, Policy	**80. Ember penetration through building envelopes, including roofs, vents, and windows, is a common pathway for building ignition.**	**1.** Buildings should be constructed and maintained to resist ember intrusion. This will include construction features (vents, roofs, etc.). **2.** Adopt stronger WUI codes (e.g., ICC International Wildland-Urban Interface Code and NFPA 1140: Standard on Wildland Fire Protection) or WUI Structure/Parcel/Community Hazard Mitigation Methodology guidance.

6.1 APPENDIX

Reference Section	Relevant Department	Actionable Areas	Finding	Recommendations
4.0 Built Environment	• MFD • County of Maui • State of HI	Prevention, Policy	**81. Window and doors were left open prior to evacuation.**	**1.** Residents and citizens should be educated on the importance of closing building openings as an important component of preparation for, and departure from, a home during an evacuation—part of a "Ready, Set, Go: Close Before You Go" campaign.
4.0 Built Environment	• MFD • County of Maui • State of HI	Prevention, Policy	**82. Age of construction is not a primary indicator of structure survival (correlation not causation).**	**1.** Ensure properties and areas around structures are well-maintained, despite the structures' age (i.e., newer structures are not exempt).
4.0 Built Environment	• MFD • County of Maui • State of HI	Prevention, Policy, Operational	**83. Defensive actions appear to have lessened fire impact in the built environment.**	**1.** Identify fire suppression strategies and tactics commensurate with resources and infrastructure capabilities and availability. Preplan based on these limitations and local conditions.
4.0 Built Environment	• MFD • County of Maui • State of HI	Prevention, Policy	**84. Fuel breaks, such as Kahoma Stream, Kaua'ula Stream, Keawe Street Apartments at the Villages of Leiali'i construction site, and grass athletic fields by the Boys and Girls Club/Lahaina Recreation Center, appear to have impacted fire progression.**	**1.** Investigate zoning changes to incorporate fuel breaks in areas within the community to slow fire progression and to act as safe refuge areas for evacuating residents.

6.2 Lahaina Fire Comprehensive Timeline Report and Minute-by-Minute Timeline

Fire Safety Research Institute
Steve Kerber and Derek Alkonis
April 17, 2024

https://doi.org/10.54206/102376/VQKQ5427

This is a collection of data points gathered from Maui County dispatch records and transcriptions, body camera recordings, weather reports, social media posts, emergency management logs, and other sources. These data points occur prior to and during the fire of August 8-9, 2023, in Lahaina, Hawaii.

The information collected for this spreadsheet is sorted chronologically and represents the data provided to Fire Safety Research Institute (FSRI) by Maui County and cooperating agencies and should not be considered a complete record of events.

Records highlighted in blue are referenced in the Lahaina Fire Comprehensive Timeline Report (Phase 1) prepared by FSRI.

The Lahaina Comprehensive Timeline Report is available free of charge from: https://ag.hawaii.gov/maui-wildfire-investigation-re-sources-page/ or https://doi.org/10.54206/102376/VQKQ5427

© 2024 Underwriters Laboratories Inc.

Fire Safety Research Institute

The Fire Saftey Research Institue (FSRI) strives to advance fire safety knowledge and strategies in order to create safer environments. As part of UL Research Institutes, the nonprofit saftey science organization within the UL enterprise, FSRI uses advanced fire science, rigorous research, extensive outreach, and education in collaboration with an international network of partners to impact stakeholders with knowledge, tools, and resources that enable them to make better, more fire safe decisions, ultimately saving lives and property. To learn more, visit fsri.org. Follow FSRI on Twitter, Instagram, Facebook, and LinkedIn.



UL Research Institute is a nonprofit research organization dedicated to advancing public safety through scientific discovery. Since 1894, our research has advanced our mission toward a safter, more secure, and sustainable future. Focused on global risks from fire mitigation and air quality to safe energy storage and digital privacy, we conduct rigorous independent research, analyze safety data and partner with experts to uncover and act on existing and emerging risks to human safety. Discover more at UL.org.

6.3 Lahaina Resident Technical Discussion Summary – March 3, 2024

Lahaina Resident Summary March 3, 2024

#1) How long have you lived in Lahaina?

70 Responses

Mean	29.79 years	(average)
Median	30 years	(middle value)
Mode	30 years	(most frequently repeated value)
Longest	82 years	
Shortest	2 years	

#2) Was the 8th the windiest day you've ever experienced in Lahaina?

70 Responses

Yes	95.71%	(67/70)
No	4.29%	(3/70)

Most were around during the 2018 Wind/Fire event and many were there during multiple tropical storms and stated 8/8 was the windiest and most destructive wind event they have experienced

#3) Were you aware the 8th was going to be a windy day?

64 Responses

Yes	59.38%	(38/64)
No	40.63%	(26/64)

Those that did know it was going to be windy stated that they did not expect it to be as strong

#4) Were you without electricity? If so, when?

61 Responses

98.36% (60/61) stated they lost power

52 Responses gave a time they lost power

- 30.76% - "Early or AM"
- 23.08% - Before 0400
- 19.23% - 0401-0500
- 5.77% - 0501-0600
- 13.46% - 0601-0700
- 7.70% - 0701-0900

Lahaina Resident Summary March 3, 2024

0% - After 0900

Due to the early hours of the power outages, most of the respondents became aware when they woke up or when their AC units tripped off causing them to wake up.

97.22% (35/36) that gave a time lost power at or before 0800,

88.88% (32/36) lost power before 0700.

69.44% (25/36) that gave a time lost power at or BEFORE 0600.

#5) Were you without water? If so, when?

44 Responses

86.36% (38/44) reported they lost water

24 Responses gave a time they lost water/pressure

8.3% - BEFORE 1400

12.5% - 1401 and 1500

12.5% - 1501 and 1600

37.5% - 1601 and 1700

16.7% - 1701 and 1800

12.5% - AFTER 1800

14 Responses - Lost water, No time given

Determining when/if water/water pressure was lost is more difficult than other utilities. Many who may not have had water at their residence might not have noticed unless they tried to use their garden hoses to protect their property. Also they may have evacuated before their area lost water/pressure.

#6) Did you receive a text notification from the county regarding the high winds and high fire danger? If so, what day and time? Can we see it?

62 Responses

Lahaina Resident Summary March 3, 2024

87.32% (62/71) stated they did NOT receive a text notification

12.68% (9/71) stated they DID receive a text notification

There were a lot of comments regarding text notifications. Vast majority stated they received no notification prior to or during the event. Some stated that they did not receive texts/alerts while the person next to them did. As the event progressed power and mobile service was lost there was no communication possible even if alerts were being sent. Another concern was those who did receive alerts during the fire, many reported that it did NOT come in a text rather in a scrolling message that came across their screen and could not be retrieved/reread. Overall did not increase awareness or urgency of need to evacuate in those that did receive and was ineffective at reaching the broader population.

#7) Did you see or hear TV or radio newscasts regarding the high winds and high fire danger?

71 Responses

62.20% (38/71) Did NOT see or hear newscasts

37.80% (23/71) DID see or hear newscasts

Almost 2/3 of residents did NOT see or hear warnings.

Those that did stated overwhelmingly they did not expect the severity of the wind event after watching/hearing newscasts.

All TV and most radio broadcasts would have been on the day prior 8/7 as there was no power or cell service in most of Lahaina from early AM on the day of the fire.

#8) When and where did you first see the fire?

59 Responses

16 First saw the AM fire

0634 Mean

0630 Median

0630 Mode

Lahaina Resident Summary March 3, 2024

43 First saw the PM fire

1514 Mean

1526 Median

1500 Mode

Most that witnessed the AM fire were at their residences in the area of Ku'ialua St. and Lahainaluna Rd.

Identified individual (Survey 15) that witnessed ignition of AM fire

Mix of residence and work locations for the PM fire

Many of the PM responses did not see active flame only Smoke

All that saw the AM fire also saw the PM fire

#9) Were you instructed to evacuate? If so, by who and when?

79 Responses

No – 59.49% (47/79)

Yes – 40.51% (32/79)

Majority indicated they did not receive an order to evacuate (56.1%)

Those that did were urged by friends/neighbors or MPD.

MPD was driving around on loudspeakers notifying residents they needed to leave area. Many commented they could not hear what was being said and there were no instructions on evacuation route to take, direction to head, or destination to head to.

#10) If you evacuated, which direction did you go and which road did you use and were there any obstructions, like trees and/or power poles or wires?

77 Responses

Yes – 83.12% (64/77)

No – 16.88% (13/77)

The route taken was most often determined by their start location.

Most headed North toward the Lahaina Civic Center as that is the Shelter most often used during emergency evacuations.

Lahaina Resident Summary March 3, 2024

Downed power poles and lines were the most common obstruction regardless of direction taken. There were long lines and delays on roads heading West (Makai) toward Honoapi'ilani highway and North and South leaving Lahaina town. Traffic was so bad on Komo Mai that many turned around and went up towards the bypass. Reports of downed power poles and lines all over Lahaina town. Traffic along Front St. was described as a "parking lot"

#11) Did you encounter police officers? If so, where and what were they doing?

68 Responses

Yes 79.41% (54/68)

No 20.59% (14/68)

Police were most often encountered by residents during the evacuation from their residence/business directing traffic. The second most common occurrence was driving around alerting residents to evacuate.

#12) Did you encounter fire fighters? If so, where and what they were doing?

67 Responses

No 53.73% (36/67)

Yes 46.8% (31/67)

Firefighters were most often encountered by residents who witnessed the morning fire or initial phases of the afternoon fire. FF were most often seen during the AM fighting the fire off Lahainaluna Rd. East of the bypass.

FF were most often seen during the PM fighting fires in the residential neighborhoods West of the bypass, North of Lahainaluna.

In the PM, FF's were working in areas most heavily involved which were evacuated or evacuating. Residents stated they either heard or saw FF's responding.

#13) Did you participate in firefighting? If so, where and what did you do?

70 Responses

6.3 APPENDIX

Lahaina Resident Summary March 3, 2024

No 68.57% (48/70)

Yes 31.43% (22/70)

The majority of the residents did not participate in any firefighting actions. Those that did primarily extinguished small fires around their homes or wet down home/vegetation.

There were varying degrees of success. Those living near the origin of the PM fire were much more successful in saving their homes than those whose residence/business were impacted later.

6.4 Subpoena Requests

Table 6.4.1 Subpoena Requests.

Subpoena No.	Service Date	Description (Summary)	Response Deadline	*Email Requests	Actual Response Date
2023-084 Maui Emergency Management Agency	Nov. 27, 2023	(1a) Current editions, as of August 2023, for all emergency management-relatedplans for Maui County. Including, but not limited to: (1b) the Maui County Emergency Operations Plan (EOP), (1c) the West Maui Emergency Plan, and (1d) any operational and/or tactical plans addressing wildfire, wind, tsunami, evacuation, emergency notification, alert/warning, and other related planning documents. (Note: We have the May 2021 EOP, and the May 2018 West Maui Emergency Plan. We are mostly interested in specific operational and/or tactical plans addressing specific emergencies, and more specifically wildfire or wildland-urban interface (WUI) fires.)	Dec. 11, 2023	Sept. 24, 2023	All Items: Oct. 13, 2023 Nov. 21, 2023 Confirmed latest via Prod. Log note
		(2) All drafts, updates, and/or revisions to the West Maui Emergency Plan draft document dated May 14, 2018.		Oct. 20, 2023	(2) Oct. 13, 2023 Nov. 21, 2023 Confirmed latest via Prod. Log note
		(3) All drafts, updates, and/or revisions to the Maui County Emergency Operations Plan, May 2021 edition (“Basic Plan”).		Oct. 20, 2023	(3) Oct. 13, 2023 Nov. 21, 2023 Confirmed latest via Prod. Log note
		(4) All “Functional and Hazard Annexes” included/referenced in Sections III and IV of the Basic Plan, May 2021 edition.		Oct. 20, 2023	(4) Oct. 13, 2023 Nov. 21, 2023 Confirmed latest via Prod. Log note
		(5) All draft and completed “Functional and Hazard Annexes,” to the Basic Plan, for wildfire-related activities and/or WUI fires.		Oct. 20, 2023	(5) Nov. 14, 2023 None
		(6) All after-action reviews (AARs) and records of any Maui County exercises (table-top, functional, full-scale) conducted for wildfire and/or WUI fires from 2013-2023.		Oct. 20, 2023	(6) Nov. 14, 2023 None recorded in Production Log

Subpoena No.	Service Date	Description (Summary)	Response Deadline	*Email Requests	Actual Response Date
		(7) All Maui County departmental strategic plans, policies, or procedures that support the Maui County Emergency Operations Plan.		Oct. 20, 2023	(7) Nov. 27, 2023
		(8) Records of daily Maui County Emergency Operations Center (EOC) activation status for the period 1-15 August 2023.		Oct. 20, 2023	(8) Dec. 13, 2023 Comms Test Log
		(9) Identification and contact information for the Maui County officials listed in Figure 5 "Lines of Succession" of the Maui County EOP, May 2021 edition, from 7-10 August 2023.		Oct. 20, 2023	(9) Dec. 13, 2023
		(10) Daily EOC organizational chart(s), by National Incident Management System Incident Command System (NIMS-ICS) role(s) and/or emergency support function(s) (ESF) for the period August 7-10, 2023		Oct. 20, 2023	(10) None recorded in Production Log
		(11) Rosters, sign-in sheets, logs, and documents, physical or electronic, listing all personnel that staffed the EOC from 8:00 p.m. on August 7, 2023, through 8:00 p.m. on August 10, 2023, as well as an accounting of the time(s) that each person was present in the EOC.		Aug. 31, 2023, Sept. 24, 2023, Oct. 20, 2023	(11) Nov. 27, 2023 Update Dec. 6, 2023 Still missing info.
		(12) All documents, physical or electronic, that were developed in the EOC during the time period from 8:00 p.m. on August 7, 2023, through 8:00 p.m. on August 10, 2023.		Oct. 20, 2023	(12) Dec. 13, 2023 Missing many Update Feb. 8, 2024 Still missing info.
		(13) Records of all communications made to or by the MEMA Administrator from 8:00 p.m. on August 7, 2023, through 8:00 p.m. on August 10, 2023. These records may include but are not limited to: texts, phone calls, and emails.		Oct. 20, 2023	(13) Dec. 13, 2023
		(14) Transcripts and records maintained by any electronic emergency management system, such as WebEOC, from 8:00 p.m. on August 7, 2023, through 8:00 p.m. on August 10, 2023.		Oct. 20, 2023	(14) Dec. 13, 2023 RFAs only. Missing info.

Subpoena No.	Service Date	Description (Summary)	Response Deadline	*Email Requests	Actual Response Date
		(15) Copies of all incident action plans (IAPs) for the fire events that occurred in Maui County on August 7-10, 2023 (“Maui Fires”) that were developed from 8:00 p.m. on August 7, 2023, through 8:00 p.m. on August 10, 2023.		Oct. 20, 2023	(15) Dec. 6, 2023 Update on Dec. 21, 2023
		(16) Recordings of all EOC operations and of images from cameras located in the community that were viewed in the EOC from 8:00 p.m. on August 7, 2023, through 8:00 p.m. on August 10, 2023.		Oct. 20, 2023	(16) Dec. 6, 2023
		(17) Training/certification and exercise records for MEMA and MEMA employees for the past two (2) years (NIMS-ICS and other), including individual qualifications, local exercises, statewide exercises, and coordinated exercises with Federal and NGO partners.		Oct. 20, 2023	(17) Dec. 13, 2023
		(18) Information on all preparedness messaging addressing the August 2023 wind event that may have been distributed by MEMA and/or Maui County prior to the Maui Fires. This includes, by way of illustration and not limitation, media releases, outreach campaigns, social media, Integrated Public Alert and Warning System (IPAWS), Wireless Emergency Alerts (WEA), and/or directives.		Oct. 20, 2023	(18) Nov. 30, 2023
		(19) All maintenance and testing logs for the statewide alert and warning siren system in Maui County.		Oct. 20, 2023	(19) Dec. 13, 2023
2023-085 Maui Public Works	Nov. 27, 2023	(1) Maui County DPW or Hawai‘i Department of Transportation Brush Clearance Standard Operating Guidelines (SOG)	Dec. 11, 2023	Sep. 24, 2023	(1) Oct. 23, 2023 None as per DPW Hwy Divs
		(2) Maui County DPW Brush Clearance Records in Lahaina are from January 1, 2020 to August 8, 2023		Sep. 24, 2023	(2) Nov. 24, 2023

6.4 APPENDIX

Subpoena No.	Service Date	Description (Summary)	Response Deadline	*Email Requests	Actual Response Date
2023-086 Maui Department of Water Supply	Nov. 27, 2023	(1) All records describing (size, location, permitted and operating capacity, etc.) the drinking water production facilities feeding the storage and distribution system;	Dec. 11, 2023	Oct. 25, 2023	(1) Dec. 13, 2023
		(2) The typical operating methodology for the drinking water treatment, storage, and distribution system in Maui County;		Oct. 25, 2023	(2) Dec. 13, 2023
		(3) Documentation giving a general description of the water storage and distribution system components;		Oct. 25, 2023	(3) As per County of Maui, sharing information requires approval of the Department of Homeland Security (DHS). Discussed during site visit Jan. 22-23, 2023 (accompanied by Deputy Director Landgraf).
		(4) All records showing the water levels in the storage tanks under normal operating conditions, just before the fire event and during the fire event;		Oct. 25, 2023	(4) Dec. 13, 2023
		(5) Design and operating information for the storage system including locations of the storage tanks and distribution system pumps;		Oct. 25, 2023	(5) For DHS approval see above. Discussed during site visit Jan. 22-23, 2023
		(6) Available fire storage capacity in the system under normal operating conditions;		Oct. 25, 2023	(6) For DHS approval see above. Discussed during site visit Jan. 22-23, 2023
		(7) All documentation showing distribution system connections between the East (mauka) and West (makai) sides of Maui;		Oct. 25, 2023	(7) For DHS approval see above. Discussed during site visit Jan. 22-23, 2023
		(8) Documentation showing the size of the distribution system pipes connected to the fire hydrants in the primary area of the Lahaina fire system;		Oct. 25, 2023	(8) For DHS approval see above. Discussed during site visit Jan. 22-23, 2023
		(9) Documentation showing the types of pipe materials used in the distribution		Oct. 25, 2023	(9) Dec. 13, 2023

6.4 APPENDIX

Subpoena No.	Service Date	Description (Summary)	Response Deadline	*Email Requests	Actual Response Date
		(10) Documentation showing the typical depth of the pipes in the distribution system;		Oct. 25, 2023	(10) Dec. 13, 2023
		(11) The emergency operating plan, if any, for a major water usage event;		Oct. 25, 2023	(11) For DHS approval see above. Discussed during site visit Jan. 22-23, 2023
		(12) All records of how the storage and distribution system was brought back online assuming a loss of pressure during the fire event.		Oct. 25, 2023	(12) No docs available. Comms via non recorded radio trans.
		*Unless stated otherwise, all requests pertaining to regularly updated plans, procedures, or other documents, are for the version that was in use on August 7-9, 2023.		Oct. 25, 2023	
2023-101 Maui Police Department	Dec. 29, 2023	(1) Automated Vehicle Location data for Aug. 8, 2023	Jan. 4, 2024	Sep. 24, 2023	All items: Jan. 18, 2024
		(2) Computer Aided Dispatch record for Aug. 8-10, 2023		Aug. 31, 2023 & Oct. 24, 2023	
2023-102 Maui Fire Department	Dec. 29, 2023	(1) Automated Vehicle Location data for Aug. 8, 2023	Jan. 4, 2024	Sep. 24, 2023	(1) Jan. 18, 2024
		(2) Computer Aided Dispatch record for Aug. 8-10, 2023		Aug. 31, 2023 & Oct. 24, 2023	(2) Jan. 18, 2024
2023-103 Maui Police Department	Dec. 29, 2023	(1) Definitions of MPD dispatch codes and identifiers, including abbreviations found in MPD Event Chronologies and Dispatch Reports for Aug. 8-10;	Jan. 12, 2024	Nov. 16, 2023	(1) Jan. 24, 2024
		(2) Documents describing unit codes;		Nov. 16, 2023	(2) Jan. 18, 2024
		(3) Policies for assigning “UDTH” event types;		Nov. 16, 2023	(3) Jan. 18, 2024
		(4) Documents defining UDTH event types;		Nov. 16, 2023	(4) Jan. 18, 2024
		(5) All recorded MPD radio comms for 8/8 – 8/10;		Aug. 31, 2023	(5) Jan. 17, 2024
		(6) Staffing rosters for 8/7, 8/8, 8/9;		Aug. 31, 2023	(6) Jan. 24, 2024
		(7) Training records for MPD personnel from date of hire to 8/8/23;		Subpoena only	(7) Jan. 24, 2024 (Not in proper format)

6.4 APPENDIX

Subpoena No.	Service Date	Description (Summary)	Response Deadline	*Email Requests	Actual Response Date
		(8) Records of mandatory/ recommended educational and training requirements for each MPD position;		Subpoena only	(8) Jan. 24, 2024 (Does not match request - produced general travel records only
		(9) Personnel deployment assignments, 2018 – 2023;		Subpoena only	(9) Jan. 24, 2024 (Does not match request)
		(10) Policies and procedures for responding to wildfire or wildland-urban interface (WUI) events;		Subpoena only	(10) Jan. 18, 2024 (partial, and records are not responsive – Natural and Manmade Disaster Plan is only record produced)
		(11) Evacuation plans and analyses;		Subpoena only	(11) Jan. 24, 2024 (Does not match request)
		(12) After Action Reports related to any and all wildfire incidents, WUI incidents, or mass evacuations;		Subpoena only	(12) No documents produced to date
		(13) Powerpoint presentation shared by Sgt. Chase Bell during Maui Police Commission meeting, Sep. 20, 2023		Subpoena only	(13) Jan. 24, 2024
2023-104 Maui Fire Department	Dec. 29, 2023	(1a) Current Fire and Rescue Operations Division personnel training/certification records for wildland firefighting, WUI firefighting, structural firefighting, incident management/command/organization, emergency medical care and/or first aid, and radio operations;		Subpoena only	(1a) Jan. 24, 2024 (training completion records) Jan. 30, 2024 (XML and CSV provided)
		(1b) Current Fire and Rescue Operations Division personnel qualifications pertaining to wildfire, WUI, and All Hazard incidents		Subpoena only	(1b) Jan. 24, 2024 (Partial – training records provided; no qualifications)
		(2) Mandatory and/or recommended educational and training requirements for each position within Fire and Rescue Operations Division		Subpoena only	(2) Jan. 17, 2024 (Partial- course sign in sheets provided)
		(3) Records of personnel deployment for all Fire and Rescue Operations Division personnel from 2018 - 2023		Subpoena only	(3) Partial documents produced to date.
		(4) Evacuation plans and analyses		Subpoena only	(4) No documents produced to date
		(5) After Action Reports related to any and all wildfire incidents, WUI incidents, or mass evacuations;		Subpoena only	(5) Jan. 17, 2024

6.4 APPENDIX

Subpoena No.	Service Date	Description (Summary)	Response Deadline	*Email Requests	Actual Response Date
		(6) Draft or completed fire incident reports for the Lahaina, Kula, Kīhei, and Olinda fires		Subpoena only	(6) Jan. 17, 2024
2023-105 County of Maui	Dec. 29, 2023	(1) Information regarding the wildfire damage assessment map posted on the County of Maui website on August 12, 2023		Subpoena only	(1) Jan. 24, 2024 (Email received stating no documents responsive to this request)
		(2) Documents regarding multi-agency training exercises, drills, and other multi-agency training activities from 2018 - 2023		Subpoena only	(2) No documents produced to date
2023-106 County of Maui Department of Finance	Dec. 29, 2023	(1) As of Aug. 8, 2023, the most current and highest definition aerial imagery of all areas impacted by the Lahaina fire		Subpoena only	(1) Jan. 30, 2024 (Provided access to EagleView)
		(2) All information on improved properties within the areas of Olinda, Kula, Kīhei, and Lahaina that were destroyed or damaged by the Maui fires on Aug. 8, 2023, including date each structure built and modified		Subpoena only	(2) Partial documents produced to date
2023-107 County of Maui Department of Water Supply	Dec. 29, 2023	(1) Operational records for water supply and distribution systems for the island of Maui from Aug. 7 – 10, 2023		Subpoena only	(1) Jan. 17, 2024
		(2) Records of water production rates for all treatment plans within the water supply and distribution systems for the island of Maui from Aug. 7 – 10, 2023		Subpoena only	(2) Jan. 17, 2024
		(3a) System information obtained during the wildfires, including but not limited to (a) loss of system pressure		Subpoena only	(3a) No documents produced to date
		(3b) empty water storage tanks		Subpoena only	(3b) No documents produced to date
		(3c) lack of power at the treatment plant resulting in loss of water production		Subpoena only	(3c) No documents produced to date

6.4 APPENDIX

Subpoena No.	Service Date	Description (Summary)	Response Deadline	*Email Requests	Actual Response Date
2023-123	Dec. 29, 2023	(1) Actions taken by MPD personnel to confirm fatalities and to document the locations and identities of the deceased during and after the fire event that took place in Lahaina beginning on August 8, 2023, including:	Jan. 04, 2024	Subpoena only	(1) Jan. 4, 2024
		(2) actions taken to staff and organize MPD's efforts to confirm and document fatalities and			(2) Jan. 4, 2024
		(3) the progression of MPD's efforts as the number of confirmed fatalities increased.		Subpoena only	(3) Jan. 4, 2024
2024-045	Mar. 18, 2024	For any and all positively identified victims of the Lahaina wildfire: (1) Records documenting the last known residential address of each decedent.	Apr. 03, 2024	Subpoena only	(1) May 23, 2024
		(2) Records documenting the location that the remains of each decedent were recovered (e.g., inside structure, outdoors, inside vehicle, etc.), including all documents used to prepare Chart 3 on page 65 of the MPD Preliminary After Action Report, "Maui Wildfires of August 8, 2023."		Subpoena only	(2) May 23, 2024
		(3) Records documenting the cause of death of each decedent, where known.		Subpoena only	(3) No documents produced to date
2024-046	Mar. 18, 2024	(1a)Any and all information collected by the County of Maui regarding each and every fire-damaged or destroyed vehicle found on public roadways and other right-of-way areas following the August 2023 Maui wildfires, including but not limited to: Data on the location of the vehicle, including without limitation: • Latitude and longitude, • Address and nearest cross streets, • Whether in the public right of way or other public area.	Apr. 03, 2024	Subpoena only	(1a) Partial documents produced Aug. 29, 2024.

6.4 APPENDIX

Subpoena No.	Service Date	Description (Summary)	Response Deadline	*Email Requests	Actual Response Date
		(1b) Vehicle manufacturer, model, year manufactured, and all images of the vehicle.		Subpoena only	(1b) Partial documents produced Aug. 29, 2024.
		(1c) Damage assessment.			(1c) No documents produced to date
		(2) Any and all records or documents setting forth the process used to collect the above data, including but not limited to the method for assessing the damage to each vehicle.			(2) No documents produced to date
2024-094	Jul. 9, 2024	(1) For any and all documents, records, and/or information relating to requests, directives, or notices of violation issued by the County of Maui Department of Fire & Public Safety pursuant to the Maui County Code or Ordinances Sections 16.04D.230, 16.04D.240, and 16.04D.250, as amended, to property owners in or around the area of Lahaina, Maui within five (5) years up to and including August 2023 regarding vegetation management (e.g. the removal or clearing of flammable vegetation, combustible materials, and/or combustible growth), and records, information, and/or data relating to the subject properties including, but not limited to, pictures, photographs, drawings, sketches, videos, notes, inspection notes, voice recordings, emails, letters, text messages, spreadsheets, and/or surveys.	Jul. 24, 2024	Subpoena only	(1) Partial documents produced Aug. 29, 2024.

6.5 2018 Lahaina Fire – Incident Commander Technical Discussion Questions

FSRI is prepared to ask the following questions of the 2018 Lahaina Fire Incident Commander during a technical discussion in September 2024, date and time to be determined.

1. What was your rank at the time of this fire?
2. What was your regular work assignment?
3. Who did you report to?
4. What was your assigned work location on the day of the 2018 Lahaina Fire?
5. Were you aware of the weather forecast calling for fire weather with strong winds?
6. If so, when were you made aware? How many days prior to the arrival of the event?
7. Explain your response to the fire starting from when you received the call.
8. List MFD and other (DOFAW, private heavy equipment, ?) resources responded.
9. Where did the fire start? Show on a map and explain verbally to capture on recording.
10. Describe the weather conditions - wind? RH? temp?
11. Describe structural damage due to wind - electrical infrastructure? Roofs? Trees?
12. Did FFs have water throughout the incident?
13. Describe and explain the incident management organization used to manage the incident.
14. Were there higher level individuals you interacted with during the incident? Did you brief someone? If so, who, and what did you share?
15. Describe the strategy and tactics used to address the incident priorities.
16. Identify the fire's progression and position of resources during fire suppression.
17. Were evacuations necessary?
18. Describe your interactions with the MPD and the evacuation effort.
19. Did the MFD complete an AAR? If so, who completed it?
20. What were the lessons learned from the incident?
21. Did the MFD make any policy, procedural or equipment changes due to the 2018 Lahaina Fire, and if so, what were they and when were they implemented?

6.6 National Weather Service (NWS) – Honolulu Product Verification*

Table 6.6.1 National Weather Service Product Verification Leading up to August 8, 2023.

National Weather Service Product Verification Leading up to August 8, 2023

Forecast	Date/time Product Released	Date/ Time Accuracy*	Date/ Time Accuracy Rating	Forecasted Location	Location Accuracy**	Location Accuracy Rating	Was the weather forecast Accurate (Y/N)
Windy, very gusty, & dry conditions; Fire Weather Watch 8/7 AM through late 8/9 PM; High Wind Watch 8/7 AM through 8/9 PM	8/6/2023 3:33AM	gusts of up to 80 mph 8/8 12:22 AM3; 8/8 10:50:00 FF crew reported wind gusts up to 80 mph & downed powerlines[10]	Yes	Maui Leeward West (makai) - Maui Central Valley for Fire Weather Watch; High Wind Watch (same time-frame) for Maui Central Valley North - Maui Central Valley South - South Maui/Upcountry	Yes; gusts of up to 80 mph 8/8 12:22 AM[3]	Yes	Yes for both severity and location
High Wind Watches 20-50 mph & localized gusts >60 mph 8/7 AM through 8/9 PM	8/6/2023 3:33AM	8/8 11:35-16:35 RAWS wind speed 40 mph with 70-82 mph gusts[7]	Yes	Portions of Maui	N.D. (location is vague)		Yes for sever-ity; N.D. for location (too vague)
Red Flag Warnings: Wind 20-30 kt & higher gusts; RH 40-45% afternoon & evening	8/6/2023 3:33AM	; Multiple spot fires reported[16]	Yes	Leeward portions of all Hawaiian Islands	Yes; Multiple spot fires reported[16]	Yes	Yes for both severity and location
Fire Weather Planning Forecast; Moderate trade winds; showers may increase on 8/6 with highest rainfall chances over windward areas; Windy, very gusty, & dry conditions 8/7-8/9	8/6/2023 3:34 AM	Multiple reports of wind damage[14,15]	Yes	Maui Leeward West - Including, Lahaina, Kā‘anapali; Fire Weather Watch in effect from 8/7 AM through 8/8 PM	Yes: Multiple reports of wind damage[14,15]	Yes	Yes for both severity and location
Red Flag Warning -Critical fire weather conditions possible 8/7 AM through 8/8 late PM	8/6/2023 4:01AM	8/8 06:42 E3 crew measured 40 mph winds, gusting to 60 mph[5]	Yes	Across Leeward areas of all Hawaiian Islands	Yes; Multiple spot fires reported[16,17]	Yes	Yes for both severity and location
Moderate trade winds prevail, but from 8/7-8/9, dry air with potentially damaging wind gusts enter the area.	8/6/2023 10:02 AM	8/8 10:50:00 FF crew reported wind gusts up to 80 mph & downed powerlines[10]	Yes	Various parts of the Hawaiian Islands, including Maui Central Valley North, Maui Central Valley South, South Maui/Upcountry.	Yes; Multiple reports of wind damage[14,15]	Yes	Yes for both severity and location

6.6 APPENDIX

National Weather Service Product Verification Leading up to August 8, 2023

Forecast	Date/time Product Released	Date/ Time Accuracy*	Date/ Time Accuracy Rating	Forecasted Location	Location Accuracy**	Location Accuracy Rating	Was the weather forecast Accurate (Y/N)
High Wind Watches - Strong & gusty winds (>65 mph possible) caused by High pressure to the north of Hawai'i and Dora to the south creating a pressure gradient 8/7-8/8 inclusive. Predicts downed trees & powerlines, leading to possible power outages &/or travel challenges.	8/6/2023 10:05 AM	Yes 8/8 7:51 E3 officer observed multiple downed powerlines6; 8/8 10:35:23 & 18:40 broken utility poles/ downed powerlines[8,9]	Yes	Portions of various Hawaiian Islands, including the central valley of Maui.	N.D. (location is vague)		Yes for severity; N.D. for location (too vague)
Same as above.	8/6/2023 3:24 PM	Same as above.		Portions of various Hawaiian Islands, including Maui.	N.D. (location is vague)		Yes for severity; N.D. for location (too vague)
Red Flag Warnings - Critical fire weather conditions possible 8/7 AM - 8/8 late PM across leeward areas. KBDI ≥ 600. RH 40-45% - fires apt to spread quickly; avoid outdoor fires.	8/6/2023 3:33 PM	Yes [4]KDBI≅600, as predicted for 8/6	Yes	Across leeward areas [of the Hawaiian Islands].	Yes; Multiple spot fires reported	Yes	Yes for both severity and location
8/7 AM - 8/9 dry air with strong winds with potentially damaging gusts enters the region. High pressure will build to the north as Dora passes westward about 500 miles south of the Big Island, driving strong gusty winds into the area. KBDI ≥ 600.	8/6/2023 3:48 PM	Yes; [4]KDBI≅600, as predicted for 8/6	Yes	Fire weather watch: critical conditions highly likely for 8/7 for several Hawaiian Islands, including Maui (Leeward west-makai) and central valley). High wind watch 8/7 AM - 8/8 late PM same areas.	gusts of up to 80 mph 8/8 12:22 AM[3]		Yes for both severity and location
Same as above.	8/6/2023 9:13 PM	Same as above		Same as above.	Same as above.		Yes for both severity and location

6.6 APPENDIX

National Weather Service Product Verification Leading up to August 8, 2023

Forecast	Date/time Product Released	Date/ Time Accuracy*	Date/ Time Accuracy Rating	Forecasted Location	Location Accuracy**	Location Accuracy Rating	Was the weather forecast Accurate (Y/N)
Red Flag Warning from 8/7 6 AM - 8/9 6 AM due to gusty winds & low RH=40-45%; East (mauka) winds 30-45 mph, gusting to >65 mph.	8/7/2023 3:15 AM	gusts of up to 80 mph 8/8 12:22 AM[3]		Leeward areas [of the Hawaiian Islands].	gusts of up to 80 mph 8/8 12:22 AM[3]		Yes for both severity and location
Red Flag Warning (through 8/9 6 AM) KDBI≅600 with low RH<45%, producing critical fire weather conditions 8/7 PM through 8/8 PM; very windy: NE 30-45 mph	8/7/2023 3:30 AM	Yes; [4]KDBI≅600, as predicted for 8/6;	Yes	Maui Leeward West (makai), including Lahaina & Kāʻanapali	Yes; Multiple spot fires reported[16,17]	Yes	Yes for both severity and location
Red Flag Warning: East (mauka) winds 30-45 mph, gusting >60mph; RH 35-45% afternoons & evenings.	8/7/2023 4:42 AM	Yes; 8/8 10:50:00 FF crew reported wind gusts up to 80 mph & downed power-lines[10]	Yes	Leeward areas [of the Hawaiian Islands].	Yes; Multiple spot fires reported[16,17]	Yes	Yes for both severity and location
High Wind Watches - Strong & gusty winds through 8/8 night.	8/7/2023 3:40 PM	Yes; Multiple reports of wind damage[14,15]	Yes	Not specified.	N.D. (no location)		Yes for severity; N.D. for location (too vague)
Red Flag & High Wind Warnings:. Critical fire weather conditions expected for 8/8; dry fuels with expected KBDI≥600 & RH below 45%. Potential exists for extreme fire behavior of any wildfires that ignite.	8/7/2023 3:53 PM	Yes; 4KDBI≅600, as predicted for 8/6	Yes	Hawaiian Islands, including Maui - Windward West, Maui Central Valley North and South, South Maui/ Upcountry	Yes; Multiple spot fires reported16	Yes	Yes for both severity and location
Peak wind gusts surged into the 45-55 mph range across the state, peaking on 8/8 & RH dipped to mid 40s. Winds & low RH should continue through midweek.	8/7/2023 8:55 PM	Yes; Multiple reports of wind damage[14,15]	Yes	Not specified.	N.D. (no location)		Yes for severity; N.D. for location (too vague)

6.6 APPENDIX

National Weather Service Product Verification Leading up to August 8, 2023

Forecast	Date/time Product Released	Date/ Time Accuracy*	Date/ Time Accuracy Rating	Forecasted Location	Location Accuracy**	Location Accuracy Rating	Was the weather forecast Accurate (Y/N)
Strengthening easterly (mauka) trade winds becoming potentially damaging through 8/8; dry air from east (mauka) will limit rainfall through 8/9.	8/7/2023 9:20 PM	Yes; Multiple downed power-lines[10,11,12,13]	Yes	Not specified.	N.D. (no location)		Yes for severity; N.D. for location (too vague)
Red Flag Warning through 8/9 6 AM for Leeward areas: 30-45 mph, gusting to 60 mph and RH 35-45% through afternoon; fires likely to spread rapidly	8/8/2023 3:17 AM	Yes; Multiple downed power-lines[10,11,12,13]	Yes	Not specified.	N.D. (no location)		Yes for severity; N.D. for location (too vague)
High Wind Warning through 8/9 6 AM; damaging winds may down trees/powerlines & damage roofs, leading to power outages.	8/8/2023 3:18 AM	Yes; 8/8 7:51 E3 officer observed multiple downed powerlines[6]	Yes	Across mountain terrain and downslope into leeward sections of the Hawaiian Islands, including Maui.	5; 8/8 7:51 E3 officer observed mul-tiple downed powerlines6	Yes	Yes for both severity and location
Fire Weather Planning Forecast: Red Flag Warn-ing through 8/9 6 AM; Very dry fuels (KDBI≅600 & RH<45%) & very windy (35-45 mph).	8/8/2023 4:00 AM	Yes; [4]KDBI≅600, as predicted for 8/6	Yes	Maui Central Valley	5; 4KDBI≅600, as predicted for 8/6	Yes	Yes for both severity and location
High Wind (30-45 mph, gusting to 60 mph) & Fire Weather Alerts	8/8/2023 9:26 AM	Yes; 8/8 11:41 downed powerlines at 20.802157 [11]	Yes	Not specified.	N.D. (no location)	Yes	Yes for severity; N.D. for location (too vague)
High Wind (30-45 mph, gusting to 60 mph) & Fire Weather (Red Flag Warning - NO outdoor burning) Alerts	8/8/2023 9:27 AM	Yes; 8/8 11:41 downed powerlines at 20.802157 11	Yes	Not specified.	N.D. (no location)		Yes for severity; N.D. for location (too vague)
Red Flag Warning through 6 AM 8/9; High wind Warning until 6 AM 8/9	8/8/2023 9:40 AM	Yes; 8/8 10:50:00 FF crew reported wind gusts up to 80 mph & multiple downed power-lines[10,11,12,13]	Yes	Hawaiian Islands, including Maui Windward West, Maui Central Valley North & South, South Maui/Upcountry	Yes; several reports of downed powerlines, substantiating damaging wind prediction	Yes	Yes for both severity and location

6.6 APPENDIX

National Weather Service Product Verification Leading up to August 8, 2023

Forecast	Date/time Product Released	Date/ Time Accuracy*	Date/ Time Accuracy Rating	Forecasted Location	Location Accuracy**	Location Accuracy Rating	Was the weather forecast Accurate (Y/N)
Red Flag Warning until 6 AM 8/9; Fire Weather: Very dry fuels (KDBI≧600) and High Wind Warning Strong & gusty easterly (mauka) winds with RH<45%	8/8/2023 3:38 PM	Yes; [4]KDBI≧600, as predicted for 8/6	Yes	Hawaiian Islands, including Maui Leeward West (makai), Maui Central Valley (North and South)	Yes; Multiple spot fires reported[16,17]	Yes	Yes for both severity and location
High Wind Watches: strong (30-45 mph) & gusty (≧60 mph) winds through 8/9 afternoon	8/8/2023 3:39 PM	Yes; Multiple downed powerlines[10,11,12,13]	Yes	Across mountain terrain and downslope into leeward sections of several Hawaiian Islands, including Maui.	Yes; several reports of downed powerlines, substantiating damaging wind prediction	Yes	Yes for both severity and location
Red Flag Warnings until 6 PM 8/9 for 30-45 mph winds, gusting to ≧60 mph and very dry fuels (RH 35-45%).	8/8/2023 3:39 PM				Yes; Multiple spot fires reported[16,17]	Yes	Yes for both severity and location
Red Flag Warning through 6 PM 8/9: Strong & potentially damaging easterly (mauka) winds: 8/9 RH 40%	8/8/2023 3:41 PM	Yes; Multiple downed powerlines[10,11,12,13]	Yes	Maui Leeward West - Including Lahaina, Kā‘anapali	Yes; several reports of downed powerlines, substantiating damaging wind prediction	Yes	Yes for both severity and location

[1]KBDI Keetch-Byram Drought Index2
[2]Keetch, John J; Byram, George. 1968. A drought index for forest fire control. Res. Paper SE-38. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station. 32 pp. (Revised 1988).
[3]Los Angeles Times Satellite imagery: Mapping how the Maui fires destroyed Lahaina - Los Angeles Times
[4]National Oceanic and Atmospheric Administration & National Weather Service Hawaiian Fire Weather Products
[5] Phase One p. 91 Table 4.3.2.4
[6] Phase One p. 91 Table 4.3.2.4
[7] Phase One p.44 4.3 Fire and Response Timeline
[8] Lahaina Fire Comprehensive Timeline, entry line 853
[9] Lahaina Fire Comprehensive Timeline, entry line 1942; Fire4 unit to Dispatch 10:35:23
[10] Lahaina Fire Comprehensive Timeline, entry line 2038; 8/8 10:50:00 Firefighter crew reporting on Kula Fire Update #2
[11] Lahaina Fire Comprehensive Timeline, entry line 2295; 8/8 11:41 downed powerlines reported at 20.802157
[12] Lahaina Fire Comprehensive Timeline, entry line 2431; 8/8 12:04:55 downed powerline reported by Unit 4B40
[13] Lahaina Fire Comprehensive Timeline, entry line 3001; 8/8 14:19:00 downed powerlines reported at 20.877851
[14] Lahaina Fire Comprehensive Timeline, entry line 1196; 8/8 07:28:23 neighbor’s roof detached & damaged vehicles
[15] Lahaina Fire Comprehensive Timeline, entry line 2070; 8/8 10:56:31 neighbor’s roof detached & damaged vehicles
[16] Lahaina Fire Comprehensive Timeline, entry line 1067; 8/8 07:05:55 Help requested from Command to Air2 to extinguish spot fires
[17] Lahaina Fire Comprehensive Timeline, entry line 7615; 8/8 22:18:39 Help requested from to extinguish spot fires
* Reviewed by NWS-Honolulu forecasters.

6.7 Brush & Vegetation Clearance Records

Table 6.7.1 County of Maui Lahaina Brush Clearance Records.

County of Maui Lahaina Brush Clearance Records						
No.	**Work Order Number**	**Date of Clearance**	**Nearest Street Address of Problem**	**Sq Ft**	**Equipment Used**	**Total Cost**
1	41453	3/9/23	Lwr Honoapi‘ilani Road	32,940	weedeat	$2,720
1	41453	3/9/23	Lwr Honoapi‘ilani Road	8,040		$0
1	41453	3/9/23	Lwr Honoapi‘ilani Road	10,808		$0
1	41453	3/9/23	Lwr Honoapi‘ilani Road	22,180	stand up mower	$0
2	41519	3/14/23	Front Street	40,952		$1,269
2	41520	3/14/23	Dickenson Street	3,206		$423
3	41589	3/15/23	Malo Street	6,820		$0
3	41589	3/15/23	Malo Street	5,070		$676
4	41595	3/16/23	Shaw Street	11,406	weedeat	$381
5	41632	3/21/23	Prison St parking lot	13,156	weedeat	$405
6	41633	3/21/23	Luakini parking lot	15,268	weedeat	$405
7	41637	3/21/23	Lahainaluna Road	25,525	stand up mower	$494
8	41638	3/21/23	Kahoma FC	18,937	mowing	$1,260
9	41644	3/22/23	Hui A Road	23,965	brush cutting	$0
9	41644	3/22/23	Hui A Road	32,521		$2,630
10	41645	3/22/23	Kahoma FC	23,981	mower	
10	41645	3/22/23	Kahoma FC	29,672		
10	41645	3/22/23	Kahoma FC	15,637		$4,205
11	41646	3/22/23	Lahainaluna Road	36,709		
11	41646	3/22/23	Lahainaluna Road	31,130		
11	41646	3/22/23	Lahainaluna Road	23,366	weedeat	$2,038
12	41716	3/24/23	Waine‘e / Prison	?		$1,073
13	41824	3/30/23	Kaopala FC	58,592		
13	41824	3/30/23	Kaopala FC	20,110		$980
14	41825	3/30/23	Kaopala FC	8,500		
14	41825	3/30/23	Kaopala FC	15,342		$822
15	41827	4/3/23	Kahananui FC	25,364		

6.7 APPENDIX

County of Maui Lahaina Brush Clearance Records						
No.	**Work Order Number**	**Date of Clearance**	**Nearest Street Address of Problem**	**Sq Ft**	**Equipment Used**	**Total Cost**
15	41827	4/3/23	Kahananui FC	24,568		$1,644
16	41828	4/3/23	Kahananui FC	45,364		
16	41828	4/3/23	Kahananui FC	38,909		$1,306
17	42334	5/10/23	Kahoma Service Road	4,500		
17	42334	5/10/23	Kahoma Service Road	2,000		
17	42334	5/10/23	Kahoma Service Road	2,000		
17	42334	5/10/23	Kahoma Service Road	99,305		
17	42334	5/10/23	Kahoma Service Road	17,856		
17	42334	5/10/23	Kahoma Service Road	13,296		$15,665
18	42531	5/15/23	Keawe Street	8,201		$861
19	42532	5/15/23	Lahainaluna Road	10,690		$861
20	42575	5/19/23	Wahikuli Ditch	44,168		
20	42575	5/19/23	Wahikuli Ditch	2,608		$2,566
21	42601	5/22/23	Wahikuli Terrace	7,667		$2,297
22	42884	6/9/223	Wahikuli Terrace	7,500		$1,067
23	42885	6/9/23	Keawe Street	8,210		$355
24	42982	6/28/23	Lahainaluna Road	30,880		$1,732
25	43015	7/3/23	Lahaina Civic Center	15,868		$422
26	43131	7/11/23	Lower Honoapi‘ilani Hwy	34,153		
26	43131	7/11/23	Lower Honoapi‘ilani Hwy	128,000		
26	43131	7/11/23	Lower Honoapi‘ilani Hwy	46,201		
26	43131	7/11/23	Lower Honoapi‘ilani Hwy	22,364		$5,420
27	43244	7/20/23	Keawe Street	8,210		$543
28	43432	8/1/23	Māhinahina FC	13,670		
28	43432	8/1/23	Māhinahina FC	57,455		$2,010
29	43480	8/3/23	Lahainaluna Road	23,366		$1,982
				844,917	sq.ft.	$58,511
				19.4	acres	

6.7 APPENDIX

Table 6.7.2 State of Hawai'i, Department of Transportation Lahaina Brush Clearance Records.

State of Hawai'i, Lahaina Brush Clearance Records

Date of Clearance	Hwy Worked On	RTE No	Beginning Location	End Location	Start at Mile Marker No.	End at Mile Marker No.	Total Miles Cleared	Type of Clearance	No. of Acres Cleared	Workers & Description of Clearance	Total Cost
1/18/23	Hwy-30	30B	Wahikuli Rd	Prison St	20	22	2	Mechanical Mowing	8	R.PALMEIRA MECHANICAL MOWING	$548.68
2/1/23	Hwy-30	30B	Wahikuli Rd	Prison St	20	22	2	GRASS TRIMMING	0.000184	K.PASTRANA - G.FEVELLA - R.PALMEIRA - D.RHODEN WEEDEAT GUARD RAILS INTERSEC-TIONS LAHAINA TOWN .	$1,048.79
2/2/23	Hwy-30	30B	Wahikuli Rd	Prison St	20	22	2	GRASS TRIMMING	0.000184	K.PASTRANA-G. FEVELLA-R. PALMEIRA-D. RHODEN CON-TINUE WEE-DEAT GUARD RAILS AND MEDIANS .	$1,042.89
5/17/23	Hwy-30	30B	Wahikuli Rd	Prison St	20	21	1	GRASS TRIMMING, CONTINUE WEED-EATING GUARD RAILS AND SIGNS AND SIGHT DISTANCE .	0.000184	C.SOUZA - K.NEEDHAM - G.FEVELLA - R.PALMEIRA	$1,238.95
6/28/23	Hwy-30	30B	Wahikuli Rd	Prison St	20	22	2	Mechanical Mowing	8	G.FEVELLA - R.PALMEIRA - CONTINUE MOWING	$1,225.85
7/10/23	Hwy-30	30B	Wahikuli Rd	Prison St	20	21	1	Mechanical Mowing	8	R.PALMEIRA - CONTINUE MOWING	$422.40

6.7 APPENDIX

State of Hawai'i, Lahaina Brush Clearance Records

Date of Clearance	Hwy Worked On	RTE No	Beginning Location	End Location	Start at Mile Marker No.	End at Mile Marker No.	Total Miles Cleared	Type of Clearance	No. of Acres Cleared	Workers & Description of Clearance	Total Cost
7/11/23	Hwy-30	30B	Wahikuli Rd	Prison St	21	22	1	Mechanical Mowing	8	R.PALMEIRA - G.FEVELLA - CONTINUE MOWING	$1,342.14
8/3/23	Hwy-30	30B	Wahikuli Rd	Prison St	20	21.5	1.5	Mechanical Mowing	8	K.NEEDHAM - CONTINUE BUSHWHACK-ING	$680.80
1/19/23	Hwy-30	30C	Prison St	Kīhei Rd	4.9	20	15.1	HWY-30, PRISON ST TO Kīhei RD MAIN-TENANCE OF SHOUL-DERS AND MEDIAL K.NEED-HAM - CLEAN SHOUL-DERS WITH LOADER ON PALI. D.RHODE - TRAFFIC CONTROL & CLEAN SHOUL-DERS WITH WATER TRUCK. K.PASTRA-NA - WEED-EAT AND PICK UP RUBBISH ON HIGH-WAY.	8 LF	K.PASTRANA - WEEDEAT AND PICK UP RUBBISH ON HIGHWAY	$1,387.61
1/25/23	Hwy-30	30C	Prison St	Kīhei Rd	15	18.5	3.5	Mechanical Mowing	8	R.PALMEIRA - TRACTOR MOWING SHOULDERS AND MEDIANS	$543.37

6.7 APPENDIX

State of Hawai‘i, Lahaina Brush Clearance Records

Date of Clearance	Hwy Worked On	RTE No	Beginning Location	End Location	Start at Mile Marker No.	End at Mile Marker No.	Total Miles Cleared	Type of Clearance	No. of Acres Cleared	Workers & Description of Clearance	Total Cost
1/25/23	Hwy-30	30C	Prison St	Kīhei Rd	17	19	2	GRASS TRIMMING	0.000184	G.FEVELLA - K.PASTRANA - WEEDEAT GUARD RAILS & MEDIANS	$528.88
1/27/23	Hwy-30	30C	Prison St	Kīhei Rd	14	16.5	2.5	Mechanical Mowing	8	K.NEEDHAM - BUSHWHACK SHOULDERS BANCKES AND SITE DISTANCE	$621.86
1/27/23	Hwy-30	30C	Prison St	Kīhei Rd	4.9	17	12.1	GRASS TRIMMING	0.000184	C.SOUZA - D.RHODE - K.PASTRANA - WEEDEAT GUARD RAILS SHOULDERS AND PICK UP TRASH AND DEBRIS	$875.34
1/31/23	Hwy-30	30C	Prison St	Kīhei Rd	4.9	20	15.1	Mechanical Mowing	8	C.SOUZA - BUSHWHACK SITE DISTANCE AND SHOUL-DERS	$532.52
2/1/23	Hwy-30	30C	Prison St	Kīhei Rd	17	20	3	Mechanical Mowing	8	C.SOUZA - CONTINUE BUSHWHACK-ING SHOUL-DERS AND GUARDRAILS , SITE DISTANCE	$709.95
2/2/23	Hwy-30	30C	Prison St	Kīhei Rd	17.5	20	2.5	Mechanical Mowing	8	C.SOUZA - CONTINUE BUSHWHACK-ING SHOUL-DERS AND SITE DISTANCE	$689.30
2/3/23	Hwy-30	30C	Prison St	Kīhei Rd	19	20	1	GRASS TRIMMING	0.000184	K.PASTRANA - D.RHODEN WEEDEAT GUARD RAILS AND PICK UP TRASH ON ROADWAYS	$570.99

6.7 APPENDIX

State of Hawai'i, Lahaina Brush Clearance Records

Date of Clearance	Hwy Worked On	RTE No	Beginning Location	End Location	Start at Mile Marker No.	End at Mile Marker No.	Total Miles Cleared	Type of Clearance	No. of Acres Cleared	Workers & Description of Clearance	Total Cost
2/6/23	Hwy-30	30C	Prison St	Kīhei Rd	4.9	20	15.1	Mechanical Mowing	8	R.PALMEIRA - TRACTOR MOWER SHOULDERS AND MEDI-ANS. C.SOUZA - CONTINUE BUSHWHACK-ING	$1,146.93
2/10/23	Hwy-30	30C	Prison St	Kīhei Rd	0	20	20	MAINTE-NANCE OF SHOUL-DERS AND MEDIAL	7 LF	C.SOUZA-K. NEEDHAM-D. RHODEN-K. PASTRA-NA CLEAN ROADWAYS SHOULDERS FROM ROCKS BRANCHES AND DEBRIS. SUCK OUT WASH RACK WITH VAC TRUCK	$1,164.01
3/24/23	Hwy-30	30C	Prison St	Kīhei Rd	15.5	16.5	1	Mechanical Mowing	8	R.PALMEIRA - CONTINUE MOWING SHOULDERS	$386.96
3/28/23	Hwy-30	30C	Prison St	Kīhei Rd	17.5	18.5	1	Mechanical Mowing	8	R.PALMEIRA - CONTINUE MOWING	$338.96
3/29/23	Hwy-30	30C	Prison St	Kīhei Rd	18.5	19.8	1.3	Mechanical Mowing	8	R.PALMEIRA - CONTINUE MOWING	$476.20
3/29/23	Hwy-30	30C	Prison St	Kīhei Rd	15.5	22	6.5	Mechanical Mowing	8	K.NEEDHAM - BUSHWHACK BEHIND GUARDRAILS IN FRONT OF OLD PEOPLES HOME BRUSH FIRE COM-PLAINT . CLEAN SHOULDERS IN FRONT OLU-WALU WITH BACKHOE .	$467.17

6.7 APPENDIX

State of Hawai‘i, Lahaina Brush Clearance Records

Date of Clearance	Hwy Worked On	RTE No	Beginning Location	End Location	Start at Mile Marker No.	End at Mile Marker No.	Total Miles Cleared	Type of Clearance	No. of Acres Cleared	Workers & Description of Clearance	Total Cost
5/9/23	Hwy-30	30C	Prison St	Kīhei Rd	14.5	15.5	1	GRASS TRIMMING	0.000184	C.SOUZA - D.RHODEN - G.FEVELLA - R.PALMEIRA WEEDEAT GUARDRAILS AND SIGNS AND CUT KOAS WITH CHAIN-SAWS .	$1,225.38
5/11/23	Hwy-30	30C	Prison St	Kīhei Rd	20.5	21	0.5	Mechanical Mowing	8	K.NEEDHAM - BUSHWHACK LAHAINA TOWN FIRE HAZARD COMPLAINT .	$584.10
5/11/23	Hwy-30	30C	Prison St	Kīhei Rd	17	17.9	0.9	GRASS TRIMMING	0.000184	G.FEVELLA - R.PALMEIRA CONTINUES WEEDEATING GUARD RAILS AND SIGNS .	$578.91
5/15/23	Hwy-30	30C	Prison St	Kīhei Rd	17.8	18.6	0.8	GRASS TRIMMING	0.000184	K.NEEDHAM - D.RHODEN - G.FEVELLA - R.PALMEIRA CONTINUE WEEDEATING GUARD RAILS AND SIGNS .	$1,230.11
5/22/23	Hwy-30	30C	Prison St	Kīhei Rd	20	22	2	GRASS TRIMMING	0.000184	C.SOUZA - K.NEEDHAM - G.FEVELLA - R.PALMEIRA WEEDEAT LAHAINA TOWN GUARDRAILS AND SIGHT DISTANCE	$1,122.47
6/22/23	Hwy-30	30C	Prison St	Kīhei Rd	17	19	2	Mechanical Mowing	8	R.PALMEIRA - CONTINUE MOWING	$524.20

6.7 APPENDIX

State of Hawai'i, Lahaina Brush Clearance Records

Date of Clearance	Hwy Worked On	RTE No	Beginning Location	End Location	Start at Mile Marker No.	End at Mile Marker No.	Total Miles Cleared	Type of Clearance	No. of Acres Cleared	Workers & Description of Clearance	Total Cost
6/26/23	Hwy-30	30C	Prison St	Kīhei Rd	18.9	19.5	0.6	Mechanical Mowing	8	R.PALMEIRA - CONTINUE MOWING	$412.96
6/27/23	Hwy-30	30C	Prison St	Kīhei Rd	18	20	2	Mechanical Mowing	8	R.PALMEIRA - CONTINUE MOWING	$556.70
6/30/23	Hwy-30	30C	Prison St	Kīhei Rd	18	19	1	GRASS TRIMMING	0.711662	WEED WHACK-ING AROUND TRAFFIC SIGNS AND GUARD-RAILS	$361.75
7/5/23	Hwy-30	30C	Prison St	Kīhei Rd	15.5	17	1.5	GRASS TRIMMING	0.000184	G.FEVELLA - R.PALMEIRA WEEDEAT SIGNS AND INTERSECTION AND ELEC-TRICAL BOX . D.RHODEN - WEEDEAT SIGNS	$977.12
7/6/23	Hwy-30	30C	Prison St	Kīhei Rd	16	16.5	0.5	GRASS TRIMMING	0.000184	G.FEVELLA - R.PALMEIRA - WEEDEAT GUARD RAILS AND SIGNS	$614.80
8/2/23	Hwy-30	30C	Prison St	Kīhei Rd	19	20	1	Mechanical Mowing	8	C.SOUZA - SETUP SIGNS AND CONES AND ESCORT FOR KIMO ON BUSHWHACK-ER K.NEEDHAM - BUSHWHACK SHOULDERS AND SIGHT DISTANCE	$1,005.87

6.7 APPENDIX

State of Hawai'i, Lahaina Brush Clearance Records

Date of Clearance	Hwy Worked On	RTE No	Beginning Location	End Location	Start at Mile Marker No.	End at Mile Marker No.	Total Miles Cleared	Type of Clearance	No. of Acres Cleared	Workers & Description of Clearance	Total Cost
2/8/23	Lahaina Bypass	3000	Hwy-30	Keawe St	3.5	4.6	1.1	GRASS TRIMMING	0.000184	G.FEVELLA-K. PASTRANA-R. PALMEIRA-C. SOUZA-D. RHODEN WEEDEAT BY-PASS GUARD RAILS, SIGNS AND MEDIANS BLOW DEBRIS AND CUT KOAS WITH CHAIN-SAW	$1,420.99
2/9/23	Lahaina Bypass	3000	Hwy-30	Keawe St	0	4.6	4.6	Mechanical Mowing	8	K.NEEDHAM - BUSHWHACK SHOULDERS AND SIGHT DISTANCE R.PALMEIRA - TRACTOR MOWER SHOULDERS AND MEDIANS	$1,154.61
2/13/23	Lahaina Bypass	3000	Hwy-30	Keawe St	0	4.6	4.6	Mechanical Mowing	8	C.SOUZA - CONTINUE BUSHWHACK SHOULDERS HILL SIDES & SIGHT DIS-TANCE	$650.17
2/14/23	Lahaina Bypass	3000	Hwy-30	Keawe St	0	4.6	4.6	Mechanical Mowing	8	K.NEEDHAM - BUSHWHACK BYPASS ROAD SHOULDERS GUARD RAILS SIGHT DISTANCE . R.PALMEIRA - TRACTOR MOWER SHOULDERS MEDIAN.	$1,139.86

6.7 APPENDIX

State of Hawai'i, Lahaina Brush Clearance Records

Date of Clearance	Hwy Worked On	RTE No	Beginning Location	End Location	Start at Mile Marker No.	End at Mile Marker No.	Total Miles Cleared	Type of Clearance	No. of Acres Cleared	Workers & Description of Clearance	Total Cost
2/14/23	Lahaina Bypass	3000	Hwy-30	Keawe St	0	4.6	4.6	GRASS TRIMMING	0.000184	C.SOUZA-K. PASTRANA-D. RHODEN WEE-DEAT GUARD RAILS & SIGNS	$897.81
2/15/23	Lahaina Bypass	3000	Hwy-30	Keawe St	0	4.6	4.6	Mechanical Mowing	8	K.NEEDHAM CONTINUE BUSHWHACK R.PALMEIRA CONTINUE TRACTOR MOWING	$1,123.93
2/15/23	Lahaina Bypass	3000	Hwy-30	Keawe St	0	4.6	4.6	GRASS TRIMMING	0.000184	D.RHODEN-G. FEVELLA-K. PASTRANA WEED EAT LA-HAINA BYPASS GUARD RAILS AND INTER-SECTIONS	$974.95
3/8/23	Lahaina Bypass	3000	Hwy-30	Keawe St	0	4.6	4.6	Mechanical Mowing	4	R.PALMEIRA - TRACTOR MOWING BY-PASS SHOUL-DERS AND MEDIANS.	$94.48
3/9/23	Lahaina Bypass	3000	Hwy-30	Keawe St	0	4.6	4.6	Mechanical Mowing	8	R.PALMEIRA - CONTINUE TRACTOR MOWING BYPASS ROAD LAHAINA	$536.20
3/10/23	Lahaina Bypass	3000	Hwy-30	Keawe St	0	1.5	1.5	GRASS TRIMMING	0.000161	R.PALMEIRA - G.FEVELLA WEEDEAT GUARD RAILS INTERSECTION AND MEDIANS	$507.39

6.7 APPENDIX

State of Hawai'i, Lahaina Brush Clearance Records

Date of Clearance	Hwy Worked On	RTE No	Beginning Location	End Location	Start at Mile Marker No.	End at Mile Marker No.	Total Miles Cleared	Type of Clearance	No. of Acres Cleared	Workers & Description of Clearance	Total Cost
5/23/23	Lahaina Bypass	3000	Hwy-30	Keawe St	0	1	1	GRASS TRIMMING	0.000184	C.SOUZA - G.FEVELLA - R.PALMEIRA CONTINUE WEED EATING GUARDRAILS AND SIGNS AND INTER-SECTION	$877.91
5/24/23	Lahaina Bypass	3000	Hwy-30	Keawe St	1	2	1	GRASS TRIMMING	0.000184	G.FEVELLA - R.PALMEIRA - D.RHODEN CONTINUE WEED EATING LAHAINA BY-PASS .	$729.98
6/2/23	Lahaina Bypass	3000	Hwy-30	Keawe St	1.5	2.5	1	GRASS TRIMMING	1.033058		$266.38
6/21/23	Lahaina Bypass	30	Hwy-30	Keawe St	0	2	2	Mechanical Mowing	8	G.FEVELLA - CONTINUE MOWING	$593.10
6/22/23	Lahaina Bypass	30	Hwy-30	Keawe St	2	3	1	Mechanical Mowing	8	G.FEVELLA - CONTINUE MOWING	$599.10
6/23/23	Lahaina Bypass	30	Hwy-30	Keawe St	2	4.6	2.6	Mechanical Mowing	8	G.FEVELLA - R.PALMEIRA - CONTINUE MOWING	$999.08
6/26/23	Lahaina Bypass	30	Hwy-30	Keawe St	0	0.5	0.5	GRASS TRIMMING	0.000184	D.RHODEN - WEEDEAT SIGNS AND IN-TERSECTION	$361.75
6/28/23	Lahaina Bypass	30	Hwy-30	Keawe St	0	2.1	2.1	GRASS TRIMMING	0.000184	K.NEEDHAM - WEEDEAT SIGNS AND IN-TERSECTIONS .	$348.10
8/4/23	Lahaina Bypass	30	Hwy-30	Keawe St	0	4.6	4.6	Mechanical Mowing	8	K.NEEDHAM - BUSHWHACK SHOULDERS AND BEHIND GUARD RAILS	$520.71

6.7 APPENDIX

State of Hawai‘i, Lahaina Brush Clearance Records

Date of Clearance	Hwy Worked On	RTE No	Beginning Location	End Location	Start at Mile Marker No.	End at Mile Marker No.	Total Miles Cleared	Type of Clearance	No. of Acres Cleared	Workers & Description of Clearance	Total Cost
7/6/23	Hwy-30	30 area 6	Ka-punakea St	Fleming Rd			0	Tree pruning and removal.		Coconuts Includ-ing Similar Palm Trees - Removal 25 to 35 Feet Tall	$980.00
5/26/23	Hwy-30	30 area 6	Ka-punakea St	Fleming Rd			0	Tree pruning and removal.		Coconuts Includ-ing Similar Palm Trees - Pruning 18- over 35 feet tall	$3,240.00
4/20/23	Hwy-30	30 area 7	Leiali'l Pkwy	Lower Hwy-30			0	Tree pruning and removal.		Hardwood and Conifer Trees - Pruning Crown Raising 18- over 12”-24” Diameter 11- over 24”-36” Diameter Shrub Trees - Removal 1- 4’-8 wide x 1’ long	$6,613.00
3/9/23	Hwy-30	30 area 6	Hōkiokio Pl	Puama-na			0	Tree pruning and removal.		Hardwood and Conifer Trees - Pruning Heavy Pruning 9- over 12”-24” Diameter 19- over 24”-36” Diameter 2- over 36”-48” Diameter	$12,015.00
							183.2				
											$63,829.42

6.8 Drinking Water Treatment, Storage, and Distribution Systems

The County of Maui Department of Water Supply has two (2) drinking water treatment plants that produce drinking water for the Lahaina area. The Lahaina membrane filtration treatment plant has a capacity of 1.8 MGD equivalent to 1,250 GPM (gallons per minute). The Māhinahina deep bed direct filtration treatment plant to the north has a capacity of 2.0 MGD (1,390 GPM). These two (2) drinking water treatment plants are also supplemented by a system of three (3) small groundwater well/tank combinations that enter directly into the system and supplement water production in the two (2) storage and distribution systems.

The following paragraphs provide a detailed description of the drinking water treatment plants along with their associated storage and distribution systems in use at the time of the fire.

Lahaina Membrane Filtration Drinking Water Treatment Plant

The Kanaha Stream is the source water for the Lahaina membrane filtration drinking water treatment plant (elevation approximately 800 feet). Water is conveyed by gravity from the stream to the screen box at the treatment plant by 300 feet of 10-inch galvanized steel pipe. A 12-inch pipe conveys water by gravity from the screen box to the 0.5 MG (million gallon) pre-sedimentation reservoir (not named). Water from the screen box is also used to supply untreated water to Lahainaluna High School and the Pioneer Mill Company.

Raw water from the pre-sedimentation reservoir (not named) is conveyed by gravity to the treatment plant building and passes through a 500-micrometer strainer. The strained water is then pumped through five (5) Memcor Continuous Microfiltration (CMF) units to remove particles greater than 0.1 micrometers in diameter. The filtered water is then chlorinated, using low-strength, on-site generated sodium hypochlorite, before passing through the 0.3 MG clearwell that provides sufficient contact time for disinfection. The disinfected water is then pumped through a 12-inch diameter pipe into the 1.0 MG Lahainaluna Tank (TK 116) which is used as a finished water storage reservoir and completes the drinking water treatment process.

This treated water is conveyed by gravity from the Lahainaluna Tank (TK 116) to the 0.3 MG Kanaha Tank (TK108). The flow to the Kanaha Tank is controlled by an influent control valve on the inlet line to the Kanaha Tank that prevents the Lahainaluna Tank (TK116) from draining. Other storage tanks within the distribution system are also filled by gravity. Pressure within the distribution system is the result of elevation change within the storage and distribution system and water level in the storage tanks. Pumps are not used to provide pressure within the distribution system. All pressure is a result of elevation change and water level in the storage tanks.

The next tank to be filled is the 0.5 MG Waipuka Tank (TK110) located along Lahainaluna Road. The 0.05 MG Waipuka Well Tank (TK101) with deepwell groundwater pumps is located adjacent to the Waipuka tank. This tank uses pumps to fill the well tank and supplement the finished water produced by the Lahaina Treatment Plant. After the Waipuka Tank, the next tank to be filled by the distribution system is the 1.0 MG Lahaina Tank (TK108) which is also located adjacent to Lahainaluna Road downgradient of the Waipuka Tank (TK110).

The last tank in the south system to be filled is the 1.5 MG Wahikuli Tank (TK102) which is located to the north of the other tanks in the storage and distribution system. Again, all storage tanks within the distribution system are filled by gravity and distribution system pressures are the result of elevation change within the system and water level in the storage tanks.

6.8 APPENDIX

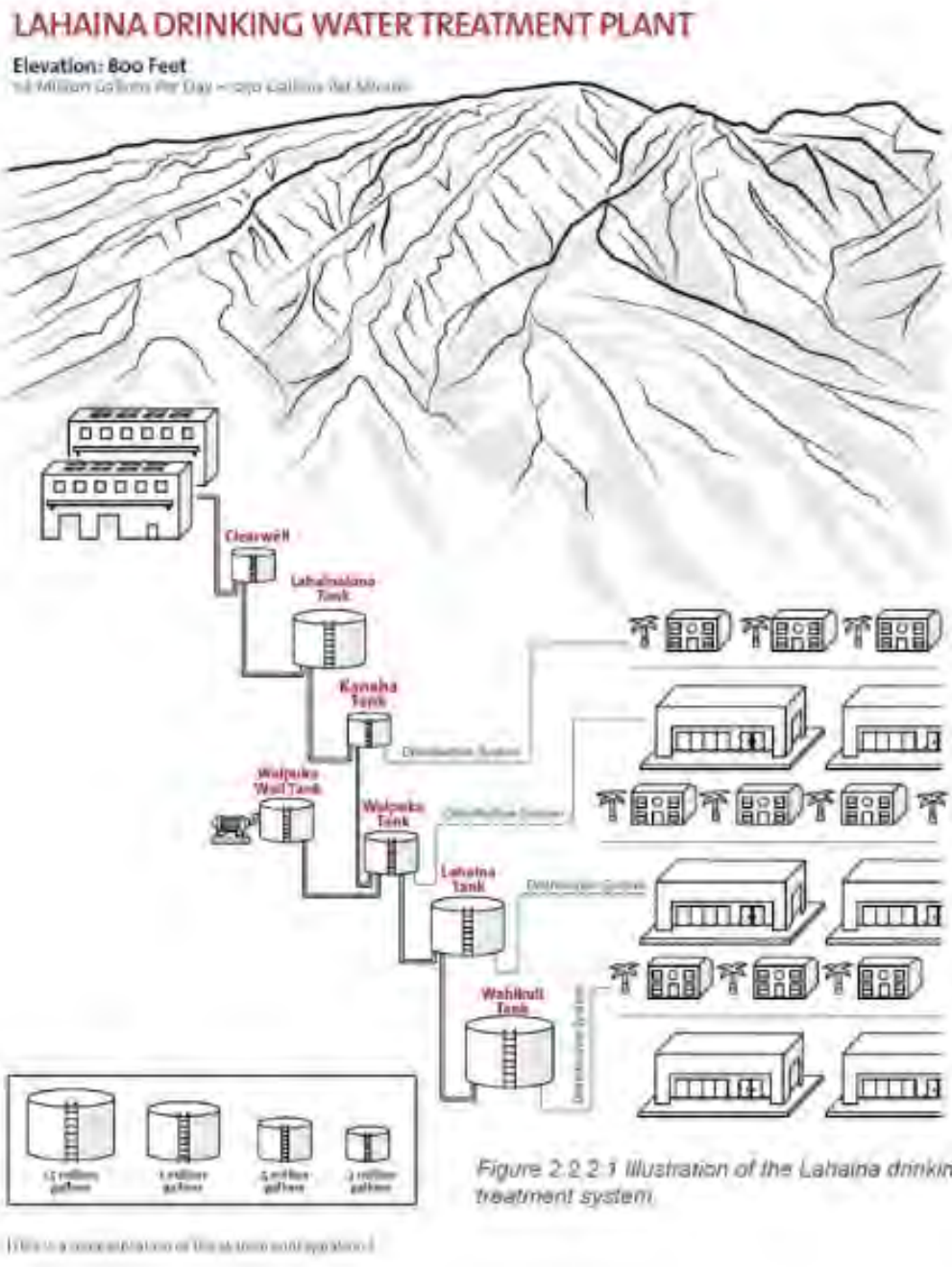


Figure 6.8.1 Lahaina drinking water treatment system.

6.8 APPENDIX

The Māhinahina deep bed direct filtration drinking water treatment plant is located on the western (makai) slopes of the West Maui Mountains at an elevation of approximately 700 feet. The source water is generated by surface runoff and transported by gravity from the watershed via the Honolua Ditch and a 24-inch diameter pipe into the 20 MG Māhinahina Raw Water Hypalon Reservoir (TK117). This reservoir is used for pre-sedimentation of particles and flow equalization. A 16-inch diameter pipe transports the water by gravity into the flash/rapid mixing process and then into the flocculation process.

Water exits the flocculation process through a 20-inch diameter wall casting and enters the filter influent channel through a 16-inch diameter pipe. Water then exits the dual-media deep bed filters using a 16-inch diameter pipe into the chlorine contact channel where it is chlorinated using low-strength, on-site generated sodium hypochlorite. The chlorine contact channel is incorporated into the 2.0 MG Māhinahina WTP Clearwell (TK118).

The treated drinking water leaves the Māhinahina Clearwell (TK118) through a 16-inch diameter pipe where it flows to the 2.0 MG Honokōwai Concrete Storage Tank (TK114), and then enters the rest of the storage and distribution system to the north and south of the Honokōwai Tank due to water level in the storage tanks and elevation change within the distribution system.

The storage tanks to the North of the Honokōwai Tank (TH114) are filled in the following order:

- Alaeloa 1.0 MG Concrete Tank (TK104);
- Alaeloa Mid-Level aka Kahana Ridge 1.0 MG Concrete Tank (TK115);
- Nāpili A Mix Tank 0.05 MG (TK106); and
- Nāpili A #2 0.3 MG Concrete Tank (TK423).

In addition to the tanks listed above, two (2) tanks in the north system are filled using groundwater well pumps similar to the Waipuka Well Tank (TK101) in the Lahaina storage and distribution system. These tanks are:

- Nāpili A #1 0.1 MG Concrete Tank w/ deepwell pump (TK105)
- Nāpili C 0.1 MG Concrete Tank w/ deepwell pump (TK111)

As in the Lahaina system, pumps are not used to provide pressure within the Māhinahina distribution system. All pressure is a result of elevation change and water tank/reservoir water levels.

The Māhinahina system to the north and the Lahaina system to the south in West County of Maui are connected using water main(s) with a maximum diameter of 16-inches located along Lower Honoapiʻilani Road and Hawaiʻi Route 30 (Hwy-30). Again, pressure generated in the drinking water distribution system is a result of elevation change and water tank/reservoir levels. Pumps are not used to provide pressure within either the Lahaina or Māhinahina drinking water distribution systems.

6.8 APPENDIX

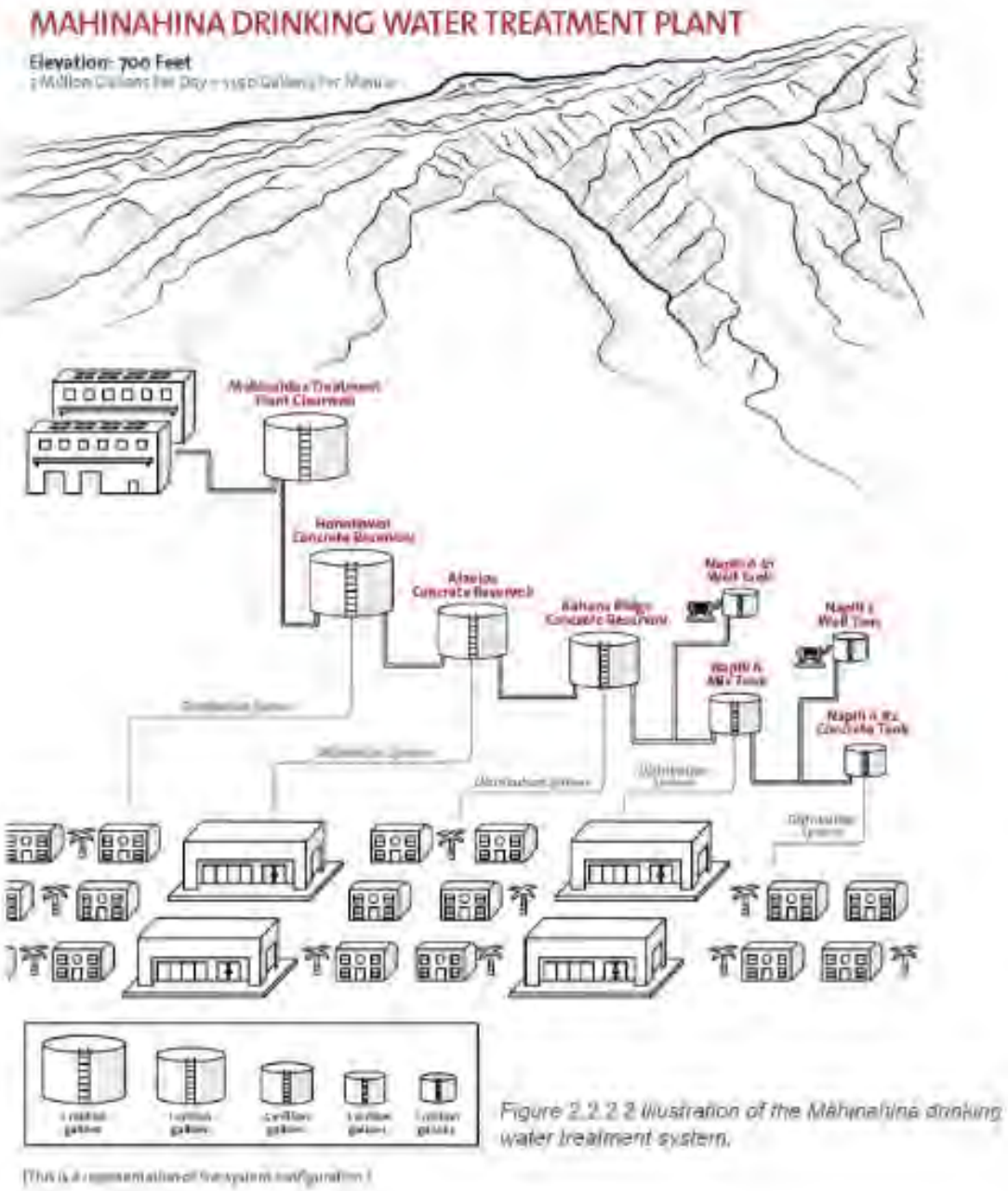


Figure 2.2.2.2 Illustration of the Māhinahina drinking water treatment system.

Figure 6.8.2 Māhinahina drinking water treatment system

6.8 APPENDIX

A data recording system for the County of Maui Department of Water Supply routinely records the water level in each of the water storage tanks in both the Lahaina and Māhinahina storage and distribution systems. The graph below shows the time variation of water volume stored versus time for the Lahaina, Māhinahina and the two (2) systems combined. The recording of water level data by the county ceases at 3:30 p.m. on August 8, 2023, for all storage tanks in both the Lahaina and Māhinahina systems. The reason given by the county for the simultaneous loss of all tank level data was a power outage.

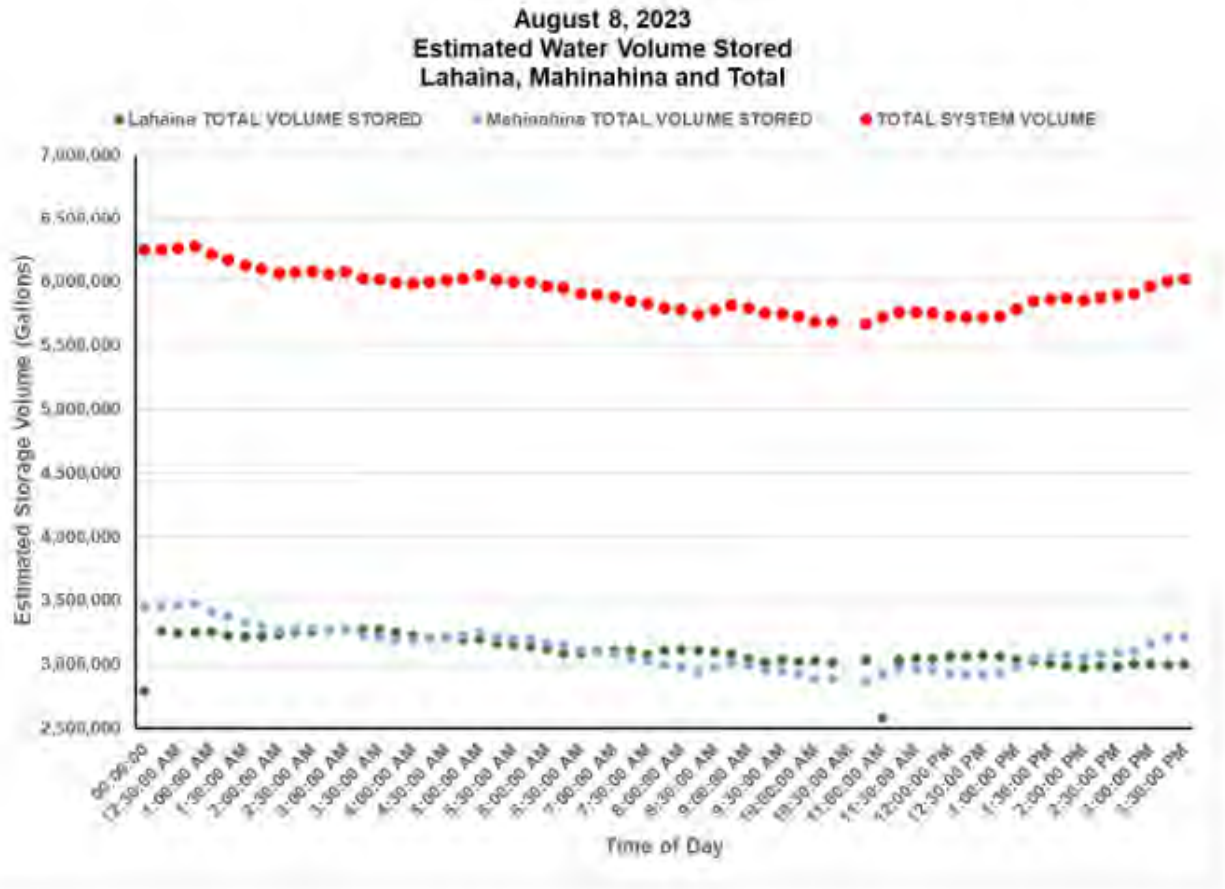


Figure 6.8.3 Estimated water volume stored in Lahaina and Māhinahina on August 8, 2023.

Note: The volumes calculated in the graph above are preliminary estimates based upon the tank capacity and the tank level recorded by the system. The recording system stopped recording data at 15:30 on August 8, 2023.

AWWA M42 entitled Steel Water Storage Tanks (2013) discusses the sizing of water storage tanks in Chapter 5. This chapter provides insight into the calculation of the peak flow for the system in addition to the fire flow requirements for the system. This industry publication also discusses the changing storage capacity of storage tanks with water level within the tanks. Additionally, the adverse impact of excess water storage on water quality is also highlighted.

6.9 Amendments to the 2002 Water System Standards. Source: Hawai'i Board of Water Supply

Amendments to the
2002 Water System Standards

Description	WSS Section Modified	Approval Date
Approved Material *PowerSeal*	Division 400, Section 402 Sub-Section I Pipes and Appurtenances	12/14/2023
Manhole Rungs	Division 200, Section 207, Sub-section 207.03 Manhole Rungs	9/26/2023
Non-Potable Water System	Division 600, Non-Potable Water System Standards	3/13/2023
Chlorination of Pipelines	Division 300, Section 302, Sub-section 302.29 Chlorination of Water Pipeline	9/1/2022
Pipe Cushion	Division 200, Section 209, Sub-section 209.02 Pipe Cushion	8/22/2022
Deadline to Comply with All Amendments	None	2/9/2022
Controlled Low Strength Material (CLSM)	Division 200, Section 209, Sub-section 209.06 Controlled Low Strength Materials (CLSM) and Division 300, Section 302, Sub-section 302.03 Trench Backfill	11/8/2021
Off-Site Fire Protection	Division 100, Section 111, Sub-section 111.03 Fire Flows, Duration and Hydrant Spacing	7/30/2021
Turbine Meter Splice Length	Division 400, Section 403 Standard Details	3/25/2021
Approved Material *J&S Valve, Inc.*	Division 400, Section 402 Sub-Section II Valves and Appurtenances	2/26/2021
Chlorination of Pipelines	Division 300, Section 302, Sub-section 302.29 Chlorination of Water Pipeline	12/16/2020
Bonded Dielectric Coating	Division 500, Water System External Corrosion Control Standards, Volume 3, dated 1991	10/5/2020
Type and Classes of Mains, and Pipe Cushion	Division 100, Section 102, Sub-section 102.05 Type, Class and Division 200, Section 209, Sub-section 209.02 Pipe Cushion	7/29/2019
Expanded Metal Fencing	Division 100, Section 105, Sub-section 105.08 Perimeter Fence and Division 300, Section 303, Sub-section 303.34 Expanded Metal Fence and Gate	8/2/2018
Polyethylene Encasement and Exterior Coating	Division 200, Section 202 - Ductile Iron Pipe, Fittings, and Appurtenances	11/17/2016
Approved Material *The Ford Meter Box Company, Inc.*	Division 400, Section 402, Sub-section III Service Laterals, Fittings and Appurtenances	5/6/2016

6.9 APPENDIX

Description	WSS Section Modified	Approval Date
Trench Backfill	Division 400, Section 403 Standard Details	4/29/2016
Ductile Iron Pipe	Division 200, Section 202 - Ductile Iron Pipe, Fittings, and Appurtenances	4/15/2016
Approved Material *DFW Plastics, Inc.*	Division 400, Section 402, Sub-section III Service Laterals, Fittings and Appurtenances	5/13/2015
Plastic Pipe	Division 200, Section 204 Plastic Pipe Division 300, Section 302 Water Mains and Appurtenances, Sub-sections 302.14 Plastic Pipe & 302.15 Fittings and Specials	4/23/2015
Water Main Clearances	Division 100, Section 102 Mains, Sub-section 102.01 Location	4/23/2015
3/4" Meter Splice Length	Division 400, Section 403 Standard Details	12/8/2014
Approved Material *Christy's*	Division 400, Section 402 Sub-section I Pipes and Appurtenances	9/19/2014
Approved Material *Clow Valve Company*	Division 400, Section 402, Sub-section IV Fire Hydrants	6/20/2014
Brass Products - Lead Free	Division 200, Section 211 Brass Products & Division 400, Section 402, Sub-section III Service Laterals, Fittings and Appurtenances	10/22/2013
Approved Material *Jensen Precast*	Division 400, Section 402, Sub-section III Service Laterals, Fittings and Appurtenances	1/4/2013
Rescinding Approval for Polyethylene (PE) Pipe	Division 200, Section 208 - Service Laterals and Appurtenances, 208.03 Plastic Tubing	12/14/2012
Brass Products	Division 200, Section 211 Brass Products & Division 400, Section 402, Sub-section III Service Laterals, Fittings and Appurtenances	6/5/2012
Approved Material *Armorcast*	Division 400, Section 402, Sub-section III Service Laterals, Fittings and Appurtenances	5/14/2012
Approved Material *Romac*	Division 400, Section 402 Sub-section I Pipes and Appurtenances	11/9/2011
Approved Material *IPEX*	Division 400, Section 402 Sub-section I Pipes and Appurtenances	9/14/2011
Rescinding Approval for Concrete Cylinder Pipe	Division 200, Section 203 Concrete Cylinder Pipe and Fittings	7/15/2011
Rescinding Approved Material *Royal Pipe Systems*	Division 400, Section 402 Sub-section I Pipes and Appurtenances	4/29/2011
Approved Material *METCO*	Division 400, Section 402 Sub-section I Pipes and Appurtenances	11/4/2010
Approved Material *Advance Products and Systems*	Division 400, Section 402 Sub-section I Pipes and Appurtenances	5/6/2010
Approved Material *Garlock*	Division 400, Section 402 Sub-section I Pipes and Appurtenances	1/19/2010

6.9 APPENDIX

Description	WSS Section Modified	Approval Date
Approved Material *North American Pipe Corporation*	Division 400, Section 402 Sub-section I Pipes and Appurtenances	11/10/2009
Approved Material *Multi Fittings*	Division 400, Section 402 Sub-section I Pipes and Appurtenances	10/27/2009
Approved Material *Diamond Plastics*	Division 400, Section 402 Sub-section I Pipes and Appurtenances	8/14/2009
FM Meter & Box Standard Details	Division 400, Section 403 Standard Details	5/18/2009
Approved Material *Polytubes*	Division 400, Section 402, Subsection III Service Laterals, Fittings and Appurtenances	2/24/2009
Minimum Utility Depth	Division 100, Section 102 Mains, Sub-section 102.03 Cover & Division 400, Section 403 Standard Details	12/31/2008
Approved Material *American R/D*	Division 400, Section 402 Sub-Section II Valves and Appurtenances	12/18/2008
Approved Material *Armorcast*	Division 400, Section 402, Sub-section III Service Laterals, Fittings and Appurtenances	12/4/2008, amended 6/26/2015
Distance between main valves	Division 100, Section 103 Sub-section 103.01 Location, Type, Working Pressure	10/21/2008
Nuts and bolts for flanged joints and fire hydrant break-off bolts	Division 200, Section 202.04 Flanged Joint and Section 206.1 General	3/18/2008
Approved Material *Sigma Corporation*	Division 400, Section 402 Sub-section I Pipes and Appurtenances	10/31/2007
Approved Material *Star Pipe Products, Inc.*	Division 400, Section 402 Sub-section I Pipes and Appurtenances	5/4/2007
Electronic Markers	New requirement	8/25/2006
Approved Material *Prior & Lambert*	Division 400, Section 402 Sub-section V Paints and Coatings	1/27/2004
Cathodic Protection	See 2021 Update of the Water System External Corrosion Control Standards ~~Division 500, Section 1.2 (Part 2), Table 3~~	~~10/15/2003~~
Approved Material *Tripac Fasteners & NSS Industries*	Division 400, Section 402 Sub-section I Pipes and Appurtenances	8/12/2003
Nuts and bolts for mechanical joints	Division 200, Section 202.02 Mechanical Joint	7/22/2003
Approved Material *Romac*	Division 400, Section 402 Sub-section I Pipes and Appurtenances	6/20/2003
Approved Material *Sherwin Williams*	Division 400, Section 402 Sub-section V Paints and Coatings	5/23/2003

6.9 APPENDIX

Description	WSS Section Modified	Approval Date
Rescinded 4/29/2011 ~~Approved Material Royal Pipe Systems~~	~~Division 400, Section 402 Sub-Section I Pipes and Appurtenances~~	~~5/19/2003~~
Approved Material *FSC Coatings*	Division 400, Section 402 Sub-section V Paints and Coatings	5/12/2003
Dis-approved Material *Powerseal*	Division 400, Section 402 Sub-section I Pipes and Appurtenances	3/24/2003
Approved Material *James Jones*	Division 400, Section 402 Sub-section III Service Laterals, Fittings and Appurtenances	11/27/2002
Approved Materials for Globe Valves	Division 400, Section 402 Sub-Section II Valves and Appurtenances	11/22/2002
Approved Material *PPG Industries*	Division 400, Section 402 Sub-section V Paints and Coatings	7/11/2002

6.10 Comparison of MFD, MPD, and Hawaiian Electric's AVL Timepoints

Lahaina Assigned Vehicles Automatic Vehicle Location Timepoint Data Comparison

The following table displays MFD, MPD, and Hawaiian Electric AVL data for Lahaina assigned vehicles within the given hourly blocks. The table compares the number of vehicles, corresponding AVL timepoints, and timepoints per vehicle for each hour timeframe starting at 14:55 when the Lahaina PM fire was reported.

The data in the table was transferred from Excel spreadsheets provided by the County of Maui and Hawaiian Electric that included data in its native form (date, time, vehicle identification, latitude/longitude) for vehicles assigned to the Lahaina area. The County of Maui also provided AVL timepoint data for vehicles not assigned to Lahaina. This data is not included within the table.

The MFD provided the least amount of data, while the MPD provided the most. The timeframe of 18:00–19:00 and 22:00–23:00 included the least amount of timepoints/vehicle. Understanding why timepoints per vehicle declined at times is beyond the scope of this study, but should be considered for further study.

Number of Agency Vehicles and AVL Timepoint Comparison

Hourly Blocks	MFD			MPD			Hawaiian Electric		
	Vehicles	Timepoints	Tp/Veh	Vehicles	Timepoints	Tp/Veh	Vehicles	Timepoints	Tp/Veh
14:55 - 16:00	5	86	28.7	10	960	96.0	14	494	35.3
16:00 - 17:00	3	45	15.0	11	1732	157.5	14	584	41.7
17:00 - 18:00	0	0	0.0	14	1102	78.7	14	467	33.4
18:00 - 19:00	1	1	1.0	15	858	57.2	12	311	25.9
19:00 - 20:00	0	0	0.0	16	1168	73.0	9	352	39.1
20:00 - 21:00	0	0	0.0	15	1067	71.1	8	129	16.1
21:00 - 22:00	2	4	2.0	15	967	64.5	7	73	10.4
22:00 - 23:00	1	5	5.0	10	821	51.3	7	17	2.4
23:00 - 24:00	2	4	2.0	12	1078	89.8	0	0	0.0
Totals	11	145	13.1	124	9753	78.7	85	2409	28.3

6.11 Statewide Siren Test Reports

6.11.1 Statewide Siren Test Report (May 2023)

404 STATEWIDE SIREN REPORT SUMMARY - MAY 2023

CCH -OAHU

41 Sirens reported as No Sound by County/State or Out of Service (OOS) **77.22%**

of 180

21 Requires maintenance

20 OOS

	NO SOUND REPORTED BY COUNTY/STATE	SUSPECTED ISSUE	Threat Level 1 - Tsunami Zone	Threat Level 2 - Hurricane	Threat Level 3 - Lava, Brush Fire, Dam Breach, Hazmat	ACTION
1	OA118A-Ala Wai Yacht Harbor	Reported by County. Confirmed on Commander by RS. Battery fail	X	X		SOH HI-EMA RS Action - To be scheduled on upcoming siren maintenance by Radioshop Techs.
2	OA120-McKinley High School	Activation fail per RS on Commander. Battery fail		X		
3	OA122-Booth Park	Activation fail per RS on Commander.		X	Dam Breach	
4	OA137-Moanalua Valley	Reported by County. TBD by onsite inspection by HI-EMA Radio Technician's		X		
5	OA300A-Halawa Dist Park	Activation fail per RS on Commander. Battery fail		X		
6	OA311A-Honouliuli	Activation fail per RS on Commander. Comm fail		X		
7	OA311B-Coral Creek	Activation fail per RS on Commander. Battery fail	X	X	Hazmat	
8	OA312C-Hoakalei #1	Activation fail per RS on Commander. Audio/Current fail			Hazmat	
9	OA313-Makakilo BWS	Activation fail per RS on Commander. Comm fail		X		
10	OA314-Campbell Ind Park	Activation fail per RS on Commander.	X	X	Hazmat	
11	OA314B-Barbers Pt.Deep Draft	Activation fail per RS on Commander.	X	X		
12	OA316-Nanaikapono School	Activation fail per RS on Commander. Comm fail	X	X		
13	OA318A-Maili North	Activation fail per RS on Commander. Comm fail	X	X		
14	OA333-Hoopili #1	Activation fail per RS on Commander. Amp fail		X		
15	OA403A-Maunawili Valley PK	Activation fail per RS on Commander.		X		
16	OA412-Heeia Playground	Activation fail per RS on Commander. Amp fail	X	X		
17	OA414-Heeia Kea Pier	Activation fail per RS on Commander. Battery fail	X	X		
18	OA419-Kalae Oio Beach PK	Activation fail per RS on Commander. Amp fail	X	X		
19	OA426A-PCC	Activation fail per RS on Commander. Amp fail	X	X		
20	OA327-Keaau Beach Park	Vandalism - Within tech repair.	X	X		SOH HI-EMA RS Action - Radioshop fix siren.
21	OA328-Makua Cave	Activation fail per RS on Commander. Comm fail. Needs Yagi antenna.	X	X		SOH HI-EMA RS Action - Radioshop to install yagi. Await new sat upgrade.

	OUT OF SERVICE	REASON	Threat Level 1 - Tsunami Zone	Threat Level 2 - Hurricane	Threat Level 3 - Lava, Brush Fire, Dam Breach, Hazmat	ACTION
22	OA101-Koko Head	Siren head rusted off		X		SOH HI-EMA Action - Schedule for HIePro solicitaion.
23	OA109-Maunalani Park	Legacy siren. Mechanical issue beyond repair.		X		
24	OA110-Palolo valley Park	Bad solar panels		X		
25	OA206-Kawailoa Beach	Bad solar panels	X	X		
26	OA211-Dillingham Airfield	Bad solar panels	X	X		
27	OA212A-Mokuleia BP	Bad solar panels	X	X		
28	OA229-Mililani Mauka HECO	Bad solar panels		X		
29	OA323-Mauna Lahilahi Beach	Vandalism - Beyond tech repair. Upgrade to UV-HSO.	X	X		
30	OA329-Kaena Point	Vandalism - Beyond tech repair. Conduits.	X	X		
31	OA331A-Kalaeloa USCG	Siren head rusted off	X	X	Hazmat	
32	OA402B-Waimanalo Town BWS	Lighting Strike Damage	X	X		
33	OA307-Palisades Elem school	Legacy siren. Frozen Motor		X		SOH DAGS Action -Scheduled for WO#3
34	OA319-Maili Beach Park	Vandalism - Beyond tech repair	X	X		
35	OA124-Alewa Heights	Legacy siren. Mechanical issue beyond repair.		X		
36	OA115-Dole St	Siren removed due to rotten wooden pole.		X		
37	OA312D-Hoakalei #2	Lighting Strike Damage	X	X	Hazmat	
38	OA115-Dole St	Legacy siren. Mechanical issue beyond repair.		X		SOH DAGS Action -Scheduled for future workorder (WO)
39	OA400A-Kaiona Beach Park	Bad solar panels	X	X		
40	OA402A-Waimanalo Valley	Bad solar panels	X	X		
41	OA422-Punaluu Beach Park	Bad solar panels	X	X		

Maui County

18 Sirens reported as No Sound by County/State or Out of Service (OOS) **76.62%**

of 77

12 Maui - Requires maintenance

0 Molokai - Requires maintenance

0 Lanai - Requires maintenance

6 OOS

	NO SOUND REPORTED BY COUNTY/STATE	SUSPECTED ISSUE	Threat Level 1 - Tsunami	Threat Level 2 - Hurricane	Threat Level 3 - Lava, Brush Fire, Dam Breach, Hazmat	ACTION
1	MA115-Wells Park	Activation fail per RS on Commander. Comm fail		X		SOH HI-EMA RS Action - To be scheduled on upcoming siren maintenance by Radioshop Techs.
2	MA117-Maui Comm College	Activation fail per RS on Commander. Battery fail	X	X		
3	MA125-Makena	Activation fail per RS on Commander. Comm & Audio/Current fail	X	X		
4	MA126-Upper Kula, Copp Rd	Activation fail per RS on Commander. Comm fail		X		
5	MA127-Waikapu	Activation fail per RS on Commander. Audio/Current fail		X		
6	MA130-Kamaole Park III	Activation fail per RS on Commander. Audio/Current fail	X	X		
7	MA131-Haiku	Activation fail per RS on Commander. Battery fail.		X		
8	MA132-Sugar Beach	Activation fail per RS on Commander. Audio/Current fail	X	X		
9	MA155-Kualono Subdivision	Activation fail per RS on Commander. Comm fail		X		
10	MA303-Wailua Valley	Activation fail per RS on Commander. Bad cell RF signal		X		Yagi antenna installed and no improvement. Await new sat upgrade.
11	MA304A-Hamoa #2	Activation fail per RS on Commander. Battery fail	X	X		SOH HI-EMA RS Action - To be scheduled on upcoming siren maintenance trip by Radioshop Techs.
12	MA101-Waiehu	Degraded with multiple bad driver lines per RS.	X	X		SOH HI-EMA PM Action - Add to future HI-ePro Siren Repair

	OUT OF SERVICE	REASON	Threat Level 1 - Tsunami	Threat Level 2 - Hurricane	Threat Level 3 - Lava, Brush Fire, Dam Breach, Hazmat	ACTION
13	MA120-Kahakuloa	Satellite Service discontinued. No cell coverage in area.	X	X		SOH DAGS Action - Satellite Upgrade Project pending NTP.
14	MA105-Naska	Electrical Issues	X	X		SOH DAGS Action - Scheduled for next Maui Lump Sum Project
15	MA108-Kuau Store	Legacy siren. Frozen Motor. Site removed due to fall hazard.	X	X		
16	MA402-Maluuluolele	Legacy siren. Frozen Motor	X	X		
17	MA403-Kapunakea	Legacy siren. Frozen Motor	X	X		
18	MA410-Puamana	Electrical Issues	X	X		

Kauai County

27 Sirens reported as No Sound by County/State or Out of Service (OOS) **51.79%**

of 56

19 Requires maintenance

8 OOS

	NO SOUND REPORTED BY COUNTY/STATE	SUSPECTED ISSUE	Threat Level 1 - Tsunami	Threat Level 2 - Hurricane	Threat Level 3 - Lava, Brush Fire, Dam Breach, Hazmat	ACTION
1	KA112-Kilauea Park	Reported by County. Confirmed on Commander by RS. Battery fail		X		SOH HI-EMA RS Action - To be scheduled on upcoming siren maintenance by Radioshop Techs.
2	KA201-Anahola Village Park	Reported by County. TBD by onsite inspection by HI-EMA Radio Technician's	X	X		
3	KA202-Anahola Aliomanu South	Reported by County. Confirmed on Commander by RS. Audio/Current fail	X	X		
4	KA211-Wailua	Activation fail per RS on Commander. Battery fail	X	X		
5	KA301-Lydgate	Activation fail per RS on Commander. Audio/Current fail	X	X		
6	KA302-Wailua Golf Course	Reported by County. Confirmed on Commander by RS. Battery fail	X	X		
7	KA304-Hanamaulu Park	Activation fail per RS on Commander. Battery fail	X	X		
8	KA305-Isenburg Field	Activation fail per RS on Commander. Audio/Current fail				
9	KA503-Poipu Crater	Activation fail per RS on Commander. Audio/Current fail				
10	KA508-Omao Park	Activation fail per RS on Commander. Battery fail				
11	KA512-Waha Park	Activation fail per RS on Commander. Audio/Current fail				
12	KA513-Kalaheo	Activation fail per RS on Commander. Audio/Current fail				
13	KA515-Numila	Reported by County. TBD by onsite inspection by HI-EMA Radio Technician's	X	X		
14	KA517-Eleele School	Activation fail per RS on Commander. Audio/Current fail				
15	KA519-Port Allen	Activation fail per RS on Commander.				
16	KA603-Makawela-Pakala	Reported by County. Confirmed on Commander by RS. Battery fail	X	X		
17	KA701-Lucy Wright Park	Activation fail per RS on Commander. Audio/Current fail				
18	KA703-Waimea Canyon	Activation fail per RS on Commander. Audio/Current fail	X	X		

19	KA103-Wainiha	Activation fail per RS on Commander. Comm fail	X	X		SOH HI-EMA RS Action - Radioshop to install yagi. Await new sat upgrade.

	OUT OF SERVICE	REASON	Threat Level 1 - Tsunami	Threat Level 2 - Hurricane	Threat Level 3 - Lava, Brush Fire, Dam Breach, Hazmat	ACTION
20	KA101-Haena	Solar panels blocked by mountain. Convert to electrical charge.	X	X		SOH DAGS Action - Scheduled for next Kauai Lump Sum Project
21	KA105-Hanalei	Legacy siren. Frozen Motor	X	X		
22	KA207-Kapaa Neighborhood Ctr	Bad solar panels	X	X		
23	KA208-Kealia Kai	Lighting Strike Damage	X	X		
24	KA210-Wailua STP	Siren removed-Vehicle Collision	X	X		
25	KA303-Hanamalu	Bad solar panels	X	X		
26	KA310-Pua Loke	Bad controller. Needs to be upgraded to a UV-HSO.		X		
27	KA315-Puhi	Bad solar panels		X		

Hawaii County

23 Sirens reported as No Sound by County/State or Out of Service (OOS) **74.73%**

of 91

15 OOS

8 OOS

	NO SOUND REPORTED BY COUNTY/STATE	SUSPECTED ISSUE	Threat Level 1 - Tsunami	Threat Level 2 - Hurricane	Threat Level 3 - Lava, Brush Fire, Dam Breach, Hazmat	ACTION
1	HA112-Kolekole	Reported by County. Confirmed on Commander by RS.	X	X		SOH HI-EMA RS Action - To be scheduled on upcoming siren maintenance by Radioshop Techs.
2	HA201-Laupahoehoe	Reported by County. Confirmed on Commander by RS.	X	X		
3	HA403-Kawaihae #1, Spencer Park	Activation fail per RS on Commander.	X	X		
4	HA603Alii Kai Sub Division	Activation fail per RS on Commander.	X	X		
5	HA609-Old Kona Airport	Reported by County. TBD by onsite inspection by HI-EMA Radio Technician's	X	X		
6	HA610-Honokohau Harbor	Activation fail per RS on Commander.	X	X		
7	HA909-Pohoiki	Reported by County. Confirmed on Commander by RS.		X	Lava Zone #2	
8	HA911-Hawaiian Beaches #2	Reported by County. TBD by onsite inspection by HI-EMA Radio Technician's		X	Lava Zone #3	
9	HA913-Paradise Park #3	Reported by County. Confirmed on Commander by RS.		X	Lava Zone #3	
10	HA505-Kapaa Beach Park	Reported by County. Confirmed on Commander by RS. Poor cellular connection.	X	X		SOH HI-EMA RS Action - Radioshop to install yagi. Await new sat upgrade.
11	HA908-Kaimu	Activation fail per RS on Commander.		X	Lava Zone #2	
12	HA116-Hilo SOB	Reported by County. Confirmed on Commander by RS. RF Interference suspected.	X	X		SOH HI-EMA RS Action - Radioshop to move antenna from existing location or install yagi antenna. Await new sat
13	HA303-Waipio Valley	Degraded with multiple bad driver lines per RS.	X	X		SOH HI-EMA PM Action - Add to future HI-ePro Siren Repair

14	HA916-Kehana	Poor cellular coverage in area.		X	Lava Zone #2	SOH HI-EMA PM Action - Work with Verizon Engineering. Await new sat upgrade.
15	HA806-Hawaiian Ocean View #2	Reported by County. Degraded with multiple bad driver lines per RS.		X	Lava Zone #2	SOH DAGS Action -Scheduled for future workorder (WO)

	OUT OF SERVICE	REASON	Threat Level 1 - Tsunami	Threat Level 2 - Hurricane	Threat Level 3 - Lava, Brush Fire, Dam Breach, Hazmat	ACTION
16	HA404-Hapuna Beach	Comms offline due to legacy equipment	X	X		SOH DAGS Action -Scheduled for WO#2
17	HA706-Milolii	Bad solar panels	X	X	Lava Zone #2	SOH DAGS Action -Scheduled for future workorder (WO)
18	HA807-Waiohinu	Siren head rusted off		X		
19	HA910-Ainaloa	Bad solar panels		X	Lava Zone #2	
20	HA501-Hawi	Bad solar panels		X		SOH DAGS Action - Site entitlement planning & design phase
21	HA904-Kapoho Beach Lots	Destroyed/overrun by 2018 Lava	X	X	Lava Zone #1	SOH DAGS Action - In site entitlement planning and design engineering phase of the procurement process.
22	HA917-Ahalanui Beach Park	Destroyed/overrun by 2018 Lava	X	X	Lava Zone #1	
23	HA926-Kapoho Vacation Land	Destroyed/overrun by 2018 Lava	X	X	Lava Zone #1	

6.11.2 Statewide Siren Test Report (June 2023)

404 STATEWIDE SIREN REPORT SUMMARY - JUNE 2023

CCH -OAHU

37 **Sirens reported as No Sound by County/State or Out of Service (OOS)** **79.44%**

of **180**

15 **Requires maintenance**

22 **OOS/SEVERELY DEGRADED**

	NO SOUND REPORTED BY COUNTY/STATE	SUSPECTED ISSUE	Threat Level 1 - Tsunami Zone	Threat Level 2 - Hurricane	Threat Level 3 - Lava, Brush Fire, Dam Breach, Hazmat	ACTION
1	OA120-McKinley High School	Reported by County. TBD by onsite inspection. Asked DOE office staff to monitor July 3rd Test.		X		HI-EMA RS Action - To be scheduled on upcoming siren maintenance by Radioshop Techs.
2	OA203-Sharks Cove	Reported by County. Confirmed by RS. (Digital Board?)	X	X		
3	OA204-Waimea Bay South	Activation fail per RS. Comm fail	X	X		
4	OA311B-Coral Creek	Reported by County. Confirmed by RS. TBD by onsite inspection.		X		
5	OA314-Campbells Ind Park	Activation fail per RS. Comm fail	X	X	Hazmat	
6	OA300A-Halawa Dist Park	Activation fail per RS. Battery fail		X		
7	OA311A-Honouliuli	Activation fail per RS. Comm fail		X	Hazmat	
8	OA313-Makakilo BWS	Reported by County. Activation fail per RS. Comm fail (reflash)		X		
9	OA430-Kahuku Shrimp	Activation fail per RS. (Amp#4, #6)	X	X		
10	OA318A-Maili North	Activation fail per RS. Comm fail (batteries stolen)	X	X		
11	OA331C-UH West Oahu	Activation fail per RS. Comm fail (battery replacement)		X		
12	OA414-Heeia Kea Pier	Activation fail per RS. Battery fail (backplane)	X	X		
13	OA419-Kalae Oio Beach PK	Activation fail per RS. Amp fail	X	X		
14	OA327-Keaau Beach Park	Vandalism - Awaiting parts.	X	X		HI-EMA RS Action - Radioshop will attempt to fix siren.
15	OA328-Makua Cave	Activation fail per RS. Comm fail. (saturation of cell signal. Needs more troubleshooting onsite. Controller?)	X	X		HI-EMA RS Action - Radioshop to install yagi. Await new sat upgrade.

	OOS/SEVERELY DEGRADED	REASON	Threat Level 1 - Tsunami Zone	Threat Level 2 - Hurricane	Threat Level 3 - Lava, Brush Fire, Dam Breach, Hazmat	ACTION
16	OA101-Koko Head	Replace bad speaker array and solar panels.		X		HI-EMA Action - HIePro solicitation. "Need additional staffing to support"
17	OA110-Palolo valley Park	Replace bad solar panels.		X		
18	OA137-Moanalua Valley	Replace bad speaker array.		X		
19	OA109-Maunalani Park	Legacy siren. Mechanical issue beyond repair.		X		
20	OA115-Dole St	Siren removed due to rotten wooden pole.		X		
21	OA124-Alewa Heights	Legacy siren. Mechanical issue beyond repair.		X		
22	OA206-Kawailoa Beach	Replace bad solar panels and upgrade to UV controller.	X	X		
23	OA208-Wailua	Replace bad solar panels and upgrade to UV controller.		X	Dam Breach	
24	OA211-Dillingham Airfield	Replace bad solar panels and upgrade to UV controller.	X	X		

25	OA212A-Mokuleia BP	Replace bad solar panels and upgrade to UV controller.	X	X		DAGS Action -Scheduled for DAGS Indefinite Quantities Contract Workorder
26	OA229-Mililani Mauka HECO	Replace bad solar panels and upgrade to UV controller.		X		
27	OA307-Palisades Elem school	Legacy siren. Frozen Motor		X		
28	OA312D-Hoakalei #2	Lighting Strike Damage	X	X	Hazmat	
29	OA319-Maili Beach Park	On going "Vandalism" - Beyond tech repair	X	X		
30	OA323-Mauna Lahilahi Beach	On going "Vandalism" - Beyond tech repair. Upgrade to UV-HSO.	X	X		
31	OA329-Kaena Point	On going "Vandalism" - Beyond tech repair. Conduits.	X	X		
32	OA331A-Kalaeloa USCG	Siren head rusted off	X	X	Hazmat	
33	OA400A-Kaiona Beach Park	Replace bad solar panels.	X	X		
34	OA402A-Waimanalo Valley	Replace bad solar panels and upgrade to UV controller.	X	X		
35	OA402B-Waimanalo Town BWS	Lighting Strike Damage	X	X		
36	OA403A-Maunawili Valley PK	Replace bad solar panels and upgrade to UV controller.		X		
37	OA422-Punaluu Beach Park	Replace bad solar panels.	X	X		

Maui County

20 Sirens reported as No Sound by County/State or Out of Service (OOS) 74.03%

of 77

13 Maui - Requires maintenance

0 Molokai - Requires maintenance

0 Lanai - Requires maintenance

7 OOS/SEVERELY DEGRADED

	NO SOUND REPORTED BY COUNTY/STATE	SUSPECTED ISSUE	Threat Level 1 - Tsunami	Threat Level 2 - Hurricane	Threat Level 3 - Lava, Brush Fire, Dam Breach, Hazmat	ACTION
1	MA115-Wells Park	Activation fail per RS. (Bad MCP Backplane. Convert to UV? Request for MEMA to monitor onsite July 3rd)		X		HI-EMA RS Action - To be scheduled on upcoming siren maintenance by Radioshop Techs.
2	MA117-Maui Comm College	Activation fail per RS. Battery fail	X	X		
3	MA122-Waimea #2	Activation fail per RS. Battery fail - 23.4V (Tripped AC?)				
4	MA125-Makena	Activation fail per RS. Comm & Audio/Current fail	X	X		
5	MA126-Upper Kula, Copp Rd	Activation fail per RS. Comm fail		X		
6	MA130-Kamaole Park III	Activation fail per RS. Audio/Current fail	X	X		
7	MA131-Haiku	Activation fail per RS. Comm fail (Verizon to install new site nearby)		X		
8	MA132-Sugar Beach	Activation fail per RS. Audio/Current fail (battery change)	X	X		
9	MA155-Kualono Subdivision	Activation fail per RS. Comm fail (modem?)		X		
10	MA302-Keanae	Activation fail per RS. Battery fail (battery change)				
11	MA304A-Hamoa #2	Activation fail per RS. Battery fail (battery change)	X	X		
12	MA411-Flemming Beach	Activation fail per RS. Battery fail (battery change)				
13	MA303-Wailua Valley	Activation fail per RS. Bad cell signal in area. Awaiting sat modem upgrade.		X		Yagi antenna installed and no improvement. Await new sat upgrade.

	OOS/SEVERELY DEGRADED	REASON	Threat Level 1 - Tsunami	Threat Level 2 - Hurricane	Threat Level 3 - Lava, Brush Fire, Dam Breach, Hazmat	ACTION
14	MA101-Waiehu	Degraded with multiple bad driver lines per RS.	X	X		DAGS Action - Scheduled for DAGS Lump Sum Contract.
15	MA105-Naska	Electrical Issues	X	X		
16	MA108-Kuau Store	Legacy siren. Frozen Motor. Site removed due to fall hazard.	X	X		
17	MA402-Maluuluolele	Legacy siren. Frozen Motor	X	X		
18	MA403-Kapunakea	Legacy siren. Frozen Motor	X	X		
19	MA410-Puamana	Ongoing electrical Issues	X	X		
20	MA120-Kahakuloa	No cell coverage in area. Sat modem upgrades in progress	X	X		DAGS Action - DAGS Satellite Upgrade Project in progress.

Kauai County

16 **Sirens reported as No Sound by County/State or Out of Service (OOS)** **71.43%**

of **56**

8 **Requires maintenance**

8 **OOS/SEVERELY DEGRADED**

	NO SOUND REPORTED BY COUNTY/STATE	SUSPECTED ISSUE	Threat Level 1 - Tsunami	Threat Level 2 - Hurricane	Threat Level 3 - Lava, Brush Fire, Dam Breach, Hazmat	ACTION
1	KA107-Anini	Reported by County. TBD by onsite inspection.	X	X		HI-EMA RS Action - To be scheduled on upcoming siren maintenance by Radioshop Techs.
2	KA112-Kilauea Park	Reported by County. Confirmed on Commander by RS. Battery fail (backplane change?)		X		
3	KA202-Anahola Aliomanu South	Reported by County. Confirmed on Commander by RS. Audio/Current fail	X	X		
4	KA203-Kealia	Reported by County. Confirmed on Commander by RS. Battery fail (battery change)	X	X		
5	KA204-Kapahi Park	Reported by County. TBD by onsite inspection.		X		
6	KA508-Omao Park	Activation fail per RS. Battery fail		X		
7	KA603-Makawela-Pakala	Reported by County. Confirmed on Commander by RS. Battery fail	X	X		
8	KA103-Wainiha	Activation fail per RS. Comm fail	X	X		HI-EMA RS Action - Radioshop to install yagi. Await new DAGS sat upgrade.

	OOS/SEVERELY DEGRADED	REASON	Threat Level 1 - Tsunami	Threat Level 2 - Hurricane	Threat Level 3 - Lava, Brush Fire, Dam Breach, Hazmat	ACTION
9	KA101-Haena	Solar panels blocked by mountain. Convert to electrical charge.	X	X		DAGS Action - Scheduled for DAGS Lump Sum Contract.
10	KA105-Hanalei	Legacy siren. Frozen Motor	X	X		
11	KA207-Kapaa Neighborhood Ctr	Replace bad solar panels and upgrade to UV controller.	X	X		
12	KA208-Kealia Kai	Lighting Strike Damage	X	X		
13	KA210-Wailua STP	Siren removed-Vehicle Collision	X	X		
14	KA303-Hanamalu	Replace bad solar panels and upgrade to UV controller.	X	X		
15	KA304-Hanamaulu Park	Replace bad solar panels		X		
16	KA310-Pua Loke	Replace bad solar panels and upgrade to UV controller.		X		

Hawaii County

21 Sirens reported as No Sound by County/State or Out of Service (OOS) **76.92%**

of 91

10 Requires maintenance

11 OOS/SEVERELY DEGRADED

	NO SOUND REPORTED BY COUNTY/STATE	SUSPECTED ISSUE	Threat Level 1 - Tsunami	Threat Level 2 - Hurricane	Threat Level 3 - Lava, Brush Fire, Dam Breach, Hazmat	ACTION
1	HA105-Kawailani Street	Reported by County. TBD by onsite inspection.		X		HI-EMA RS Action - To be scheduled on upcoming siren maintenance by Radioshop Techs.
2	HA112-Kolekole	Reported by County. Confirmed on Commander by RS. (battery change)	X	X		
3	HA306-Kukuihaele Park	Reported by County. No response in Commander. (Flash?) TBD by onsite inspection.		X		
4	HA403-Kawaihae #1, Spencer Park	Activation fail per RS (Solar Charger?).	X	X		
5	HA911-Hawaiian Beaches #2	Reported by County. TBD by onsite inspection.		X		
6	HA913-Paradise Park #3	Reported by County. Confirmed on Commander by RS.		X		
7	HA505-Kapaa Beach Park	Activation fail per RS. Poor cellular coverage in lower Puna. Install Yagi? Awaiting sat modem upgrade.	X	X		HI-EMA RS Action - Radioshop to install yagi. Work with Verizon Engineering. Await new sat upgrade.
8	HA908-Kaimu	Activation fail per RS. Poor cellular coverage in lower Puna. Install Yagi? Awaiting sat modem upgrade.		X	Lava Zone #2	
9	HA909-Pohoiki	Reported by County. Confirmed on Commander by RS.		X	Lava Zone #2	
10	HA916-Kehana	Activation fail per RS. Poor cellular coverage in lower Puna. Install Yagi? Awaiting sat modem upgrade.		X	Lava Zone #2	

	OOS/SEVERELY DEGRADED	REASON	Threat Level 1 - Tsunami	Threat Level 2 - Hurricane	Threat Level 3 - Lava, Brush Fire, Dam Breach, Hazmat	ACTION
11	HA404-Hapuna Beach	Comms offline due to legacy equipment	X	X		DAGS Action - Scheduled for WO#2
12	HA303-Waipio Valley	Replace bad drivers with 6024b speaker array, bad solar panels, and upgrade to UV controller.	X	X		DAGS Action -Scheduled for DAGS Indefinite Quantities Contract Workorder
13	HA609-Old Kona Airport	Replace bad drivers with 6024b speaker array, bad solar panels, and upgrade to UV controller.	X	X		
14	HA706-Milolii	Replace bad solar panels	X	X	Lava Zone #2	
15	HA806-Hawaiian Ocean View #2	Degraded with multiple bad driver lines per RS.		X	Lava Zone #2	
16	HA807-Waiohinu	Siren head rusted off		X		
17	HA910-Ainaloa	Replace bad solar panels		X	Lava Zone #2	
18	HA501-Hawi	Bad solar panels. Site to be moved to County base yard.		X		
19	HA904-Kapoho Beach Lots	Destroyed by 2018 Lava East Rift Zone	X	X	Lava Zone #1	
20	HA917-Ahalanui Beach Park	Destroyed by 2018 Lava East Rift Zone	X	X	Lava Zone #1	
21	HA926-Kapoho Vacation Land	Destroyed by 2018 Lava East Rift Zone	X	X	Lava Zone #1	

6.11.3 Statewide Siren Test Report (July 2023)

404 **STATEWIDE SIREN REPORT SUMMARY - JULY 2023**

Statewide

			last month
82	Sirens reported as No Sound or Out of Service (OOS)/DEGRADED	79.15%	75.46%
of	404		
35	Requires maintenance		
56	OOS/DEGRADED		

CCH -OAHU

			last month
35	Sirens reported as No Sound or Out of Service (OOS)/DEGRADED	80.56%	79.44%
of	180		
12	Requires maintenance		
23	OOS/DEGRADED		

Maui County

			last month
17	Sirens reported as No Sound or Out of Service (OOS)/DEGRADED	77.92%	74.03%
of	77		
7	Maui - Requires maintenance		
0	Molokai - Requires maintenance		
0	Lanai - Requires maintenance		
10	OOS/DEGRADED		

Kauai County

			last month
13	Sirens reported as No Sound or Out of Service (OOS)/DEGRADED	76.79%	71.43%
of	56		
4	Requires maintenance		
9	OOS/DEGRADED		

Hawaii County

			last month
17	Sirens reported as No Sound or Out of Service (OOS)/DEGRADED	81.32%	76.92%
of	91		
3	Requires maintenance		
14	OOS/DEGRADED		

CCH -OAHU

35 Sirens reported as No Sound or Out of Service (OOS)/DEGRADED **80.56%**

of 180

12 Requires maintenance

23 OOS/DEGRADED

	NO SOUND REPORTED BY COUNTY/STATE	SUSPECTED ISSUE	Threat Level 1 - Tsunami Zone	Threat Level 2 - Hurricane	Threat Level 3 - Lava, Brush Fire, Dam Breach, Hazmat	ACTION
1	OA100A-Kalama Valley Park	Comm fail. Radiotech's to replace batteries this month.		X		HI-EMA RS Action - To be scheduled on upcoming siren maintenance by Radioshop Techs.
2	OA108A-Fort Ruger	Comm fail (Needs DMR reflash).		X		
3	OA112-Kuulei Cliffs	Comm fail. Radiotech's to replace batteries this month.		X		
4	OA300A-Halawa Dist Park	Battery fail. Radiotech's to investigate onsite 7/14.		X		
5	OA311A-Honouliuli	Comm fail. Radiotech's to invesitgfate onsite this month.		X	Hazmat	
6	OA313-Makakilo BWS	Comm fail (reflashed/visited 6/30). Will moinitor onsite 8/1.		X		
7	OA318A-Maili North	Comm fail. Possible batteries stolen? Radiotech's to investigate onsite this month.	X	X		
8	OA331C-UH West Oahu	Comm fail. Radiotech's to replace batteries this month.		X		
9	OA414-Heeia Kea Pier	Activation fail. Possible "backplane" needs to be replaced.	X	X		
10	OA419-Kalae Oio Beach PK	Comm fail. Radiotech's to replace batteries this month.	X	X		
11	OA327-Keaau Beach Park	Vandalism - Awaiting parts (power cable).	X	X		HI-EMA RS Action - Radioshop will attempt to fix siren.
12	OA328-Makua Cave	Comm fail. (saturation of cell signal. Needs more troubleshooting onsite. Controller?)	X	X		HI-EMA RS Action - Radioshop to install yagi. Await new sat upgrade.

	OOS/DEGRADED	REASON	Threat Level 1 - Tsunami Zone	Threat Level 2 - Hurricane	Threat Level 3 - Lava, Brush Fire, Dam Breach, Hazmat	ACTION
13	OA101-Koko Head	Replace bad speaker array and solar panels.		X		HI-EMA Action - HIePro solicitation. "Need additional staffing to support"
14	OA110-Palolo valley Park	Replace bad solar panels.		X		
15	OA137-Moanalua Valley	Replace bad speaker array.		X		
16	OA109-Maunalani Park	Legacy siren. Mechanical issue beyond repair.		X		DAGS Action -Scheduled for DAGS Indefinite Quantities Contract Workorder
17	OA115-Dole St	Siren removed due to rotten wooden pole.		X		
18	OA124-Alewa Heights	Legacy siren. Mechanical issue beyond repair.		X		
19	OA203-Sharks Cove	Replace bad solar panels, drivers, and upgrade to UV controller.	X	X		
20	OA206-Kawailoa Beach	Replace bad solar panels and upgrade to UV controller.	X	X		
21	OA208-Wailua	Replace bad solar panels and upgrade to UV controller.		X	Dam Breach	
22	OA211-Dillingham Airfield	Replace bad solar panels and upgrade to UV controller.	X	X		
23	OA212A-Mokuleia BP	Replace bad solar panels and upgrade to UV controller.	X	X		
24	OA229-Mililani Mauka HECO	Replace bad solar panels and upgrade to UV controller.		X		
25	OA307-Palisades Elem school	Legacy siren. Frozen Motor		X		
26	OA312D-Hoakalei #2	Lighting Strike Damage	X	X	Hazmat	
27	OA319-Maili Beach Park	On going "Vandalism" - Beyond tech repair	X	X		
28	OA323-Mauna Lahilahi Beach	On going "Vandalism" - Beyond tech repair. Upgrade to UV-HSO.	X	X		
29	OA329-Kaena Point	On going "Vandalism" - Beyond tech repair. Conduits.	X	X		
30	OA331A-Kalaeloa USCG	Siren head rusted off	X	X	Hazmat	
31	OA400A-Kaiona Beach Park	Replace bad solar panels.	X	X		
32	OA402A-Waimanalo Valley	Replace bad solar panels and upgrade to UV controller.	X	X		
33	OA402B-Waimanalo Town BWS	Lighting Strike Damage	X	X		
34	OA403A-Maunawili Valley PK	Replace bad solar panels and upgrade to UV controller.		X		
35	OA422-Punaluu Beach Park	Replace bad solar panels.	X	X		

Maui County

17 Sirens reported as No Sound or Out of Service (OOS)/DEGRADED **77.92%**

of 77

7 Maui - Requires maintenance

0 Molokai - Requires maintenance

0 Lanai - Requires maintenance

10 OOS/DEGRADED

	NO SOUND REPORTED BY COUNTY/STATE	SUSPECTED ISSUE	Threat Level 1 - Tsunami	Threat Level 2 - Hurricane	Threat Level 3 - Lava, Brush Fire, Dam Breach, Hazmat	ACTION
1	MA116-Kahului School	Comm fail. Radiotech's to investigate onsite (charger?)	X	X		HI-EMA RS Action - To be scheduled on upcoming siren maintenance by Radioshop Techs.
2	MA117-Maui Comm College	Comm fail. Radiotech's to replace batteries.	X	X		
3	MA122-Wailea #2	Comm fail. Radiotech's to replace batteries.				
4	MA125-Makena	Comm fail. Radiotech's to replace batteries.	X	X		
5	MA126-Upper Kula, Copp Rd	Activation fail. Radiotech's to investigate onsite.		X		
6	MA132-Sugar Beach	Activation fail. Radiotech's to investigate onsite.	X	X		
7	MA302-Keanae	Comm fail. Radiotech's to replace batteries.				

	OOS/DEGRADED	REASON	Threat Level 1 - Tsunami	Threat Level 2 - Hurricane	Threat Level 3 - Lava, Brush Fire, Dam Breach, Hazmat	ACTION
8	MA101-Waiehu	Degraded with multiple bad driver lines per RS.	X	X		DAGS Action - Scheduled for DAGS Lump Sum Contract.
9	MA105-Naska	Electrical Issues	X	X		
10	MA108-Kuau Store	Legacy siren. Frozen Motor. Site removed due to fall hazard.	X	X		
11	MA115-Wells Park	Upgrade to UV controller.		X		
12	MA131-Haiku	Comm fail. Pending Verizon to install new site nearby.		X		
13	MA402-Maluuluolele	Legacy siren. Frozen Motor	X	X		
14	MA403-Kapunakea	Legacy siren. Frozen Motor	X	X		
15	MA410-Puamana	Ongoing electrical Issues	X	X		
16	MA303-Wailua Valley	Activation fail per RS. Bad cell signal in area. Awaiting sat modem upgrade.		X		Yagi antenna installed and no improvement. Await new sat upgrade.
17	MA120-Kahakuloa	No cell coverage in area. Sat modem upgrades in progress	X	X		DAGS Action - DAGS Satellite Upgrade Project in progress.

Kauai County

13 **Sirens reported as No Sound or Out of Service (OOS)/DEGRADED** **76.79%**

of **56**

4 **Requires maintenance**

9 **OOS/DEGRADED**

	NO SOUND REPORTED BY COUNTY/STATE	SUSPECTED ISSUE	Threat Level 1 - Tsunami	Threat Level 2 - Hurricane	Threat Level 3 - Lava, Brush Fire, Dam Breach, Hazmat	ACTION
1	KA107-Anini	Activation fail. Radiotech's to investigate onsite.	X	X		HI-EMA RS Action - To be scheduled on upcoming siren maintenance by Radioshop Techs.
2	KA112-Kilauea Park	Activation fail. Possible "backplane" needs to be replaced.		X		
3	KA603-Makawela-Pakala	Battery fail. Radiotech's to replace batteries.	X	X		
4	KA103-Wainiha	Activation fail per RS. Comm fail	X	X		HI-EMA RS Action - Radioshop to install yagi. Await new DAGS sat upgrade.

	OOS/DEGRADED	REASON	Threat Level 1 - Tsunami	Threat Level 2 - Hurricane	Threat Level 3 - Lava, Brush Fire, Dam Breach, Hazmat	ACTION
5	KA101-Haena	Solar panels blocked by mountain. Convert to electrical charge.	X	X		DAGS Action - Scheduled for DAGS Lump Sum Contract.
6	KA105-Hanalei	Legacy siren. Frozen Motor	X	X		
7	KA203-Kealia	Bad drivers. Refer to DAGS.	X	X		
8	KA207-Kapaa Neighborhood Ctr	Replace bad solar panels and upgrade to UV controller.	X	X		
9	KA208-Kealia Kai	Lighting Strike Damage	X	X		
10	KA210-Wailua STP	Siren removed-Vehicle Collision	X	X		
11	KA303-Hanamalu	Replace bad solar panels and upgrade to UV controller.	X	X		
12	KA304-Hanamaulu Park	Replace bad solar panels		X		
13	KA310-Pua Loke	Replace bad solar panels and upgrade to UV controller.		X		

Hawaii County

17 Sirens reported as No Sound or Out of Service (OOS)/DEGRADED **81.32%**

of 91

3 Requires maintenance

14 OOS/DEGRADED

	NO SOUND REPORTED BY COUNTY/STATE	SUSPECTED ISSUE	Threat Level 1 - Tsunami	Threat Level 2 - Hurricane	Threat Level 3 - Lava, Brush Fire, Dam Breach, Hazmat	ACTION
1	HA112-Kolekole	Comms fail. Radiotech's to replace batteries (or charger issue).	X	X		HI-EMA RS Action - To be scheduled on upcoming siren maintenance by Radioshop Techs.
2	HA306-Kukuihaele Park	Comm fail. Radiotech's to investigate onsite.		X		
3	HA913-Paradise Park #3	Comm fail. Replace Cell Modem (not powered on per HCDA onsite visit 7/13)		X		

	OOS/DEGRADED	REASON	Threat Level 1 - Tsunami	Threat Level 2 - Hurricane	Threat Level 3 - Lava, Brush Fire, Dam Breach, Hazmat	ACTION
4	HA404-Hapuna Beach	Comms offline due to legacy equipment	X	X		DAGS Action - Scheduled for WO#2
5	HA908-Kaimu	Comm Fail. No cellular coverage in lower Puna after East Rift Zone Eruption. Awaiting sat modem upgrade.		X	Lava Zone #2	DAGS Action -Scheduled for DAGS Indefinite Quantities Contract Workorder
6	HA909-Pohoiki	Comm Fail. No cellular coverage in lower Puna after East Rift Zone Eruption. Awaiting sat modem upgrade.		X	Lava Zone #2	
7	HA916-Kehana	Comm Fail. No cellular coverage in lower Puna after East Rift Zone Eruption. Awaiting sat modem upgrade.		X	Lava Zone #2	
8	HA303-Waipio Valley	Replace bad drivers with 6024b speaker array, bad solar panels, and upgrade to UV controller.	X	X		
9	HA609-Old Kona Airport	Replace bad drivers with 6024b speaker array, bad solar panels, and upgrade to UV controller.	X	X		
10	HA706-Milolii	Replace bad solar panels	X	X	Lava Zone #2	
11	HA806-Hawaiian Ocean View #2	Degraded with multiple bad driver lines per RS.		X	Lava Zone #2	
12	HA807-Waiohinu	Siren head rusted off		X		
13	HA910-Ainaloa	Replace bad solar panels		X	Lava Zone #2	
14	HA501-Hawi	Bad solar panels. Site to be moved to County base yard.		X		
15	HA904-Kapoho Beach Lots	Destroyed by 2018 Lava East Rift Zone	X	X	Lava Zone #1	
16	HA917-Ahalanui Beach Park	Destroyed by 2018 Lava East Rift Zone	X	X	Lava Zone #1	
17	HA926-Kapoho Vacation Land	Destroyed by 2018 Lava East Rift Zone	X	X	Lava Zone #1	

6.11.4 Statewide Siren Test Report (August 2023)

FOR OFFICIAL USE ONLY (FOUO) - CONFIDENTIAL

404 **STATEWIDE SIREN REPORT SUMMARY - AUGUST 2023**

Statewide

			last month
86	Sirens reported as No Sound or Out of Service (OOS)/DEGRADED	78.98%	79.15%
of	404		
27	Requires maintenance		
59	OOS/DEGRADED		

CCH -OAHU

			last month
39	Sirens reported as No Sound or Out of Service (OOS)/DEGRADED	78.33%	80.56%
of	180		
14	Requires maintenance		
25	OOS/DEGRADED		

Maui County

			last month
16	Sirens reported as No Sound or Out of Service (OOS)/DEGRADED	79.22%	77.92%
of	77		
6	Maui - Requires maintenance		
0	Molokai - Requires maintenance		
0	Lanai - Requires maintenance		
10	OOS/DEGRADED		

Kauai County

			last month
11	Sirens reported as No Sound or Out of Service (OOS)/DEGRADED	80.36%	76.79%
of	56		
1	Requires maintenance		
10	OOS/DEGRADED		

Hawaii County

			last month
20	Sirens reported as No Sound or Out of Service (OOS)/DEGRADED	78.02%	81.32%
of	91		
6	Requires maintenance		
14	OOS/DEGRADED		

FOR OFFICIAL USE ONLY (FOUO) - CONFIDENTIAL

FOR OFFICIAL USE ONLY (FOUO) - CONFIDENTIAL

CCH -OAHU

39 Sirens reported as No Sound or Out of Service (OOS)/DEGRADED **78.33%**

of 180

14 Requires maintenance

25 OOS/DEGRADED

	NO SOUND REPORTED BY COUNTY/STATE	SUSPECTED ISSUE	Threat Level 1 - Tsunami Zone	Threat Level 2 - Hurricane	Threat Level 3 - Lava, Brush Fire, Dam Breach, Hazmat	ACTION
1	OA100A-Kalama Valley Park	Comm fail. Radiotech's to troubleshoot. Possible bad cell modem.		X		HI-EMA Radioshop
2	OA120-McKinley HS	Comm fail. Radiotech's to replace batteries.		X		
3	OA122-Booth Park	Activation fail. Radiotech's to troubleshoot onsite.		X		
4	OA128-Kokea Street	Activation fail. Radiotech's to troubleshoot onsite.	X	X		
5	OA209-Silva Pump	Comm fail. Posisbly batteries stolen.	X	X		
6	OA214-Leilehua HS	Comm fail. Radiotech's to troubleshoot. Possible cell modem reset.				
7	OA311A-Honouliuli	Comm fail. Radiotech's to investigate onsite.		X	Hazmat	
8	OA317-Nanakuli Maili	Resident reported	X	X		
9	OA327-Keaau Beach Park	Vandalism - Awaiting parts (power cable).	X	X		
10	OA328-Makua Cave	Comm fail. (saturation of cell signal. Needs more troubleshooting onsite. Controller?)	X	X		
11	OA331C-UH West Oahu	Comm fail. Radiotech's to replace batteries.		X		
12	OA414-Heeia Kea Pier	Activation fail. Possible "backplane" needs to be replaced.	X	X		
13	OA419-Kalae Oio Beach PK	Comm fail. Radiotech's to replace batteries.	X	X		
14	OA426A-PCC	Activation fail. Radiotech's to troubleshoot onsite.	X	X		

	OOS/DEGRADED	REASON	Threat Level 1 - Tsunami Zone	Threat Level 2 - Hurricane	Threat Level 3 - Lava, Brush Fire, Dam Breach, Hazmat	ACTION
1	OA101-Koko Head	Replace bad speaker array and solar panels.		X		HI-EMA Action - **HIePro solicitation
2	OA109-Maunalani Park	Legacy siren. Mechanical issue beyond repair.		X		DAGS Action - Workorder Contract
3	OA110-Palolo valley Park	Replace bad solar panels.		X		HI-EMA Action - **HIePro solicitation
4	OA112-Kuulei Cliffs	Replace bad solar panels.	X	X		HI-EMA Action - **HIePro solicitation
5	OA115-Dole St	Siren removed due to rotten wooden pole.		X		DAGS Action - Workorder Contract
6	OA124-Alewa Heights	Legacy siren. Mechanical issue beyond repair.		X		DAGS Action - Workorder Contract
7	OA137-Moanalua Valley	Replace bad speaker array.		X		HI-EMA Action - **HIePro solicitation
8	OA203-Sharks Cove	Replace bad solar panels, drivers, and upgrade to UV controller.	X	X		DAGS Action - Workorder Contract
9	OA206-Kawailoa Beach	Replace bad solar panels and upgrade to UV controller.	X	X		DAGS Action - Workorder Contract
10	OA208-Wailua	Replace bad solar panels and upgrade to UV controller.		X	Dam Breach	DAGS Action - Workorder Contract
11	OA211-Dillingham Airfield	Replace bad solar panels and upgrade to UV controller.	X	X		DAGS Action - Workorder Contract
12	OA212A-Mokuleia BP	Replace bad solar panels and upgrade to UV controller.	X	X		DAGS Action - Workorder Contract

FOR OFFICIAL USE ONLY (FOUO) - CONFIDENTIAL

FOR OFFICIAL USE ONLY (FOUO) - CONFIDENTIAL

13	OA229-Mililani Mauka HECO	Replace bad solar panels and upgrade to UV controller.		X		DAGS Action - Workorder Contract
14	OA303-Aiea Heights	Legacy siren. INOP Blower and Chopper		X		DAGS Action - Workorder Contract
15	OA307-Palisades Elem school	Legacy siren. Frozen Motor		X		DAGS Action - Workorder Contract
16	OA312D-Hoakalei #2	Lighting Strike Damage	X	X	Hazmat	DAGS Action - Workorder Contract
17	OA319-Maili Beach Park	On going "Vandalism" - Beyond tech repair	X	X		DAGS Action - Workorder Contract
18	OA323-Mauna Lahilahi Beach	On going "Vandalism" - Beyond tech repair. Upgrade to UV-HSO.	X	X		DAGS Action - Workorder Contract
19	OA329-Kaena Point	On going "Vandalism" - Beyond tech repair. Conduits.	X	X		DAGS Action - Workorder Contract
20	OA331A-Kalaeloa USCG	Siren head rusted off	X	X	Hazmat	DAGS Action - Workorder Contract
21	OA400A-Kaiona Beach Park	Replace bad solar panels.	X	X		DAGS Action - Workorder Contract
22	OA402A-Waimanalo Valley	Replace bad solar panels and upgrade to UV controller.	X	X		DAGS Action - Workorder Contract
23	OA402B-Waimanalo Town BWS	Lighting Strike Damage	X	X		DAGS Action - Workorder Contract
24	OA403A-Maunawili Valley PK	Replace bad solar panels and upgrade to UV controller.		X		DAGS Action - Workorder Contract
25	OA422-Punaluu Beach Park	Replace bad solar panels.	X	X		HI-EMA Action - **HIePro solicitation

**NOTE: "Need additional staffing to support"

FOR OFFICIAL USE ONLY (FOUO) - CONFIDENTIAL

FOR OFFICIAL USE ONLY (FOUO) - CONFIDENTIAL

Maui County

16 **Sirens reported as No Sound or Out of Service (OOS)/DEGRADED** **79.22%**

of **77**

6 **Maui - Requires maintenance**

0 **Molokai - Requires maintenance**

0 **Lanai - Requires maintenance**

10 **OOS/DEGRADED**

	NO SOUND REPORTED BY COUNTY/STATE	SUSPECTED ISSUE	Threat Level 1 - Tsunami	Threat Level 2 - Hurricane	Threat Level 3 - Lava, Brush Fire, Dam Breach, Hazmat	ACTION
1	MA115-Wells Park	Comm fail. Radiotech's to replace batteries. Upgrade to UV controller.		X		HI-EMA Radioshop
2	MA116-Kahului School	Comm fail. Radiotech's to investigate onsite (charger?)	X	X		
3	MA117-Maui Comm College	Comm fail. Radiotech's to replace batteries.	X	X		
4	MA122-Wailea #2	Comm fail. Radiotech's to replace batteries.	X	X		
5	MA125-Makena	Comm fail. Radiotech's to replace batteries.	X	X		
6	MA302-Keanae	Comm fail. Radiotech's to replace batteries.	X	X		

	OOS/DEGRADED	REASON	Threat Level 1 - Tsunami	Threat Level 2 - Hurricane	Threat Level 3 - Lava, Brush Fire, Dam Breach, Hazmat	ACTION
1	MA101-Waiehu	Degraded with multiple bad driver lines per RS.	X	X		DAGS Action - Workorder Contract
2	MA105-Naska	Electrical Issues	X	X		DAGS Action - Workorder Contract
3	MA108-Kuau Store	Legacy siren. Frozen Motor. Site removed due to fall hazard.	X	X		DAGS Action - Workorder Contract
4	MA131-Haiku	Comm fail. Verizon site is installed as of July. Awaiting to be online.		X		Awaiting Verizon/DAGS Sat Project
5	MA303-Wailua	Comm fail. No cell coverage in area. Awaiting sat upgrade.		X		DAGS Action - DAGS Sat Project
6	MA402-Maluuluolele	Legacy siren. Frozen Motor	X	X		DAGS Action - Workorder Contract
7	MA403-Kapunakea	Legacy siren. Frozen Motor	X	X		DAGS Action - Workorder Contract
8	MA410-Puamana	Ongoing electrical Issues	X	X		DAGS Action - Workorder Contract
9	MA303-Wailua Valley	Activation fail. Bad cell signal in area. Awaiting sat modem upgrade.		X		DAGS Action - DAGS Sat Project
10	MA120-Kahakuloa	No cell coverage in area. Sat modem upgrades in progress	X	X		DAGS Action - DAGS Sat Project

FOR OFFICIAL USE ONLY (FOUO) - CONFIDENTIAL

FOR OFFICIAL USE ONLY (FOUO) - CONFIDENTIAL

Kauai County

11 Sirens reported as No Sound or Out of Service (OOS)/DEGRADED **80.36%**

of 56

1 Requires maintenance

10 OOS/DEGRADED

	NO SOUND REPORTED BY COUNTY/STATE	SUSPECTED ISSUE	Threat Level 1 - Tsunami	Threat Level 2 - Hurricane	Threat Level 3 - Lava, Brush Fire, Dam Breach, Hazmat	ACTION
1	KA112-Kilauea Park	Activation fail. Possible "backplane" needs to be replaced.		X		HI-EMA Radioshop

	OOS/DEGRADED	REASON	Threat Level 1 - Tsunami	Threat Level 2 - Hurricane	Threat Level 3 - Lava, Brush Fire, Dam Breach, Hazmat	ACTION
1	KA101-Haena	Solar panels blocked by mountain. Convert to electrical charge.	X	X		DAGS Action - Workorder Contract
2	KA103-Wainiha	Comm fail. Needs yagi for cell and awaiting sat upgrade.	X	X		DAGS Action - DAGS Sat Project
3	KA105-Hanalei	Legacy siren. Frozen Motor	X	X		DAGS Action - Workorder Contract
4	KA203-Kealia	Bad drivers. Refer to DAGS.	X	X		DAGS Action - Workorder Contract
5	KA207-Kapaa Neighborhood Ctr	Replace bad solar panels and upgrade to UV controller.	X	X		DAGS Action - Workorder Contract
6	KA208-Kealia Kai	Lighting Strike Damage	X	X		DAGS Action - Workorder Contract
7	KA210-Wailua STP	Siren removed-Vehicle Collision	X	X		DAGS Action - Workorder Contract
8	KA303-Hanamalu	Replace bad solar panels and upgrade to UV controller.	X	X		DAGS Action - Workorder Contract
9	KA304-Hanamaulu Park	Replace bad solar panels		X		DAGS Action - Workorder Contract
10	KA310-Pua Loke	Replace bad solar panels and upgrade to UV controller.		X		DAGS Action - Workorder Contract

FOR OFFICIAL USE ONLY (FOUO) - CONFIDENTIAL

FOR OFFICIAL USE ONLY (FOUO) - CONFIDENTIAL

Hawaii County

20 Sirens reported as No Sound or Out of Service (OOS)/DEGRADED **78.02%**

of 91

6 Requires maintenance

14 OOS/DEGRADED

	NO SOUND REPORTED BY COUNTY/STATE	SUSPECTED ISSUE	Threat Level 1 - Tsunami	Threat Level 2 - Hurricane	Threat Level 3 - Lava, Brush Fire, Dam Breach, Hazmat	ACTION
1	HA114-Carvalho Park	Comm fail. Batteries stolen - Need to make police report and replace.		X		HI-EMA Radioshop
2	HA306-Kukuihaele Park	Comm fail. Radiotech's to investigate onsite.		X		
3	HA405-Puako #1	Comm fail. Radiotech's to investigate onsite.	X	X		
4	HA704-Palipoko	Battery fail. Radiotech's to replace batteries.		X		
5	HA806-HOVE #2	Activation fail. Radiotech's to investigate onsite.	X	X	X	
6	HA913-Paradise Park #3	Comm fail. Replace Cell Modem (not powered on per HCDA onsite visit 7/13)		X		

	OOS/DEGRADED	REASON	Threat Level 1 - Tsunami	Threat Level 2 - Hurricane	Threat Level 3 - Lava, Brush Fire, Dam Breach, Hazmat	ACTION
1	HA303-Waipio Valley	Replace bad drivers with 6024b speaker array, bad solar panels, and upgrade to UV controller.	X	X		DAGS Action - Workorder Contract
2	HA404-Hapuna Beach	Comms offline due to legacy equipment	X	X		DAGS Action - Workorder Contract
3	HA501-Hawi	Bad solar panels. Site to be moved to County base yard.		X		DAGS Action - Workorder Contract
4	HA609-Old Kona Airport	Replace bad drivers with 6024b speaker array, bad solar panels, and upgrade to UV controller.	X	X		DAGS Action - Workorder Contract
5	HA706-Milolii	Replace bad solar panels	X	X	Lava Zone #2	DAGS Action - Workorder Contract
6	HA806-Hawaiian Ocean View #2	Degraded with multiple bad driver lines per RS.		X	Lava Zone #2	DAGS Action - Workorder Contract
7	HA807-Waiohinu	Siren head rusted off		X		DAGS Action - Workorder Contract
8	HA904-Kapoho Beach Lots	Destroyed by 2018 Lava East Rift Zone	X	X	Lava Zone #1	DAGS Action - Workorder Contract
9	HA908-Kaimu	Comm Fail. No cellular coverage in lower Puna after East Rift Zone Eruption. Awaiting sat modem upgrade.		X	Lava Zone #2	DAGS Action - DAGS Sat Project
10	HA909-Pohoiki	Comm Fail. No cellular coverage in lower Puna after East Rift Zone Eruption. Awaiting sat modem upgrade.		X	Lava Zone #2	DAGS Action - DAGS Sat Project
11	HA910-Ainaloa	Replace bad solar panels		X	Lava Zone #2	DAGS Action - Workorder Contract
12	HA916-Kehana	Comm Fail. No cellular coverage in lower Puna after East Rift Zone Eruption. Awaiting sat modem upgrade.		X	Lava Zone #2	DAGS Action - DAGS Sat Project
13	HA917-Ahalanui Beach Park	Destroyed by 2018 Lava East Rift Zone	X	X	Lava Zone #1	DAGS Action - Workorder Contract
14	HA926-Kapoho Vacation Land	Destroyed by 2018 Lava East Rift Zone	X	X	Lava Zone #1	DAGS Action - Workorder Contract

FOR OFFICIAL USE ONLY (FOUO) - CONFIDENTIAL

6.12 County of Maui Policies

6.12.1 Traffic Operations G.O. 405.1

MAUI COUNTY POLICE DEPARTMENT

GENERAL ORDERS
CHAPTER 405
TRAFFIC OPERATIONS

Effective date: 7/07/21 Revision date: 6/07/21 Rescinds: GO 405.1 (10/14/94)

Accreditation Standards:

TRAFFIC SECTION
G.O. 405.1

I. PURPOSE

The purpose of this directive is to establish the Department's Traffic Section.

II. POLICY

The primary responsibility for traffic law enforcement and traffic control activities rest within the Uniformed Services Bureau. The Traffic Section supplements traffic enforcement activities.

III. FUNCTION

A. The Traffic Section is organized within the Maui Police Department to be primarily responsible for traffic functions and specialized traffic needs.

B. Traffic Section officers conduct general investigations and technical accident investigations of serious, liability, or fatality accidents.

C. The Traffic Section coordinates the Adult Crossing Guard program and the Junior Police Officer Program.

D. The Solo Bike Detail assists with the funeral escorts and dignitary escorts, as well as selective enforcement of traffic laws.

IV. ORGANIZATIONAL STRUCTURE

A. Section Commander

The Commander of the Traffic Section is an officer holding the rank of Lieutenant.

1. The Section Commander reports to the Assistant Chief of the Uniformed Services Bureau.

B. Sergeants

Three sergeants are assigned to the Traffic Section. They report to the Section Commander. The sergeants oversee the Vehicle Homicide Unit, the Solo Bike Detail, and the OUI Task Force.

C. Police Officers

Officers assigned to the Vehicle Homicide Unit, the Solo Bike Detail, and the OUI Task Force report to their respective supervisor.

DEAN M. RICKARD
Acting Chief of Police

6.12.2 Traffic Operations G.O. 405.7

MAUI COUNTY POLICE DEPARTMENT

GENERAL ORDERS
CHAPTER 405
TRAFFIC OPERATIONS

Effective date: 08/27/21 Revision date: 07/08/21 Rescinds: GO 405.7 (03/28/03)

Accreditation Standards:

TRAFFIC DIRECTION AND CONTROL
G.O. 405.7

I. PURPOSE

To establish on and off-duty procedures and guidelines for safe and efficient traffic direction and control.

II. POLICY

To provide for the safe and efficient movement of vehicle and pedestrian traffic within the County of Maui.

III. FUNCTIONS

A. Traffic direction and control functions are performed by sworn and nonsworn personnel to various extents to provide for the orderly and safe flow of vehicular and pedestrian movements. Traffic control and direction may be by unmanned mechanical devices, signals and signs.

B. Sworn personnel shall perform traffic direction and control activities at times and places where police intervention is required until the traffic flow problem is solved or until a temporary traffic control device can be set up/installed.

1. Officer may be assigned to perform specific traffic control functions at special events or for temporary special needs, such as parades, funeral processions, etc.

IV. PROCEDURES

A. Manual Traffic Direction

1. Personnel performing manual traffic control shall ensure that they are visible by using available equipment to enhance their safety. This equipment may include, but is not limited to the following: vehicle auxiliary lighting, flashlights, and cones. This is especially important during adverse weather or lighting conditions. A reflective vest shall be worn when the officer is on a roadway controlling or directing traffic. Personnel shall utilize uniform hand signals and gestures for manual traffic control as dictated by training.

B. High Visibility Clothing

1. The Department will provide high visibility reflective outerwear to all personnel who may have to perform manual traffic direction. The use of high visibility reflective outerwear when directing traffic enhances officer safety and driver's recognition and response.

    a. This reflective outerwear shall be worn in addition to the full uniform at all times when an officer is directing traffic or investigating major or minor collisions. In emergency situations, non-uniformed officers may direct traffic however, reflective outwear shall be worn.

2. Department issued service cap and high visibility reflective gloves shall be worn at all times when an officer is directing traffic at a stationary traffic post, funeral post, or off-duty post.

C. Traffic Direction at Fire Scenes

1. The primary task of Department personnel engaged in traffic direction and control at fire scenes will be to maintain access to and from the scene of the fire for the fire department and other emergency vehicles. Officer shall ensure that all private vehicles, including those belonging to volunteer fire fighters, do not obstruct emergency operations.

2. Officers will coordinate their efforts with the Fire Department to provide crowd control and adequate safety measures for vehicular and pedestrian traffic.

D. Traffic Direction at Traffic Collision Scenes

1. Upon arrival at the scene, officers should park police vehicles in such a manner to provide maximum protection to the scene, but without endangering the public.

2. Officers shall utilize appropriate traffic control devices and manual traffic direction procedures to redirect traffic and to provide for a safe collision scene.

E. Traffic Direction – Adverse Road and Weather Conditions

1. Adverse road conditions may include, but not be limited to:

    a. Objects that have fallen onto the roadway.

    b. Acts of nature, i.e., fog, snow, ice, flooding, etc.

    c. Engineering hazards, exposed guardrail ends, down power lines, etc.

2. Upon discovering an adverse road or weather-related condition, officer shall take appropriate action, which includes, but is not limited to:

   a. Notifying the district's communications section to contact the appropriate agency to assist or correct the hazard.

   b. Provide traffic control, as necessary.

   c. Immediately rectify the situation, where feasible.

DEAN M. RICKARD
Acting Chief of Police

6.12.3 MFD Policy: Radio Communications E.O.300.04

RADIO COMMUNICATIONS	E.O. 300.04

Effective Date	Total Pages	Version Number	Revision Date
7/1/2019	7	1	1/3/2019
9/1/2020	7	2	7/17/2020

PURPOSE: Provide guidance to consistent and effective communication over the radio.

GUIDELINE:

I. ROUTINE RADIO TRAFFIC

Routine radio traffic should be the most common communication performed on the emergency scene. In most instances, routine radio traffic should only be initiated by the IC.

A. Command must structure all routine radio traffic using the Order Model.

B. Once a Unit is assigned into the hazard zone, they should maintain radio silence unless they are contacted by Command.

C. All communications that details the routine work that Units perform in their assigned work areas should be done face to face and must not be transmitted over the tactical channel.

D. "Good News" reporting should only be reported when requested by command as operational benchmarks in a C.A.N. report. The following are examples:

- Fire knock down
- Primary all-clears
- No fire extension
- Fire control
- Loss control
- Ventilation complete
- PAR's

II. PRIORITY RADIO TRAFFIC

Unit/members with priority traffic are allowed to break into the order model of routine radio traffic to deliver their priority traffic report. Once the IC has acknowledged the priority traffic report, they should conclude their radio transmission with the unit whose traffic was broken into.

A. All Priority traffic reports are to be direct to and acknowledged by the IC.

B. Priority traffic reports include the following:

1. Unable to complete a critical assigned task/tactical objective
2. Urgent need to be reinforced/backed-up to complete an assigned task/tactical objective
3. Victims encountered
4. Working concealed space fires not easily controlled by the locating unit
5. A roof report that includes: attic fire, unsafe roof structure, imminent collapse threat
6. Sudden, significant incident events (i.e. flashover, back draft, collapse, unstable structure, live power line down)

C. Dispatch does not repeat priority traffic messages

III. EMERGENCY TRAFFIC

A. The IC is the only person who can initiate an emergency traffic report. Companies operating in and around the hazard zone will contact the IC with priority traffic reports and the IC will determine the need for emergency traffic.

B. Emergency traffic should be structured in the following manner:

1. The IC will contact fire ground units via radio and announce "Emergency Traffic."
2. IC will communicate emergency traffic message.

   Example: IC – "Emergency Traffic," "Emergency Traffic, Wailuku Command to all units, we are going defensive on this structure. All units operating in the fire structure exit the structure and report PAR's upon exiting."

C. All other units operating at the incident site will maintain radio discipline until the emergency traffic has been cleared by the IC.

D. Once the situation that caused the emergency traffic has been mitigated the IC should clear the emergency traffic with a brief report stating why.

Example: "Command to all units, all units have exited the structure with PAR's. Command is clearing emergency traffic and will remain in the defensive strategy. All units return to routine radio traffic."

E.O. 300.04

IV. STATUS CHANGE

A status change is defined as: moving from an assigned work location to a different geographic work location or exiting the structure to recycle or rehab.

A. If a Unit has completed their entire work assignment, they should contact Command and request another assignment.

Example: "Command from E-1, Engine 1 has a primary all-clear, there is no fire extension to the 2nd floor or the attic space, we are at 75% air, and are ready to be reassigned."

B. A status change report should be made as soon as possible if a unit is unable to gain access to an assigned work area (access or building arrangement).

Example: "Command from E-2" – "E-2 has it made it to the Charlie side and there is no access to the interior from the Charlie side. E2 needs to be reassigned."

V. PROTOCOLS FOR RADIO MESSAGES

A Use Clear Text

1. No 10-codes should be used.

2. Standard words and phrases indicate the following

3. When designating items by letter, the following should be used:

A = Alpha	**J** = Juliet	**S** = Sierra
B = Bravo	**K** = Kilo	**T** = Tango
C = Charlie	**L** = Lima	**U** = Uniform
D = Delta	**M** = Mike	**V** = Victor
E = Echo	**N** = November	**W** = Whiskey
F = Foxtrot	**O** = Oscar	**X** = X-ray
G = Golf	**P** = Papa	**Y** = Yankee
H = Hotel	**Q** = Quebec	**Z** = Zulu
I = India	**R** = Romeo	

B. Radio Discipline

1. Know exactly what you're going to say before clicking the microphone to talk.

E.O. 300.04

2. Only communicate information on the tactical channel that pertains to the completion of the tactical priorities and firefighter safety.

3. Always let communication loops close before clicking the microphone button to talk.

4. Let the IC be the one to contact you.

5. Always end every CAN report with a NEED assessment (or with "No Needs").

6. Never get on the radio to give good news

C. Use Order Model

1. When the sender is ready to transmit a message, they call the receiver to determine if they are ready to receive the message.

2. The receiver then acknowledges the sender.

3. When the sender receives the readiness reply, they can transmit the message.

4. The receiver then gives a brief restatement of the message to acknowledge the receipt of the message.

5. The sender restates the message if misunderstood.

D. Communications should focus on the completion of the tactical priorities and firefighter safety.

VI. RADIO DESIGNATIONS

A. Supervisors

1. The radio designation for the person in charge of any organizational element shall be the name of the organizational element.

- Captain of Engine 11 will be "Engine 11"
- Division 3 Supervisor will be "Division 3"
- Food Unit Leader will be "Food Unit"

2. Same radio designation remains with the organizational element on mobile and portable radio.

E.O. 300.04

3. Same radio designation remains with the supervisor of an organization element on primary and secondary vehicles (mini, utility).

4. If Rescue 10 personnel board Air-1, their radio designation remains as "Rescue 10"

5. The names of organizational elements and the titles for the person in charge shall comply with NIMS ICS

B. Fire Apparatus Operators

1. FAO's shall be designated as "Operators" (i.e., E1 FAO shall be designated as "E1 Operator").

2. Same radio designation remains on mobile and portable radio.

3. When the FAO is not functioning as an FAO (i.e. handling utilities, advancing a hoseline), his/her designation shall be "Pac 2" (i.e., E1 FAO shall be designated as "E1 Pac 2").

C. Firefighters

1. Radio designation for any given firefighter shall correspond to the portable radio number assigned. A firefighter working on Engine 1 and assigned portable 3 shall be designated as "Engine 1 Pac 3".

2. When a firefighter is reassigned to work with another company, he shall maintain his original radio designation.

D. Bureau Personnel

Bureau personnel shall each be assigned a number within their respective bureaus. (i.e., Training Bureau personnel shall be designated as Training 1, 2, 3, 4, etc...)

E. Chief Officers

Chief Officer's radio designations are as follows:

- Fire Chief ..... Fire 1
- Deputy Fire Chief ..... Fire 2
- Assistant Chief of Operations ..... Fire 3
- Assistant Chief of Support Services ..... Fire 4
- Fire Services Officer ..... FSO

E.O. 300.04

- Battalion Chief, Battalion 1, A-watch..... BC1
- Battalion Chief, Battalion 1, B-watch..... BC2
- Battalion Chief, Battalion 1, C-watch..... BC3
- Battalion Chief, Battalion 2, A-watch..... BC4
- Battalion Chief, Battalion 2, B-watch..... BC5
- Battalion Chief, Battalion 2, C-watch..... BC6

F. Base Station

Base station radios shall be designated by their station number (i.e., “Station 6”).

VII. ASSIGNMENT OF PORTABLE RADIOS

A. The department shall make every effort to ensure that all line personnel are provided a portable radio. At a minimum, every firefighter working in a hostile environment should have a portable radio.

B. Assignments of portable radios are at the discretion of the company commander.

C. Each member shall be responsible to account for his/her portable radio at the start of the work shift.

D. Each member shall be responsible to have a fully charged radio that is operational.

E. At the end of shifts, radios should be “handed off” to personnel who are coming on to shift.

F. Available battery chargers and batteries should be kept on board all in-service apparatus.

VIII. RADIO CHANNELS

A. The following table lists department radio channels

Zone	Channel Name / Talkgroup	Description
Fire	FD 1	Maui dispatch channel.
Fire	FD 2	First back up channel / Tactical Operations.
Fire	FD 3	Second back up channel / Tactical Operations.
Fire	FD 4	Third back up channel / Tactical Operations.
Fire	FD 5	Molokai & Lanai dispatch channel.

Fire	FD 6	Molokai Tactical Operations.
Fire	D3 PD	Hana dispatch channel (incl. Police & Public Works).
Fire	TALK FD	Fire Dept. conventional channel (radio to radio)
Fire	FD DVRS	Fire Dept. digital vehicular repeater system.
Fire	HONO DVR	Honokohau digital repeater system.
Fire	CNTY WD	County Wide Talkgroup.
Fire	EMERGY	Emergency Talkgroup.
Mutual TAC	ITAC1D	National Mutual Aid Operations - conventional channel.
Mutual TAC	ITAC2D	National Mutual Aid Operations - conventional channel.
Mutual TAC	ITAC3D	National Mutual Aid Operations - conventional channel.
Mutual TAC	ITAC4D	National Mutual Aid Operations - conventional channel.

B. For incidents involving multiple companies, communications should be switched from FD1 to the next available back up channel as soon as practical.

C. For large or complex incidents, the incident commander may consider multiple back up channels.

1. One or more channels may be designated as “command channels”, reserved for communications to, from and between the command staff and general staff.

2. One or more channels may be designated as “tactical channels”, reserved for communications between personnel within the operations section.

3. To ensure timely assistance in the event of an emergency, any and all designated tactical channels must be monitored by someone outside of any hazardous zone.

4. A designated “support” channel can be designated for personnel operating within support functions.

5. For incidents utilizing multiple helicopters, the Incident Commander should consider designating air-to-air and air-to-ground channels.

E.O. 300.04

6.12.4 MPD Policy: Radio Communications G.O. 301.5

MAUI COUNTY POLICE DEPARTMENT

GENERAL ORDERS
CHAPTER 301
COMMUNICATIONS

Effective date: 02/28/22 | Revision date: 12/23/21 | Rescinds: GO 301.5 (07/31/19)
New material underlined

Accreditation Standards: 41.1.1, 81.1.2, 81.2.3, 81.2.5 c, 81.2.8 a-c, 81.3.1 a, 81.3.4

RADIO COMMUNICATIONS
G.O. 301.5

I. PURPOSE

To establish uniform policies and procedures in radio communications.

II. POLICY

The policy of the Communications Section is to ensure prompt, efficient response and assistance to citizens requesting service, as well as the support and safety of all field units, and to disseminate uniform procedures in two-way radio communications.

III. PROCEDURE

A. Accountability

1. All radio communications utilizing Federal Communications Commission (FCC) assigned radio frequencies shall be subject to FCC rules and regulations addressed to Public Safety Systems. Refer to Part 90, FCC Rules and Regulations.

2. All users of radio frequencies assigned to the Maui Police Department shall be subject to these policies and procedures.

B. Authority

1. Communications Section personnel shall self-initiate decisions concerning call priorities, assignments, and cover units, dependent upon the circumstances surrounding the incident in conjunction with training and standard operating procedures. Field units will carry out the assignments received by Communications Section personnel as if they were directly received by the Chief of Police.

2. If a unit has reason to object to the communication, the unit will make the objection through appropriate channels, after fulfilling the assignment. A watch Commander or Field Supervisor on duty, will have the ultimate authority to override any decision made by an Emergency Services Dispatcher. A lawful order or directive issued by the Watch Commander

or Field Supervisor shall be followed or obeyed. Any conflicts of orders or policies and procedures may be addressed at a later time, if necessary, through the established chain of command.

3. The Emergency Services Dispatcher shall be responsible for clearing radio traffic as quickly as possible, maintaining discipline on the air and determining message priority. A report shall be submitted to the Communications Section Commander via the Supervising Emergency Services Dispatcher, regarding all violations of policy, procedure, rules and regulations. This report shall be submitted before the end of shift. Unsafe conditions shall be reported to the Supervising Emergency Services Dispatcher immediately.

4. Supervising Emergency Services Dispatchers shall oversee the operations of the communications center on a daily basis and ensure that policy, procedures, and rules and regulations are followed. They shall report directly to the Communications Section Commander.

C. Functions of the Communications Section

1. Receipt of calls for service by telephone and two-way radio.

2. Two-way radio transmissions to field units.

3. Transmission and reception of teletype law enforcement communications.

4. Initiation of data processing functions.

5. Assign all case and incident report numbers.

6. Information referral to citizens and other law enforcement agencies.

7. Central dispatching for police, fire and medic operations.

D. Access to the Communications Section Center

1. The communications center is considered an emergency dispatch center. Access to the center is limited to personnel assigned to the Communications Section, departmental command staff, on duty watch commander or supervisor.

2. The Supervising Emergency Services Dispatcher may limit the number of non-divisional persons in the center.

3. For security reasons, the main door to the center shall remain locked. The door shall be locked and opened for personnel only after adequate identification is received.

E. Communications Recordings

1. All radio channels and telephones monitored in the Communications Center are digitally recorded twenty-four hours a day by the Department's recording system and stored onto the system's hard disk drive. Recordings are voice, fax or TDD transmissions that are captured and stored on the recording system. The system is designed to provide an authentic record of telephone calls and radio broadcasts and may be used to verify conversations or complaints.

2. All recordings are converted digitally as a WAV file and automatically archived in the recording system's hard drive by the year, month, and day. Recordings shall be stored and available for review or reproduction for one year and can only be accessed through designated licensed workstations. All workstations are password protected for security measures.

3. Retrieve, Listen to, or Duplicate Recordings

   a. Only authorized and trained Department personnel are allowed to retrieve, listen to, or duplicate recordings. Instructions are provided in the recording system's operator guide, located at the Supervising Emergency Services Dispatcher's workstation.

   b. Duplication of Recordings

      (1) Department personnel requesting copies of recordings shall submit their requests to the Communications Section Commander, via channels. Only trained Department personnel are authorized to duplicate recordings.

      (2) Trained personnel from the Prosecutor's Office requesting copies of recordings shall obtain verbal approval from the Communications Section Commander or his/her designee. The authorized person duplicating the recording shall be responsible for completing the Recording System Duplication Log.

      (3) All other requests to listen to or duplicate a recording shall be made in writing, to the Chief of Police. If the duplication of a recording is approved by the Chief, the requesting party is responsible for reproduction costs.

4. Duties and Responsibilities

   a. The Communications Section Commander shall be responsible for the overall operation and proper maintenance of the Department's recording system and for selecting a Recording System Administrator.

   b. The Recording System Administrator shall be responsible for training users of the recording system, issuing passwords, and setting user capabilities.

   c. The on-duty Supervising Emergency Services Dispatcher shall be responsible for reporting any mechanical breakdown or apparent malfunctioning of the recording system.

   d. Communications Section personnel who receive training on the recording system shall playback recorded audio when clarification is needed.

F. Assignment of Radio/Car Designators

   1. It is the responsibility of the Communications Section Commander to assign radio designators to all radio users who require radio identification.

   2. It is the responsibility of the Supervising Emergency Services Dispatcher to ensure that the communications center has a current and accurate list of radio designators.

G. Equipment Repair

   1. It is the responsibility of the Radio Shop Coordinator to coordinate the repair of Department mobile and portable radios. All requests for repair will be submitted to the Radio Shop Coordinator in writing, via channels and approved by the respective division commander.

   2. It is the responsibility of the Supervising Emergency Services Dispatcher to ensure that all equipment within the communications center is maintained and functioning properly and to request repair of any equipment when necessary.

H. Communications Standards

   1. The Communications Section coordinates the accurate exchange of information between the Emergency Services Dispatcher and mobile units, or between mobile units. The Maui Police Department provides twenty-four hour two-way radio capability between communications personnel and field units.

2. Transmissions shall be definite, comprehensive, and distinctly spoken. Utilize simple working phrases, speak at a moderate speed, using normal conversational tones. Users should speak distinctly and clearly. Loud voices will only distort transmissions. Superfluous broadcasting shall be avoided. Any user should, prior to transmitting, monitor the channel to avoid interrupting a transmission. Users, while on a channel, should be cognizant of what is occurring to avoid interrupting priority or emergency transmissions.

3. Communications Section personnel and field units shall omit personal greeting and pleasantries. Do not address users by name; use their unit numbers or stations numbers. Users shall be courteous, however, expressions of courtesy will be avoided in the interest of brevity. Indecent or profane language is prohibited on the radio system. Avoid displaying humor.

4. Radio conversations shall be brief and concise, without unnecessary radio traffic, and shall be transmitted by telephone whenever possible. If the transmission is lengthy, the message should be broken every ten seconds for a period of three to four seconds to allow for urgent radio transmissions.

5. All field units shall adhere to the following format when requesting information from the communications center (state call sign of station being called).

   a. Traffic Stops:

      (1) Unit ID, type of stop, location, license plate (repeated twice), and number of occupants.

   b. Subject Stops:

      (1) Unit ID, type of stop, location, description of subject; male/female, race, and approximate age.

   c. License Checks:

      (1) Unit ID, driver's license number, and State that issued license.

      (2) Unit ID, last name, first name, date of birth, and State that issued license.

d. Registered Owner(s) of Vehicle:

(1) Unit ID, license plate number (repeated twice), State that issued plate.

(2) Unit ID, vehicle identification number (VIN), (repeated twice).

e. NCIC/RAP/OBTS Checks:

(1) Unit ID, last name, first name, date of birth, social security number (repeated twice).

6. Communications are used in conjunction with the "ten code" and shall be utilized when transmitting and accepting assignments.

CODE NO.	MESSAGE
10- 1	Return to station
10- 2	Call by phone
10- 3	Meet officer
10- 4	Confirm call
10- 5	Your location
10- 6	Repeat message
10- 7	Arrival at scene
10- 8	Back on Road
10- 9	Off vehicle(state reason)
10-10	Ambulance needed
10-11	Make fast call
10-12	Lavatory break
10-13	Call home
10-14	Lunch hour
10-15	Officer in trouble
10-16	Cancel last assignment
10-17	Change radio channel
10-18	Burglary alarm/no reset
10-19	Cover vacant beat

a. Procedure for Code 10-19

(1) In the event an officer is absent from his beat for a long period of time due to an arrest, court appearance, or other assignment, the Emergency Services Dispatcher shall use the Radio Code; 10-19, to assign the adjoining beat officer to cover that vacant beat.

Example: "1A21, 10-19 beat 20"- means that unit 1A20 will be off his beat and the dispatcher is assigning unit 1A21 to cover that vacant beat.

(2) The Emergency Services Dispatcher will clear the "10-19" with the Field Supervisor.

(3) Upon return of the absent field unit, the radio code, 10-16 (cancel last assignment) shall be transmitted to the officer covering the vacant beat, informing that officer that the original beat officer has returned to beat and further coverage of that vacant beat is no longer required.

7. Radio Frequencies

a. The Maui Police Department utilizes an E.F. Johnson 800-Mhz analog trunked radio system. The trunking system utilizes frequencies within the FCC regulated 800-Mhz band that is reserved for public safety and managed by the National Public Safety Planning Advisory Committee.

b. Acquisition or purchase of all communications equipment shall meet authorized frequencies and be approved by the Chief of Police.

8. Criminal Codes

a. The following Criminal Codes shall be used whenever possible:

Code	Meaning
1	Traffic accident
2	Drug violation
3	Investigation (unknown)
4	Homicide
5	Sexual Assault
6	Robbery
7	Burglary
8	Assaults
9	Thefts
10	Vehicle theft
11	(Vacant)
12	Indecent exposure
13	(Vacant)
14	Runaway juvenile
15	Public nuisance
16	Criminal property damage

17	Offensively armed
18	Spouse/family abuse
19	Harassment
20	Forgery
21	Disorderly conduct
22	Escaped prisoner
23	Trespass
24	Terroristic threatening
25	Mentally ill person
26	Criminal littering
27	Impersonating a police officer
28	Gambling
29	Riot
30	Hit and run accident
31	DUI liquor/drugs
32	Unlicensed driver
33	Burglar alarm
34	Holdup alarm
35	Bomb threat

9. Phonetic Alphabet

a. The following phonetic alphabet shall be used to make clear any radio transmission:

A-ALPHA	N-NOVEMBER
B-BRAVO	O-OSCAR
C-CHARLIE	P-PAPA
D-DELTA	Q-QUEBEC
E-ECHO	R-ROMEO
F-FOX TROT	S-SIERRA
G-GOLF	T-TANGO
H-HOTEL	U-UNIFORM
I-INDIA	V-VICTOR
J-JULIET	W-WHISKEY
K-KILO	X-X-RAY
L-LIMA	Y-YANKEE
M-MIKE	Z-ZULU

b. Numbers shall be pronounced as follows to make clear any radio transmission:

0-Zee-row	5-Fiyiv
1-Wun	6-Siks
2-Too	7-Sev-ven
3-Thuree	8-Ate
4-Fo-wer	9-Niyen

(1) Users shall not use the phonetic alphabet to excess. Rather, depend on proper pronunciation and enunciation of common words.

(2) All numbers such as licenses, case record numbers, VIN numbers, etc., shall be read in series of three's, counting from the left. For example; 654238122 shall be read 645 238 122.

10. Talk Groups are listed in Appendix A

11. Unit Call Signs:

a. Administrative Staff

Chief of Police	A-1
Deputy Chief of Police	A-2
Assistant Chief, Uniformed Services Bureau	A-[~~4~~]3
Assistant Chief, Investigative Services Bureau	A-[~~3~~]4
Assistant Chief, Support Services Bureau	A-5
Captain, Technical Services	A-10
Captain, Quality Assurance	A-11

b. Patrol Unit Identification

District	Shift	Beat
1	A,B,C	10-19 (WAILUKU) 20-29 (KAHULUI) 30-39 (UP-COUNTRY)
2	A,B,C,D,E	10-19 (LANAI)
3	A,B,C,D,E	10-19 (HANA)
4	A,B,C	10-19 (LAHAINA-SECTOR1) 20-29 (LAHAINA-SECTOR 2) 30-39 (LAHAINA-SECTOR 3) 40-49 (LAHAINA-SECTOR 4) 50-59 (LAHAINA-SECTOR 5)
5	A,B,C,D,E	10-19 (MOLOKAI-EAST END) 20-29 (MOLOKAI-WEST END)
6	A,B,C	40-49 (KIHEI)

(1) All personnel shall use the full call number of a unit beginning with the district number, then the shift designator, and the beat designator (example; 1A10,2B10,3C10 etc.).

(2) Beat officers shall be assigned the mobile unit call sign of the beat to which they are assigned. If two or more units are assigned to the same beat, subsequent units shall be assigned the next highest unit number for that specific area.

(3) For Police Districts utilizing an eight (8) hour workday shift, the A shift will always indicate the hours of 2230-0715 hours. The B shift will always indicate the hours of 0630-1515 hours. The C shift will always indicate the hours of 1430-2315 hours. The D and E shift hours will vary according to demand for service. For Police Districts utilizing a twelve (12) hour work day shift, the A shift will indicate the evening to the following morning shift, and the B shift will indicate the morning to the evening shift. Starting and ending hours may vary among Police Districts.

c. Superior officers (patrol):

(1) Superior officers within the Patrol Division shall be identified by the "hundred series" corresponding to the respective district number beginning with the hundred and first number assigned to the District Commander. Lieutenants and Sergeants shall be assigned permanent unit numbers as directed in this directive.

(a) District 1 - Wailuku Patrol (100 Series)

Captain----------101
Lieutenants----------102-114
Sergeants----------115-170

(b) District 2 - Lanai (200 Series)

Lieutenant----------201
Sergeant----------202

(c) District 3 - Hana (300 Series)

Lieutenant----------301
Sergeant----------302

(d) District 4 - Lahaina (400 Series)

Captain----------401
Lieutenants----------402-414
Sergeants----------415-470

(e) District 5 - Molokai (500 Series)

Captain----------501
Lieutenant----------502
Sergeants----------508-520

(f) District 6 - Kihei (600 Series)

Captain----------601
Lieutenant----------602
Sergeants----------615-625

d. Superior Officers (other units)

(1) Superior Officers of all other units shall be identified by their district, then division or section alphabetic designator, then by a single digit, with the lowest digit (1) indicating a command position.

e. Communications Section (Oscar)

Lieutenant----------	1-O-1
Supervising ESD----------	1-O-2-7
Receiving Desk Sergeants----------	161-169

f. Community Relations Section (Golf)

Lieutenant----------	1-G-1
Sergeant----------	1-G-2
Officers----------	1-G-10-15

g. Criminal Intelligence Unit (Yankee)

Lieutenant----------	1-Y-1
Sergeant----------	1-Y-2
Officers----------	1-Y-10-15

h. Criminal Investigation Division (Kilo)

Captain---------- 1-K-1

Lieutenants (District 1)---------- 1-K-2 through 1-K-5
Detectives (District 1)---------- 1-K-10-40
Evidence Specialist---------- 1-R-2 through 1-R-10
Lieutenants (District 4)---------- 4-K-2 through 4-K-5
Detectives (District 4)---------- 4-K-10-20

i. Internal Affairs (India)

Lieutenant---------- 1-I-1
Detectives or Investigators 1-I-10 through 1-I-15

j. Juvenile Section (Juliet)

Lieutenant---------- 1-J-1
Sergeants---------- 1-J-2-4
Officers (District 1)---------- 1-J-10 through 1-J-15
(District 4)---------- 4-J-10 through 4-J-15

k. Patrol Division (special units)

Crime Reduction Unit---------- 1-U-5 through 1-U-10
4-U-5 through 4-U-10
Parks/Beach Unit---------- 1-P-10 through 1-P-15
4-P-11

Community Police Officers----------1-Z-10 through 1-Z-49
4-Z-10 through 4-Z-59
5-Z-10
6-Z-40 through 6-Z-42

l. Plans, Training, Research and Development Section (Quebec)

Lieutenant----------1-Q-1
Sergeants----------1-Q-2 through 1-Q-5
Officers----------1-Q-6 through 1-Q-10

m. Records Section (Romeo)

Records Manager---------- 1-R-1
Warrants Officers----------1-R-11 through 1-R-15

n. Vice Division (Victor)

Captain---------- 1-V-1

Lieutenant----------1-V-2
Sergeant (Gambling)---------- 1-V-3
Sergeants (Narcotics)----------1-V-4 through 1-V-5
Sergeant (Canine/Narcotics)----------1-V-6
Officers (Narcotics)----------1-V-10 through 1-V-19
(Canine/Narcotics)---------- 1-V-20 through 1-V-25
(Gambling)---------- 1-V-26 through 1-V-30
Officers - District 4 (Narcotics)-------4-V-10 through 4-V-15

o. Traffic Section (Tango)

Lieutenant----------1-T-1
Sergeant----------1-T-2
Sergeant (DUI Task Force)----------1-T-3
Officers----------1-T-10 through 1-T-19
(Traffic Enforcement/TAIS)----------1-T-20 through 1-T-29
(DUI Task Force)---------- 1-T-30 through 1-T-39
Reconstructionist----------1-T-40

p. Miscellaneous Call Signs

Patrol Wagon (all districts)---------- "Wagon"
Parking Enforcement (District 1)----- 199
Parking Enforcement (District 4)----- 499
Police Chaplains---------- Chaplain-1 through 8
School Resource Unit– (District 1) 1-S-2 through 1-S-30
(District 2) 2-S-10
(District 3) 3-S-10
(District 4) 4-S-10
(District 5) 5-S-10
(District 6) 6-S-10

Visitor Oriented Police Unit----------VOP1 through VOP8
Radio Shop----------RS-1 through RS-10
Motor Pool----------MP1 through MP10

q. Other Departments

Mayor----------CM-1
Managing Director----------CM-2

Public Works Director----------CM-27

Civil Defense Director----------CD-1
Civil Defense Assistant----------CD-2

Prosecutor----------K-1

Deputy Prosecutors----------K-2 through K-40

Animal Control Office----------ACO-Base
Animal Control Officers----------ACO-1 through 20

County Lifeguards----------LG-1-20

r. Other Agencies

Airport Manager (State of Hawaii)--- AIRPORT-1

Conservation Officers (State of Hawaii) CR-1-20
Conservation Officer (State of Hawaii) CR-7 (Molokai)
Conservation Officer (State of Hawaii) CR-35 (Molokai)

Department of Public Safety Sheriffs
(State of Hawaii)----------SD 1-20

Drug Enforcement Agency (Federal) F-10-15

Federal Bureau of Investigation------- F-1-9

Motor Vehicle Safety Officer (State)- MVS-1

Park Enforcement (County)---------- PE1-PE6

Park Rangers (Federal)----------PR-1-6

State Harbors/Marine Police (State)--ME-1-10

U.S. Coast Guard----------CG Base
CG 1- 3

U.S. Immigration Department---------F-16-20

U.S. Marshals---------- F-21-30

U.S. (Others)---------- F-31-40

Helicopters---------- AIR-1-5

12. Priority of Calls

a. Priority 1 - A call for service that requires immediate response (police, fire, & medics). Priority 1 calls will be aired immediately upon receipt.

(1) Any in-progress crime is a priority 1 call.

(2) Any crime just occurred where there is still risk to safety of citizens or suspect apprehension is highly possible. Priority 1 cases are those cases that are in progress or just occurred, meaning within the past 15 minutes. Examples:

(a) Officer needs help
(b) Homicide/suicide
(c) Robbery (any type)
(d) Assaults/injuries
(e) Kidnapping
(f) Accidental injuries or deaths
(g) Disturbances (all types)
(h) Ambulance/fire calls
(i) Traffic accidents with injuries
(j) Hostage situations
(k) Child abuse cases
(l) Burglary (in progress)
(m) Alarms (Hold up, Fire)
(n) Escapees
(o) Bomb threats

b. Priority 2 - A call for service that requires quick response for preservation of crime scenes, collection of evidence or to protect property and assure continued citizen safety. Example:

(1) Assaults (no injury-delayed reports)
(2) Criminal trespass
(3) Auto theft
(4) Prowler
(5) Traffic Accident (with property damage or hit/run-no injuries).
(6) Alarms
(7) Lost/missing persons
(8) Theft
(9) Suspicious vehicle/incident
(10) Telephone threats
(11) Check well being of persons

c. Priority 3 - Calls requiring a report or information that will be taken by the officer (cold calls). Examples:

(1) Auto theft
(2) Burglary
(3) Animal calls
(4) Shoplifting
(5) Telephone harassment

(6) Abandoned vehicle
(7) Lost or found property
(8) Noise complaints

13. Emergency Traffic

a. When communications personnel are airing a Priority 1 call, utilizing the alert tone, the dispatcher will state; "Emergency Transmissions Only". All units shall remain off the air unless they become involved in a high priority situation, or are involved in the priority itself. Supervising Emergency Services Dispatchers or field supervisors shall determine if units involved in the priority situation should change to a tact channel or remain on the radio channel the incident is occurring on.

b. Supervising Emergency Services Dispatchers or field supervisors may initiate "Emergency Transmissions Only" or cancel same.

14. Alert Tone

a. The alert tone will be utilized prior to broadcasting emergency calls. In general, emergency calls are those which threaten life. Emergency calls include "in-progress" or "just occurred" calls of:

(1) Homicide
(2) Attempted suicide involving a weapon
(3) Barricaded subject or hostage situation
(4) Sexual assault
(5) Assault involving a weapon
(6) Robbery
(7) Burglary
(8) Domestic disturbance
(9) Emergency officer assistance
(10) Riot

b. The alert tone shall be depressed approximately three seconds and simulcast on channels needed for the broadcast.

15. Change of Shifts/Signing Off

a. Communications Section personnel will recall units of a particular shift when sufficient man power has reported "in-service" for the next tour of duty. This procedure will ensure proper beat coverage during the change of shifts. Communications Section personnel shall state the following when sufficient coverage has occurred; "all units of the ----- shift, 10-1 and sign off". No unit shall sign off or leave their respective beats without proper authority.

6.12 APPENDIX

h. Patrol supervisors may authorize an early sign off of any unit and shall inform communications personnel of this matter.

JOHN PELLETIER
Chief of Police

APPENDIX A

TALK GROUPS	DESCRIPTION
D-1	WAILUKU PATROL DISTRICT
D-2	LANAI PATROL DISTRICT (FUTURE GROWTH)
D-3	HANA PATROL DISTRICT
D-4	LAHAINA & LANAI PATROL DISTRICT
D-5	MOLOKAI PATROL DISTRICT
D-6	KIHEI PATROL DISTRICT
TAC 1	CENTRAL TACTICAL
TAC 2	CENTRAL TACTICAL
UTILITY	UTILITY CHANNEL (DL&R, DW, HARBORS, etc.)
SRT	SPECIAL RESPONSE TEAM
VICE	VICE PERSONNEL
TALK PD	TALK AROUND
SRT T	TALK AROUND
CTYWD	COUNTY WIDE (EMERGENCY ONLY)
FIRE ALL	PAGING FOR ALL FIRE STATIONS
FIRE 1	OPERATIONS CENTRAL MAUI, LAHAINA, LANAI
FIRE 1A	OPERATIONS BACKUP #1
FIRE 4	OPERATIONS BACKUP #2
FIRE 5	D5 OPERATIONS (MOLOKAI)
	*NOTE: HANA FIRE TO OPERATE ON D-3 POLICE
TALK FD	TALK AROUND
MEDIC ALL	PAGING FOR ALL MEDICS (FUTURE GROWTH)
MEDIC 1	FUTURE GROWTH
MEDIC 2	FUTURE GROWTH
MEDIC 3	FUTURE GROWTH
MEDIC 4	FUTURE GROWTH

MEDIC 5	FUTURE GROWTH
PW 1	CENTRAL LOCAL GOVERNMENT
PW 1A	MAKAWAO LOCAL GOVERNMENT
PW 2	LANAI LOCAL GOVERNMENT
PW 3	HANA LOCAL GOVERNMENT
PW 4	LAHAINA LOCAL GOVERNMENT
PW5	MOLOKAI LOCAL GOVERNMENT
PW ALL	ALL LOCAL GOVERNMENT
WW	WASTEWATER DIVISION
TALK PW	TALK AROUND
CD SIREN	ALL CD SIRENS IN MAUI COUNTY
CD	CD PERSONNEL
MAINT	MPD RADIO SHOP CHANNEL
UID	UNIQUE ID CALL GROUP
TEL	TELEPHONE CALL GROUP
MUTUAL	MUTUAL AID

6.12.5 MFD Policy: Maui Incident Management Team D.O. 600.05

MAUI INCIDENT MANAGEMENT TEAM	D.O 600.05

Effective Date	Total Pages	Version Number	Revision Date
7/1/2019	5	1	1/3/2019

PURPOSE: The Maui Incident Management Team (MIMT) was established to ensure the County is prepared to direct, coordinate, and support complex or major incidents that exceed routine response capability. The MIMT consist of personnel who assume Command and General Staff positions within the framework of the Incident Command System.

GUIDELINE:

I. OPERATIONAL CONCEPT

The MIMT consists of personnel who have received specialized training in Command and General Staff functions of the Incident Command System (ICS) to manage complex or major incidents. For a major incident, the MIMT is activated and reports to an incident scene or location designated by the Incident Commander.

II. STAFFING PATTERN

The MIMT assigns personnel trained and experienced in incident management during major incidents, regardless of routine staffing patterns. Personnel assigned to the MIMT have the responsibility and authority of the ICS position they fill, regardless of their administrative title. The on-scene chain-of-command follows ICS structure and principles.

A. The standard IMT configuration consists of the following ICS positions:

1. Incident Commander
2. Deputy Incident Commander
3. Safety Officer
4. Liaison Officer
5. Public Information Officer
6. Operations Section Chief
7. Deputy Operations Section Chief
8. Planning Section Chief
9. Deputy Planning Section Chief
10. Resource Unit Leader
11. Situation Unit Leader
12. Logistics Section Chief
13. Deputy Logistics Section Chief
14. Facilities Unit Leader
15. Supply Unit Leader
16. Medical Unit Leader
17. Communications Unit Leader
18. Finance Section Chief
19. Incident specific positions

III. TEAM STAFFING SELECTION

A. MIMT positions may be staffed by sworn or non-sworn MFD personnel; individual participation is subject to the approval of the MIMT Program Manager and the Incident Commanders. Criteria for selection include:

1. Succession planning/career development.

2. Aptitude and demonstrated ability to fulfill responsibilities of assigned position.

3. Approval by peer review committee.

B. Upon approval of the Fire Chief, positions may be staffed by personnel from partner organizations.

1. By definition, personnel filling DIC positions are considered fully qualified to serve as IC. The Fire Chief or designee has ultimate authority to limit control of incident resources.

IV. SCHEDULING AND NOTIFICATION

A. The MIMT is divided into two teams. Teams rotate on-call shifts on a bi-weekly basis.

B. The current on-call schedule and staffing roster are posted on the MIMT's website. The MIMT Program Manager is responsible for ensuring that both the staffing roster and schedule are accurate.

1. Team members may "trade" coverage with each other as they desire, as long as positions are covered throughout the on-call period. Team-members are responsible for ensuring that their respective teams are aware of any changes.

C. Once Activated, MIMT members should report to the designated location. Members requiring specific direction or clarification should contact the IC. Team members should not contact Dispatch unless specifically directed to do so. The MIMT is responsible for making necessary notifications and requesting additional personnel.

V. MAUI INCIDENT MANAGEMENT TEAM ACTIVATION

A. Activation

1. The MIMT is activated for complex or major incidents that strain or exceed the County's routing response.

D.O. 600.05

B. Discretionary Activation

1. The Fire Chief, Deputy Chief, or Assistant Chiefs may activate the MIMT based on existing, imminent, or projected hazardous conditions.

2. The MIMT may be activated to plan for or manage a scheduled or other non-emergent event.

VI. TRAINING REQUIREMENTS

A. All MIMT members must complete the following training:

1. ICS-100, ICS-200, ICS-300, and ICS-400

2. IS-700, IS-701, IS-703, IS-800

3. USFA Type 3 IMT Course

4. Position-specific classes and (as applicable) task books

B. In addition to the general MIMT requirements, all Incident Commanders and Deputy Incident Commanders must complete the following classes:

1. Operations Section Chief

2. Planning Section Chief

3. Safety Officer

4. On-scene Hazardous Materials Incident Commander*

**NOTE*: This is an OSHA requirement; Incident Commanders responding to a hazardous materials incident must have completed training.

C. In addition to standardized training requirements, all MIMT members must attend at least two MIMT meetings or team training sessions per year.

VII. EXERCISE/DRILL REQUIREMENTS

A. All MIMT members must participate in functional or full-scale exercises. Participation in a wildfire "shadow team" assignment may count as a functional exercise.

B. MIMT members must participate in drills that are specifically scheduled for the MIMT.

D.O. 600.05

C. The MIMT Program Manager is responsible for maintaining exercise/drill participation records.

VIII. MAUI INCIDENT MANAGEMENT TEAM MEMBER RESPONSIBILITIES

A. Responsibilities for all MIMT members

1. MIMT members are responsible for maintaining readiness to respond when their team is on call, including:

   a. Wearing appropriate personal protective equipment and having materials and supplies necessary to perform their assigned function.
   b. Being able to arrive to an incident scene or other identified site within two hours.
   c. Maintaining suitable preparedness (e.g. necessary family arrangements, spare clothing, and other supplies) to allow for relative self-sufficiency for extended response.

2. Team members who are unable to respond during their on-call rotation are responsible for finding an alternate who is fully qualified in the position.

3. MIMT members are responsible for ensuring they meet training and exercise/drill requirements of the program.

B. Responsibilities for MIMT Incident Commanders

1. Clearly communicating expectations of team members in terms of response protocols and maintaining readiness.

2. Promoting team-based training and drills.

3. Specific to external deployment:
   a. Assessing impacts of requested external deployments on MFD operations and staff.
   b. Determining and clearly communicating priorities for professional conflicts (e.g., projects, meetings, training, and travel), in consultation with senior management and the MIMT Program Manager.
   c. Establishing a realistic initial response timeline, with the goal of providing as much notice as possible to members, and allowing for extreme personal conflicts among individual team-members who are unable to find a replacement on short notice.

IX. PROGRAM MANAGEMENT

The MIMT Program Manager is responsible for day-to-day program function and for making recommendations for program direction. This includes, but is not limited to, maintaining a current staffing pattern at acceptable levels, maintaining a current on-call rotation schedule, developing and revising operational guidelines, developing policy directives for dispatch relating to IMT notification and activation, developing and maintaining electronic resources such as the MIMT website and, scheduling of training and exercises/drills.

A. For deployments, the MIMT Program Manager is responsible for providing input to County executives, including staffing patterns and impact on MFD operations and staff.

6.12.6 MPD Policy: ICS and SRT Operations G.O. 412.1

MAUI COUNTY POLICE DEPARTMENT

GENERAL ORDERS
CHAPTER 412
SPECIAL RESPONSE TEAM

Effective date: 08/07/20 Revision date: 07/21/20 Rescinds: GO 412.1 (06/10/20)
New materials underscored

Accreditation Standards: 46.1.2a c d g m n p s t, 46.1.4, 46.1.11 a-g, 46.2.1, 46.1.4, 61.3.3a

ICS AND SRT OPERATIONS
G.O. 412.1

I. PURPOSE

To establish the organizational structure and policies and procedures for the operations of the Incident Command System (ICS) and the Special Response Teams (SRT).

II. POLICY

The Maui County Police Department has available and will utilize the Incident Command System and the Special Response Teams when circumstances or events are beyond the capabilities of normally trained and equipped officers.

III. DEFINITIONS

COUNTER SNIPER TEAM: A counter sniper teams consists of a counter sniper and an observer who are paired together and supports the tactical team. They assist the tactical team by covering areas of approach, gathering detailed information, and engaging/neutralizing a threat only if necessary.

HAWAII INTERISLAND BOMB SQUAD: An interagency bomb squad composed of personnel from the Maui Police Department, Hawaii Police Department, and Kauai Police Department who use progressively developed practices and techniques involving suspected, explosive hazardous devices.

INCIDENT COMMAND SYSTEM (ICS): A system for command, control, and coordination of a response that provides a means to coordinate the efforts of individual persons and agencies as they work toward the common goal of stabilizing an incident while protecting life, property and the environment.

INCIDENT COMMANDER: Assistant Chief of Investigative Services Bureau

SPECIAL RESPONSE TEAM (SRT): A unit of specially selected, trained and equipped officers, generally from Districts I, IV and/or VI and organized into two teams identified as the Tactical Team and Negotiating Team.

NEGOTIATING TEAM: The Negotiating Team (NT) falls under the command of the Negotiations Commander. The team is comprised of two units that fall under the direction of a team leader, designated by the Negotiations Commander. The two units are made up of four members.

TACTICAL TEAM: The Tactical Team serves as the Department's Special Weapons and Tactics Team (SWAT) and falls under the command of the Tactical Commander. The team is comprised of two entry units that share collateral duties, and one marksman unit. Each of these units is under the direction of a team leader, designated by the Tactical Commander. The entry unit has a minimum of eight members each and the marksman unit has a minimum of four members.

TRACKING CANINE: The tracking canine is trained to detect the odor/scent of a human being. Every human being leaves scent/odor behind in the form of skin particles. The tracking canine is designed to track that particular scent/odor. The tracking canine can save lives by locating Alzheimer patients and lost children before they succumb to the elements of nature (hypothermia, dehydration, etc.) The tracking canine can also be used to track down suspect(s) who recently committed a crime.

IV. ORGANIZATION AND RESPONSIBILITIES

A. The Incident Commander is responsible for the Department's ICS during an unusual occurrence, which requires the services of SRT.

1. If the Incident Commander is not available, the designee shall be the Assistant Chief of Uniformed Services, followed by the Assistant Chief of Support Services.

2. The Incident Commander shall coordinate and control the activities of all Department personnel while an ICS event is occurring.

3. The Incident Commander shall respond to the scene of the incident and operate from a field command post.

a. The appearance of the Chief and/or Deputy Chief at an ICS Incident does not indicate they are assuming command.

4. In the event of an unusual occurrence that does not require the services of the SRT, but is of a scale that requires the activation of the ICS, the guidelines and procedures of General Order 411.4, Natural and Man-Made Disaster Plan shall apply.

B. Special Response Team

1. The Department shall have at its disposal personnel with specialized training to respond to unusual occurrences. The SRT is under the command of the Assistant

Chief of Investigative Services Bureau.

2. The Tactical Commander of the SWAT Team or his/her designee shall be responsible for the coordination and/or participation in an annual ICS training exercise and the documentation of this training in the form of an after action report. The report shall also contain an analysis of the effectiveness of the training. A copy of the report shall be forwarded to the Quality Assurance Section.

3. At least once every three years, the Tactical Commander of the SWAT Team or his designee shall complete a comprehensive analysis of all ICS incidents to which the SWAT Team responded. This report will also include an analysis of the effectiveness of annual ICS training. The original report shall be forwarded to the Office of the Chief for review, and a copy shall be forwarded to the Quality Assurance Section.

C. Tactical Commander

1. The Tactical Commander is the Lieutenant assigned to the Investigative Services Bureau Special Response Team.

2. He/she shall be responsible for supervising and directing the activities of the Team Leaders and SWAT members.

3. He will assume all duties and responsibilities, in accordance with S.O.P. 102.1, Organization and Management.

4. During an ICS incident, the Tactical Team Leader shall coordinate his/her activities through the Incident Commander.

5. The Tactical Commander shall direct the efforts of the tactical team during all training and actual incidents.

   a. The Tactical Commander will develop training for the tactical team. He/she will provide a training notice for each team member.

6. The Tactical Commander shall assign and direct personnel in order to implement the operational plan. He shall confer with the Incident Commander in carrying out tactical plans. No tactical plan shall be carried out without the approval of the Incident Commander.

7. The Tactical Team Leader shall have the authority to reassign personnel within the unit.

8. The Tactical Team Leader shall respond to the scene of the ICS incident.

D. Assistant Tactical Commander

1. The Assistant Tactical Commander is the Sergeant assigned to the Investigative Services Bureau Special Response Team.

2. The Assistant Tactical Commander shall assume the responsibilities of the team leader when the team leader is absent or unable to assume command of the team. In the event that the Tactical Commander and Assistant Tactical Commander cannot respond, the most senior member of the SRT Entry Unit or a team member assigned by the Tactical Commander shall assume command.

3. The Assistant Tactical Commander shall respond to the scene of the ICS incident.

4. The Assistant Tactical Commander shall assist with tactical planning for operations. He/she shall assist with the implementation of these plans.

5. The Assistant Tactical Commander shall be responsible for the assignment of equipment to tactical team members. He/she shall also be responsible for the care and condition of the equipment.

6. The Assistant Tactical Commander will, in the absence of the team leader, have the functional authority to direct the tactical team.

E. Negotiating Team Leader

1. The Negotiating Team Leader shall be appointed by the Chief of Police.

2. During an ICS incident, the Negotiating Team Leader shall coordinate his activities through the Incident Commander.

3. The Negotiating Team Leader shall direct the efforts of the negotiating team during all training and actual incidents.

4. The Negotiating Team Leader will develop training for the negotiating team members. He will provide a training notice for each member.

5. The Negotiating Team Leader shall assign and direct personnel to the implementation of the operational plan. He shall confer with the Incident Commander and Tactical Team Leader in carrying out tactical plans.

6. The Negotiating Team Leader shall have the authority to reassign personnel within the unit.

7. The Negotiating Team Leader shall respond to the scene of the ICS incident.

F. Assistant Team Leader of Negotiating Team

1. The Assistant Team Leader shall be a Police Sergeant, Detective, or Lieutenant appointed by the Negotiating Team Leader.

2. The Assistant Team Leader shall assume the responsibilities of the team leader when the team leader is absent or unable to assume command of the team.

3. The Assistant Team Leader shall assist with planning for negotiations. He shall also assist with the implementation of these plans.

4. The Assistant Team Leader shall be responsible for the assignment of equipment to members of the negotiating team and is responsible for the care and condition of the equipment.

5. The Assistant Team Leader will, in the absence of the team leader, have the functional authority to direct the negotiating team.

G. The Assistant Chief of the Investigative Services or his designee shall be responsible for the coordination and/or participation in an annual ICS training exercise and the documentation of this training in the form of an after action report. The report shall also contain an analysis of the effectiveness of the training. A copy of the report shall be forwarded to the Quality Assurance Section.

1. At least once every three years, the Assistant Chief of the Investigative Services Bureau or his/her designee shall complete a comprehensive analysis of all ICS incidents to which the personnel under his command responded. This report will also include an analysis of the effectiveness of annual ICS training. The original report shall be forwarded to the Office of the Chief for review, and a copy shall be forwarded to the Quality Assurance Section.

H. The Commander of the Specialized Emergency Enforcement Detail or his/her designee shall be responsible for the coordination and/or participation in an annual ICS training exercise and the documentation of this training in the form of an after action report. The report shall also contain an analysis of the effectiveness of the training. A copy of the report shall be forwarded to the Quality Assurance Section.

1. At least once every three years, the Commander of S.P.E.E.D. or his/her designee shall complete a comprehensive analysis of all ICS incidents to which S.P.E.E.D. responded. This report will also include an analysis of the effectiveness of annual ICS training. The original report shall be forwarded to the Office of the Chief for review, and a copy shall be forwarded to the Quality Assurance Section.

V. OPERATIONAL PROCEDURES

The ICS and the SRT act as a ready response and support group handling critical incidents. Hostages, barricaded suspects, witness protection, high-risk search warrants, and VIP protection

are examples of incidents, but are not limited to, where the ICS and SRT may be deployed. The SRT may be deployed independently of the ICS.

A. Functional Activities

1. The SRT shall be called upon to assist with hostage situations, barricaded and armed persons, high-risk search warrants and arrests, bomb threats, missing persons, and any high-risk incidents. They shall be called out at the discretion of the Incident Commander.

2. Negotiations with hostage-takers and barricaded persons shall be the responsibility of the negotiating team whenever possible. This shall not relieve the initial police units from trying to make contact with the suspect.

3. The Tactical Team Leader shall be responsible for any special purpose vehicles assigned to the SRT. The use of any special purpose vehicles in hostage/barricaded persons situations shall be the responsibility of the Tactical Team Leader after consultations with the Incident Commander at the scene

4. Any requests for all or parts of the SRT at special events shall be the responsibility of the Incident Commander.

5. The SRT shall assist with the protection of governmental dignitaries and other VIPs as directed by the Chief of Police. They shall work in concert with the Criminal Investigation Division and other agencies that may have primary protective responsibilities.

6. As a specialized unit, the SRT shall not be involved with natural disasters, except as directed by the Chief of Police.

7. As a specialized unit, the SRT shall not be involved in civil disturbances, except as directed by the Chief of Police.

8. As a specialized unit, the SRT shall not be involved in civil defense emergencies, except as directed by the Chief of Police.

9. The SRT, when commanded, shall be involved in the extrication of officers and citizens.

B. Call out procedures

1. Notifying Watch Commander

When a patrol supervisor determines that he/she has become involved in an unusual incident that may require the services of the SRT team, he/she shall notify the on-duty Watch Commander.

2. Notifying Incident Commander

   a. The Watch Commander shall notify the Incident Commander of the situation.

   b. The Watch Commander shall notify the Assistant Chief of Uniformed Services of the incident and its status.

C. Initial responsibility of Incident Commander

1. It shall be the responsibility of the Incident Commander to make the decision to call out the SRT team and activate the ICS, if necessary.

2. The Incident Commander shall notify the Tactical Commander of his/her decision. If the decision is to activate the ICS and the SRT, the Tactical Commander shall coordinate the contact and deployment of SRT and, if necessary, the ICS.

D. Initial responsibility of Tactical Commander

1. Once the Tactical Commander has been activated, he/she shall be advised of the current situation. He shall determine the location of the staging area for the SRT.

2. The Tactical Commander shall be responsible for determining the minimum manpower that his/her unit shall need.

E. Call-Out Procedure

1. As members of the SRT Team respond to the call, they shall be informed of the location of the staging area and respond to that location and not to the field command post, unless instructed by the team leader.

2. Telephone notification will be done for all Call Out notification purposes. Should the Officer not answer his/her phone, a message will be left for the Officer to respond.

3. The Negotiating Team Leader will inform the Communication Section of the individuals from that team to be paged.

4. Any change in the incident that would affect the responding officers, shall cause the Communications Section supervisor to call the team members and advise them of the change in status. Text messaging shall serve this purpose.

F. Field command post

The selection of the initial field command post shall be the responsibility of the on-duty Watch Commander. The final location of the command post shall be the responsibility of the Tactical Commander. The location of the SRT tactical operations center shall be determined by the Tactical Commander or designee.

1. The Command Post shall be out of sight and out of the line of fire from the scene of the incident.

2. At the minimum, the Command Post shall be manned by the Incident Commander and Commanders of the tactical and negotiating teams (or their designees), the on-duty Watch Commander, and the Captain or Lieutenant from the Investigative Services Bureau involved in the incident. This shall not prohibit the Tactical and Negotiating Commanders or their designees from leaving the command post for other duties pertaining to the incident.

G. Incident Command

1. The on-duty Watch Commander shall respond to the SRT incident and act as the temporary Incident Commander until the arrival of the Incident Commander.

2. The Watch Commander shall transfer Incident Command to the Incident Commander upon his/her arrival. The Watch Commander shall then assist the Incident Commander with such things as:

   a. Evacuations

   b. Traffic and crowd control

   c. Special equipment and transportation

   d. Emergency staffing

3. Upon the arrival of the Incident Commander, the Watch Commander shall fall under his command.

4. During the normal SRT incident, the Incident Commander shall respond to the scene and assume overall command.

5. Upon the arrival of the SRT, the Tactical Commander shall fall under the command of the Incident Commander.

6. No tactical plan shall be implemented without the knowledge and affirmation of the Incident Commander and the Tactical Commander.

7. The SRT Team members shall only take directions from SRT command personnel.

H. Termination of assignment

1. The SRT members shall remain at their assigned duties until released by SRT command personnel.

2. The supervisor of an on-duty ICS or SRT member shall release the member from normal duty without unnecessary delay.

3. The on-duty supervisor shall be responsible to replace the on-duty ICS and SRT member by calling in another employee.

4. The on-duty supervisor shall notify on-coming shift supervisors if the on-coming shift is shorthanded due to the ICS Incident.

5. ICS shall release their members from the incident without unnecessary delay if they are no longer needed.

6. On-duty ICS and SRT members will return to their normal duty assignments, as quickly as possible, after release from the ICS incident.

7. It shall be the responsibility of the Tactical Team Leader to determine when the tactical team leaves the scene and returns to normal duty.

I. Debriefing

A debriefing of the SRT Team shall be held immediately after an ICS incident.

J. After action reports

All personnel whose observations or actions are pertinent to the incident (i.e. movement of evidence, use of force, etc.) shall submit a written report of their assignment and activities.

K. Handling of the news media

1. The Incident Commander shall appoint or serve as the news media contact until the duties of the public information function is delegated at which time this responsibility shifts to another person.

2. During normal business hours the Incident Commander shall assign the Public Information Officer (Lieutenant, Community Relations) to respond to the field command post.

a. If the PIO officer is unavailable, or has not arrived at the scene, the Incident Commander shall designate another officer to assist the news

media personnel.

b. After business hours the PIO officer may be assigned to respond, otherwise the Incident Commander may designate another officer to perform the public information function.

3. At the field command post and/or the scene of the incident, the PIO officer shall be responsible for assigning the news media personnel to a specific area for control and safety purposes.

4. For more details of procedures on dealing with the news media, refer to General Order 302.4, Public Information.

TIVOLI S. FAAUMU
Chief of Police

6.12.7 MPD Policy: Command Vehicle Standard G.O.304.11

MAUI COUNTY POLICE DEPARTMENT

GENERAL ORDERS
CHAPTER 304
FACILITIES AND EQUIPMENT

Effective date: 01/31/20 Revision date: 1/13/20 Rescinds: GO 304.11 (3/06/12)
New materials underscored

Accreditation Standards: 41.1.3 abc

COMMAND VEHICLE STANDARD OPERATING PROCEDURES
G.O. 304.11

I. PURPOSE

To establish procedural guidelines related to the operation and utilization of the Command Vehicle.

II. POLICY

It is the policy of the Maui Police Department to provide a Command Vehicle that shall be utilized in critical operations as deemed necessary. All departmental employees shall be guided by the rules, regulations, and procedures established herein.

III. DEFINITIONS

OPERATOR: The Primary Officer (highest ranking) in charge of the vehicle during training and call-out operations.

OPERATOR ASSISTANT: The Secondary Officer that will assist in other duties as needed to facilitate the operations of the Command Vehicle.

SECURED ENVIRONMENT: An area that is predetermined not to be in the zone of potential threat either by natural or manmade means. The Command Vehicle should be situated in a location that, if needed, can be relocated in a timely manner.

TECHNICAL SUPPORT: Members of the Maui Police Department's Radio Shop who is in charge of all the equipment utilized for communications.

MECHANICAL SUPPORT: The Maui Fire Department's mechanical team that is in charge of mechanical repairs to the Command Vehicle as agreed upon in the Memorandum of Understanding.

IV. PROCEDURES

A. It shall be the discretion of the Assistant Chief of the Uniform Services Bureau or his/her

designee to utilize the Command Vehicle in critical operations. Upon request, the supervisor, of the Command Vehicle, shall call out a team of two (2) members, on (1) Operator, and one (1) Operator Assistant.

The supervisor will also call the supervisor of the Radio Shop to have his/her personnel respond for technical support and to verify their response.

B. The Operator and Operator Assistant shall conduct a pre-check of the Command Vehicle upon leaving and a post check upon returning to the truck bay.

C. The Operator and Operator Assistant shall plan a route to the scene and respond with lights and sirens. However, due to the size of the Command Vehicle, utmost discretion shall be used to maintain control. The driver shall maintain a safe speed regardless of the amount of time in responding to the scene.

D. The Command Vehicle shall be located at a safe and secure environment away from the scene. A perimeter shall be set around the Command Vehicle and an Entry Control Point shall be made for security measures. The Entry Control Point shall be manned by a sworn officer at all times throughout the operation.

E. A minimum of two (2) sworn officers trained in the Command Vehicle shall be present during the operation. Upon completion of the operation, the Command Vehicle shall be cleaned, inspected and prepared as soon as reasonably possible.

V. TRAINING

A. Training will be done at least twice a month to ensure driving proficiency as well as planning of routes due to changes in roadways, new subdivisions, and new commercial parks.

B. Cleaning, inspection, and preparation of the Command Vehicle shall be done at the end of each training for possible operations.

VI. TECHNICAL SUPPORT

A. It shall be the responsibility of the Radio Shop personnel to conduct any technical support of the Command Vehicle during the operation. At least one (1) person from the Radio Shop shall be present during the course of the operation.

VII. MECHANICAL SUPPORT

A. It shall be the responsibility under the Memorandum of Agreement that the Maui Fire Department mechanical support will be limited to the vehicle itself and to respond to the replenishment of fuel due to extended operations.

VIII. PROHIBITIONS

A. The Command Vehicle shall not be utilized as a personnel carrying vehicle. Personnel riding in the Command Vehicle shall only sit within the confines of the two (2) front seats and the dispatch area. For safety reasons, no one will be allowed to sit in the operations or meeting areas while the mobile command vehicle is in motion.

B. The Command Vehicle shall be used for meetings set by the highest ranking officer in charge. Permission for enter the Command Vehicle will be given by the Commander in Charge.

C. The Command Vehicle shall not be used as a comfort station.

IX. MEMORANDUM OF AGREEMENT

A. There is an agreement between the Maui Police Department and the Maui Fire Department for the use of the Command Vehicle.

B. The Fire Chief or his designee may call for the use of the Command vehicle when needed in support of their operations. In these situations, the Operators may be a member of the Maui Police Department or the Maui Fire Department.

C. It shall be the responsibility of the agency utilizing the Command Vehicle to follow their own Standard Operating Procedures.

TIVOLI S. FAAUMU
Chief of Police

6.12.8 MFD Policy: Hazard Zone Command E.O.302.01

HAZARD ZONE COMMAND	E.O. 302.01

Effective Date	Total Pages	Version Number	Revision Date
7/1/2019	8	1	1/3/2019
9/1/2020	8	2	8/4/2020

PURPOSE: Provide guidance to be employed in establishing components of the Incident Command System and applicable components of the National Incident Management System (NIMS).

GUIDELINE:

I. REASONS FOR COMMAND GUIDELINES

A. Fix the responsibility for Command on a specific individual through a standard identification system, dependent upon the arrival sequence companies and Chief Officers.

B. Ensure that a strong, direct, and visible Command will be established from the onset of the incident.

C. Establish an effective incident organization defining the activities and responsibilities assigned to the individuals operating within the Incident Command System.

D. Provide a system to process information to support incident management, planning, and decision-making.

E. Provide a system for the orderly transfer of Command to subsequent arriving officers.

F. Ensure a seamless transition from a Type 5/4 incident to a Type 3/2/1 (NIMS).

II. RESPONSIBILITIES OF COMMAND

The Incident Commander is responsible for the completion of the incident priorities. The Incident Priorities (listed in order of priority) are:

A. Remove endangered occupants and treat the injured.

B. Stabilize the incident and provide for life safety.

C. Protect property.

D. Provide for the safety, accountability, and welfare of personnel.

III. COMMAND FUNCTIONS

The Functions of Command are standard activities that are performed by the Incident Commander to achieve the Tactical Objectives. Functions of Command include:

A. Assume and announce Command and establish an effective initial command position (the Command Post).

B. Rapidly evaluate (size-up) the situation.

C. Initiate, maintain, and control effective incident communications.

D. Provide and manage a steady, adequate, and timely stream of appropriate resources.

E. Identify the incident strategy, develop an Incident Action Plan (IAP), and assign companies and personnel consistent with plans and SOGs.

F. Develop an effective incident organization using Divisions/Groups to decentralize and delegate geographic and functional responsibility.

G. Review the strategy and revise as needed to keep the IAP current.

H. Provide for the continuity, transfer, and termination of Command.

IV. MODES OF COMMAND

The first arriving unit or member is responsible for assuming Command of the incident and is presented with several command mode options, listed below. The command options are situation dependent and define the initial Incident Commander's level of direct involvement in tactical activities.

A. Investigative Mode (Nothing Showing)

An initial IC in investigative mode is mobile, moving around and evaluating conditions while looking for the incident problem, and runs Command from a portable radio. Guidelines for Investigative Mode include:

1. Provide an initial radio report (e.g. "Dispatch, Engine 1 is on scene of medium-sized, single-story, commercial, with nothing showing from the alpha, we will be investigating.)

2. Command must be established if conditions warrant an upgrade in response.

3. In Investigative Mode, your action plan is "investigating."

4. The company officer / initial IC should go with the company to investigate while utilizing a portable radio to command the incident.

5. A portable extinguisher and halligan/flat head axe set shall be the minimum tools carried during the investigation.

B. Fast Attack Mode

Fast Attack Mode is used when fire conditions are present and the initial IC believes his direct involvement will be beneficial for the attack. Guidelines for Fast Attack Mode include:

1. Provide an initial radio report and quickly engage.

2. Next arriving units all go to Level 1 Staging.

3. Initial IC makes entry with a portable radio to supervise his/her crew. Examples of situations that may require the IC to make entry include:

   a. A visible working fire in a house or small commercial occupancy

   b. A critical life safety situation (e.g. a rescue that must be made in as short of a time frame as possible)

   c. Any incident where the safety and welfare of fire fighters in the hazard zone is a major concern

   d. Obvious working incidents that require further investigation by the company officer / initial IC

   e. Supervision of a crew with a low combined experience level

4. The initial IC must initiate and continue Command until another company officer arrives and the transfer of command is completed.

5. All responding resources must realize that the IC is in fast attack mode inside the hazard zone attempting to quickly solve the incident problem.

E.O. 302.01

6. Responding resources must critically listen to radio traffic; update, review, and reinforce the initial size up; verify the safety, welfare, and accountability of the fast attack crew; and be ready to support the initial attack.

7. Initial command in the Fast Attack Mode should not last more than a few minutes and will end with one of the following:

   a. Situation is stabilized.

   b. Command is transferred from the fast attack company officer / initial IC to a later arriving command officer.

   c. If the situation is not stabilized, the fast attack company officer / initial IC must move to an exterior, stationary command position and switch to Command Mode.

C. Command Mode (Stationary Command Post)

Certain incidents, by virtue of their size, complexity, or potential for rapid expansion, demand a strong, stationary Command from the onset. At these incidents, the first arriving company officer will assume Incident Command and stay out of the hazard zone in a stationary exterior command position from the beginning of the operation. The initial IC in Command Mode must remain there until the incident is terminated or Command is transferred.

If the initial IC is operating in Command Mode, the following options are available with regards to the assignment of remaining crew members:

1. "Move up" an acting officer within the Company. This is dependent upon the individual and collective capabilities and experience of the crew.

2. Assign the crew members to perform staff functions to assist the IC. Staff functions include recon/reporting, communications assistance, help with tactical worksheet tracking, etc.

3. Assign crew members to another company. This creates a larger work group assigned to the company officer. The reassignment of personnel to another company must be acknowledged by both the original and the receiving officer and must be reflected in the accountability system.

V. ESTABLISHING COMMAND

A. The first officer to arrive at the scene of a multiple unit response shall assume

Command of the incident and shall remain in Command until Command is transferred or the incident is stabilized and Command is terminated.

B. When a Chief Officer arrives at the scene at the same time as the initial arriving company, the Chief Officer should assume Command of the incident.

C. The officer assuming Command initiates the command process by giving an Initial Radio Report (IRR).

D. **Initial Radio Report (IRR)**

1. Clear the Alarm ("Engine 1 on scene of…")
2. Building/Area Description
   a. Size (small, medium, large, huge)
   b. Height (number of stories and/or sublevels)
   c. Occupancy type (house, apartment, strip mall, high-rise, etc.)
3. Problem Description and Location
   a. Nothing showing
   b. Light smoke showing
   c. Working fire
   d. Defensive fire conditions
4. Initial Incident Action Plan (IAP)
   a. The TASK(S) of the initial arriving unit
   b. The LOCATION of the task(s)
   c. The OBJECTIVE(S) of the task(s)
5. Declare the Incident Strategy (see the Fire Ground Strategy SOG)
   a. Offensive
   b. Defensive

E.O. 302.01

6. Resource Determination to Dispatch

   a. Cancel the original assignment

   b. Hold the original assignment

   c. Upgrade the original assignment to a full alarm

   d. Upgrade with specific single resources

   e. Strike additional alarms

7. Assume and Name Command

E. **Follow-Up Report –** The initial IC should communicate a Follow-up Report after more on scene information is gathered, typically following a 360. Follow-Up Reports typically include the following information:

1. Any immediate safety concerns

2. Revision of the IAP

3. Accountability location

4. Tactical channel designation

VI. TRANSFER OF COMMAND

A. At working incident, it may be necessary to transfer Command from a fast attack position to a stationary command position. Transfers of Command will typically be done over the radio, as follows:

1. Verify that all operating positions match the current incident conditions.

2. Announce arrival on scene.

3. Contact the current IC.

4. Confirm the position and function of all on-scene resources with the current IC.

5. Inform the current IC that you are taking Command (e.g. "I'll take it from out here").

E.O. 302.01

6. Inform Dispatch that you are taking Command.

7. Announce to all units that you are assuming Command ("Battalion Chief 2 will be assuming Market Street Command").

8. Reevaluate and communicate fire ground strategy.

9. Reevaluate the adequacy of responding and on-scene resources.

10. Announce the command post (CP) location.

B. In some situations, it may be advantageous for the initial IC to transfer command to the next company officer to arrive on scene.

C. COMMAND SHALL NOT BE TRANSFERRED TO AN OFFICER WHO IS NOT ON THE SCENE.

D. Command is only transferred when the Transfer of Command process has been completed. The person being relieved of Command will be reassigned by the officer assuming Command.

VII. COMMAND SUPPORT

The incident scene is often dynamic and intense. As the incident grows into and past the requirements of a first alarm assignment, the IC can become overwhelmed with information management, assigning companies, filling out and updating a tactical worksheet, planning, forecasting, calling for additional resources, talking on the radio, and fulfilling all the other functions of Command. The immediate need of Command at this point is support. Two immediate positions that provide immediate command support are the IC aide and a Deputy IC.

A. IC Aide:

1. Define, evaluate, and recommend changes to the incident action plan.

2. Provide direction relating to tactical priorities and specific critical fire ground factors.

3. Become the Incident Safety Officer (Mandatory for MFD to establish a Safety Officer)

4. Evaluate the need for additional resources.

5. Assign logistics responsibilities.

6. Assist with the tactical worksheet for control and accountability.

7. Evaluate the fire ground organization and span of control.

8. Other duties as necessary.

9. Work in the Command Post with the IC.

B. Deputy IC:

1. Review and evaluate the incident action plan, and recommend any needed changes.

2. Provide on-going review of the overall incident (THE BIG PICTURE).

3. Review the organizational structure, initiate change or expansion to meet incident needs.

4. Initiate Section and Branch functions as required.

5. Provide a liaison with other city agencies and officials, outside agencies, property owners and/or tenants.

6. Forecast and react to the affect this incident will have on surrounding neighborhoods, Public Officials, and city staffing.

7. Prepare to transition to long-term operations by establishing operational periods and advising the Assistant Chief of Operations as to the need for an All Hazards Incident Management Team (AHIMT), state or federal assistance.

8. Provide a transitional briefing to the incoming IMT if one has been assigned to the incident.

9. Work in the Command Post with the IC.

E.O. 302.01

6.12.9 MFD Policy: Accountability E.O. 300.08

ACCOUNTABILITY	E.O. 300.08

Effective Date	Total Pages	Version Number	Revision Date
7/1/2019	3	1	1/3/2019
9/1/2020	3	2	8/4/2020

PURPOSE: Identifies a system to account for all fire fighters operating in the hazard zone.

GUIDELINE:

I. STRATEGIC ACCOUNTABILITY

Command will address accountability by:

A. Tracking of all crews and divisions/groups by location and function on a tactical worksheet.

B. Command must know who is in charge of each Division/Group, crews assigned to each Division/Group, where each Division/Group is located, and what each Division/Group is assigned to do.

C. Command will include accountability as a major element in strategy and attack planning, and must consider and react to any barriers to effective accountability.

D. Command will consider air supply when making tactical assignments including rotation of crews.

E. Command must obtain personal accountability reports (PAR) from Division/Group Supervisors and crews.

II. TACTICAL ACCOUNTABILITY

Division/Group Supervisors will address accountability by:

A. Tracking of crews assigned to their Division/Group.

B. Division/Group Supervisors must know the location and function of assigned crews.

C. Division/Group Supervisors must be in his/her assigned area to maintain close supervision of assigned crews.

D. Division/Group Supervisors must obtain PARs of all crewmembers of all

companies assigned to his/her Division/Group.

III. TASK LEVEL ACCOUNTABILITY

Company officers will address accountability by:

A. Knowing where each firefighter is located, and what each firefighter is doing.

B. Company officers shall maintain a current PASSPORT of personnel responding on the apparatus at all times.

C. Company officers must ensure that all crewmembers have proper helmet, department ID, and nametags on helmet.

D. Company officers must obtain PARs for their crews, which is a confirmation that all members assigned to his/her crew are accounted for and have an adequate exit air supply.

E. Company officers must keep crew intact and maintain an awareness of the crews exit air supply.

F. Company officer must ensure that passport is delivered to their accountability location prior to entering the hot zone and retrieved upon exiting the hot zone.

IV. ACCOUNTABILITY LOCATION

Is defined as a designated apparatus (typically first due) used to organize and account for crew operations within a designated area.

A. The accountability location is communicated over the radio during the on scene follow up report “E1 will be the Alpha side accountability location.”

B. The accountability location is the physical placement of the apparatus in relationship to the fire building.

C. Multiple accountability locations may exist in fires at large buildings.

D. Fire Apparatus Operators on the fire apparatus identified and assigned as the Accountability Location will initiate accountability actions by collecting company accountability hardware.

E. Company identification working in the hazard zone may be achieved by utilization of a hose marking system done at the apparatus/accountability location.

E.O. 300.08

F. Companies will default to their designated accountability location when exiting the building.

G. The division supervisor will coordinate with the officer to account for crews in the hazard zone.

V. PERSONNEL ACCOUNTABILITY REPORT (PAR)

The Personnel Accountability Report (PAR) involves a roll call of all personnel assigned to crews and Divisions/Groups that are working in the hazard zone. The PAR is a confirmation that all members are accounted for and have an adequate exit air supply.

A. For the Division/Group Supervisor, a "PAR" is an accounting for all crewmembers of all companies assigned to the Division/Group.

B. For the Company Officer, a PAR is an accounting of all crew members assigned to his/her company.

C. Reports of PAR's should be conducted face-to-face within the Division/Group or company whenever possible.

D. A personnel accountability report will be required for the following situations:

1. Any report of a missing or trapped fire fighter.

2. Any change from offensive to defensive.

3. Any sudden hazardous event at the incident - flash over, back draft, collapse, May Day, etc.

4. As companies report an all clear.

5. As companies report fire control.

6. Any time Command feels it is necessary.

E.O. 300.08

6.12.10 MPD Policy: Natural and Man-Made Disaster Plan G.O.411.4

MAUI COUNTY POLICE DEPARTMENT

GENERAL ORDERS
CHAPTER 411
UNUSUAL OCCURRENCES

Effective date: 06/01/21 | Revision date: 05/04/21 | Rescinds: GO 411.4 (04/15/04)
New materials underscored

Accreditation Standards:

NATURAL AND MAN-MADE DISASTER PLAN
G.O. 411.4

I. PURPOSE

To establish guidelines to be used in the event of an unusual occurrence affecting Maui County that proves to be beyond the capabilities of the Department's normal daily operations.

II. POLICY

To respond to unusual occurrences with appropriate numbers of personnel and equipment in the attempt to establish control and the return of normalcy in a safe, effective, and efficient method.

III. DEFINITIONS

DISASTER: The result of flood, tornadoes, earthquakes, explosions, chemical/nuclear accidents or other natural disorders.

EOC: Emergency Operations Center

MCDA: Maui Civil Defense Agency

UNUSUAL OCCURRENCE: A situation that results from a disaster, whether natural or man- made.

IV. GENERAL PROVISIONS

A. In dealing with emergency situations, officers should be aware that state laws give additional powers to law enforcement officials for dealing with circumstances associated with unusual occurrences. See Chapter 127, Hawaii Revised Statutes (HRS), Disaster Relief Act, and Chapter 128, Hawaii Revised Statutes (HRS), Civil Defense and Emergency Act.

B. In the event of an unusual occurrence, the planned response of Department personnel is imperative since the occurrence will be beyond the capabilities of the Department's normal daily operations.

V. COMMAND AUTHORITY DURING UNUSUAL OCCURRENCES

A. In an attempt to provide for unity of command during those situations, the highest ranking Department member on the scene shall exercise command and control over all civil law enforcement resources committed to the resolution of the incident until relieved by a higher ranking Department authority. The order of command precedence during unusual occurrences situations shall be as follows:

1. Chief of Police,

2. Deputy Chief of Police,

3. Assistant Chief of Uniform Services,

4. Assistant Chief of Investigative Services,

5. Assistant Chief of Support Services,

6. Respective District Commanders,

7. Respective Watch Commanders, and

8. Respective Field Supervisors.

B. The on- scene commander will retain responsibility for law enforcement efforts and will also act as a liaison for other Departments and agencies involved in the operations, including local, state, and federal authorities.

VI. PLANNING RESPONSIBILITIES

A. The Department's Assistant Chief of Uniform Services shall be responsible for the development and review of the unusual occurrences plans and the County Disaster Plan. He shall oversee all phases of operations for the Department.

B. The Assistant Chief of Uniform Services shall annually review and update, when necessary, the Department's unusual occurrence plans.

1. As part of the annual review of the unusual occurrence plan, the Assistant Chief of Uniform Services will maintain liaison with other emergency management authorities. This will permit coordination with state and federal disaster agencies and provide a basis for their input related to the Department's plan.

C. Element Commanders are responsible for conducting a documented monthly inspection of equipment designated for use in unusual occurrence situations for operational readiness.

D. If another jurisdiction has an unusual occurrence (natural or man-made disaster), requests for mutual aid will be reviewed by the Chief of Police, or designee, prior to approval. For additional guidelines and procedures that may be applicable, refer to General Order 415.2, Jurisdiction and Mutual Aid.

VII. NATURAL AND MAN-MADE DISASTER PLAN

A. The Department's written plan for responding to natural and man-made disasters shall be issued to all command personnel and is a part of the overall County Disaster Plan developed for such emergencies. It is the policy of the Department to assist and expedite emergency operations during man-made or natural disasters. The Department may also be requested to supplement other agencies who have primary responsibility over an unusual occurrence or disaster. The following provisions shall apply during unusual occurrences or disasters.

1. Communications: During the initial phase of an unusual occurrence, the E 911 Central Dispatch Communications Center will play a vital part. At the direction of the Assistant Chief of Uniformed Services Bureau, the Department's Emergency Operations Center (EOC) will be activated. Without effective communications, the response of this Department could be significantly impaired. Some of the functions performed by the EOC are:

a. The Information and Education Specialist will be responsible for media releases and other rumor control functions. When the EOC is activated, the public information officer shall release coordinated press releases to reduce confusion.

b. Dedicating a radio channel(s) for the specific emergency traffic. A common frequency should be used, if available.

c. Ensuring communications are maintained with all effected personnel.

d. Completing all notifications and coordinations as ordered by the MCDA director.

e. Notifying all other agencies of the implementation and location of any Field Command Post.

f. Providing an accurate update of all incident details to the Department's command staff.

g. Providing detailed sectional maps of Maui County for use in plotting operational commitments during unusual occurrences.

2. Situation Maps: The Assistant Chief of Uniformed Services Bureau is

responsible for maintaining and issuing maps of the islands of Maui, Molokai, and Lanai to Department personnel involved in the planning of unusual occurrences.

3. Field Command Post: When a Field Command Post is activated, the senior ranking officer present will select an appropriate site. In all cases where there is a joint emergency operation involving other agencies, a consolidated command post will be established with all responding agencies. When warranted, a weather forecast should be obtained prior to determining a location, especially when the Department's Mobile Field Command Post is to be deployed. The Field Command Post will be deactivated when all operational phases cease and the incident is terminated.

4. Casualty Information: In those unusual occurrences where fatalities occur, the Maui Police Department in conjunction with other involved law enforcement agencies will coordinate and disseminate identification information. The Department will coordinate and disseminate all information related to injuries.

5. Public Information: In those unusual occurrences involving public safety personnel, the Department's Information and Education Specialist shall coordinate the issuance of information, instructions, and advice to the public. For additional guidelines and procedures that may be applicable, refer to General Order 104.8, Public Information.

6. Other Law Enforcement Agency Support: Mutual aid agreements are either signed or verbal between heads of government for reciprocal assistance in the event of an emergency or unusual occurrence. However, the Chief of Police recognizes the responsibility of the Department to provide assistance to any agency that requests it. Liaison must be established with all agencies involved since it is essential to prevent duplication of effort, confusion, and unnecessary delay.

7. Military Support (martial law): The deployment of the National Guard to aid local law enforcement authorities in the event of a disaster is accomplished only by order of the Governor of Hawaii. Assistance can only be obtained through proper channels to the Office of the Governor of Hawaii. All inquiries concerning deployment requests should be referred to the MCDA director.

8. Public facility security: In order to protect the integrity of an unusual occurrence area, perimeters may be established. The size and number of personnel needed to maintain any perimeter will be determined by the incident supervisor. There are two types of perimeters: 1) inner perimeter used to establish a strict control area, and 2) outer perimeter used to establish a larger area for security or evacuation.

a. Control of the perimeter around an emergency is a primary concern. The agency acting as the primary control force is responsible for determining whether public access is allowed into the endangered area and, if allowed, what criteria will be used for entry. To ensure decisions and communications regarding this matter are fully understood, all involved agencies should use liaison officers.

(1) Those officers assigned to the task for perimeter control shall direct all persons requesting access into the affected area to the entry control point.

b. An entry control point will be established as near as practicable to the Field Command Post and be manned by an MPD officer or other law enforcement officer. All persons will be directed to the entry control point for access. The entry control officers shall control access into the affected area by allowing entry only to those persons authorized by a competent authority.

(1) The type of access will depend upon the conditions as viewed by the incident supervisor. The two types of access determination is made, Department actions will include:

(a) No-Access prohibits unauthorized persons from entering the closed area. When a no access determination is made, Department actions will include:

i) Establishing the perimeter and entry control points of the closed area,

ii) Warning residents and directing concerned evacuees to evacuation centers,

iii) Aiding and rescuing endangered persons, and

iv) Patrolling the interior, when possible.

(b) Limited-Access allows persons into the closed area according to the criteria established by the incident supervisor. When a limited access determination is made, in addition to the above listed actions, entry authorization will be issued and the number of people allowed into the closed area will be monitored.

(2) If limited access is allowed through the perimeter, entry criteria will be established by the incident supervisor. Entry criteria shall define those persons allowed through the perimeter and any motor

vehicle restrictions. As a practical matter, selected persons may be admitted entry. Consideration should be given to individuals who could reduce the volume of duties assigned to officers and those who could assist in restoring the involved area to normal. These persons may include the following:

(a) Residents with valid identification;

(b) Public utility employees;

(c) Persons with press passes; and

(d) Owners, managers, and employees of business located within the perimeter.

9. Traffic Control: Certain officers may have the task of establishing traffic control points. A traffic control point may also be a perimeter point. Duties of establishing a traffic control point include: 1) keeping roadways/ intersections clear for emergency vehicles, and 2) preventing unnecessary traffic from entering the affected area. The incident supervisor will determine entry/ exit procedure into the affected area.

10. Equipment Requirements: An important duty of the Assistant Chief of Uniformed Services Bureau is to act as an expediter of resources during unusual occurrences. He shall coordinate any special equipment needs through the county EOC. Personnel being activated for the unusual occurrence will be advised of any special equipment they need to bring. A list of resources for specialized equipment and its availability is contained within the County Disaster Plan.

11. Transportation: After receiving an evacuation order, some residents may not have transportation to an evacuation center. When the need arises, the use of local school buses should be considered. This should be coordinated with the county EOC.

    a. After receiving an evacuation order, debris and other obstructions may impede the movement of vehicles in the evacuation area. Such conditions may require that evacuees board buses in specific areas. Consequently, evacuees should be kept informed of areas to assemble for transportation.

12. De-escalation Procedures: As the emergency lessens, the strategy is to employ an economy of force by reducing the number of personnel and amount of equipment in the involved area. Personnel reduction should coincide with the restoration of public services. Care should be exercised in the withdrawal of emergency personnel to ensure that involved areas

are protected. Some emergencies present special problems because of a greater potential for looting. Therefore, interior patrols should be maintained even after citizens are allowed limited access into closed areas. If withdrawal is too early, the emergency may be aggravated.

a. When law enforcement mutual aid is employed, the order of the emergency force withdrawal should be in the order of federal, state, and, finally, local. The withdrawal of these forces should be phased to:

(1) Relieve those forces which are the greatest distance from their jurisdiction;

(2) Relieve those forces which have been deployed the greatest length of time;

(3) Ensure that the assignments of remaining mutual aid forces are evenly divided; and

(4) Ensure that there is a reserve of sufficient personnel for immediate response to an escalating problem.

b. When emergency personnel are withdrawn from the occurrence, they should be directed to an assembly area and debriefed. The debriefing will serve to:

(1) Obtain intelligence for operations planning,

(2) Critique tactics employed for emergency control,

(3) Encourage the reporting of incidents not previously known or included in incident reports, and

(4) Ensure all participating agencies have an opportunity to contribute to after-action reporting.

c. Provisions must be made for service, repair or replacement of damaged equipment and the restocking of expended supplies. Damaged or lost equipment must be reported to the appropriate supervisor.

13. Rumor Control: Rumor control is the responsibility of every officer working during an unusual occurrence. To the extent that rumors may cause panic in the general public, it is important that officers be supplied with accurate, timely information. It shall be the responsibility of the Information and Education Specialist to confirm or deny rumors as they become known and to maintain contact with the incident supervisor, command staff, MCDA director, and personnel assigned to the EOC for the control

of rumors.

14. Availability For Command (order of precedence): In the event of an unusual occurrence, the command staff will be notified in the following order:

    a. Uniform Services Bureau commander,

    b. Deputy Chief of Police,

    c. Chief of Police,

    d. Investigative Services Bureau commander,

    e. Support Services Bureau commander.

15. Post-Occurrence (aftermath) Duties: The restoration of order occurs only after control is established, the severity of the emergency diminishes, and recovery operations begin. During major emergencies, large areas of the county may be affected. Therefore, it is likely a number of county Departments will be temporarily involved in different phases of operations including recovery operations. These measures should be employed as early as possible during the emergency. As control is established in the involved area, law enforcement response may be reduced. There still remains an obligation to assist and support other involved Departments and agencies working in the area in whatever law enforcement role necessary. Once order is established attention should be directed towards restoring public service. The faster public services are restored the sooner the community will return to normal.

16. After- Action Reports: An' After- Action' Report shall be prepared within seven (7) days of an unusual occurrence and will document the activities of individuals, units, sections, divisions, and/ or bureaus involved in the control of the unusual occurrence. The Assistant Chief of Uniform Services will have the responsibility for the coordination, preparation, and distribution of the After-Action' Report. Copies of the report will be provided to the Chief of Police, Deputy Chief of Police, other Bureau commanders and others as needed. The Chief or Deputy Chief of Police will determine which of the following categories need to be addressed in the report.

    a. The type of occurrence shall be indicated, i.e., fire, flood, etc.

        (1) A brief background/ intelligence summary,

        (2) The date(s) and time(s) and the duration of the unusual occurrence, and

        (3) The location of the unusual occurrence including the affected

area(s) and perimeters(s).

b. Field command post information:

(1) Location and type of field command post,

(2) Staffing of the field command post, and

(3) Personnel figures to show the total number of work hours expended during the occurrence, to include a breakdown indicating straight time and overtime.

c. Chronological narration of all significant events related to the unusual occurrence. Special emphasis should be placed on law enforcement strategy and tactics.

d. Crimes and arrest information will be reported in the following manner:

(1) Adult felony arrestees will be categorized by gender and listed alphabetically with the charge and case number.

(2) Adult misdemeanor arrestees will be categorized by gender and listed alphabetically with the charge and case number.

(3) Juvenile felony arrestees will be categorized by gender and listed numerically by case number and charge. There will be no reference to the names of the juveniles documented within the report.

(4) Juvenile misdemeanor arrestees will be categorized by gender and listed numerically by case number and charge. There will be no reference to the names of the juveniles documented within the report.

e. Deaths and injuries will contain significant information. Following the statistical summary, there should be a description of the circumstances surrounding each death or injury. The description should include names listed alphabetically, location of occurrence, the cause and type of death or injury, and, when applicable, a case number.

(1) The names of juveniles will be omitted from this section of the report. All references of juveniles will be listed by sex, age, location of occurrence, and the cause and type of death or injury.

f. When applicable, the report will contain a listing of all known property damaged. Department owned property will be listed separately from all other property damage.

g. The number of sworn and nonsworn Department personnel by rank who were assigned to the unusual occurrence. The report should provide the total work hours expended by rank for sworn and nonsworn personnel with straight time recorded separately from overtime.

h. Record all of the equipment and supplies used during the unusual occurrence. Include the costs incurred for the use of Department equipment and the cost of expended logistical items.

i. Summarize and evaluate the operations and procedures used during the unusual occurrence. Include suggestions for modifying procedures and/ or operations and suggestions for training when applicable. The summary will represent a compilation of all critiques related to the unusual occurrence. Any recommendations will be evaluated and any updates to this plan will then be made.

DEAN M. RICKARD
Acting Chief of Police

6.12.11 MFD Policy: Hurricane and High Wind Events D.O. 600.01

HURRICANE / HIGH WIND EVENTS	D.O. 600.01

Effective Date	Total Pages	Version Number	Revision Date
7/1/2019	5	1	4/24/2019
7/23/2020	5	2	7/22/2020

PURPOSE: To provide guidance prior to and during hurricanes and high wind events impacting Maui County.

GUIDELINE:

I. The following steps and procedures are expected to be implemented by the highest ranking officer at each of the fire stations within the Maui County Fire Department. Guidance from the Battalion Chief on duty shall be obtained if there are any questions or concerns regarding this process or policy. In most cases, there will be 48 to 72 hours of prior notice that a hurricane is approaching and action must be taken.

II. Securing of Families and Possessions

A. Department members who are scheduled to be on duty during a hurricane or high wind event must take steps to secure their family and possessions prior to reporting for duty. It is a good idea to implement these actions when a Hurricane Watch is announced by the National Weather Service. Member's families should have a shelter plan in place; whether it's with other nearby family members in a safe area or they may wish to bring their families to a designated facility (ie. Red Cross Shelter or Nearest Fire Station).

III. When a hurricane watch is announced, storm winds in excess of 74 mph may possibly arrive within 48 hours. At this announcement, all fire stations shall:

A. Fuel all fire department vehicles (top off)

B. Request emergency diesel fuel delivery for station fuel tank for generator & vehicles if time permits (does not apply to Kihei & Pukoo fire stations due to evacuation of these stations)

C. Secure loose items outside the fire station like furniture, equipment, tools etc.

D. Turn thermostat of refrigerator to coldest setting and keep door closed

E. Turn off propane tank valves

F. Fill clean, large containers with water for future sanitary purposes in case the water supply is shut off

G. Check portable radio batteries are charged

H. Install covering over windows in self-preservation areas of the fire station if pre-designed to do so

IV. When the hurricane watch is announced, the Assistant Chief of Operations shall begin to staff the seven Incident Facilities and fire stations as needed. An initial staffing roster and rotational schedule for relief personnel shall be in place prior to sustained winds exceeding 40 mph.

V. The MFD has identified the following seven facilities that may be used by the initial unified command structure at the following locations:

A. Central Maui – Wailuku Fire Station (Pali Tunnel to Kealia power plant to Kahakuloa and Specklesville)

B. Upcountry – Kula Fire Station (Kaupo Store, to Hailiimaile, Baldwin Park to Keanae)

C. West Maui – Lahaina Fire Station (Pali tunnel to Kahakuloa)

D. Molokai – Kaunakakai Fire Station (all of Molokai)

E. Lanai – Lanai Police Station (all of Lanai)

F. South Maui – Wailea Fire Station (Sugar Beach to Makena)

G. East Maui – Hana Fire Station (Keanae to Kaupo Store)

VI. When a Hurricane Warning is announced, storm winds in excess of 74mph are expected within 36 hours. Incident command staff shall be increased as directed by the command (IC or Unified). A plan to address objectives that have been identified by command must commence when all general staff have arrived.

VII. ICS positions must be filled by qualified members who have training and experience in their assigned position. ICS participants DO NOT need to be members of the MFD but must have knowledge of the positions duties and approval of the IC. The IC (or Unified) must communicate information to the Emergency Operations Center (EOC) in Wailuku as the incident dictates.

VIII. A map of the seven districts is provided for clarification.

D.O. 600.01

- 1-Central Maui
- 2- Upcountry
- 3- West Maui
- 4- Molokai
- 5- Lanai
- 6- South Maui
- 7- Hana

IX. Although not required, fire stations were selected for six of the seven command posts for the following reasons:

- Ability of ICP to resist a hurricane
- Large backup generator
- Large fuel tank for generator
- Sleeping quarters
- Computers & printers
- Food & ice

X. Coordination of evacuation is the responsibility of the Maui Police Department. MFD's responsibility is to assist the police department with evacuation. Outdoor evacuation activities shall continue until the sustained winds reach 40 miles per hour. Sustained winds are measured in excess of one minute. The EOC is responsible to announce when this threshold is met and communicate this to the incident facility in each district. When the 40mph wind threshold is achieved, firefighting personnel shall take self-preservation measures and report to their designated hurricane shelter (unless directed otherwise by the IC or EOC).

XI. The following are the designated self-preservation sites for each fire station.

- Station 1 Wailuku in station
- Station 2 Paia in station
- Station 3 Lahaina in station
- Station 4 Kaunakakai in station
- Station 5 Makawao in station
- Station 6 Kihei Wailea Fire Station
- Station 7 Hana in station
- Station 8 Lanai in station
- Station 9 Hoolehua in station
- Station 10 Kahului in station
- Station 11 Napili in station
- Station 12 Pukoo Kaunakakai Fire Station
- Station 13 Kula in station

D.O. 600.01

- Station 14 Wailea in station

XII. For Kihei and Pukoo fire stations, evacuation for self-preservation shall be timed to permit ample travel time to the designated shelter site prior to meeting the 40mph wind threshold. The following items shall be secured and taken with you when leaving Kihei and Pukoo fire stations:

A. Take log book.

B. Secure utilities such as electric and gas.

C. Take reasonable food & water rations to shelter site.

XIII. Much thought and deliberation went in to deciding whether to include evacuating Paia Fire Station during a hurricane event. The possibility of a storm surge reaching Paia Fire Station is very remote. Most hurricanes form and approach Maui County from the south or southeast, per the Central Pacific Hurricane Center. Having a hurricane impact Paia Fire Station with a storm surge would require a hurricane to make landfall from the north or northeast. In general, waters north of Maui County tend to be cooler and not productive for hurricane creation or strengthening. If a hurricane does approach Maui from the north or northeast, Paia Fire Station personnel must be evacuated to a safe location.

XIV. Each of the command posts identified must have the following supplies available during a hurricane event.

- ICS forms
- Computer
- Printer
- Paper
- 5 portable radios & spare batteries (2 for IC, 1 each Ops, Logs and Planning)
- Satellite phone (if available)
- Food for 5 days
- Water for 5 days

XV. At the point the storm winds have fallen below the threshold, assistance to the public may continue. The EOC is responsible to announce when winds have fallen below 40mph. Captain's must be prepared to encounter roadways that are blocked by debris. Do your best to clear the roadway for your vehicle until Public Works crews arrive to do a more thorough job. Flat tires on emergency vehicles are a very common occurrence after a hurricane. Realize that roadway debris can cause damage to the apparatus.

D.O. 600.01

XVI. Although there is a calling to help everyone after a storm, it is highly important to conduct a damage assessment of the entire district so additional equipment can be identified and requested via the EOC immediately. There should be no delay in getting this information to the EOC. Sending a resource request list to the EOC in a timely fashion is one of the IC's highest priorities. The IC, or unified command staff, must allocate resources to accomplish the damage assessment process while also balancing the life safety assistance provided to the community.

XVII. EOC's Responsibility to the Incident Facilities

A. Communicate amongst the incident facilities (via 911or radio)

B. Identify & open shelters

C. Provide weather updates at specified intervals

D. Obtain resources as requested (USAR, heavy machinery, personnel, equipment etc.)

6.12.12 MFD Policy: Apparatus and Equipment Check, Management and Administration (M.A.) 100.25

APPARATUS AND EQUIPMENT CHECKS	M.A. 100.25

Effective Date	Total Pages	Version Number	Revision Date
7/1/2019	5	1	1/3/2019

PURPOSE: To ensure the readiness and maintenance of all apparatus (both front line and relief), and establish standardization, tracking and accountability guidelines for the use, maintenance, and loss prevention of emergency equipment.

GUIDELINE:

I. AUTHORITY & RESPONSIBILITY

Apparatus Operators are responsible for the proper inspection, maintenance, and documentation of their assigned apparatus and emergency-related equipment. Company Officers are responsible for ensuring all response apparatus within their facility are in good working order, clean, and ready for emergency response.

II. EQUIPMENT STANDARDIZATION

A. All types of Maui Fire Department apparatus shall maintain minimum standardized equipment inventories, compliments, and assemblies as identified within the most updated edition of the Maui Fire Department Apparatus Standardization Manual.

B. All personnel shall become familiar with capabilities and limitations of tools and equipment on the apparatus assigned to.

C. All personnel shall not alter or augment minimum standardized equipment inventories, compliments, and assemblies carried on fire apparatus without the approval of the Fire Chief.

D. Wherever possible, equipment shall be grouped on fire apparatus in standardized locations to enable efficient and effective equipment access and deployment for use at the task level.

E. A standard list of equipment has been established for each type of apparatus. All apparatus will be equipped as outlined in the inventories available on the Department's Shared drive. A copy of the standard inventory will be maintained in the Station files.

III. SECURING EQUIPMENT

A. All equipment must be secured to the apparatus, placed inside a compartment,

secured inside pick-up beds, or tied down using straps, netting, or fastening devices that are appropriate for the type of load and apparatus.

B. All contaminated loose or rolled hose must be carried in the hose bed and secured with tie-downs or straps. Other non-contaminated hose may be carried in an enclosed compartment, not including the cab.

IV. FRONT LINE APPARATUS AND EQUIPMENT

A. General

1. The assigned Apparatus Operator is responsible throughout the course of the shift for ensuring that the apparatus is ready to respond and that all equipment is accounted for and operational.

2. Station personnel at a Battalion Chief's station will perform checks and routine maintenance on the Battalion Chief's vehicle.

3. Daily Apparatus Inspection Reports will be completed daily by Apparatus Operators and will document findings to ensure readiness of the apparatus. Completed Daily Apparatus Inspection Reports shall be submitted to the Deputy Fire Chief's Office on the 1st of every month.

4. Monthly Apparatus Inspection Reports will be completed by Apparatus Operators monthly and will be submitted to the Deputy Fire Chief's Office on the 1st of every month.

B. Daily Apparatus Checks

1. Pre-trip shall meet or exceed DOT regulations

- Apparatus appearance
- Fluid leaks
- All fluid levels
- Batteries
- DOT lighting
- Emergency lighting
- Emergency Audible Devices
- Wheels/Tires
- 7-step air brake check
- Windshield wipers

2. Fire Components and Equipment

- CAFS compressor fluid level (if applicable)

M.A. 100.25

- Engage water pump and accessories
- Engage foam pump (if applicable)
- Engage CAFS compressor (If applicable)
- Check water tank level
- Check foam tank level (If applicable)
- Portable radios
- SCBA's
- Equipment inventory

3. Medical Equipment

- First in medical boxes and other associated medical kits should be checked for proper inventory
- Oxygen tanks shall be checked to ensure they have adequate O2 levels.

C. Weekly Apparatus Checks

1. Operate Hydraulic Ladder Rack (If Applicable)
2. Engage Aerial PTO (If Applicable)
3. Operate Aerial Device (If Applicable)
4. Operate Generators (If Applicable)
5. Engage PTO for Misc. Equipment (If Applicable)
6. Foam Pump Fluid Levels (If Applicable)
7. Hydraulic System (If Applicable)
8. Exercise Water Pump Drains
9. Exercise Discharge Relief Valve (If Applicable)
10. Exercise Primer
11. Ground Ladders
12. Hoses
13. Operate hydraulic ladder rack (if applicable)

D. Equipment Checks

1. At a minimum all small engine equipment shall be checked on the first day of each shift and after each use.

2. At a minimum all battery powered equipment shall be checked on the first day of each shift and after each use.

3. At a minimum all hand tools and misc. equipment shall be checked for cleanliness and damages on the first day of each shift and after each use.

M.A. 100.25

4. Rescue and Hazmat companies refer to your in company equipment check procedures regarding specialized equipment. **

V. FRONT LINE AND RELIEF APPARATUS TRANSFERS

A. The station that houses the relief apparatus is ultimately responsible for the accountability of that apparatus and equipment with the exception of Station 10.

B. When a company moves from a front line apparatus to a relief, they will:

1. Complete a thorough inventory of the relief apparatus on the same shift (preferably at the time of transfer) utilizing the Relief Apparatus Inventory form, and documenting any discrepancies.

2. If there are any equipment discrepancies at this time (missing, damaged, inoperable, etc.), the relief apparatus home station Company Officer, or Lead Fire Mechanic for apparatus stored at Station 10 will be notified immediately and they will be responsible for remedying the problem. This action should be documented on the form.

3. The front line apparatus personnel will record the items that had to be transferred due to missing, damaged, or inoperable equipment on the relief apparatus.

4. When a relief apparatus has been placed into front line status, all routine checks will be conducted as outlined in Section IV.

C. When a company moves from a relief back into a front line apparatus, they will:

1. Ensure the apparatus is clean and fueled. Prior to returning the relief to its home location, the company will conduct a final inventory, and document any discrepancies.

2. If any new equipment discrepancies (missing, damaged, inoperable, etc.) are identified, the company is responsible for remedying the problem, documenting their actions on the form, and notifying the home station Company Officer of the discrepancy.

D. When a relief apparatus is returned to the home station, the home station crew will:

M.A. 100.25

1. Complete a thorough inventory of the relief apparatus ***on the same shift*** (preferably at the time of transfer).

2. If any equipment discrepancies are found that were not documented by the company returning the relief apparatus, the home station Company Officer will contact the Company Officer who was in possession of the relief and immediately establish a plan to remedy the situation.

E. Clear and concise documentation for the Relief Apparatus is imperative as it will be used to track any equipment discrepancies and determine responsibility from both a repair/replacement (budget) impact and accountability standpoint.

VI. SERVICEABILITY

A. Apparatus will be taken out of service if there is any doubt or evidence of damage or malfunction of any of the components or systems that are critical to the mission of that apparatus.

B. During regular business hours, the Deputy Fire Chief, Assistant Chief of Operations and Lead Fire Mechanic will be notified immediately when an apparatus is taken out of service. After regular business hours, the on duty Battalion Chief and Lead Fire Mechanic shall be notified.

M.A. 100.25

6.12.13 MFD Policy: Emergency Callout E.O. 300.12

EMERGENCY CALLOUT	E.O. 300.12

Effective Date	Total Pages	Version Number	Revision Date
7/1/2019	2	1	1/3/2019
9/1/2020	2	2	8/4/2020

PURPOSE: To provide a guideline for recalling off-duty MFD personnel during emergency operations.

GUIDELINE:

I. EMERGENCY RECALL

A. Upon authorization by the Fire Chief or their designee, the following will govern the recall of off-duty platoons:

1. Administrative staff shall, upon receipt of notice to recall the off-duty platoons, immediately refer to the Department Phone List for telephone numbers and notify all off-duty members to report.

2. Recalled members shall report to their regular place of assignment, unless otherwise specifically ordered. In the event of circumstances prohibiting or seriously curtailing vehicular traffic, they shall report to the nearest or most convenient fire station.

3. Members on suspension and/or sick leave shall not respond unless sick leave personnel call in as available and get BC approval prior to recall.

4. Personnel contacted to report for duty during an emergency recall who are ill, under the influence of medication, or under the influence of alcohol, to such an extent that their judgment and/or coordination is impaired, shall refrain from participating in the emergency recall.

5. Members on vacation leave or on their day off will report for duty.

6. Recall of off-duty platoons will, in each instance, be followed by a form letter from the Company Commander to the Battalion Chief, showing who reported and the time and date in each individual case.

7. Recalled members shall be listed in the Company journal and be entered into the Fire Records Management System (RMS) with the appropriate unit they are assigned to and their working dates and times.

II. CALLOUT

A. Whenever it is determined by a Battalion Chief or Incident Commander that an emergency will soon exceed or has already exceeded the capabilities of the entire on-duty staffing, that Battalion Chief or Incident Commander shall be able to obtain additional personnel by calling back off-duty personnel.

B. The Battalion Chief or Incident Commander shall refer to the Department Phone List for telephone numbers and notify members where report to. The use of gang paging" and/or mass notification programs such as Everbridge is also permissible.

C. Personnel contacted will report to an official staging area with full personal protective equipment or other equipment that was designated when contacted, unless otherwise specified.

D. Members on suspension and/or sick leave shall not be eligible for call back, unless the employee on sick leave called in "well" prior to the call back opportunity.

E. Personnel who are ill, under the influence of medication, or under the influence of alcohol, to such an extent that their judgment and/or coordination is impaired, shall refrain from participating in a callout.

F. Members on vacation leave may cancel their vacation leave and report for duty.

III. COMPENSATION

A. An employee on off-duty status who is called back to duty because of an emergency shall receive the greater of:

1. Four (4) straight time hours in the case of Employees on a twenty-four (24) hours shift and two (2) straight time hours in the case of Employees on other than twenty-four (24) hour work shifts; or

2. Overtime compensation at the applicable overtime rate calculated on the basis of actual time worked plus the time incurred in traveling from and to the Employee's home.

B. An Employee who is called out more than two (2) hours prior to the start of the Employee's next scheduled work shift and is required to continue working into such regular shift without eight (8) consecutive hours off, shall be released from routine station duty assignments for an equivalent period to rest at the station. However, the Employee shall be required to perform duties necessary to enable the unit to respond to emergencies.

E.O. 300.12

6.12.14 MFD Policy: Mayday E.O. 300.07

MAYDAY	E.O. 300.07

Effective Date	Total Pages	Version Number	Revision Date
7/1/2019	4	1	1/3/2019
9/1/2020	4	2	7/17/2020

PURPOSE: The purpose of this guideline is to provide action steps to be taken by the lost/trapped or in trouble firefighter(s), and the Incident Commander to initiate the Rapid Intervention Crew (RIC), for successful removal of the affected firefighter(s) from the hazardous environment.

GUIDELINE:

A mayday is defined as: Anytime a firefighter cannot safely exit an IDLH hazard zone.

I. MAYDAY PREVENTION

The best way to run a mayday incident is to operate in a manner that eliminates them from occurring in the first place. This is done by:

A. Perform a thorough size-up.

B. Operate in the correct strategy.

C. Maintain a tactical reserve.

D. Manage the work rest cycles.

E. All resources work within the IAP.

F. Manage air supplies (all members exit the hazard zone with at least 33% air reserve.)

II. HELP ORDER

The Help Order is the order in which an IC or a Division Supervisor will try to assist a firefighter who is experiencing a mayday. This order is:

A. Communicating to a lost firefighter self-rescue techniques to assist with the rescue.

B. Using a mayday firefighter(s) own company to assist with the rescue.

C. Using a company already located inside of the hazard zone to assist with the

rescue.

D. Using an On-Deck company located outside of the hazard zone as a RIC crew.

III. FIREFIGHTER MAYDAY

A firefighter or interior unit having a mayday must:

A. Call for a mayday as soon as you realize you cannot safely exit the hazard zone.

B. Declare a mayday 3 times to ensure emergency radio traffic.

C. Give a CAN report that includes:

1. Name
2. Unit #
3. Assignment
4. Location
5. Needs

D. Calm down and begin self-help/self-rescue techniques.

E. Conserve air.

F. Activate PASS.

G. Make yourself as easy to find as you can, without using too much air or injuring yourself.

H. Maintain radio contact with the IC or Division supervisor as required.

IV. MAYDAY ALGORITHM

A. Mayday is declared.

B. IC acknowledges mayday and requests info for Rescue IAP.

C. IC provides any necessary self-help to mayday firefighter.

D. IC requests alert tones to dispatch.

E.O. 300.07

E. IC communicates “Emergency Traffic” report

1. Mayday update

2. Announce radio silence

3. Request resources as required

Example: “Emergency traffic, emergency traffic on the fireground, we have a mayday with Engine 1, maintain radio silence, communicate priority traffic only.”

F. IC uses Help Order to address mayday.

G. Clear mayday when firefighter is found.

V. COMPANY RESPONSIBILITIES

Other Companies operating in the hazard zone during a mayday must:

A. Maintain radio silence.

B. Mayday announcements, priority traffic and status reports ONLY.

C. Be prepared to assist with the rescue if you are able to do so.

D. Interior crews that are actively addressing fire control when a mayday occurs should continue with their fire control efforts.

E. Perform accountability check with your crew. Do not communicate PAR unless requested to do so.

VI. COMMAND RESPONSIBILITIES

A. Take strong control of communication process.

B. Change the IAP to high priority rescue effort.

C. A NO PAR policy will take effect.

D. Request additional resources.

E. Take control of entry points: do not allow freelancing and self-deployment.

E.O. 300.07

F. Establish treatment.

G. Push control of the rescue operation down to the Division Supervisor where the mayday is occurring.

H. If there are no tactical level supervisors in place when a mayday is declared on the incident scene, the IC must continue to manage the entire tactical rescue effort required to resolve the mayday.

VII. CLEARING A MAYDAY

A. Once the mayday(s) have been controlled and there is adequate treatment under way, the IC should contact the Dispatch and clear the mayday radio traffic. This announcement should include:

1. A brief Mayday conclusion report

2. The strategy and IAP for the next operational period in the incident

3. Resource determination

Example: "Dispatch from Command: The mayday firefighter has been extricated from the building and is currently in treatment for fall injuries. I'm clearing the mayday radio traffic at 456 Main St. All units resume normal radio traffic. We will remain in the offensive strategy; we have primary and secondary all-clears and fire control in the fire structure. On-scene units will continue to overhaul and perform loss control. I am holding the current assignment."

6.12.15 MFD Policy: Brush and Wildland Fire Policy E.O. 302.14

BRUSH AND WILDLAND FIRES	E.O. 302.14

Effective Date	Total Pages	Version Number	Revision Date
7/1/2019	6	1	1/3/2019
9/1/2020	6	2	7/20/2020
7/1/2021	6	3	5/12/2021

PURPOSE: Establish guidance of operations to brush fires and wildland fire incidents.

GUIDELINE:

I. FIRST-IN UNIT RESPONSIBILITIES

A. Vehicles should be parked in a safe accessible location pointing away from the fire.

B. Determine the location of Safety Zones and Escape Routes.

C. Recon the fire thoroughly before committing to an attack strategy or committing resources.

D. Do an initial size-up upon arrival and provide an **Initial Radio Report (IRR)** based on the following considerations:

1.	**S**ize of Fire	in feet or acres/small or large
2.	**T**ype of Fuel	light, medium heavy, grass, brush, trees
3.	**A**dvancing/Spread	creeping, running, crowning, spotting
4.	**R**esidential/WUI	Homes involved or threatened
5.	**W**ind	Speed and Direction
6.	**A**ction/Access	Direct, indirect, point protection, access
7.	**R**esources	on the way, on scene and require
8.	**S**pecial Situations	People, utilities, livestock, traffic

E. Execute action plan

II. RESPONSE PACKAGE

A. Reported Brush Fire

- 1 Engine
- 1 Water tender

B. 1st Alarm Assignment

- 2 Engines
- 2 Mini's
- 2 Water tenders
- 1 Response Chief
- Air-1 on Stand-by

C. 2rd Alarm Assignment

- 4 Engines
- 2 Mini's
- 4 Water tenders (Public Works, Private)
- 2 Wildland Apparatus
- 2 Response Chiefs
- 2 Helicopters
- AHIMT on stand-by
- Rehab Unit
- Emergency call back

D. 3rd Alarm

- 6 Engines
- 2 Mini's
- 2 Wildland Apparatus (M42, M62)
- 4 Water tenders (Public Works, Private)
- 3 Response Chiefs
- AHIMT
- 3 Helicopters
- Rehab Unit
- Communications Unit
- Emergency call back
- Public Works notification (Water tenders, Heavy Equipment)
- Private Company notifications (West Maui Land Management, Lanai Company, Goodfellow, etc.)

E.O. 302.14

III. FIRE CONTROL STRATEGIES

A. Direct Attack:

Should be used whenever fire conditions allow fire personnel to work directly and safely on the fire perimeter.

1. Can be used initially on most small fires.

2. Personnel should "anchor and flank" a fire by first establishing a safe location, or anchor point, to start the attack without being out flanked by fire.

3. Fire suppression personnel on fires in light fuels should use the "one foot in the black" method in an inside out attack where the safety zone is the previously burned area adjacent to the burning fire perimeter.

4. A direct water attack is the fastest control evolution available to counteract wildfire spread. Brush trucks can accomplish this through pump-and-roll tactics.

5. Involves greater danger to personnel, especially when there is unburned fuel between you and the fire or you are working downwind of the fire.

6. Utilize class A foam when possible.

B. Indirect attack:

Used when fire personnel are prohibited from direct attack due to fire conditions or access to the fire. For indirect attack strategy, fire personnel work some distance away from the fire perimeter. This maybe in support of Wildland fire crew burning out and back fire operations, structure protection or other tactics.

1. Take advantage of natural and manmade barriers.

2. Fire control line should be continuous, to bare mineral soil.

3. Only set utilize back fires and burning out methods if properly trained and authorized to do so.

4. Use heavy equipment when possible.

C. Urban Interface Operations:

E.O. 302.14

Should be used when a brush fire threatens structures.

1. Structural triage is based on forecasted fire behavior, the surrounding area terrain, and defensible space.

2. Units assigned to protect a structure or improvement should first thoroughly size up the site to ensure firefighter safety can be maintained.

3. Entry into the structure through normal means or forcible entry should be established to utilize the interior of a structure as an emergency refuge area.

4. The company officer should ensure apparatus have good access and clearance and that the site is deemed safe to protect.

5. Apparatus should back into allow for quick egress if necessary.

6. During structure protection, crews should plan to remain as mobile as possible in case escape is necessary.

7. Hoselays should be as short as possible and limited to one or two at most.

8. If time permits, the exterior and interior of a structure should be prepared to limit the spread of fire and assist with fire control.

9. Utilize Dry CAFS for structural protection when necessary

IV. FIREFIGHTER SAFETY

A. 10 Standard Fire Orders

1. Fight fire aggressively, but provide for safety first.

2. Initiate all actions based on current and expected fire behavior.

3. Recognize current weather conditions and obtain forecasts.

4. Ensure instructions are given and understood.

5. Obtain current information of fire status.

6. Remain in communication with crew members, your supervision, and adjoining forces.

E.O. 302.14

7. Determine safety zones and escape routes.
8. Establish lookouts in potentially hazardous situations.
9. Retain control at all times.
10. Stay alert, keep calm, think clearly, act decisively.

B. 18 Watch Out Situations

1. Fire not scouted or sized-up.
2. In country not seen in daylight.
3. Safety zones and escape routes not identified.
4. Unfamiliar with weather and local factors influencing fire behavior.
5. Uninformed on strategy, tactics and hazards.
6. Instructions and assignments not clear.
7. No communications link with crew members/supervisor.
8. Constructing line without a safe anchor point.
9. Building fire line downhill with fire below.
10. Attempting a frontal assault on the fire.
11. Unburned fuel between you and the fire.
12. Cannot see the main fire or not in contact with anyone who can.
13. You are on a hillside where rolling material can ignite fuel below.
14. Weather is getting hotter and drier.
15. Wind increases and/or changes direction.
16. Getting frequent spot fires across the line.
17. Terrain and fuels make escape to safety zones difficult.

E.O. 302.14

18. Taking a nap near the fire line.

C. Common Denominators of Fire Behavior on Tragedy Fires

1. On relative small fires or deceptively quiet areas of large fires.

2. In relatively light fuels, such as grass, herbs, and light brush.

3. When there is a unexpected shift in wind direction or wind speed.

4. When fire responds to topographical conditions and runs uphill. Alignment of topography and wind during the burning period should always be considered a trigger point to re-evaluate strategy and tactics

V. MOP-UP

A. On small fires, all fires should be extinguished in the mop up area, where quantities of burning materials are not so large as to make this impractical.

B. On large fires, completely mop enough of the area adjacent to the line to be certain no fire can blow, spot, or roll over the fire line under the worst possible conditions.

C. The areas or perimeter of the fire with the greatest chance for spread (e.g. head, uphill, flanks, downwind, or special hazards) should be given the highest priority for initial mop-up.

D. All smoldering material that is not put out should be spread well inside of the control line.

E. Eliminate all burned trees inside of the control line that could throw sparks over the control line.

F. Add Class A foam to water when possible for increased effectiveness.

G. Determine the distance inside the control line to be overhauled.

H. During rehab of mop-up crews, ensure at least two firefighters remain in the area to monitor for re-ignition or spread of fire.

I. Schedule for follow-up checks by crews to ensure the fire is contained, controlled, or extinguished inside of the control line.

E.O. 302.14

6.12.16 MPD Policy: Body-Worn Camera System G.O. 304.12

MAUI COUNTY POLICE DEPARTMENT

GENERAL ORDERS
CHAPTER 304
FACILITIES AND EQUIPMENT

Effective date: ***05/01/23*** Revision date: ***05/01/23*** Rescinds: GO 304.12 ***(10/14/21)***

Accreditation Standards:

BODY-WORN CAMERA SYSTEM
G.O. 304.12

I. PURPOSE

The purpose of this policy is to provide officers with instructions for the use of body-worn cameras (BWCs) in order to accurately record law enforcement actions and to capture evidence for investigations and court proceedings. This policy also sets forth guidelines for the management, storage, release, and retrieval of digital multimedia recorded by BWCs.

Officers shall utilize body-worn cameras in accordance with the provisions set forth in this general order in order to maximize the effectiveness of the audio/visual documentation to achieve operational objectives and to ensure evidentiary integrity.

BWCs provide additional information regarding investigative or enforcement contact with members of the public. BWC recordings however, provide a limited perspective of the encounter and must be considered with all other available evidence, such as witness statements, officer interviews, forensic analysis, and documentary evidence.

II. POLICY

It is the policy of this Department that officers shall activate their BWCs when such use is appropriate in the proper performance of their official duties and the recordings are consistent with this policy and the law. This policy does not apply to the use of covert recording devices, such as those used in undercover operations.

III. DEFINITIONS

AUDIT: The review of BWC recordings to ensure compliance with departmental directives.

BODY-WORN CAMERAS (BWCs): Body-worn cameras are camera systems issued by the Department and designed to be worn by police officers to capture digital multimedia evidence.

BUFFERING MODE: The BWC is on, but Event Mode has not been activated. While in the buffering mode, the camera will continuously record video only (no sound) in thirty (30) second loops.

BWC SYSTEM ADMINISTRATOR: The Quality Assurance Section Commander or

1

designee.

DIGITAL MULTIMEDIA EVIDENCE: Digital multimedia evidence, or digital evidence, consists of all digital recordings, including but not limited to: Audio, video, photographs, and their associated metadata. Metadata includes any digital identifiers that are captured as part of the actual recording, such as date/time, GPS coordinates, labeling, etc.

EVENT MODE: When the event button on the BWC is activated, the camera is recording both audio and video.

EVIDENCE DOCKING STATION (EDS): A portable multi-port docking station installed in each district. The EDS simultaneously recharges the BWC while uploading all digitally encrypted data from the device. The docking station then transfers the digitally encrypted data to Evidence.com.

EVIDENCE.COM: A digital evidence management service that stores digitally encrypted data in a secure environment accessible to authorized personnel based on security clearance.

IV. ADMINISTRATION

A. Only authorized personnel shall use, or be in possession of, a department issued BWC device.

B. All officers issued a BWC are required to wear, and use, their BWC while on duty.

C. Officers shall use only BWCs issued by the Department. The wearing of personally owned BWC equipment is not permitted.

D. BWC equipment is for official use only and shall not be utilized for personal use.

E. BWCs shall not be used to record:

1. Communications with other police personnel without the permission of the Chief of Police.

2. Encounters with undercover officers or confidential informants.

3. When on break or otherwise engaged in personal activities.

F. In any location where individuals have a reasonable expectation of privacy, such as a restroom or locker room.

G. Officers shall not alter, tamper with, or dismantle any hardware or software component of any BWC device.

H. All digital evidence collected using the BWC shall be considered government records pertaining to the prosecution or defense of any judicial or quasi-judicial action to which the State or any county is, or may be, a party. This provision includes records that, by their nature, must be confidential in order for the government to avoid the frustration of a legitimate government function, or other exemption from disclosure as may be appropriate.

I. Accessing, copying, forwarding, or releasing any digital evidence other than for official law enforcement use and is contrary to this procedure is strictly prohibited. Public release of digital evidence is prohibited unless approved by the Chief of Police, or designee.

J. Use of a secondary recording device (such as a video camera, cell phone, or other device) to record or capture digital evidence from Evidence.com or Axon View XL is strictly prohibited.

K. It shall be deemed a violation of this policy for supervisors to review BWC recordings for the sole purpose of searching for violations of department policy or law not related to a specific complaint or incident.

L. Audits of BWC videos shall be initiated by the BWC System Administrator to ensure only authorized users are accessing the data for legitimate and authorized purposes.

M. Accidental Activation

In the event of accidental activation of the BWC, the recording officer may request the file be deleted by submitting an e-mail request, with sufficient information to locate the file, to the BWC System Administrator who shall review the file, and approve or deny the request, and take appropriate action accordingly.

1. The BWC System Administrator, or designee, will respond via e-mail to the requestor and indicate whether the request was approved or denied.

   a. The e-mail request and findings will be printed out and filed in the designated Accidental Activation BWC request folder.

b. Upon BWC System Administrator (or designee's) approval, the requested accidental activation will be accessed via Evidence.com.

(1) Once the requested video is accessed, an explanation for the deletion shall be documented in Evidence.com, and the audit log shall be printed.

(2) The printed audit log shall be filed in the designated Accidental Activation BWC request folder attached to the specified e-mail request and approval.

V. TRAINING

All officers assigned a BWC must complete Department provided training to ensure proper use and operation. Additional training may be required at periodic intervals to ensure continued effective use of the operation and performance of the BWC, as well as to incorporate changes, updates, or other revisions in policy and equipment.

VI. STORAGE

When not in use, BWCs shall be stored in the designated evidence docking station (EDS). Officers shall ensure the BWC is properly seated into the EDS to allow for downloading, charging, and updating.

VII. PRIVACY CONCERNS

A. Private Citizens do not have a reasonable expectation of privacy when talking with police officers during the scope of an officer's official duties, even when the contact is in a private residence. When officers are lawfully present in a home in the course of official duties, there is no reasonable expectation of privacy. Therefore, officers are not required to give notice they are recording. However, if asked, officers may advise citizens they are being recorded.

B. Officers shall activate or cease recording an event, in accordance with this policy and the law. Officers are not required to initiate or cease recording an event, situation or circumstance solely at the demand of a citizen.

C. Officers may cease recording at their discretion provided they state the reason for cessation prior to cessation as required in Article VIII, Paragraph B 7.

VIII. PROCEDURES

A. Camera Equipment

1. Prior to beginning a shift, officers shall retrieve their assigned BWC and conduct an operational inspection, then position the camera on their person to record video and audio from the officer's point of view.

2. Officers shall position the BWC at center mass on the chest to ensure the camera is in a position where the field of view provides for effective recording.

3. If at any time BWC equipment is not functioning properly, the officer shall immediately notify his or her on-duty supervisor and dispatch. The on-duty supervisor shall immediately contact, via phone, the BWC System Administrator, or designee, as soon as reasonably possible, to coordinate the repair of the BWC equipment.

   a. An e-mail shall also be sent by the notified on-duty supervisor to the BWC System Administrator, or designee, documenting date and time taken out of service, the name of the officer the camera is assigned to, and the malfunction the BWC is experiencing.

B. Officer Responsibility

1. Officer safety and public safety take precedence over recording events. Officers shall follow existing officer safety policies when conducting enforcement stops as outlined in Department policies and procedures. The ability to record an event shall not take precedence over officer safety and the safety of the public, which shall be the primary consideration when contacting citizens or conducting vehicle stops.

2. BWCs shall be used to capture audio and visual evidence for investigations and enforcement encounters. Police reports are still required and are the appropriate place to document the incident.

3. All officers who are issued a BWC shall keep their BWC on Buffering Mode while on duty, except during instances listed in this procedure under Privacy and Restricted Use.

4. Officers shall use the Event Mode to record enforcement related contacts. The Event Mode should be activated while driving to a call that has the potential to

involve an enforcement contact and continue recording until the contact is concluded or the contact transitions from an enforcement contact into intelligence gathering. Enforcement related contacts include: calls for service, law enforcement action, subject stop, traffic stop, and/or police services, provided that such activation does not interfere with officer safety or public safety.

5. Every officer at a scene shall activate their BWC and leave it on for the duration of the incident. This shall include transporting to, and entering the holding facility.

6. Officers on scene at intoxication checkpoints are not required to activate their BWC while flagging vehicles into the checkpoint or during the screening process, however the officer may do so at their own discretion.

7. Once an officer directs a motorist into the holding area of an intoxication checkpoint for further investigation, the investigating officer shall then activate their BWC. Officers that are not actively involved in the investigation being conducted in the holding area are not required to have their BWC activated as part of that specific investigation.

8. Officers utilizing the SELECT button when recording to intentionally enable the mute function shall state the reason prior to muting their recording (i.e. Confer).

9. Officers shall note that a BWC recording was made in the continuation section of the incident report or motor vehicle accident report (i.e., video captured utilizing my issued AXON Body Worn Camera).

10. If an officer fails to activate the BWC, or fails to record the entire contact, or interrupts/mutes the recording the officer shall document the reason the event was not recorded in the continuation section of the incident report or motor vehicle accident report.

11. It shall be deemed a violation of this policy when an officer intentionally fails to activate the BWC when such use is appropriate in the proper performance of his/her official duties and is consistent with this policy and the law, or intentionally terminates a recording having no documented or recorded reason.

12. Officers working plain clothes assignments are exempt from this policy.

C. BWC System Administrator Responsibilities

1. Operations and administration of the system.

2. System Evaluation.

3. Training.

4. Policy and Procedure review and evaluation.

5. Ensure all BWC recordings are retained per this policy.

6. Serve as Custodian of Records and manage requests for video evidence per this policy including requests pursuant to Hawaii Revised Statutes, Chapter 92F, Uniform Information Practices Act (HRS Chapter 92F.)

7. Manage requests for the deletion of accidental activation recordings.

8. Conducts a monthly audit of selected BWC video.

D. Category

1. Officers utilizing BWCs shall identify each video by category. In the event a video is taken and has no apparent evidentiary or administrative value, the officer may leave the video as uncategorized.

2. Categories

a. Uncategorized

b. Abuse

c. Additional Information

d. All Other

e. Arrest

f. Assault

g. Assault – Felony

6.12 APPENDIX

h. Burglary

i. Civil Matter

j. Disorderly Conduct

k. OUI

l. Face Page

m. Felony

n. Field Contact

o. Follow-up

p. Critical Incident

q. Harassment

r. Homicide

s. MVA

t. No Enforcement

u. Pending Review

v. Personal Assistance

w. Robbery

x. Suicide

y. Terroristic Threatening

z. Terroristic Threatening – Felony

aa. Theft

bb. Theft - Felony

cc. Traffic

dd. UCPV

ee. UEMV

ff. Use of Force

E. Entering Metadata

Each recorded segment requires metadata be entered, even if the segments are of the same event. All officers are required to add metadata at the conclusion of the event. The only exception is for officer safety reasons, at which time metadata should be added as soon as possible. Officer safety incidents may include critical incidents, exigent circumstances, and/or pending calls for service.

1. At a minimum, the metadata for each video shall include:

   a. The report number. Absent a report number, a citation number, or incident number.
   b. The category that most accurately fits the recording.

2. The information may be entered using a Department work station, via the Axon View XL application.

F. Retention of Digital Evidence

1. All recordings related to any criminal proceeding, claim filed, pending litigation, or a personnel complaint shall be securely stored until that matter is resolved and/or in accordance with the records and retention schedules for the State of Hawaii and/or the Maui Police Department.

2. Officers may make requests for the redaction of portions of a recording (e.g. in the event of a personal recording, conversations with confidential informants, etc.) in writing. The Chief of Police, or designee, via the BWC System Administrator, shall approve or deny requests in accordance with records and retention schedules. All requests for redactions and the final decision shall be

kept on file by the BWC System Administrator.

G. Accessing Digital Evidence

1. Evidence.com automatically date/time stamps, and records each access by officer name.

2. Once uploaded to Evidence.com, officers may view their own BWC recording for:
   a. The purpose of completing a criminal investigation and preparing official reports.

   b. Prior to courtroom testimony or for courtroom presentation.

   c. Prior to providing a statement pursuant to an administrative inquiry/investigation, including officer involved shooting investigations.

3. All other Departmental personnel shall request access to BWC evidence via the BWC Administrator in writing. The request should indicate the reason for the request, the identification number, date, time, and recording officer name(s). The request should be submitted via e-mail or To/From.

4. As defined herein, BWC evidence is exempt from disclosure pursuant to HRS Chapter 92F, but may be disclosed by the Chief of Police at his/her discretion, except where disclosure is prohibited by law.

H. Critical Incidents

1. The on-scene supervisor shall turn off and secure the involved officer(s) BWC and deliver the BWC to the BWC System Administrator. The BWC System Administrator, or designee, will upload the digital recordings and properly label them in Evidence.com.

2. Officers may review their video ***prior to*** making their preliminary verbal statement and writing their preliminary report.

I. Schools

1. While on any public or private school property, officers and School Resource Officers (SROs) shall only activate the recording function of their BWC when the

officer or SRO is investigating suspected criminal activity or during other enforcement activities. Contacts that become adversarial in nature should also be recorded.

2. SROs and officers should not activate the recording function of their BWCs during meetings, conferences, presentations or other routine interactions involving students and school staff that are of an administrative nature.

3. Officers shall activate the recording function of their BWC if any interaction at a public or private school evolves into an enforcement related contact or investigation.

4. Officers shall utilize their BWC as otherwise described in this directive.

IX. RANDOM AUDIT PROCEDURES

A. The BWC System Administrator shall conduct a monthly audit of selected BWC video to assess the camera is being utilized according to this directive, and to identify any video that may benefit future training.

1. The list of BWC videos shall be selected randomly, with a minimum of one video selected from each district and watch.

2. The random audit shall be conducted on a monthly basis.

3. This audit does not preclude the BWC System Administrator from reviewing video during the course of his or her duties as needed.

4. The monthly audit shall be documented and submitted to the Quality Assurance Captain for review and comment. Any video that may be used for training purposes shall be forwarded to the Plans and Training Section for review.

JOHN PELLETIER
Chief of Police

6.12.17 MFD Policy: Fire Ground Communication E.O. 302.02

FIRE GROUND COMMUNICATION	E.O. 302.02

Effective Date	Total Pages	Version Number	Revision Date
7/1/2019	6	1	1/3/2019
9/1/2020	6	2	7/20/2020

PURPOSE: To establish standardized communication and provide guidance for fire ground reporting.

GUIDELINE:

I. INITIAL RADIO REPORT

The initial IC begins the command, control, and communication process with an Initial Radio Report (IRR). This report provides Dispatch and all other resources responding to the scene with a size-up of conditions visible from the initial command position, typically from the seat of the apparatus.

A. Clear the Alarm

Clearing the alarm ensures that the IRR is delivered on the right channel, lets other responding units know that you are about to deliver the IRR and assume command, and automatically activates Level 1 Staging for other responding resources.

1. Call Dispatch (e.g. “Dispatch from Engine 1.”) and wait for a response.

2. Clear the alarm and begin your IRR (e.g. “Engine 1 is on scene of a…”)

B. Building/Area Description

1. Size

- Small – A 150 ft. interior line can access 100% of the potential fire area.
- Medium – A 150 ft. interior line can access 75% of the potential fire area.
- Large – A 150 ft. interior line can access 50% of the potential fire area.
- Huge/Gigantic/Mega - A 150 ft. interior line can access less than 25% of the potential fire area.

2. Height

   - Number of stories
   - Number of sublevels

3. Occupancy Type

   - House
   - Apartment (stand alone or complex)
   - Commercial building
   - Strip mall
   - Restaurant
   - High-rise

C. Problem Description and Location

1. Nothing showing
2. Light smoke showing
3. Working fire
4. Defensive fire conditions

D. Initial Incident Action Plan (IAP)

1. The TASK(S) of the initial arriving unit
2. The LOCATION of the task(s)
3. The OBJECTIVES of the task(s)

E. Declare the Incident Strategy (see the Fire Ground Strategy SOG)

1. Offensive
2. Defensive

F. Resource Determination to Dispatch

1. Cancel the original assignment
2. Hold the original assignment
3. Upgrade the original assignment to a full alarm

E.O. 302.02

4. Upgrade with specific single resources

5. Strike additional alarms

G. Assume and Name Command

II. FOLLOW UP REPORT

A. The follow up report provides additional information to responding units that was not included in the IRR, usually obtained as a result of a 360.

B. Information to be included in a follow up report:

1. Any immediate safety concerns

a. Potential collapse area

b. Hazardous roof structure

c. Power lines down or arching

d. Gas meter/tank exposed to fire

e. Swimming pools

f. Heavy roof coverings (ceramic or clay tiles)

g. Basement/sublevels

h. Number of stories on Charlie side (if different from the IRR)

2. Revision of the IAP

a. Physical rescue not seen from the initial command position

b. Sub-level fires

c. Fire located in a different area not seen from the initial command position

3. Accountability location

a. The initial arriving unit will be the initial accountability location for that area.

b. The apparatus position (not the entry point) is used as the accountability location.

c. The accountability location is where later assigned units will drop off their tags

4. Tactical channel designation

III. ASSIGNING UNITS

A. Use TLO (task, location, objective) format to assign units.

B. Direct apparatus placement.

C. Direct which apparatus to pull hose lines from.

IV. COMMAND TRANSFERS

When a fast attacking IC transfers command to a subsequent arriving command officer, typically he/she is physically located in the hazard zone, so the transfer will take place using a portable radio. Command must be transferred in a standard manner, as follows:

A. Verify that all operating positions match the current incident conditions.

B. Announce arrival to scene.

C. Contact the current IC.

D. Confirm the position and function of all on-scene resources with the current IC.

E. Inform the current IC that you are taking command (e.g. “I’ll take it from out here”).

F. Inform Dispatch that you are taking command.

G. Announce to all units that you are assuming command (“Battalion Chief 2 will be assuming Market Street Command”).

H. Reevaluate and communicate the fire ground strategy.

I. Reevaluate the adequacy of on-scene and responding resources.

J. Announce the command post (CP) location.

E.O. 302.02

V. CAN REPORT

CAN reports should address the IC's assignment and the completion of the tactical priorities. Here is a basic list to choose from when providing a CAN report to command:

CONDITIONS	ACTIONS	NEEDS
What's burning	A/C progress	Reinforcement
Any obstacles	F/C progress	Relief
Smoke conditions	Can't find the fire	Support work
Fire conditions	Checking for extension	Tools or equipment
Heat conditions	PAR's	Cover other areas
Fire separation	All Clears	Urgent help
Fuel loads	Loss stopped	

VI. ROOF REPORT

Roof reports, communicated to command via radio from the company assigned to the roof, help to determine appropriate strategy, tactics and tasks.

A. The initial roof report should include the following:

1. Type of roof if not easily identified from the ground (peaked, flat, etc.)
2. Condition of roof (stable, unstable)
3. Fire or smoke conditions
4. Location of any firewalls
5. Unusual heavy roof loads (if present)
6. Conditions in the Attic (if known)
7. Basic blueprint of building if unusual
8. Action being taken

B. After venting the roof, the roof should communicate the following information.

1. Where you cut

2. The affect on the fire

3. Conditions in the attic space

4. Roof stability

VII. OFFENSIVE TO DEFENSIVE STRATEGIC SHIFT

The announcement of a change to a defensive strategy will be made as follows:

A. Announce "Emergency Traffic, Emergency Traffic"

B. Announce the following: **"All units, we are switching to a defensive strategy. EXIT/ABANDON the structure and report PARs upon exit."**

1. "EXIT the Structure" – Means an orderly retreat of personnel out of the hazard zone with interior lines and equipment being withdrawn and repositioned for defensive operations.

2. "ABANDON the Structure" – Means an emergency retreat of personnel with all interior lines and heavy equipment being left in place. All personnel in the hazard zone must exit the structure as quickly and safely as possible. Personnel Evacuation horn guidelines should be followed.

E.O. 302.02

6.13 Fatalities with Age, Sex, and Recovery Geolocation (Data Provided by MPD as per Table Subpoena 2024-045)

Table 6.13.1 Fatalities with age, sex, and recovery geolocation.

#	Name	Age	Gender	Home Address	Latitude of Recovery	Longitude of Recovery	Recovery Location
1	Abihai, Louise	97	F	8[redacted] Kelawea Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Home - Inside
2	Allen, Laurie	65	F	3[redacted] Pauwala Place, Lahaina, HI	N/A	N/A	Hospital (died due to injuries caused by the fire)
3	Anbe, June	78	F	8[redacted] Kelawea Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Home - Outside
4	Baclig, Angelica	31	F	8[redacted] Kopili Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Other Building or House - Inside
5	Baylosis, Narciso Jr.	67	M	7[redacted] Pauoa Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Outside
6	Baylosis, Vanessa	67	F	7[redacted] Pauoa Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Outside
7	Benjamin, Melva May	71	F	8[redacted] Kopili Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Vehicle - Inside
8	Bernabe, Luz	64	F	3[redacted] Hauola Place, Lahaina, HI	20.[redacted]	-156.[redacted]	Home - Inside
9	Buen, Maurice	79	M	10[redacted] Waine‘e Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Home - Outside
10	Carter, Buddy	85	M	2[redacted] Kamaka Circle, Lahaina, HI	20.[redacted]	-156.[redacted]	Home - Inside
11	Carter, Kirk	44	M	12[redacted] Nahale Place, Lahaina, HI	N/A	N/A	Hospital (died due to injuries caused by the fire)
12	Castillo, Ediomede	35	M	3[redacted] Keone Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Vehicle - Inside
13	Cole, Rex	64	M	6[redacted] Luakini Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Home - Outside
14	Coloma, Lydia	70	F	3[redacted] Hauola Place, Lahaina, HI	20.[redacted]	-156.[redacted]	Home - Inside
15	Coloma, Salvador	77	M	3[redacted] Hauola Place, Lahaina, HI	20.[redacted]	-156.[redacted]	Home - Inside
16	Constantino, Allen	25	M	9[redacted] Kuhua Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Home - Inside
17	Constantino, Leticia	56	F	9[redacted] Kuhua Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Home - Inside

6.13 APPENDIX

#	Name	Age	Gender	Home Address	Latitude of Recovery	Longitude of Recovery	Recovery Location
18	Cook, Theresa	72	F	6[redacted] Wharf Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Ocean/Seawall
19	Deleon, Juan	45	M	3[redacted] Keone Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Vehicle - Inside
20	Dias, Marilou	60	F	14[redacted] Komohana Place, Lahaina, HI	20.[redacted]	-156.[redacted]	Outside
21	Dofa, Virginia	90	F	8[redacted] Kelawea Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Home - Outside
22	Dyckman, Bette Jo	73	F	9[redacted] Puiki Place, Lahaina, HI	20.[redacted]	-156.[redacted]	Vehicle - Inside
23	Dyckman, Robert	74	M	9[redacted] Puiki Place, Lahaina, HI	20.[redacted]	-156.[redacted]	Vehicle - Inside
24	Eliason, Jeanne	57	F	5[redacted] Ka‘akolu Place, Lahaina, HI	20.[redacted]	-156.[redacted]	Other Building or House - Inside
25	Fuentes, Keyiro	14	M	8[redacted] Ka‘akepa Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Home - Inside
26	Galinato, Alfredo	79	M	9[redacted] Kopili Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Outside
27	Gloege, Douglas	59	M	3[redacted] Paeohi Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Outside
28	Gomes, Donna	71	F	3[redacted] Lahainaluna Road, Lahaina, HI	20.[redacted]	-156.[redacted]	Home - Outside
29	Gordon, Michael	68	M	6[redacted] Waine‘e Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Home - Inside
30	Hall III, George	67	M	8[redacted] Waine‘e Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Outside
31	Hartley, Carole	60	F	3[redacted] Hauola Place, Lahaina, HI	20.[redacted]	-156.[redacted]	Home - Inside
32	Heermance, Claudette	68	F	10[redacted] Waine‘e Street Lahaina, HI	N/A	N/A	Hospital (died due to injuries caused by the fire)
33	Ibara-Hinao, Roxanne	68	F	10[redacted] Waine‘e Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Home - Inside
34	Imperial, Rafael	63	M	8[redacted] Kopili Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Other Building or House - Inside
35	Jantoc, Buddy	78	M	8[redacted] Kelawea Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Home - Outside
36	Jones, Coleen	59	F	3[redacted] Lahainaluna Road, Lahaina, HI	20.[redacted]	-156.[redacted]	Home - Inside
37	Kaita, Morris	74	M	2[redacted] Panaewa Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Home - Inside

6.13 APPENDIX

#	Name	Age	Gender	Home Address	Latitude of Recovery	Longitude of Recovery	Recovery Location
38	Kam, Richard	88	M	Unknown	20.[redacted]	-156.[redacted]	Home - Inside
39	Kaminsky, Mark	59	M	10[redacted] Limahana Place, Lahaina, HI	20.[redacted]	-156.[redacted]	Outside
40	Kasprzycki, Paul	76	M	2[redacted] Wili Ko Place, Lahaina, HI	20.[redacted]	-156.[redacted]	Outside
41	Kauffman, Valerie	78	F	10[redacted] Waine‘e Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Home - Inside
42	Kitaguchi, Albert	62	M	1[redacted] Wahikuli Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Home - Inside
43	Lara, Joseph	86	M	7[redacted] Paunau Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Vehicle - Outside
44	Losano, Poomaikai	28	M	1[redacted] Ipu ‘Aumakua Lane, Lahaina, HI	20.[redacted]	-156.[redacted]	Other Building or House - Inside
45	Lutrania, Bibiana	58	F	___Mela Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Vehicle - Inside
46	Mabalot, Rogelio	68	M	9[redacted] N Laalo Place, Lahaina, HI	20.[redacted]	-156.[redacted]	Outside
47	Mahnensmith, Michael	80	M	2[redacted] Wili Ko Place, Lahaina, HI	20.[redacted]	-156.[redacted]	Home - Outside
48	Manibog, Lynn	74	F	3[redacted] Pauwala Place, Lahaina, HI	20.[redacted]	-156.[redacted]	Outside
49	Matsuda-Boucher, Douglas	65	M	6[redacted] Luakini Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Home - Outside
50	McCarthy, John Joseph III	74	M	2[redacted] Dickenson Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Home - Inside
51	Misaka, Michael	61	M	9[redacted] Puiki Place, Lahaina, HI	20.[redacted]	-156.[redacted]	Other Building or House - Inside
52	Molina, Antonia	63	F	7[redacted] Pauoa Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Home - Inside
53	Morinho, Michael	61	M	3[redacted] Hauola Place, Lahaina, HI	20.[redacted]	-156.[redacted]	Home - Inside
54	Nakamoto, Tim	69	M	8[redacted] Kaili Place, Lahaina, HI	20.[redacted]	-156.[redacted]	Home - Inside
55	Nakamura, Todd	61	M	4[redacted] Aki Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Outside
56	Nuesca, David Jr.	59	M	1[redacted] Malolo Place, Lahaina, HI	20.[redacted]	-156.[redacted]	Home - Inside
57	Ono, Carolyn	73	F	4[redacted] Pā‘ū‘ū Place, Lahaina, HI	20.[redacted]	-156.[redacted]	Outside

6.13 APPENDIX

#	Name	Age	Gender	Home Address	Latitude of Recovery	Longitude of Recovery	Recovery Location
58	Osato, Matsuyuki	83	M	8[redacted] Kuhua Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Home - Inside
59	Pagdilao, Pablo III	75	M	8[redacted] Kopili Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Outside
60	Ponali, Tau	66	F	6[redacted] Front Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Outside
61	Portabes, Bernard	75	M	4[redacted] Hauola Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Outside
62	Puou, Gwendolyn	83	F	8[redacted] Mela Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Outside
63	Quijano, Felimon	60	M	3[redacted] Hauola Place, Lahaina, HI	20.[redacted]	-156.[redacted]	Other Building or House - Inside
64	Quijano, Junmark	30	M	8[redacted] Kopili Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Other Building or House - Inside
65	Rabang, Sharlene	78	F	4[redacted] Alio Street, Lahaina, HI	N/A	N/A	Hospital (died due to injuries caused by the fire)
66	Rans, Rebecca	57	F	3[redacted] Paeohi Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Outside
67	Rawlings, Alfred	84	M	8[redacted] Kelawea Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Home - Inside
68	Recolizado, Eugene	50	M	3[redacted] Aki Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Other Building or House - Inside
69	Recolizado, Justin	11	M	3[redacted] Aki Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Other Building or House - Inside
70	Recolizado, Maria Victoria	51	F	3[redacted] Aki Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Other Building or House - Inside
71	Ritcher, Dale Ann	66	F	8[redacted] Kuhua Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Vehicle - Inside
72	Rocutan, Rodolfo	76	M	4[redacted] Pāʻūʻū Place, Lahaina, HI	20.[redacted]	-156.[redacted]	Outside
73	Rogo, Lee	76	M	5[redacted] Waineʻe Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Outside
74	Sagudang, Conchita	75	F	3[redacted] Pauwala Place, Lahaina, HI	20.[redacted]	-156.[redacted]	Outside
75	Sagudang, Danilo	55	M	3[redacted] Pauwala Place, Lahaina, HI	20.[redacted]	-156.[redacted]	Outside
76	Sato, Edward	76	M	8[redacted] Kopili Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Outside
77	Schilling, Joseph	67	M	8[redacted] Kelawea Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Outside

6.13 APPENDIX

#	Name	Age	Gender	Home Address	Latitude of Recovery	Longitude of Recovery	Recovery Location
78	Simpson, Anthony	43	M	3[redacted] Keone Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Other Building or House - Inside
79	Smith, James	79	M	7[redacted] Waine'e Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Ocean/Seawall
80	Smith, Leslie	80	F	3[redacted] Kamano Place, Lahaina, HI	20.[redacted]	-156.[redacted]	Home - Inside
81	Somaoang, Jonathan	76	M	7[redacted] Pupu Place, Lahaina, HI	20.[redacted]	-156.[redacted]	Outside
82	St. Clair, Floyd	75	M	9[redacted] Puiki Place, Lahaina, HI	20.[redacted]	-156.[redacted]	Vehicle - Inside
83	St. Clair, Janet	75	F	9[redacted] Puiki Place, Lahaina, HI	20.[redacted]	-156.[redacted]	Vehicle - Inside
84	Takafua, Tony	7	M	9[redacted] Kuhua Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Vehicle - Outside
85	Tam Lung, Freeman	80	M	7[redacted] Luakini Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Outside
86	Thomas, Terri	62	F	8[redacted] Kuhua Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Vehicle - Inside
87	Tobias, Carlo	54	M	14[redacted] Kahoma Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Home - Inside
88	Tomboc, Revelina	81	F	___Mela Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Vehicle - Inside
89	Tone, Fa'aoso	70	F	9[redacted] Kuhua Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Vehicle - Inside
90	Tone, Malui'fonua	73	M	9[redacted] Kuhua Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Vehicle - Inside
91	Tone, Salote (Takafua)	39	F	9[redacted] Kuhua Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Vehicle - Outside
92	Trejos, Franklin	68	M	Unknown - Lived with Geoff and Shannon Bogar	20.[redacted]	-156.[redacted]	Vehicle - Inside
93	Turbin, Nicholas	71	M	8[redacted] Puiki Place, Lahaina, HI	20.[redacted]	-156.[redacted]	Other Building or House - Inside
94	Vaikeli, Linda	69	F	10[redacted] Waine'e Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Home - Inside
95	Vasquez, Angelita	88	F	8[redacted] Kelawea Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Home - Inside
96	Villegas, Adela	53	F	8[redacted] Kopili Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Other Building or House - Inside

6.13 APPENDIX

#	Name	Age	Gender	Home Address	Latitude of Recovery	Longitude of Recovery	Recovery Location
97	Villegas, Joel	55	M	8[redacted] Kopili Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Outside
98	Wagner, Leroy	69	M	7[redacted] Paunau Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Home - Outside
99	Wakida, Clyde	74	M	2[redacted] Puapihi Place, Lahaina, HI	20.[redacted]	-156.[redacted]	Home - Inside
100	Yabes, Glenda	48	F	3[redacted] Hauola Place, Lahaina, HI	20.[redacted]	-156.[redacted]	Other Building or House - Inside
101	Yamafuji, Todd	68	M	6[redacted] Luakini Street, Lahaina, HI	20.[redacted]	-156.[redacted]	Vehicle - Inside
102	Yoshino, Glenn	75	M	3[redacted] Pauwala Place, Lahaina, HI	20.[redacted]	-156.[redacted]	Outside

7.0 Glossary

Term	Definition
1015	Firefighter Mayday signal
AVL Timepoints	A moment in time when an event or measurement takes place
Burnover	An event in which a fire moves through a location or overtakes personnel or equipment where there is no opportunity to utilize escape routes and safety zones
Central	911 Center
Contraflow	A traffic management system that involves directing traffic in one or more lanes to travel in the opposite direction to normal flow
Department Operations Center (DOC)	Location used by the Department as a coordination point for agency resources and facilities during major incidents and planned events.
Ember	A small piece of burning or glowing coal or wood
Ember wash	Airborne and ground traveling embers
Egress	Path of travel or means of exiting
El Niño	Long-term weather events that greatly exacerbate dry/wet season patterns, often increasing rainfall at the start of the event followed by severe, region-wide drought
Formal Briefings	Where all agency representatives gather during regular intervals to report priority information regarding the incident
Gated wye	A type of firefighting hose valve with gateable valves on each outlet, which gives the firefighter maximum control over the water flow
Handline	A firefighting hose that is operated and maneuvered by firefighters (usually a 1 ¾” in diameter)
Headloss	The pressure, or energy lost by water flowing in a pipe or channel as a result of turbulence caused by the velocity of the flowing water and the roughness of the pipe
Hoʻoilo	Native Hawaiian for winter season
Kau	Native Hawaiian for summer season
Kauaʻula winds	A strong wind from the mountains, occasioned by the breaking over of the trade winds; often destructive at Lahaina
Kuʻialua fire	See “Lahaina PM fire” in the glossary
Lahaina AM fire	Fire that occurred in Lahaina August 8, 2023, between 06:34 and 14:17 HST
Lahaina PM fire	Fire that occurred in Lahaina on August 8-9, 2023, between 14:55 and 06:00 HST. Also referred to as the Kuʻialua fire in some dispatch reports
Makai	Directional queue meaning “toward the ocean”
Maui Nui	The islands that make up Maui County: Maui, Molokaʻi, Lānaʻi, and Kahoʻolawe (and the islet of Molokini)
Mauka	Directional queue meaning “toward the mountain”

7.0 GLOSSARY

Term	Definition
Med Comm	Emergency medical services for American Medical Response
Orographic Effect	Also known as the “rain shadow” effect, this term refers to the drier southern and western sides of Maui caused by the mountain shielding of those leeward sides
Red Flag Warning	Used to warn of an impending or occurring Red Flag event. Its issuance denotes a high degree of confidence that weather and fuel conditions consistent with Red Flag event criteria are occurring or will occur in 48 hours or less
Relief Apparatus	Older apparatus that were no longer front line
Systems Approach	A holistic and interdisciplinary method for understanding and solving complex problems
Upstaff	Increase staffing in anticipation of increased call volumes
Urban Conflagration	A large, destructive fire that spreads rapidly through a community, often beyond natural or artificial barriers
Utility Expert	Someone who has advanced electrical detection and management tools
Utility Vehicles	Typically standard pickup trucks - no water tank or pump - used to transport personnel into the operational area
WebEOC	Portal for resource tracking and incident communication that is maintained/monitored by HI-EMA and available to all county-level emergency management agencies across the State of Hawai‘i
Wildland-Urban Interface	The wildland–urban interface is a zone of transition between wilderness and land developed by human activity–an area where a built environment meets or intermingles with a natural environment

8.0 Acronyms and Abbreviations

Acronym	Meaning
AAR	After Action Report/Review
ADU	Accessory Dwelling Units
AG	Hawai‘i Attorney General
AI	Artificial Intelligence
ALS	Advanced Life Support
AMR	American Medical Response
ARFF	Aircraft Rescue and Firefighting
ASOS	Automated Surface Observation System
ATF	United States Bureau of Alcohol, Tobacco, Firearms, and Explosives
AVL	Automatic Vehicle Locator/Location
AWWA	American Water Works Association
BC	Battalion Chief
BWC	Body-Worn Camera
CAD	Computer Aided Design
CAP	Civil Air Patrol
CAT	Crisis Action Team
CBA	Collective Bargaining Agreement
CERT	Community Emergency Response Team
CFR	Code of Federal Regulations
CGSB	Coast Guard Honolulu Small Boat
CMF	Continuous Microfiltration
CONUS	Continental United States
COOP	Continuity of Operations
COP	Common Operating Picture
CPR	Cardiopulmonary Resuscitation
CRA	Community Risk Assessment
CRR	Community Risk Reduction
CWPP	Community Wildfire Protection Plan
CWS	Community Water Systems

8.0 ACRONYMS AND ABBREVIATIONS

Acronym	Meaning
DLNR	Department of Land and Natural Resources
DOAG	Hawai‘i Department of the Attorney General
DOC	Department Operations Center
DOFAW	Hawai‘i Division of Forestry and Wildlife
DOI	United States Department of Interior
DPW	County of Maui Department of Public Works
EAP	Employee Assistance Programs
EAS	Emergency Alert System
EMC	Emergency Management Center
EMS	Emergency Medical Services
EMT	Emergency Medical Technician
EO	Emergency Operations
E.O.	Executive Order
EOC	Maui County Emergency Operations Center
EOP	Emergency Operations Plan
EPA	United States Environmental Protection Agency
ERT	Emergency Response Teams
EVOC	Emergency Vehicle Operations Course
FD	Fire Department
FEMA	Federal Emergency Management Agency
FS	Fire Station
FMAG	Fire Management Assistance Grant
FPS	Feet per Second
FRSI	Fire Safety Research Institute
GRM	Gallons per Minute
G.O.	General Order
GPS	Global Positioning System
HAWAS	Hawai‘i Warning System
HC&S	Hawaiian Commercial & Sugar Company

8.0 ACRONYMS AND ABBREVIATIONS

Acronym	Meaning
HDOT	Hawai'i Department of Transportation
HECO	Hawaiian Electric Company
HFO	Honolulu Field Office, National Weather Service
HI-EMA	Hawai'i Emergency Management Agency
HANG	Hawai'i Air National Guard
HIARNG	Hawai'i Army National Guard
HIG	Hawai'i Institute for Geophysics
HING	Hawai'i National Guard
HWMO	Hawai'i Wildfire Management Organization
IBC	International Building Code©
ICC	International Code Council
IAP	Incident Action Plans
ICP	Incident Command Post
ICS	Incident Command System
IDLH	Immediately Dangerous to Life and Health
IMS	Incident Management System
IMT	Incident Management Team, HI-EMA
IPAWS	Integrated Public Alert and Warning System
IRC	International Residential Code©
IRPG	Incident Response Pocket Guide
IWI	Incident Within an Incident
JFSP	Joint Fire Science Program
KBDI	Keetch-Byram Drought Index
LMR	Land Mobile Radio
LG	Lieutenant Governor
LPG	Liquid Propane Gas
MCC	Maui Corporation Counsel
MDD	Major Disaster Declaration
MECO	Hawaiian Electric (slang)

8.0 ACRONYMS AND ABBREVIATIONS

Acronym	Meaning
MEMA	Maui Emergency Management Agency
MFD	County of Maui Fire and Public Safety, aka Maui Fire Department
MG	Major General
MG	Million Gallons
MGD	Million Gallons per Day
MDP	Maui Police Department
NACTO	National Association of City Transportation Officials
NCEI	National Centers for Environmental Information
NFIRS	National Fire Incident Reporting System
NFPA	National Fire Protection Association
NIMS	National Incident Management System
NOAA	National Oceanic and Atmospheric Administration
NRT	National Response Team
NWCG	National Wildfire Coordinating Group
NWS	United States National Weather Service
OSHA	Occupational Safety and Health Administration
PA	Public Address
PAR	Personnel Accountability Report
PDC	Pacific Disaster Center
PFX	Pacific Fire Exchange
PHNL	Honolulu International Airport
PIO	Public Information Officer
POTS	Plain Old Telephone System
PPE	Personal Protective Equipment
PSI	Pounds per Square Inch
PSPS	Public Safety Power Shutoffs
POV	Privately-Owned Vehicle
PUC	Hawai‘i Public Utilities Commision
PV	Photovoltaic

8.0 ACRONYMS AND ABBREVIATIONS

Acronym	Meaning
RAWS	Remote Automatic Weather Stations
RBM	Response Boat - Medium
RFA	Request for Assistance
RFI	Requests for Information
RH	Relative Humidity
SAAO	State Aviation Action Officer
SAR	Search and Rescue
SCBA	Self-Contained Breathing Apparatus
SDWA	Safe Drinking Water Act
SEOC	State Emergency Operations Center
SITREP	Situation Report
SOC	Standards of Cover
SOP	Standard Operating Procedure
SRV	Special Response Paramedic Unit
SWP	State Warning Point
TAG	The Adjutant General
TD	Technical Discussions
UHM-CTAHR	University of Hawai‘i at Mānoa College of Tropical Agricultural and Human Resources
UL	Underwriters Laboratories
ULRI	UL Research Institutes
USAR	Urban Search and Rescue
USCG	United States Coast Guard
USDA	United States Department of Agriculture
VoIP	Voice over Internet Protocol
VTC	Video Teleconference
WAS	Weather Alert System
WEA	Wireless Emergency Alert
WebEOC	Data management system used to manage EOC staffing and operations
WUI	Wildland-Urban Interface

SOURCES

1. Forests and Rangelands. “The National Cohesive Wildland Fire Management Strategy,” 2014. https://www.forestsandrangelands.gov/strategy/thestrategy.shtml#:~:text=The%20National%20Cohesive%20Wildland%20Fire%20Management%20Strategy%20is%20a%20strategic,Safe%20and%20Effective%20Wildfire%20Response.

2. Hawai‘i Wildfire Management Organization. “Understanding the Wildfire Management System.” hawaiiwildfire.org. Accessed July 15, 2024. https://static1.squarespace.com/static/660b500392aae13704d0e302/t/66860ffe991bb54becab9e27/1720061957587/Understanding+Wildfire+Management+System_Graphics.pdf.

3. “Western Maui Community Wildfire Protection Plan.” Department of Land and Natural Resources. Hawai‘i Wildfire Management Organization, 2014. https://dlnr.hawaii.gov/forestry/files/2024/01/Western-Maui-CWPP.pdf.

4. “South Maui Community Wildfire Protection Plan.” Department of Land and Natural Resources. Hawai‘i Wildfire Management Organization, 2016. https://dlnr.hawaii.gov/forestry/files/2018/04/2016_SouthMauiCWPP_HWMO.pdf.

5. “Leeward Haleakalā Community Wildfire Protection Plan.” Department of Land and Natural Resources. Hawai‘i Wildfire Management Organization, 2020. https://dlnr.hawaii.gov/forestry/files/2023/10/LH-CWPP-2020_FINAL-w-appendices-compressed.pdf.

6. Alkonis, Derek, and Steve Kerber. “Lahaina Fire Comprehensive Timeline Report.” Fire Safety Research Institute, April 2024. https://d1gi3fvbl0xj2a.cloudfront.net/2024-04/FSRI_Lahaina_Fire-Comprehensive_Timeline_Report_04_17_2024_Redacted_Final_0.pdf.

7. Wildland Fire Leadership Council. “National Cohesive Wildland Fire Management Strategy Addendum Update.” Forests and Rangelands. Wildland Fire Leadership Council, January 2023. https://forestsandrangelands.gov/documents/strategy/natl-cohesive-wildland-fire-mgmt-strategy-addendum-update-2023.pdf.

8. “Wildfire Risk to Communities,” n.d. https://wildfirerisk.org/explore/overview/15/.

9. “Wildfire Risk to Communities,” n.d. https://wildfirerisk.org/explore/overview/15/15009/1500042950/.

10. Big Island Video News. “Fire Update: Mauna Kea Resort Evacuations, Other Orders Lifted,” August 8, 2023. https://www.bigislandvideonews.com/2023/08/08/fire-update-mauna-kea-resort-evacuations-other-orders-lifted/.

11. As reported in the Washington Post, Maui’s neglected grasslands caused Lahaina fire to grow with deadly speed. Piper, Imogen, Joyce Lee, Elahe Izadi, and Brianna Sacks. “Maui’s neglected grasslands caused Lahaina fire to grow with deadly speed.” Washington Post, September 2, 2023. https://www.washingtonpost.com/investigations/interactive/2023/lahaina-wildfires-invasive-grass-destruction/.

12. SILVIS LAB. “The Global Wildland-Urban Interface (WUI) – 2020.” Accessed July 15, 2024. https://silvis.forest.wisc.edu/globalwui/.

13. SILVIS LAB. “Global WUI Hotspots,” n.d. https://geoserver.silvis.forest.wisc.edu/geodata/fast/globalwui/.

14. Big Island Video News, “Hawai‘i Fire Update: Two New Blazes Ignite in Ka‘ū, as Threat to Kohala Continues,” August 10, 2023. https://www.bigislandvideonews.com/2023/08/09/hawai%CA%BBi-fire-update-two-new-blazes-ignite-in-ka%CA%BBu-as-threat-to-kohala-continues/.

15. The Garden Island, “Multiple Fires Continue to Burn on Big Island Coastline,” August 10, 2023. https://www.thegardenisland.com/2023/08/09/hawaii-news/update-multiple-fires-continue-to-burn-on-south-kohala-coastline-unprecedented-disaster-on-maui/.

16. Alison D. Nugent et al., “Fire and Rain: The Legacy of Hurricane Lane in Hawai‘i,” East-West Center, August 5, 2020, https://www.eastwestcenter.org/news/east-west-wire/fire-and-rain-the-legacy-hurricane-lane-in-hawai%CA%BBi.

17. “Keauhou Ranch Fire - Hawai‘i Volcanoes National Park (U.S. National Park Service).” Accessed July 15, 2024. https://www.nps.gov/havo/keauhou-ranch-fire.htm#:~:text=The%20Keauhou%20Ranch%20Fire%20started,miles%20north%20of%20Highway%2011.

18. Clay Trauernicht et al., “The Contemporary Scale and Context of Wildfire in Hawai‘i,” Pacific Science, 69(4):427-444. (University of Hawai‘i Press, October 2015), https://gms.ctahr.hawaii.edu/gs/handler/getmedia.ashx?moid=6556&dt=3&g=12.

19. Hawai‘i Wildfire Management Organization. “Wildfire & Drought LOOKOUT! — Protecting Hawai‘i: Uniting Against Wildfire Threats.” Accessed July 15, 2024. https://www.hwmo.org/lookout.

20. Thomas Heaton. “Hawai‘i Has Long Shortchanged Wildfire Protection: ‘We Could Have Saved Lives’” Honolulu Civil Beat, August 20, 2023. https://www.civilbeat.org/2023/08/hawaii-has-long-shortchanged-wildfire-protection-we-could-have-saved-lives/.

21. Hawai‘i Wildfire Management Organization. “Wildfire Plans and Maps — Community Wildfire Protection Plans.” Accessed July 15, 2024. https://www.hwmo.org/wildfire-plans#CommunityWildfireProtectionPlan.

22. Department of Land and Natural Resources, Division of Forestry and Wildlife. “Hawai‘i Forest Action Plan.” Department of Land and Natural Resources, 2016. https://dlnr.hawaii.gov/forestry/info/fap/#:~:text=The%20plan%20identifies%20nine%20priority,%2Dbased%20recreation%2C%20and%20tourism%3B.

SOURCES

23. Thomas Heaton. “Hawai‘i Has Long Shortchanged Wildfire Protection: ‘We Could Have Saved Lives’” Honolulu Civil Beat, August 20, 2023. https://www.civilbeat.org/2023/08/hawaii-has-long-shortchanged-wildfire-protection-we-could-have-saved-lives/.

24. “Wildfire in Hawai‘i: Reflections & Future Directions.” Hawai’i Wildfire Management Organization, 2023. https://static1.squarespace.com/static/660b500392aae13704d0e302/t/6690553cafc73c2c2ab03577/1720735049526/2023+Reflections+Summary+Report_7.11.24_compressed.pdf.

25. “State of Hawai‘i Program Memoranda.” Hawai‘i Legislative Reference Bureau Library Catalog. Department of Budget and Finance, Program Planning and Management Division, January 2007. https://library.lrb.hawaii.gov/cgi-bin/koha/opac-retrieve-file.pl?id=1a0140bc17780346a385e478583299a7.

26. “State of Hawai‘i Program Memoranda.” Hawai‘i Legislative Reference Bureau Library Catalog. Department of Budget and Finance, Budget Program Planning and Management Division, January 2023. https://library.lrb.hawaii.gov/cgi-bin/koha/opac-retrieve-file.pl?id=c4585e603ba2ac2f2f961c4484acc776.

27. “Western Maui Community Wildfire Protection Plan.” Department of Land and Natural Resources. Hawai‘i Wildfire Management Organization, 2014. https://dlnr.hawaii.gov/forestry/files/2024/01/Western-Maui-CWPP.pdf.

28. “A Collaborative, Landscape-Level Approach to Reduce Wildfire Hazard Across Hawai‘i: 2018-19 Vegetation Management Rapid Mapping Assessment and Collaborative Action Planning.” Hawai‘i Wildfire Management Organization, 2019. https://static1.squarespace.com/static/5254fbe2e4b04bbc53b57821/t/5dc678007cdf127e9982c0ef/1573287946858/Maui_compressed.pdf.

29. “Report on Wildfire Prevention and Cost Recovery on Maui.” Maui County. County of Maui Cost of Government Commission, July 2021. https://www.mauicounty.gov/DocumentCenter/View/129493/Report-on-Wildfire-Prevention--Cost-Recovery-on-Maui---Part-1-Report--Exhibits-A-B-33-MB.

30. Thomas Heaton. “Hawai‘i Has Long Shortchanged Wildfire Protection: ‘We Could Have Saved Lives’” Honolulu Civil Beat, August 20, 2023. https://www.civilbeat.org/2023/08/hawaii-has-long-shortchanged-wildfire-protection-we-could-have-saved-lives/.

31. Summary of project presented by Hawai‘i Wildfire Management Organization at Hawai‘i Fire Chiefs Association 44th Annual Training & Business Meeting.

32. Pickett, Elizabeth. “Wildfire in Hawai‘i: Reflecting Back, Making Sense of Our New Chapter, and Looking Ahead.” Hawai‘i Wildfire Management Organization, 2023. https://drive.google.com/file/d/168Z8AOt2GnRTD27r_8BxNIV_5WuBdWi6/view.

33. “CWPP State Coverage Map.” Hawai‘i Wildfire Management Organization, April 19, 2024. https://www.hwmo.org/resource-library/cwpp-state-coverage-map.

34. Thomas Heaton. “Hawai‘i Has Long Shortchanged Wildfire Protection: ‘We Could Have Saved Lives’” Honolulu Civil Beat, August 20, 2023. https://www.civilbeat.org/2023/08/hawaii-has-long-shortchanged-wildfire-protection-we-could-have-saved-lives/.

35. “Hawai‘i Wildfire Management Organization Application for Grants.” State of Hawai‘i State Procurement Office, 2024. https://www.capitol.hawaii.gov/sessions/session2024/2024GIA-Apps/Hawaii%20Wildfire%20Management%20Organization_1041373_OP_Redacted.pdf.

36. Department of Land and Natural Resources, Division of Forestry and Wildlife. “Risk Reduction Grant Programs.” Accessed July 15, 2024. https://dlnr.hawaii.gov/forestry/fire/wildland-urban-interface-grants/.

37. “The Pacific Fire Exchange.” Accessed July 15, 2024. https://pacificfireexchange.org/.

38. Clay Trauernicht et al., “The Contemporary Scale and Context of Wildfire in Hawai‘i,” Pacific Science, 69(4):427-444. (University of Hawai’i Press, October 2015), https://gms.ctahr.hawaii.edu/gs/handler/getmedia.ashx?moid=6556&dt=3&g=12.

39. Cram, Douglas et al., “Fire and Drought in Paradise-Say It Isn’t So, Smokey.” University of Hawai’i. Rural Connections. Accessed July 15, 2024. https://www.hawaii.edu/climate-data-portal/wp-content/uploads/2021/05/Cram_etal._2013_Fire-and-drought-in-paradise.pdf.

40. Clay Trauernicht et al., “The Contemporary Scale and Context of Wildfire in Hawai‘i,” Pacific Science, 69(4):427-444. (University of Hawai’i Press, October 2015), https://gms.ctahr.hawaii.edu/gs/handler/getmedia.ashx?moid=6556&dt=3&g=12.

41. Cram, Douglas et al., “Fire and Drought in Paradise-Say It Isn’t So, Smokey.” University of Hawai’i. Rural Connections. Accessed July 15, 2024. https://www.hawaii.edu/climate-data-portal/wp-content/uploads/2021/05/Cram_etal._2013_Fire-and-drought-in-paradise.pdf.

42. National Interagency Coordination Center. “Intelligence.” Accessed July 15, 2024. https://www.nifc.gov/nicc/predictive-services/intelligence.

43. “Wildland Fire Summary and Statistics Annual Report.” National Interagency Coordination Center, 2013, 64. https://www.nifc.gov/sites/default/files/NICC/2-Predictive%20Services/Intelligence/Annual%20Reports/2013/Annual_Report_2013_508.pdf.

44. “Wildland Fire Summary and Statistics Annual Report.” National Interagency Coordination Center, 2013, 60. https://www.nifc.gov/sites/default/files/NICC/2-Predictive%20Services/Intelligence/Annual%20Reports/2013/Annual_Report_2013_508.pdf.

SOURCES

45. “Wildland Fire Summary and Statistics Annual Report.” National Interagency Coordination Center, 2013, 62. https://www.nifc.gov/sites/default/files/NICC/2-Predictive%20Services/Intelligence/Annual%20Reports/2013/Annual_Report_2013_508.pdf.

46. The Pacific Fire Exchange. “Hawai‘i Island Wildfires 2004-2020.” Accessed July 15, 2024. https://pacificfireexchange.org/wp-content/uploads/2024/01/Hawaii.Island.Wildfires-2004-2020.jpg.

47. “Module 2: Principles of Wildland Fire Behavior.” National Wildfire Coordinating Group, n.d., 16. https://training.nwcg.gov/classes/S190/508Files/071231_s190_m2_508.pdf.

48. Chris Sugidono, “HC&S Shutdown Adds Urgency to Wildfire Training,” Maui News, April 20, 2017, https://www.mauinews.com/news/local-news/2017/04/hcs-shutdown-adds-urgency-to-wildfire-training/.

49. A law passed during the 2024 legislative session establishes an Office of the State Fire Marshal. “Bill SB2085 SD2 HD1 CD1.” State of Hawai‘i, July 2024. https://www.capitol.hawaii.gov/sessions/session2024/bills/GM1310_.pdf.

50. “Hawai‘i Revised Statute § 132-16,” 2024. https://casetext.com/statute/hawaii-revised-statutes/division-1-government/title-10-public-safety-and-internal-security/chapter-132-fire-protection/section-132-16-state-fire-council-composition-functions.

51. Team Rubicon. “Resilient Hawai’i: One Year After the Maui Wildfire | Team Rubicon,” August 8, 2024. https://www.youtube.com/watch?v=8HEFVSpuni4.

52. Hawai’i Wildfire Management Organization. “Wildfire Plans and Maps,” n.d. https://www.hwmo.org/wildfire-plans.

53. “Community Risk Reduction Program for Wildland Urban Interface.” Maui Fire Department. Accessed July 15, 2024. https://www.mauicounty.gov/DocumentCenter/View/142946/-Maui-County-Wildland-Urban-Interface-WUI-Program.

54. Hawai‘i County Civil Defense Agency. “Wildfire.” Accessed July 15, 2024. https://hawaii-county-civil-defense-agency-hawaiicountygis.hub.arcgis.com/pages/wildfire.

55. Honolulu Fire Department. “Wildland Fire Preparedness.” Accessed July 15, 2024. https://fire.honolulu.gov/fire-and-life-safety/wildland-fire-preparedness/.

56. County of Kaua’i. “Kauai Fire Department Wildfire Prevention Video.” Accessed August 15, 2024. https://www.kauai.gov/Government/Departments-Agencies/Fire-Department.

57. Department of Land and Natural Resources, Division of Forestry and Wildlife. “Fire Management.” Accessed August 15, 2024. https://dlnr.hawaii.gov/forestry/fire/.

58. Hawai‘i Wildfire Management Organization. “2014 Western Maui Community Wildfire Protection Plan,” 2014. https://www.hwmo.org/resource-library/western-maui-cwpp-2014.

59. Hawai‘i Wildfire Management Organization. “2016 South Maui Community Wildfire Protection Plan,” 2016. https://www.hwmo.org/resource-library/south-maui-cwpp-2016.

60. Hawai‘i Wildfire Management Organization. “2016 Upcountry Maui Community Wildfire Protection Plan,” 2016. https://www.hwmo.org/resource-library/upcountry-maui-cwpp-2016.

61. Hawai‘i Wildfire Management Organization. “2016 Molokai Community Wildfire Protection Plan,” 2016. https://www.hwmo.org/resource-library/molokai-cwpp-2016.

62. Hawai‘i Wildfire Management Organization. “2020 Leeward Haleakalā, Maui Community Wildfire Protection Plan,” 2020. https://www.hwmo.org/resource-library/leeward-haleakala-cwpp-2020.

63. Pickett, Elizabeth, and Ilene Grossman. “Wahikuli-Honokōwai Wildfire Mitigation Plan.” Hawai‘i Wildfire Management Organization, 2014. https://drive.google.com/file/d/1-ZuCHVahkcN7o-TA-PWAiKmFc0-rl-JA/view.

64. Hawai‘i Wildfire Management Organization. “Empowering Communities: Join the Firewise USA® Movement in Hawai‘i.” Accessed August 20, 2024. https://www.hwmo.org/articles/firewise-program.

65. Hawai‘i Wildfire Management Organization. “Ready, Set, Go! Wildfire Preparedness Guide.” Accessed August 20, 2024. https://www.hwmo.org/get-prepared-materials.

66. Hawai‘i Wildfire Management Organization. “Ready, Set, Go! Wildfire Preparedness Guide.” Accessed August 20, 2024. https://www.hwmo.org/get-prepared-materials.

67. Lahaina News. “Wildfire LOOKOUT! Campaign Raises Awareness About the Threat of Fires,” August 25, 2018. https://www.lahainanews.com/news/local-news/2018/08/30/wildfire-lookout-campaign-raises-awareness-about-the-threat-of-fires/.

SOURCES

68. “A Collaborative, Landscape-Level Approach to Reduce Wildfire Hazard Across Hawai‘i: 2018-19 Vegetation Management Rapid Mapping Assessment and Collaborative Action Planning.” Hawai‘i Wildfire Management Organization, 2019. https://static1.squarespace.com/static/5254fbe2e4b04bbc53b57821/t/5dc678007cdf127e9982c0ef/1573287946858/Maui_compressed.pdf.

69. “Report on Wildfire Prevention and Cost Recovery on Maui.” Maui County. County of Maui Cost of Government Commission, July 2021. https://www.mauicounty.gov/DocumentCenter/View/129493/Report-on-Wildfire-Prevention--Cost-Recovery-on-Maui---Part-1-Report--Exhibits-A-B-33-MB.

70. “The Pacific Fire Exchange,” n.d. https://pacificfireexchange.org/.

71. Beven II, John L., and Derek Wroe. “Hurricane Lane.” National Hurricane Center, December 16, 2019. https://www.nhc.noaa.gov/data/tcr/EP142018_Lane.pdf.

72. Hawai‘i News Now. “Retired MFD Commander Who Took Charge in 2018 Wildfire Looks at Parallels With Lahaina Fire,” October 12, 2023. https://www.youtube.com/watch?v=W339zxAQGa0.

73. “After Action Report & Improvement Plan for 2018-08-18 Tropical Cyclone Lane.” County of Maui Emergency Management Agency, August 2019. https://d1gi3fvbl0xj2a.cloudfront.net/2024-07/After%20Action%20Report%20&%20Improvement%20Plan%20%20%20for%20%202018-08-18%20Tropical%20Cyclone%20Lane.pdf.

74. “ICS Form 209, Incident Status Summary.” FEMA. Accessed August 16, 2024. https://training.fema.gov/emiweb/is/icsresource/assets/ics%20forms/ics%20form%20209.%20incident%20status%20summary%20(v3).pdf.

75. RAWS USA Climate Archive. “Kohala Ranch Hawai‘i RAWS.” Accessed July 16, 2024. https://raws.dri.edu/cgi-bin/rawMAIN.pl?hiHKOH.

76. RAWS USA Climate Archive. “Kohala Ranch Hawai‘i RAWS.” Accessed July 16, 2024. https://raws.dri.edu/cgi-bin/rawMAIN.pl?hiHKOH.

77. National Weather Service. “Hawaiian Fire Weather Products.” Accessed July 16, 2024. https://www.weather.gov/hfo/firewx., and “Fire Weather Operations Plan.” Accessed July 16, 2024. https://www.weather.gov/media/hfo/Firewxops.doc.

78. Dolling, Klaus et al., “Natural Variability of the Keetch–Byram Drought Index in the Hawaiian Islands.” International Journal of Wildland Fire, 2009. https://www.soest.hawaii.edu/MET/Hsco/Paper/Natural%20variability%20of%20the%20KeetchByram%20Drought%20Index.pdf., and Dolling, Klaus et al., “A Climatological Study of the Keetch/Byram Drought Index and Fire Activity in the Hawaiian Islands.” Agricultural and Forest Meteorology, 2005. https://www.soest.hawaii.edu/MET/Hsco/Paper/40.pdf., and Chu, Pao-Shin et al.,“Fire-Climate Relationships and Long-Lead Seasonal Wildfire Prediction for Hawai‘i.” International Journal of Wildland Fire, 2002. https://www.soest.hawaii.edu/MET/Hsco/Paper/33.pdf.

79. NOAA. “National Weather Service Oxnard/Los Angeles Historical Red Flag Warning Web Map.” Accessed August 22, 2024. https://noaa.maps.arcgis.com/apps/mapviewer/index.html?webmap=5ecd80a75f404c53bc930ace6297417c.

80. NOAA. “Storm Events Database.” Accessed August 22, 2024. https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28Z%29+High+Wind&beginDate_mm=08&beginDate_dd=01&beginDate_yyyy=2023&endDate_mm=08&endDate_dd=31&endDate_yyyy=2023&county=ALL&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=15%2CHAWAII.

81. NOAA. “Storm Events Database.” Accessed August 22, 2024. https://www.ncdc.noaa.gov/stormevents/listevents.jsp?eventType=%28Z%29+High+Wind&beginDate_mm=08&beginDate_dd=01&beginDate_yyyy=2023&endDate_mm=08&endDate_dd=31&endDate_yyyy=2023&county=ALL&hailfilter=0.00&tornfilter=0&windfilter=000&sort=DT&submitbutton=Search&statefips=15%2CHAWAII.

82. NOAA. “Beaufort Wind Scale.” Accessed August 22, 2024. https://www.weather.gov/mfl/beaufort.

83. Due to the scope of this report, which is primarily focused on the August 2023 wildfires in Maui, how emergency fire managers on other islands responded to this information is unknown.

84. “California Fire Weather Annual Operating Plan.” California Wildfire Coordinating Group, 2024. https://gacc.nifc.gov/oscc/predictive/weather/AOP.pdf.

85. Trauernicht, Clay, and Melissa Kunz. “Fuel Breaks and Fuels-Management Strategies for Pacific Island Grasslands and Savannas.” Forestry and Natural Resources Management. College of Tropical Agriculture and Human Resources, University of Hawai‘i of Mānoa, December 2019. https://www.ctahr.hawaii.edu/oc/freepubs/pdf/RM-22.pdf.

86. “Allfirezone.” Accessed July 18, 2024. https://www.arcgis.com/sharing/rest/content/items/66a59db4bc31459298b28a94564de533/info/metadata/metadata.xml?format=default&output=html.

87. “The Operating and Capital Budget - Statewide Summaries.” State of Hawai‘i Department of Budget and Finance, 2024. https://budget.hawaii.gov/wp-content/uploads/2022/12/06.-The-Operating-and-Capital-Budget-Statewide-Summaries-FB23-25-PFP.Pk0_.pdf.

SOURCES

88. Hawai‘i State Legislature. “Relating to Fire Prevention.” Accessed August 24, 2024. https://www.capitol.hawaii.gov/session/measure_indiv.aspx?billtype=SB&billnumber=409&year=2024.

89. “Hawaiian Electric Wildfire Mitigation Plan.” Hawaiian Electric, January 2023, 5. https://www.hawaiianelectric.com/documents/about_us/our_vision_and_commitment/resilience/20230101_wildfire_mitigation_plan.pdf.

90. Municode - Maui County Code of Ordinances. “Title 14 - Public Services,” August 9, 2024. https://library.municode.com/hi/county_of_maui/codes/code_of_ordinances?nodeId=TIT14PUSE.

91. “Repeal of State of Hawai‘i, Public Utilities Commission, Rules for Overhead Electric Lines Construction in State of Hawai‘i General Order No. 6.” State of Hawai‘i Department of Budget and Finance, March 8, 2007. https://puc.hawaii.gov/wp-content/uploads/2013/04/Chapter-6-73.pdf.

92. “Standards for Electric Utility Service in the State of Hawai‘i General Order No. 7.” State of Hawai‘i Department of Regulatory Agencies. Accessed August 22, 2024. https://puc.hawaii.gov/wp-content/uploads/2013/04/General-Order-7.pdf.

93. “IBHS Early Insights Lahaina Fire—2023.” Insurance Institute for Business & Home Safety (IBHS), August 2023. https://ibhs.org/wp-content/uploads/IBHSEarlyInsights-LahainaFire.pdf.

94. Hawai‘i Wildfire Management Organization. “Empowering Communities: Join the Firewise USA® Movement in Hawai‘i” Accessed August 20, 2024. https://www.hwmo.org/articles/firewise-program.

95. University of Hawai‘i News. “What Fuels Hawai‘i Wildfires? UH Expert Explains,” August 10, 2023. https://www.hawaii.edu/news/2023/08/10/what-fuels-hawaii-wildfires-uh-expert-explains/.

96. “Western Maui Community Wildfire Protection Plan.” Department of Land and Natural Resources. Hawai‘i Wildfire Management Organization, 2014. https://dlnr.hawaii.gov/forestry/files/2024/01/Western-Maui-CWPP.pdf.

97. “Report on Wildfire Prevention and Cost Recovery on Maui.” Maui County. County of Maui Cost of Government Commission, July 2021. https://www.mauicounty.gov/DocumentCenter/View/129493/Report-on-Wildfire-Prevention--Cost-Recovery-on-Maui---Part-1-Report--Exhibits-A-B-33-MB.

98. “A Collaborative, Landscape-Level Approach to Reduce Wildfire Hazard Across Hawai‘i: 2018-19 Vegetation Management Rapid Mapping Assessment and Collaborative Action Planning.” Hawai‘i Wildfire Management Organization, 2019. https://static1.squarespace.com/static/5254fbe2e4b04bbc53b57821/t/5dc678007cdf127e9982c0ef/1573287946858/Maui_compressed.pdf.

99. Hawai‘i News Now. “Nonprofit Head: Maui Trying to Bury 2018 Wildfire Report Offering Insight Into Government Inaction,” October 19, 2023. https://www.youtube.com/watch?v=N3o5I1GWaAU.

100. Parsons, Dr. Elliott, and Christy Martin. “The Tragedy in Lahaina: How Invasive Grasses and Shrubs Are Fueling the Wildfire Crisis in Hawai‘i.” North American Invasive Species Management Association (NAISMA). Accessed August 21, 2024. https://naisma.org/wp-content/uploads/2023/10/Tragedy-in-Lahaina-Parsons-and-Martin-2023-with-Endnotes-FINAL.pdf.

101. Heaton, Thomas. “Fast-Growing and Fire-Resistant Grasses Are Flourishing in Hawai‘i.” Honolulu Civil Beat (blog), September 18, 2024. https://www.civilbeat.org/2023/09/fast-growing-and-fire-resistant-grasses-are-flourishing-in-hawaii/#:~:text=For%20instance%2C%20Guinea%20grass%20grows,to%20six%20inches%20a%20day.

102. “Pennisetum ciliare, buffelgrass.” Forest Service U.S. Department of Agriculture, 2022. https://www.fs.usda.gov/database/feis/plants/graminoid/pencil/all.pdf.

103. “Field Guide for Managing Buffelgrass in the Southwest.” United States Department of Agriculture, September 2014. https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5410107.pdf.

104. “A Collaborative, Landscape-Level Approach to Reduce Wildfire Hazard Across Hawai‘i: 2018-19 Vegetation Management Rapid Mapping Assessment and Collaborative Action Planning.” Hawai‘i Wildfire Management Organization, 2019. https://static1.squarespace.com/static/5254fbe2e4b04bbc53b57821/t/5dc678007cdf127e9982c0ef/1573287946858/Maui_compressed.pdf.

105. “Report on Wildfire Prevention and Cost Recovery on Maui.” Cost of Government Commission. County of Maui. Accessed August 21, 2024. https://www.mauicounty.gov/DocumentCenter/View/127768/210708-Agenda-Item-VIIC----210708-Draft-Report-on-Wildfire-Prevention-and-Cost-Recovery-on-Maui.

106. “Western Maui Community Wildfire Protection Plan.” Department of Land and Natural Resources. Hawai‘i Wildfire Management Organization, 2014. https://dlnr.hawaii.gov/forestry/files/2024/01/Western-Maui-CWPP.pdf.

107. Forests and Rangelands. “The National Cohesive Wildland Fire Management Strategy,” 2014. https://www.forestsandrangelands.gov/strategy/thestrategy.shtml.

SOURCES

108. Personal Communications. Hawai'i Wildfire Management Organization.

109. "A Collaborative, Landscape-Level Approach to Reduce Wildfire Hazard Across Hawai'i: 2018-19 Vegetation Management Rapid Mapping Assessment and Collaborative Action Planning." Hawai'i Wildfire Management Organization, 2019. https://static1.squarespace.com/static/5254fbe2e4b04bbc53b57821/t/5dc678007cdf127e9982c0ef/1573287946858/Maui_compressed.pdf.

110. Municode - Maui County Code of Ordinances. "16.04D.230 - Subsection 10.13.10 amended.," August 9, 2024. https://library.municode.com/hi/county_of_maui/codes/code_of_ordinances?nodeId=TIT16BUCO_CH16.04DFICO_16.04D.230SU10.13.10AM.

111. County of Maui. "Planning Department." Accessed August 21, 2024. https://www.mauicounty.gov/121/Planning-Department.

112. Mowery, Molly et al., "Planning the Wildland-Urban Interface." American Planning Association, April 1, 2019. https://www.planning.org/publications/report/9174069/.

113. County of Maui. "General Plan 2030." Accessed August 21, 2024. https://www.mauicounty.gov/421/General-Plan-2030.

114. County of Maui. "Maui Island Plan." Accessed August 21, 2024. https://www.mauicounty.gov/1503/Maui-Island-Plan.

115. "West Maui Community Plan." County of Maui Department of Planning, January 2022. https://www.mauicounty.gov/DocumentCenter/View/131915/West-Maui-Community-Plan-January-2022.

116. Municode - Maui County Code of Ordinances. "Title 19 - ZONING," August 9, 2024. https://library.municode.com/hi/county_of_maui/codes/code_of_ordinances?nodeId=TIT19ZO.

117. County of Maui. "Digital Zoning Map Update Project." Accessed August 21, 2024. https://www.mauicounty.gov/2159/Digital-Zoning-Map-Update-Project.

118. International Code Council (ICC). "INDEX - 2018 INTERNATIONAL RESIDENTIAL CODE (IRC)." Accessed August 22, 2024. https://codes.iccsafe.org/content/IRC2018/index.

119. International Code Council (ICC). "2018 International Building Code (IBC)." Accessed August 22, 2024. https://codes.iccsafe.org/content/IBC2018P6.

120. Hawai'i State Legislature. "§107-22 State Building Code Council." Accessed August 22, 2024. https://www.capitol.hawaii.gov/hrscurrent/Vol02_Ch0046-0115/HRS0107/HRS_0107-0022.htm.

121. "Western Maui Community Wildfire Protection Plan." Department of Land and Natural Resources. Hawai'i Wildfire Management Organization, 2014. https://dlnr.hawaii.gov/forestry/files/2024/01/Western-Maui-CWPP.pdf.

122. "IBHS Early Insights Lahaina Fire—2023." Insurance Institute for Business & Home Safety (IBHS), August 2023. https://ibhs.org/wp-content/uploads/IBHSEarlyInsights-LahainaFire.pdf.

123. "County of Maui Hazard Mitigation Plan Update." Maui Emergency Management Agency, August 2020. https://www.mauicounty.gov/DocumentCenter/View/125977/2020-Maui-County-Hazard-Mitigation-Plan-Final.

124. "Lahaina, Hawai'i Population 2024." Accessed August 21, 2024. https://worldpopulationreview.com/us-cities/hawaii/lahaina.

125. Lahaina Town. "Fire & Rebuild Updates From Lahaina, Maui, Hawai'i." Accessed August 23, 2024. https://lahainatown.com/#:~:text=Lahaina%20is%20a%20location%20that,of%20Maui%20tourism%2C%20per%20year.

126. Daisa, James M., and John B. Peers. "Narrow Residential Streets: Do They Really Slow Down Speeds?" National Association of City Transportation Officials. Accessed August 23, 2024. https://nacto.org/docs/usdg/narrow_residential_streets_daisa.pdf#:~:text=URL%3A%20https%3A%2F%2Fnacto.org%2Fdocs%2Fusdg%2Fnarrow_residential_streets_daisa.pdf%0AVisible%3A%200%25%20.

127. Kim, Karl. "Rapid Integrated Damage Assessment Tool." National Disaster Preparedness Training Center, Pacific Urban Resilience Lab, University of Hawai'i. Accessed August 23, 2024. https://ndptc.hawaii.edu/.

128. Kim, Karl. "Rapid Integrated Damage Assessment Tool." National Disaster Preparedness Training Center, Pacific Urban Resilience Lab, University of Hawai'i. Accessed August 23, 2024. https://ndptc.hawaii.edu/.

129. Google. "Google Maps Street View." Accessed August 23, 2024. https://www.google.com/streetview/.

130. "Maui Wildfires - Before & After." Accessed August 23, 2024. https://lahaina-797633b9-022b-4fbb-a957-634431b7a5b4.s3.amazonaws.com/compare/index.html.

131. "EagleView." EagleView US. Accessed August 22, 2024. https://www.eagleview.com/.

SOURCES

132. US Census Bureau. “American Community Survey (ACS),” Accessed August 20, 2024. https://www.census.gov/programs-surveys/acs.

133. Kim, Karl. “Rapid Integrated Damage Assessment Tool.” National Disaster Preparedness Training Center, Pacific Urban Resilience Lab, University of Hawai‘i. Accessed August 23, 2024. https://ndptc.hawaii.edu/.

134. Municode - Maui County Code of Ordinances. “Chapter 10.48 - STOPPING, STANDING AND PARKING.” Accessed August 22, 2024. https://library.municode.com/hi/county_of_maui/codes/code_of_ordinances?nodeId=TIT10VETR_ARTIMATRCO_CH10.48STSTPA.

135. Kim, Karl. “Rapid Integrated Damage Assessment Tool.” National Disaster Preparedness Training Center, Pacific Urban Resilience Lab, University of Hawai‘i. Accessed August 23, 2024. https://ndptc.hawaii.edu/.

136. Board of Water Supply. “Water System Standards.” Accessed August 22, 2024. https://www.boardofwatersupply.com/customer-service/applications-and-permits/water-system-standards.

137. “Recommended Standards for Water Works: Policies for the Review and Approval of Plans and Specifications for Public Water Supplies.” Great Lakes – Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers. Minnesota Government Publications, 2022. https://files.dep.state.pa.us/Water/BSDW/Public_Water_Supply_Permits/2022_Recommended_Standards_for_Water_Works.pdf.

138. “Guide for Determination of Required Fire Flow.” Insurance Services Office, June 2014. https://www.isomitigation.com/siteassets/downloads/guide-determinerequiredfireflow.pdf.

139. “Water System Standards: Amendments to the 2002 Water System Standards.” Board of Water Supply. State of Hawai‘i, December 2023. https://www.boardofwatersupply.com/bws/media/files/water-system-standards-with-amendments-2002-updated-2023-12-14.pdf.

140. “Water System Standards: Amendments to the 2002 Water System Standards.” Board of Water Supply. State of Hawai‘i, December 2023. https://www.boardofwatersupply.com/bws/media/files/water-system-standards-with-amendments-2002-updated-2023-12-14.pdf.

141. “Water System Standards: Amendments to the 2002 Water System Standards.” Board of Water Supply. State of Hawai‘i, December 2023. https://www.boardofwatersupply.com/bws/media/files/water-system-standards-with-amendments-2002-updated-2023-12-14.pdf.

142. “Water System Standards: Amendments to the 2002 Water System Standards.” Board of Water Supply. State of Hawai‘i, December 2023. https://www.boardofwatersupply.com/bws/media/files/water-system-standards-with-amendments-2002-updated-2023-12-14.pdf.

143. U.S. Census Bureau. “QuickFacts Lahaina CDP, Hawai‘i.” Accessed August 23, 2024. https://www.census.gov/quickfacts/lahainacdphawaii.

144. Hawaiian Electric. “Resilience Working Group Documents.” Accessed August 23, 2024. https://www.hawaiianelectric.com/clean-energy-hawaii/integrated-grid-planning/stakeholder-and-community-engagement/working-groups/resilience-documents.

145. Tsai, Michael. “Public Utilities Commission Approves HECO Resiliency Plan.” Spectrum News Hawai‘i, February 2, 2024. https://spectrumlocalnews.com/hi/hawaii/news/2024/02/02/puc-approves-heco-resiliency-plan.

146. Hawaiian Electric. “Resilience.” Accessed August 21, 2024. https://www.hawaiianelectric.com/about-us/our-vision-and-commitment/resilience.

147. Fire Safety Research Institute. “Lahaina Fire Comprehensive Timeline,” August 17, 2024. https://docs.google.com/spreadsheets/d/11cDTSsS3vpW53pO61Xnudt0ACuTBw9CN/edit?gid=885504235#gid=885504235.

148. Southern California Edison. “First Responders.” Accessed August 21, 2024. https://www.sce.com/safety/first-responders.

149. “Hawaiian Electric Asks West Maui, Upcountry Customers to Prepare for Possible Extended Outages Into This Evening.” Press release, August 8, 2023. https://www.hawaiianelectric.com/documents/about_us/news/2023/20230808_hawaiian_electric_asks_west_maui_upcountry_customers_to_prepare_for_possible_extended_outages_into_this_evening.pdf.

150. Federal Communications Commission. “Communications Status Report for Areas Impacted by Hawai‘i Wildfires,” April 15, 2023. https://docs.fcc.gov/public/attachments/DOC-396019A1.pdf.

151. Hawai‘i Emergency Management Agency. “All-Hazard Statewide Outdoor Warning Siren System.” Accessed August 22, 2024. https://dod.hawaii.gov/hiema/all-hazard-statewide-outdoor-warning-siren-system/.

152. “False Ballistic Missile Alert Investigation for January 18, 2018.” State of Hawai‘i Department of Defense, January 29, 2018. https://dod.hawaii.gov/wp-content/uploads/2018/01/report2018-01-29-181149.pdf.

SOURCES

153. Hawai'i Emergency Management Agency. "Public Siren Dashboard," August 20, 2024. https://hiema.maps.arcgis.com/apps/dashboards/226e62cd78f340c29e52d4f38c46ac21.

154. Hawai'i Emergency Management Agency. "Public Siren Dashboard," August 20, 2024. https://hiema.maps.arcgis.com/apps/dashboards/226e62cd78f340c29e52d4f38c46ac21.

155. Hawai'i Emergency Management Agency. "All-Hazard Statewide Outdoor Warning Siren System." Accessed August 22, 2024. https://dod.hawaii.gov/hiema/all-hazard-statewide-outdoor-warning-siren-system/.

156. U.S. Fire Administration. "All-Hazard Incident Management Team Overview." Accessed August 22, 2024. https://www.usfa.fema.gov/a-z/incident-management-teams/overview.html.

157. Maui Emergency Management Agency. "Emergency." Accessed August 21, 2024. https://www.mauicounty.gov/emergency.

158. National Wildfire Coordinating Group. "NWCG Standards for Wildland Fire Resource Typing PMS 200." Accessed August 20, 2024. https://www.nwcg.gov/publications/pms200/equipment-pms-200.

159. California Governor's Office of Emergency Services. "Fleet." Accessed August 20, 2024. https://www.caloes.ca.gov/office-of-the-director/operations/response-operations/fire-rescue/fleet/.

160. "Collective Bargaining Agreement." State of Hawai'i Department of Human Resources Development. Hawai'i Fire Fighters Association IAFF Local 1463, 2021. https://dhrd.hawaii.gov/wp-content/uploads/2023/04/HFFA-2021-2025.pdf.

161. National Wildfire Coordinating Group. "Patrolling and Securing the Fireline." Accessed August 22, 2024. https://training.nwcg.gov/classes/s130/508%20Files/071231_s130_m9_508.pdf.

162. MFD Brush and Wildland Fires E.O. 302.14 (Appendix 6.12.15)

163. McNary, Sharon. "Unglamorous 'Mop-Up' Duty Keeps Fires Extinguished." KQED, August 24, 2016. https://www.kqed.org/news/11048294/unglamorous-mop-up-duty-keeps-fires-extinguished.

164. National Wildfire Coordinating Group. "Patrolling and Securing the Fireline." Accessed August 22, 2024. https://training.nwcg.gov/classes/s130/508%20Files/071231_s130_m9_508.pdf.

165. Gouette, Kelley et al., "Wildland Urban Interface Operating Principles." California Department of Forestry and Fire Protection, 2014. https://www.iaff.org/wp-content/uploads/2019/05/CAL-FIRE-Wildland-Urban-Interface-Book.pdf.

166. National Wildfire Coordinating Group. "NWCG Incident Response Pocket Guide," January 2022. https://www.nwcg.gov/publications/pms461.

167. Data USA. "Lahaina, HI." Accessed August 23, 2024. https://datausa.io/profile/geo/lahaina-hi/.

168. ArcGIS. "Urban and Rural Population in the US (Census 2020)," 2020. https://www.arcgis.com/apps/instant/insets/index.html?appid=458e2c20ebb2479086bc32b7d09ffe27.

169. Wildfire Risk to Communities. "Vulnerable Populations." Accessed August 21, 2024. https://wildfirerisk.org/explore/vulnerable-populations/15/15009/1500042950/.

170. Hannah, Lindsay. "The Effect of Environment on Sound Propagation." Factors Affecting Outdoor Sound Propagation, 2006. https://www.acoustics.org.nz/sites/www.acoustics.org.nz/files/journal/pdfs/Hannah_L_NZA2007_b.pdf.

171. Census Reporter. "Census Profile: BG 1, Tract 314.05, Maui, HI." Accessed August 20, 2024. https://censusreporter.org/profiles/15000US150090314051-bg-1-tract-31405-maui-hi/.

172. Census Reporter. "Census Profile: BG 2, Tract 314.05, Maui, HI." Accessed August 20, 2024. https://censusreporter.org/profiles/15000US150090314052-bg-2-tract-31405-maui-hi/.

173. Census Reporter. "Census Profile: BG 3, Tract 314.05, Maui, HI." Accessed August 20, 2024. https://censusreporter.org/profiles/15000US150090314053-bg-3-tract-31405-maui-hi/.

174. Census Reporter. "Census Profile: BG 4, Tract 314.05, Maui, HI." Accessed August 20, 2024. https://censusreporter.org/profiles/15000US150090314054-bg-4-tract-31405-maui-hi/.

SOURCES

175. Census Reporter. “Census Profile: BG 1, Tract 314.02, Maui, HI.” Accessed August 21, 2024. https://censusreporter.org/profiles/15000US150090314021-bg-1-tract-31402-maui-hi/.

176. Census Reporter. “Census Profile: BG 2, Tract 314.02, Maui, HI.” Accessed August 21, 2024. https://censusreporter.org/profiles/15000US150090314022-bg-2-tract-31402-maui-hi/.

177. “Maui Wildfires of August 8, 2023: Preliminary After-Action Report.” Maui Police Department. Accessed August 22, 2024. https://www.mauipolice.com/uploads/1/3/1/2/131209824/pre_aar_master_copy_final_draft_1.23.24.pdf.

178. Eliason, Losano, Turbin, and Mabalot were not included in this calculation because their home addresses and recovery locations do not support them evacuating in that way.

179. Ramones, Megan. “At 98, Beloved Grandmother Lost in Fire Remembered as ‘Strongest’ Person in Her Family.” Hawai‘i News Now, September 6, 2023. https://www.hawaiinewsnow.com/2023/09/06/even-98-years-old-beloved-grandmother-lost-fire-remembered-strongest-person/.

180. AP News. “A Woman Who Fled the Maui Wildfire on Foot Has Died After Weeks in a Hospital Burn Unit,” October 1, 2023. https://apnews.com/article/lahaina-hawaii-wildfire-woman-burned-f2d71c20433229ac4c4a037183d0f3f8.

181. Napuunoa, Nicole et al., “Remembering Those Lost in the Maui Fires.” KHON2, June 24, 2024. https://www.khon2.com/hawaii-fires/remembering-those-lost-in-the-maui-fires/.

182. Baker, M. “She Fled the Lahaina Fire on Foot. After 7 Weeks in a Burn Unit, She Couldn’t Be Saved.” New York Times, October 1, 2023. https://www.nytimes.com/2023/09/30/us/maui-hawaii-fire-victim-burn-unit.html.

183. Terrell, Jessica. “2 of the First Lahaina Victims ID’D Were From Senior Complex.” Honolulu Civil Beat, August 17, 2023. https://www.civilbeat.org/beat/2-of-the-first-lahaina-victims-idd-were-from-senior-complex/.

184. Honolulu Star-Advertiser. “In Memoriam: A List of the People Killed in Maui Fires,” January 4, 2024. https://www.staradvertiser.com/2023/09/15/breaking-news/in-memoriam-a-list-of-victims-killed-in-maui-fires/.

185. Honolulu Star-Advertiser. “In Memoriam: A List of the People Killed in Maui Fires,” January 4, 2024. https://www.staradvertiser.com/2023/09/15/breaking-news/in-memoriam-a-list-of-victims-killed-in-maui-fires/.

186. Honolulu Star-Advertiser. “In Memoriam: A List of the People Killed in Maui Fires,” January 4, 2024. https://www.staradvertiser.com/2023/09/15/breaking-news/in-memoriam-a-list-of-victims-killed-in-maui-fires/.

187. Honolulu Star-Advertiser. “In Memoriam: A List of the People Killed in Maui Fires,” January 4, 2024. https://www.staradvertiser.com/2023/09/15/breaking-news/in-memoriam-a-list-of-victims-killed-in-maui-fires/.

188. Honolulu Star-Advertiser. “In Memoriam: A List of the People Killed in Maui Fires,” January 4, 2024. https://www.staradvertiser.com/2023/09/15/breaking-news/in-memoriam-a-list-of-victims-killed-in-maui-fires/.

189. Honolulu Star-Advertiser. “In Memoriam: A List of the People Killed in Maui Fires,” January 4, 2024. https://www.staradvertiser.com/2023/09/15/breaking-news/in-memoriam-a-list-of-victims-killed-in-maui-fires/.

190. Inquirer. “8 Members of a Single Filipino Family Died in Maui Wildfires,” September 29, 2023. https://usa.inquirer.net/137499/8-members-of-a-single-filipino-family-died-in-maui-wildfires.

191. Valerio, Mike, and Aya Elamroussi. “Hawai‘i Officials Identify 70-year-old Mother as the Last of the 100 Known Victims of the Lahaina Wildfire.” CNN, January 27, 2024. https://edition.cnn.com/2024/01/26/us/hawaii-wildfire-last-victim-identification/index.html.

192. Hawai‘i News Now. “CA Woman, a Beloved Mom and Grandmother, Is First Visitor Identified as Wildfire Victim,” August 23, 2023. https://www.hawaiinewsnow.com/2023/08/24/ca-woman-beloved-mom-grandmother-is-first-visitor-identified-wildfire-victim/.

193. Honolulu Star-Advertiser. “In Memoriam: A List of the People Killed in Maui Fires,” January 4, 2024. https://www.staradvertiser.com/2023/09/15/breaking-news/in-memoriam-a-list-of-victims-killed-in-maui-fires/.

194. Charalambous, Peter. “‘Helping Others up to the Very End’: Family Believes Missing Lahaina Man Likely Died Trying to Help Neighbors.” ABC News, August 17, 2023. https://abcnews.go.com/US/helping-end-family-believes-lahaina-man-died-save/story?id=102256601.

195. Richardson, Mahealani. “Those Lost in Lahaina: A Big-hearted Teen. An Inseparable Couple. A Loving Dad.” Hawai‘i News Now, August 22, 2023. https://www.hawaiinewsnow.com/2023/08/23/growing-tributes-maui-fire-victims/.

SOURCES

196. Richardson, Mahealani. “Those Lost in Lahaina: A Big-hearted Teen. An Inseparable Couple. A Loving Dad.” Hawai‘i News Now, August 22, 2023. https://www.hawaiinewsnow.com/2023/08/23/growing-tributes-maui-fire-victims/.

197. Honolulu Star-Advertiser. “In Memoriam: A List of the People Killed in Maui Fires,” January 4, 2024. https://www.staradvertiser.com/2023/09/15/breaking-news/in-memoriam-a-list-of-victims-killed-in-maui-fires/.

198. Richardson, Mahealani. “Those Lost in Lahaina: A Big-hearted Teen. An Inseparable Couple. A Loving Dad.” Hawai‘i News Now, August 22, 2023. https://www.hawaiinewsnow.com/2023/08/23/growing-tributes-maui-fire-victims/.

199. Honolulu Star-Advertiser. “In Memoriam: A List of the People Killed in Maui Fires,” January 4, 2024. https://www.staradvertiser.com/2023/09/15/breaking-news/in-memoriam-a-list-of-victims-killed-in-maui-fires/.

200. Hawai‘i News Now. “Lahaina Family Remembers Beloved Matriarch for Her Tough Love and Big Heart,” August 18, 2023. https://www.hawaiinewsnow.com/2023/08/18/lahaina-family-remembers-their-beloved-matriarch-the-boss-for-her-tough-love-big-heart/.

201. Richardson, Mahealani. “Those Lost in Lahaina: A Big-hearted Teen. An Inseparable Couple. A Loving Dad.” Hawai‘i News Now, August 22, 2023. https://www.hawaiinewsnow.com/2023/08/23/growing-tributes-maui-fire-victims/.

202. Martinez, Jolanie. “‘Love Each Other Now’: Family Mourns 102nd Victim of Lahaina Disaster.” Hawai‘i News Now, July 1, 2024. https://www.hawaiinewsnow.com/2024/07/01/love-each-other-now-family-mourns-beloved-mother-sister-who-died-lahaina-wildfire-injuries/.

203. Hughes, Caelan. “Family Was His Life. When He Didn’t Pick up, They Knew Something Was Wrong.” Hawai‘i News Now, August 17, 2023. https://www.hawaiinewsnow.com/2023/08/17/music-family-was-his-life-when-he-didnt-pick-up-they-knew-something-was-wrong/.

204. Honolulu Star-Advertiser. “Lahaina Man, 76, Identified as the 101st Fire Victim,” February 13, 2024. https://www.staradvertiser.com/2024/02/13/breaking-news/unaccounted-for-lahaina-man-76-identified-as-the-101st-fire-victim/.

205. Hawai‘i News Now. “Mental Health a Top Concern for Wildfire Survivors as 101st Victim Is Officially Identified,” February 13, 2024. https://www.hawaiinewsnow.com/2024/02/13/maui-county-identifies-1-more-victim-lahaina-wildfire-raising-death-toll-101/.

206. Hawai‘i News Now. “A Legacy of Generosity: Beloved Lahaina Father Remembered for All That He Gave in Life,” September 5, 2023. https://www.hawaiinewsnow.com/2023/09/05/lahaina-family-remembers-86-year-old-father-his-humor-generosity/.

207. Honolulu Star-Advertiser. “In Memoriam: A List of the People Killed in Maui Fires,” January 4, 2024. https://www.staradvertiser.com/2023/09/15/breaking-news/in-memoriam-a-list-of-victims-killed-in-maui-fires/.

208. Honolulu Star-Advertiser. “In Memoriam: A List of the People Killed in Maui Fires,” January 4, 2024. https://www.staradvertiser.com/2023/09/15/breaking-news/in-memoriam-a-list-of-victims-killed-in-maui-fires/.

209. Honolulu Star-Advertiser. “In Memoriam: A List of the People Killed in Maui Fires,” January 4, 2024. https://www.staradvertiser.com/2023/09/15/breaking-news/in-memoriam-a-list-of-victims-killed-in-maui-fires/.

210. Honolulu Star-Advertiser. “In Memoriam: A List of the People Killed in Maui Fires,” January 4, 2024. https://www.staradvertiser.com/2023/09/15/breaking-news/in-memoriam-a-list-of-victims-killed-in-maui-fires/.

211. Honolulu Star-Advertiser. “In Memoriam: A List of the People Killed in Maui Fires,” January 4, 2024. https://www.staradvertiser.com/2023/09/15/breaking-news/in-memoriam-a-list-of-victims-killed-in-maui-fires/.

212. Honolulu Star-Advertiser. “In Memoriam: A List of the People Killed in Maui Fires,” January 4, 2024. https://www.staradvertiser.com/2023/09/15/breaking-news/in-memoriam-a-list-of-victims-killed-in-maui-fires/.

213. Johnson, Gene et al., “Family Details Fight to Have Woman Listed as Fire Victim.” Maui News, December 28, 2023. https://www.mauinews.com/news/local-news/2023/12/family-details-fight-to-have-woman-listed-as-fire-victim/.

214. Richardson, Mahealani. “Those Lost in Lahaina: A Big-hearted Teen. An Inseparable Couple. A Loving Dad.” Hawai‘i News Now, August 22, 2023. https://www.hawaiinewsnow.com/2023/08/23/growing-tributes-maui-fire-victims/.

215. Honolulu Star-Advertiser. “In Memoriam: A List of the People Killed in Maui Fires,” January 4, 2024. https://www.staradvertiser.com/2023/09/15/breaking-news/in-memoriam-a-list-of-victims-killed-in-maui-fires/.

216. Terrell, Jessica. “2 Of the First Lahaina Victims ID’D Were From Senior Complex,” Honolulu Civil Beat, August 17, 2023, https://www.civilbeat.org/beat/2-of-the-first-lahaina-victims-idd-were-from-senior-complex/.

SOURCES

217. Terrell, Jessica. “Lahaina Death Trap: The Day Fire Engulfed Kuhua Street,” Honolulu Civil Beat, February 13, 2024, https://www.civilbeat.org/2024/02/lahaina-death-trap-the-night-fire-engulfed-kuhua-street/.

218. Terrell, Jessica. “Lahaina Death Trap: The Day Fire Engulfed Kuhua Street,” Honolulu Civil Beat, February 13, 2024, https://www.civilbeat.org/2024/02/lahaina-death-trap-the-night-fire-engulfed-kuhua-street/.

219. Terrell, Jessica. “Lahaina Death Trap: The Day Fire Engulfed Kuhua Street,” Honolulu Civil Beat, February 13, 2024, https://www.civilbeat.org/2024/02/lahaina-death-trap-the-night-fire-engulfed-kuhua-street/.

220. Honolulu Star-Advertiser. “In Memoriam: A List of the People Killed in Maui Fires,” January 4, 2024. https://www.staradvertiser.com/2023/09/15/breaking-news/in-memoriam-a-list-of-victims-killed-in-maui-fires/.

221. Honolulu Star-Advertiser. “In Memoriam: A List of the People Killed in Maui Fires,” January 4, 2024. https://www.staradvertiser.com/2023/09/15/breaking-news/in-memoriam-a-list-of-victims-killed-in-maui-fires/.

222. Honolulu Star-Advertiser. “In Memoriam: A List of the People Killed in Maui Fires,” January 4, 2024. https://www.staradvertiser.com/2023/09/15/breaking-news/in-memoriam-a-list-of-victims-killed-in-maui-fires/.

223. Honolulu Star-Advertiser. “In Memoriam: A List of the People Killed in Maui Fires,” January 4, 2024. https://www.staradvertiser.com/2023/09/15/breaking-news/in-memoriam-a-list-of-victims-killed-in-maui-fires/.

224. Hawai‘i News Now. “Maui EMT Who Died in Lahaina Remembered as Someone Who ‘Loved Helping People,’” September 3, 2023. https://www.hawaiinewsnow.com/2023/09/04/maui-emt-who-died-lahaina-remembered-someone-who-loved-helping-people/.

225. Hughes, Caelan. “‘Indescribable Grief’: Loved Ones Identify Family of 4 Killed While Fleeing Lahaina Wildfire,” Hawai‘i News Now, August 12, 2023, https://www.hawaiinewsnow.com/2023/08/13/indescribable-grief-loved-ones-identify-family-4-killed-while-fleeing-lahaina-wildfire/.

226. Honolulu Star-Advertiser. “In Memoriam: A List of the People Killed in Maui Fires,” January 4, 2024. https://www.staradvertiser.com/2023/09/15/breaking-news/in-memoriam-a-list-of-victims-killed-in-maui-fires/.

227. Honolulu Star-Advertiser. “In Memoriam: A List of the People Killed in Maui Fires,” January 4, 2024. https://www.staradvertiser.com/2023/09/15/breaking-news/in-memoriam-a-list-of-victims-killed-in-maui-fires/.

228. Hughes, Caelan. “‘Indescribable Grief’: Loved Ones Identify Family of 4 Killed While Fleeing Lahaina Wildfire,” Hawai‘i News Now, August 12, 2023, https://www.hawaiinewsnow.com/2023/08/13/indescribable-grief-loved-ones-identify-family-4-killed-while-fleeing-lahaina-wildfire/.

229. Terrell, Jessica. “Lahaina Death Trap: The Day Fire Engulfed Kuhua Street,” Honolulu Civil Beat, February 13, 2024, https://www.civilbeat.org/2024/02/lahaina-death-trap-the-night-fire-engulfed-kuhua-street/.

230. Hughes, Caelan. “‘Indescribable Grief’: Loved Ones Identify Family of 4 Killed While Fleeing Lahaina Wildfire,” Hawai‘i News Now, August 12, 2023, https://www.hawaiinewsnow.com/2023/08/13/indescribable-grief-loved-ones-identify-family-4-killed-while-fleeing-lahaina-wildfire/.

231. Terrell, Jessica. “Lahaina Death Trap: The Day Fire Engulfed Kuhua Street,” Honolulu Civil Beat, February 13, 2024, https://www.civilbeat.org/2024/02/lahaina-death-trap-the-night-fire-engulfed-kuhua-street/.

232. Hughes, Caelan. “‘Indescribable Grief’: Loved Ones Identify Family of 4 Killed While Fleeing Lahaina Wildfire,” Hawai‘i News Now, August 12, 2023, https://www.hawaiinewsnow.com/2023/08/13/indescribable-grief-loved-ones-identify-family-4-killed-while-fleeing-lahaina-wildfire/.

233. Terrell, Jessica. “Lahaina Death Trap: The Day Fire Engulfed Kuhua Street,” Honolulu Civil Beat, February 13, 2024, https://www.civilbeat.org/2024/02/lahaina-death-trap-the-night-fire-engulfed-kuhua-street/.

234. Hawai‘i News Now. “‘God Took a Good Man’: Lahaina Victim Spent Last Moments Shielding Dog,” August 17, 2023. https://www.hawaiinewsnow.com/2023/08/17/god-took-good-man-lahaina-victim-spent-last-moments-shielding-beloved-dog/.

235. Honolulu Star-Advertiser. “In Memoriam: A List of the People Killed in Maui Fires,” January 4, 2024. https://www.staradvertiser.com/2023/09/15/breaking-news/in-memoriam-a-list-of-victims-killed-in-maui-fires/.

236. Honolulu Star-Advertiser. “In Memoriam: A List of the People Killed in Maui Fires,” January 4, 2024. https://www.staradvertiser.com/2023/09/15/breaking-news/in-memoriam-a-list-of-victims-killed-in-maui-fires/.

237. Honolulu Star-Advertiser. “In Memoriam: A List of the People Killed in Maui Fires,” January 4, 2024. https://www.staradvertiser.com/2023/09/15/breaking-news/in-memoriam-a-list-of-victims-killed-in-maui-fires/.

SOURCES

238. Honolulu Star-Advertiser. “In Memoriam: A List of the People Killed in Maui Fires,” January 4, 2024. https://www.staradvertiser.com/2023/09/15/breaking-news/in-memoriam-a-list-of-victims-killed-in-maui-fires/.

239. Honolulu Star-Advertiser. “In Memoriam: A List of the People Killed in Maui Fires,” January 4, 2024. https://www.staradvertiser.com/2023/09/15/breaking-news/in-memoriam-a-list-of-victims-killed-in-maui-fires/.

240. Municode - Maui County Code of Ordinances. “Chapter 16.08A - RESIDENTIAL CODE[4],” August 9, 2024. https://library.municode.com/hi/county_of_maui/codes/code_of_ordinances?nodeId=TIT16BUCO_CH16.08ARECO.

241. “Buffelgrass Facts and Figures.” National Park Service, January 2018. https://www.nps.gov/sagu/learn/nature/upload/BG-facts-and-figures-Jan-2018.pdf.

242. Municode - Maui County Code of Ordinances. “16.04D.230 - Subsection 10.13.10 Amended.,” August 9, 2024. https://library.municode.com/hi/county_of_maui/codes/code_of_ordinances?nodeId=TIT16BUCO_CH16.04DFICO_16.04D.230SU10.13.10AM.

243. U.S. Census Bureau. “Lahaina CCD, Maui County, Hawai‘i.” Accessed August 22, 2024. https://data.census.gov/profile/Lahaina_CCD,_Maui_County,_Hawaii?g=060XX00US1500991980.

244. “Wildfire Aware.” Accessed August 22, 2024. https://livingatlas.arcgis.com/wildfireaware/#@=-156.683,20.875,14,loc.

245. Kim, Shi En. “How Swaths of Invasive Grass Made Maui’s Fires so Devastating.” Smithsonian Magazine, August 15, 2023. https://www.smithsonianmag.com/smart-news/how-swaths-of-invasive-grass-made-mauis-fires-so-devastating-180982729.

246. “Hawai‘i Wildfire Management Organization.” Accessed August 22, 2024. https://hwmo.org/.

247. “Wildfire Risk to Communities.” Accessed August 22, 2024. https://wildfirerisk.org/.

248. Wildfire Risk to Communities. “Lahaina Risk,” August 1, 2024. https://wildfirerisk.org/explore/overview/15/15009/1500042950/.

249. Kim, Karl. “Rapid Integrated Damage Assessment Tool.” National Disaster Preparedness Training Center, Pacific Urban Resilience Lab, University of Hawai‘i. Accessed August 23, 2024. https://ndptc.hawaii.edu/.

250. Kim, Karl. “Rapid Integrated Damage Assessment Tool.” National Disaster Preparedness Training Center, Pacific Urban Resilience Lab, University of Hawai‘i. Accessed August 23, 2024. https://ndptc.hawaii.edu/.

251. Hawai‘i News Now. “New Assessment Maps Reveal Extensive Damage, Residential Impact of Maui Wildfires,” August 12, 2023. https://www.hawaiinewsnow.com/2023/08/12/assessment-maps-reveal-extensive-structural-damage-residential-impact-maui-wildfires/.

252. Escobar, Molly et al., “Map: See the Damage to Lahaina From the Maui Fires.” The New York Times, August 13, 2023. https://www.nytimes.com/interactive/2023/08/10/us/maui-wildfire-map-hawaii.html.

253. FEMA. “Hawai‘i Wildfires, August 2023.” Accessed August 22, 2024. https://gis-fema.hub.arcgis.com/pages/hawaii-wildfires-august-2023#ai.

254. ArcGIS REST Services Directory. “Layer: Footprints_2022_JPL (ID:0).” Accessed August 25, 2024. https://services3.arcgis.com/fsrDo0QMPlK9CkZD/ArcGIS/rest/services/Footprints_2022_JPL/FeatureServer/0.

255. Maranghides, Alexander et al., “A Case Study of the Camp Fire - Fire Progression Timeline.” National Institute of Standards and Technology, February 8, 2021. https://www.nist.gov/publications/case-study-camp-fire-fire-progression-timeline.

256. “FEMA Mitigation Assessment Team (MAT) Report, Marshal Fire Building Performance, Observations, Recommendations, and Technical Guidance.” FEMA, June 2023. https://www.fema.gov/sites/default/files/documents/fema_p2320-marshall-fire-mat-report-appendices.pdf.

257. Maranghides, Alexander et al., “NIST Technical Note 2205 WUI Structure/Parcel/Community Fire Hazard Mitigation Methodology.” National Institute of Standards and Technology, March 2022. https://nvlpubs.nist.gov/nistpubs/TechnicalNotes/NIST.TN.2205.pdf.

258. “PV System Owner’s Guide to Identifying, Assessing, and Addressing Weather Vulnerabilities, Risks, and Impacts.” U.S. Department of Energy, September 2021. https://www.energy.gov/sites/default/files/2021-09/pv-system-owners-guide-to-weather-vulnerabilities.pdf.

259. Manzello, Samuel L., and Ethan I. D. Foote. “Characterizing Firebrand Exposure From Wildland–Urban Interface (WUI) Fires: Results From the 2007 Angora Fire.” Fire Technology 50, no. 1 (September 22, 2012): 105–24. https://doi.org/10.1007/s10694-012-0295-4.

260. Babrauskas, Vytenis. “Glass breakage in fires.” ResearchGate. Accessed August 22, 2024. https://www.researchgate.net/publication/267852703_Glass_breakage_in_fires.

SOURCES

261. National Institute of Standards and Technology. “Wind-Driven Fire Spread to a Structure from Fences and Mulch (nist.gov).” Accessed August 22, 2024. https://tsapps.nist.gov/publication/get_pdf.cfm?pub_id=934667.

262. Clark, Cammy. “A Low-Income Housing Complex Is Ready to Rebuild After Lahaina Fire. It Just Needs $36M.” Honolulu Civil Beat, April 11, 2024. https://www.civilbeat.org/2024/04/a-low-income-housing-complex-is-ready-to-rebuild-after-lahaina-fire-it-just-needs-36m/.

263. International Code Council. “What Is the International Wildland-Urban Interface Code?,” 2021. https://www.iccsafe.org/products-and-services/wildland-urban-interface-code/.

264. National Fire Protection Association. “NFPA 1140 Standard for Wildland Fire Protection,” 2022. https://www.nfpa.org/codes-and-standards/nfpa-1140-standard-development/1140.

265. Maranghides, Alexander et al., “NIST Technical Note 2205 WUI Structure/Parcel/Community Fire Hazard Mitigation Methodology.” National Institute of Standards and Technology, March 2022. https://nvlpubs.nist.gov/nistpubs/TechnicalNotes/NIST.TN.2205.pdf.

As this report deals with topics related to Hawaiian culture, geography, environment, and language, FSRI chose to include Hawaiian diacritical marks, such as the ʻokina (ʻ) and kahakō (macron) over vowels, throughout this report when writing Hawaiian words. These markings are essential features of modern, written Hawaiian language, serving to represent the proper pronunciation and meaning.

While we have made our best effort to use these marks properly, we acknowledge there may be unintentional errors. We did not include diacritical markings where we were unable to identify the proper spelling of a particular Hawaiian word (eg., Aa Street) or in instances where the information is from a third party's direct record (e.g., social media posts).

By including these marks, we aim to honor the Hawaiian language and show respect for its linguistic traditions – and for the people of Maui.

Lahaina Fire Incident Analysis Report



Steve Kerber, Ph.D., P.E.
Vice President and
Executive Director, FSRI

Derek Alkonis
Research Program Manager

Fire Safety Research Institute

© 2024 Underwriters Laboratories Inc.

Lahaina Fire Comprehensive Timeline Report

Steve Kerber
Derek Alkonis

This publication is available free of charge from:
https://doi.org/10.54206/102376/VQKQ5427



Photo Credit: Dahlquist Photography

Fire Safety Research Institute
April 17, 2024
Columbia, MD

© 2024 Underwriters Laboratories Inc.

ACKNOWLEDGMENTS

The authors express sincere gratitude to the people of Maui for their willingness to share information and personal stories about this incident. The authors also acknowledge the steadfast commitment of the Hawai‘i Attorney General, Anne E. Lopez, and the Hawai‘i Department of the Attorney General to completing this independent research and analysis.

The authors also thank the County of Maui, and the following individuals for their invaluable contributions: Clay Trauernicht from the University of Hawai‘i, John Bravender and Derek Wroe from the National Weather Service, Elizabeth Pickett from the Hawai‘i Wildfire Management Organization, Michael Walker from State of Hawai‘i Division of Forestry and Wildlife, the former Hawai‘i County Mayor and Civil Defense Agency Administrator Harry Kim, and Darus Ane, Jim Barnes, Leonard Casson, Alysa Finlayson, Tim Hagel, Todd Harms, Garrett Kim, TJ Martin, Jessica Pickett, Kevin Roche, and Adam Thiel from FACETS. Their insights and data have been instrumental in the compilation of this report.

Special thanks also go to FSRI’s Gavin Horn and Daniel Gorham for their contributions to the assessment, Dawn Ey for her role as project manager and editor of the report, as well as FSRI team members Charley Fleischmann, Holli Knight, Dan Madrzykowski, Michelle Sauer, Amanda Srsic, and Brian Straczewski for their supporting efforts.

DISCLAIMER

In no event shall UL Research Institutes (ULRI) be responsible to anyone for whatever use or non-use is made of the information contained in this report and in no event shall ULRI, its employees, or its agents incur any obligation or liability for damages including, but not limited to, consequential damage arising out of or in connection with the use or inability to use the information contained in this report.

ABSTRACT

On August 8–9, 2023, the town of Lahaina, Hawai‘i (on the island of Maui), endured a devastating fire fueled by environmental conditions, leading to 101 fatalities, widespread destruction, and devastating community impacts.

The Fire Safety Research Institute (FSRI) conducted an extensive data collection effort to establish a comprehensive timeline and fact base around the Lahaina fires. This Lahaina Fire Comprehensive Timeline Report (Phase 1) focuses on the events that occurred prior to, during, and immediately following the Lahaina fire, such as preparedness efforts, weather and its impact to infrastructure, and other fires occurring on Maui for the time period beginning at 14:55 (2:55 p.m. HST) on August 8, 2023, and concluding at 08:30 (8:30 a.m.) on August 9, 2023. Data from the three (3) other Maui fires is also included in specific sections to give context to the situation in Lahaina.

Keywords: Maui fire, wildland-urban interface, WUI, Lahaina Fire, grassland fire, urban conflagration

TABLE OF CONTENTS

i ABSTRACT
ii TABLE OF CONTENTS
v LIST OF TABLES
viii LIST OF FIGURES
xiii EXECUTIVE SUMMARY

1 **1.0 Introduction**
1 1.1 Fire Safety Research Institute's (FSRI) Responsibility
2 1.2 Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) Responsibility
2 1.3 FSRI Analysis of Structure-to-Structure Fire Spread in Lahaina Town
3 1.4 Scope of the Analysis Performed by FSRI

5 **2.0 Background**
5 2.1 Description of Area–Fire Environment
2.1.1 Physical Characteristics
2.1.2 Climate and Weather
2.1.3 Wind, Storms, and Fire Behavior
2.1.4 Vegetation and Fuels
2.1.5 Hawai'i Fire History
Wildfire Ignitions
2.1.6 Land Use
Land Use: Agriculture
Links Between Agriculture and Wildfire
Land Use: Conservation and Natural Resources
Land Use: Rural
Land Use: Urban
Links Between the Built Environment and Wildfire
17 2.2 Power and Water Infrastructure
2.2.1 Hawaiian Electric
2.2.2 Department of Water Supply
23 2.3 Wildfire Prevention and Preparedness Organizations and Efforts
2.3.1 Maui Wildfire Task Forces
2.3.2 Maui Fire Department Fire Prevention Bureau
2.3.3 State Department of Land and Natural Resources–Division of Forestry and Wildlife (DLNR-DOFAW)
2.3.4 Hawai'i Wildfire Management Organization (HWMO)
2.3.5 University of Hawai'i at Mānoa College of Tropical Agricultural and Human Resources (UHM-CTAHR)
2.3.6 National Weather Service

25 2.4 Emergency Response Organizations
2.4.1 Maui County Emergency Services and Public Safety
2.4.2 State: Hawai'i Department of Land and Natural Resources-Division of Forestry and Wildlife (DLNR-DOFAW)
2.4.3 Federal: The Department of the Interior (DOI)
2.4.4 Maui Emergency Management Agency (MEMA)
2.4.5 Hawai'i Emergency Management Agency (HI-EMA)
2.5.6 Heavy Equipment Contractors

27 **3.0 Data Collection**

31 **4.0 Timeline of Events**
31 4.1 Summary of August 8, 2023, and August 9, 2023, Maui Fires
34 4.2 Pre-Fire Events
4.2.1 Weather Alerts
National Weather Service (NWS)
Maui Emergency Management Agency (MEMA)
4.2.2 Staffing and Preparedness
Hawai'i Emergency Management Agency (HI-EMA)
Maui Emergency Management Agency (MEMA)
Maui Police Department (MPD)
Maui Fire Department (MFD)
Dispatch
Hawaiian Electric
Department of Water Supply
Hawai'i Division of Forestry and Wildlife (DOFAW)
4.2.3 Pre-Fire Utility and Structure Damage/Destruction
Impact of Downed Utility Poles on Traffic and Evacuation Routes
Compromised Structures
44 4.3 Fire and Response Timeline
4.3.1 Fire Progression
4.3.2 Maui Fire Department (MFD) Response
Staffing
Fire Incident Management Organization
Resource Assignments
Event Log Fire 2 and Fire 3
Aviation Resources
4.3.3 Maui Police Department (MPD) Response
Staffing
Communication
Dispatch

TABLE OF CONTENTS

4.3.4 Hawaiian Electric
Downed Equipment
Hawaiian Electric Communications Regarding Power Status
4.3.5 Department of Water Supply
4.3.6 Maui Emergency Management Agency (MEMA)
MEMA Timeline of Significant Events
4.3.7 Crisis Communications
Maui Mayor Richard T. Bissen, Jr.
Governor Josh Green, M.D.
Lieutenant Governor Sylvia Luke
Hawai'i Emergency Management Agency (HI-EMA)
4.3.8 American Medical Response (AMR)
4.3.9 U.S.Coast Guard Operations (USCG)
4.3.10 Aircraft Rescue and Firefighting (ARFF) Units
4.3.11 Hawai'i Division of Forestry and Wildlife (DOFAW) Fire Response Units

269 **5.0 Summary**

271 **6.0 Appendix**

271 6.1 Subpoena Requests and Statuses
279 6.2 National Weather Service (NWS) Products Released (Communications)
307 6.3 PreFire Social Media Posts
313 6.4 Wind Conditions Reported by Remote Automatic Weather Stations (RAWS)
315 6.5 Maui Emergency Management Agency (MEMA) Emergency Operations Center (EOC) Sign-Ins August 7, 2023 to August 9, 2023
327 6.6 Hawaiian Electric Emergency Operations Center (EOC) Update August 8, 2023
328 6.7 Maui Emergency Management Agency (MEMA) Emergency Operations Center (EOC) Situation Report No. 1: August 8, 2023
329 6.8 Maui Emergency Management Agency (MEMA) Emergency Operations Center (EOC) Situation Report: No.2: August 8, 2023
330 6.9 Emergency Proclamation: Mayor of Maui
335 6.10 Emergency Proclamation: Office of the Governor State of Hawai'i
341 6.11 HI-EMA Director Administrator of Events
345 6.12 Lahaina Fire Staffing Matrix
349 6.13 Fire Progression Map Data
363 6.14 FSRI Research Team Biographies

371 **7.0 Glossary**

373 **8.0 Acronyms and Abbreviation**

Lists of Tables

30 Table 3.4.1 Technical Discussions Conducted by FSRI.
36 Table 4.2.2.1 Hawai'i Division of Forestry and Wildlife (DOFAW) Personnel on August 8, 2023.
37 Table 4.2.2.2 Hawai'i Division of Forestry and Wildlife (DOFAW) Fire Suppression Equipment Inventory on August 8, 2023.
46 Table 4.3.1.1 Maui Fire Department (MFD) Command communications with Relief Engine 11 (RE11) and Engine 3 (E3) on August 8, 2023, at 15:24.
84 Table 4.3.2.1 Maui Fire Department (MFD) Shift Schedule August 7, 2023 through August 10, 2023.
85 Table 4.3.2.2 Maui Fire Department (MFD) Incident Management Assignments on August 8, 2023, and August 9, 2023.
87 Table 4.3.2.3 Maui Fire Department (MFD) Resource Assignments on August 8, 2023.
91 Table 4.3.2.4 Maui Fire Department (MFD) Incident Management Assignments for Engine 3 (E3)
101 Table 4.3.2.5 Maui Fire Department (MFD) Incident Management Assignments for Wildland 3 (WL3)
103 Table 4.3.2.6 Maui Fire Department (MFD) Incident Management Assignments for Ladder 3 (L3)
109 Table 4.3.2.7 Maui Fire Department (MFD) Incident Management Assignments for Engine 11 (E11) and Mini 11
117 Table 4.3.2.8 Maui Fire Department (MFD) Incident Management Assignments for Relief Engine 11 (RE11)
126 Table 4.3.2.9 Maui Fire Department (MFD) Incident Management Assignments for Engine 6 (E6) o
130 Table 4.3.2.10 Maui Fire Department (MFD) Incident Management Assignments for Wildland 6 (WL6)
132 Table 4.3.2.11 Maui Fire Department (MFD) Resources Assignments for Engine 1 (E1)
136 Table 4.3.2.12 Maui Fire Department (MFD) Incident Management Assignments for Mini 1
143 Table 4.3.2.13 Maui Fire Department (MFD) Incident Management Assignments for Relief Engine 1 (RE1)
149 Table 4.3.2.14 Maui Fire Department (MFD) Incident Management Assignments for Utility 3 (U3)
158 Table 4.3.2.15 Maui Fire Department (MFD) Incident Management Assignments for Utility 3B (U3B)
175 Table 4.3.2.16 Maui Fire Department (MFD) Incident Management Assignments for Utility 5 (U5)
180 Table 4.3.2.17 Maui Fire Department (MFD) Incident Management Assignments for Engine 3A (E3A)
182 Table 4.3.2.18 MFD Incident Management Assignments for Relief Engine 14 (RE14)
194 Table 4.3.2.19 Maui Fire Department (MFD) Timeline of MFD aviation communications
200 Table 4.3.3.1 Chronology of significant dispatch events on August 8, 2023, and August 9, 2023.
203 Table 4.3.3.2 Traffic Control Challenges as Reported by Maui Police Department (MPD).
212 Table 4.3.3.3 Direct Rescues and Evacuations Discussed in Law Enforcement Technical Discussions.
231 Table 4.3.4.1 Table 4.3.4.1 Equipment Down as Reported by Hawaiian Electric.
232 Table 4.3.4.2 Additional reports of downed Hawaiian Electric equipment.

Lists of Tables

235 Table 4.3.4.3 Hawaiian Electric Record of Communications with Maui Police Department (MPD) and Maui Fire Department (MFD) Regarding Power Status. Central is MPD's central dispatch.

240 Table 4.3.6.1 Maui Emergency Management Agency (MEMA) Emergency Operations Center (EOC) staffing as of August 8, 2023.

242 Table 4.3.6.2 Maui WebEOC Event Log Entries August 7, 2023, through August 9, 2023.

244 Table 4.3.6.3 Maui Emergency Management Agency (MEMA) Public Alerts August 8, 2023 – August 9, 2023.

247 Table 4.3.6.4 Emergency Operations Center (EOC) Requests for Assistance (RFAs) August 8, 2023 – August 9, 2023.



Lists of Figures

5 Figure 2.1.1.1 Maui Nui (the islands that make up Maui County, including Maui, Molokaʻi, Lānaʻi, Kahoʻolawe).

5 Figure 2.1.1.2 Maui Island.

6 Figure 2.1.2.1 Mean Annual Rainfall Islands of Molokaʻi, Lānaʻi, Maui, and Kohoʻolawe / 2013 Rainfall Atlas of Hawaiʻi.

7 Figure 2.1.3.1 Distribution of source of high wind events in Hawaiʻi.

10 Figure 2.1.5.1 Wildfire Occurrence In Hawaiʻi. 1904-2021.

10 Figure 2.1.5.2 Maui County Wildfire Ignitions and Acres Burned by Year. 2000-2020.

10 Figure 2.1.5.3 Maui County Ignitions and Acres Burned by Month. 2012-2020.

11 Figure 2.1.5.4 Maui Ignition Locations and Large Fire Burned Areas. 1999-2022.

12 Figure 2.1.5.5 Density of Wildfires on Maui and Kaho'olawe. 2012-2020.

13 Figure 2.1.6.1 Maui Crop Summary. 2020.

14 Figure 2.1.6.2 Hawaiʻi Fire History and Agricultural Decline.

14 Figure 2.1.6.3 Historic and Active Land Use Maui Fires.

19 Figure 2.2.2.1 Illustration of the Lahaina drinking water treatment system.

21 Figure 2.2.2.2 Illustration of the Mahinahina drinking water treatment system.

25 Figure 2.4.2.1 Island of Maui Fire Response Zones.

31 Figure 4.1.1 Map of Maui, showing the location and extent of the four fires over the August 8, 2023 and August 9, 2023 incident.

32 Figure 4.1.2 Map of the Maui County showing the extent of the Olinda fire.

32 Figure 4.1.3 Map of the greater Lahaina area of Maui County showing the extent of the Lahaina fire.

33 Figure 4.1.4 Map of the Maui County showing the extent of the Kula fire.

33 Figure 4.1.5 Map of Maui County showing the extent of the Pulehu-Kihei fire

36 Figure 4.2.2.1 HI-EMA ERT Roster, June 2, 2023.

37 Figure 4.2.2.2 NWS HFO “Critical Fire Weather” Message, August 4, 2023.

37 Figure 4.2.2.3 SEOC Staffing Email, August 8, 2023.

39 Figure 4.2.2.4 MPD station locations. Source: Maui County.

40 Figure 4.2.2.5 MFD engine company districts.

43 Figure 4.2.3.1 Image capture of civilian video showing westbound traffic on Lahainaluna Road between Kale Street and Pauoa Street at 09:07.

43 Figure 4.2.3.2 Civilian photo of a utility pole blocking Hwy-30 at the Lahaina Civic Center.

44 Figure 4.2.3.3 Civilian image taken August 8, 2023, at 16:11 showing westbound traffic on Komo Mai Street toward Kuhua Street and Keawe Street.

44 Figure 4.2.3.4 August 8, 2023, at 13:46. Civilian photo of roof damage looking west down Lahainaluna Road from Luakini Street.

44 Figure 4.2.3.5 August 8, 2023, at 07:01. Civilian image of trampoline in overhead electrical lines at Dickenson Street and Mill Street.

46 Figure 4.3.1.1 Comprehensive fire progression map of the greater Lahaina and western Maui areas.

47 Figure 4.3.1.2 Fire progression map of western Maui with detailed data from various sources.

48 Figure 4.3.1.3 Building ignition mechanisms from WUI fire exposures: embers, radiant heat, and direct flame contact.

49 Figure 4.3.1.4 Map of fire progression running roughly along Lahainaluna Road from 14:55 through 15:37.

50 Figure 4.3.1.5 Image capture from civilian video showing smoke in the area of the ravine moving with the wind toward the Lahaina Bypass exit for Lahainaluna Road (14:58).

51 Figure 4.3.1.6 Fire progression map showing fires in or near the Lahainaluna Road area from 15:38 through 16:08.

52 Figure 4.3.1.7 Smoke boundary map of the greater Lahaina area at approximately 16:00.

53 Figure 4.3.1.8 Map showing fire progression in the Lahainaluna Road, Dickenson Road, and Hwy-30 area from 16:09 through 16:36.

54 Figure 4.3.1.9 Fire progression map showing particularly fierce fire spread in the Waineʻe Street area from 16:42 through 17:42.

56 Figure 4.3.1.10 Southern flank of fire showing fire progression from 17:44 and 18:00.

57 Figure 4.3.1.11 Image capture from a civilian video recorded from 1[redacted] Shaw Street looking north showing fire progression from Waineʻe Street to Front Street (18:00).

57 Figure 4.3.1.12 Fire progression map of the northern flank of the fire from 17:55 to 18:18.

58 Figure 4.3.1.13 Map of fire progression showing fire spread from the Kahoma Stream area, near the end of Komo Mai Street.

59 Figure 4.3.1.14 Image capture from a civilian video of the far west end (makai) of Komo Mai Street (18:14).

59 Figure 4.3.1.15 Image capture from a civilian video of the west end (makai) of Komo Mai Street (18:14).

60 Figure 4.3.1.16 Image capture from a civilian video of the west end (makai) of Komo Mai Street (18:14).

60 Figure 4.3.1.17 Image capture from a civilian video of the east end (mauka) of Komo Mai Street (18:14).

61 Figure 4.3.1.18 Image capture from a civilian video taken at Front Street Apartments near Kenai Street East (18:12).

61 Figure 4.3.1.19 Image capture from civilian video taken of Front Street near Kenui West (18:18).

62 Figure 4.3.1.20 Map of fire progression from multiple fires from 18:28 through 19:38 in the southern area of the fire.

62 Figure 4.3.1.21 Image capture from a civilian video taken from Paulei Drive in the Puamana community and showing the southernmost vantage point of the fire with heavy smoke moving east (mauka) to west (makai) and imaged facing north (18:28).

Lists of Figures

63 Figure 4.3.1.22 Image capture from a civilian video taken near Shaw Street and Front Street showing a structure on 505 Front Street on fire. The same video shows 1[redacted] Shaw Street (Salvation Army Building) well involved in fire (18:47).

63 Figure 4.3.1.23 A civilian image taken near Shaw Street and Front Street showing another structure (near to the Salvation Army building) on fire just north on Front Street (18:47).

64 Figure 4.3.1.24 Fire progression map from 18:57 through 20:29 showing fire spread in the Kahoma region, spreading west and north.

64 Figure 4.3.1.25 Image capture from civilian video showing spot fires in the trees along Kuhua Street, behind 40 Kupuohi Street (19:00).

65 Figure 4.3.1.26 Image capture from a civilian video of the view from Lahainaluna Road (19:26).

65 Figure 4.3.1.27 Image capture from a civilian video showing another view from Lahainaluna Road looking southwest (19:26).

66 Figure 4.3.1.28 Image capture from a civilian video taken from Lahainaluna Road looking southwest toward Ku'ialua Street showing multiple spot fires (19:26).

66 Figure 4.3.1.29 Image capture from a civilian video from Lahainaluna Road showing multiple spot fires on Kuiʻalua Street (19:26).

67 Figure 4.3.1.30 Image capture from a civilian video of a fifth view from Lahainaluna Road showing a burned tree with surrounding embers in the foreground (19:26).

67 Figure 4.3.1.31 Image capture from a civilian video of another view from Lahainaluna Road showing multiple spot fires looking west (19:26).

68 Figure 4.3.1.32 Image capture from a civilian video of another view from Lahainaluna Road showing multiple spot fires looking west (19:26).

69 Figure 4.3.1.33 Fire progression map from 20:29 through 21:01 showing the fire spreading south.

70 Figure 4.3.1.34 Civilian image taken at Front Street and Hwy-30 looking north toward Aholo Street with a bystander in the foreground (20:29).

71 Figure 4.3.1.35 Fire progression map from 21:25 through 22:29 showing the fire spreading west and north.

71 Figure 4.3.1.36 Image capture from civilian video of the fire wrapping the east (mauka) and north sides of the construction site north of Keawe Street (21:29).

72 Figure 4.3.1.37 Image capture from civilian video of a fully engulfed car on Oil Road (21:31).

72 Figure 4.3.1.38 Image capture from civilian video taken from the Nahale Street cul-de-sac looking north (22:09).

73 Figure 4.3.1.39 Civilian image showing fire moving east (mauka) to west (makai) down Fleming Road (22:29).

73 Figure 4.3.1.40 Fire progression map from 22:28 through 02:02 showing the fire spreading south to southeast.

74 Figure 4.3.1.41 Fire progression map from 22:40 through 06:07 showing the fire spreading west and north.

75 Figure 4.3.1.42 Image of fires at Kahoma to Hiki Place (22:44).

77 Figure 4.3.1.43 Image capture from civilian video of fire at 12[redacted] Nahale Street (23:59).

77 Figure 4.3.1.44 Image capture from a civilian video showing a close up view 12[redacted] Nahale Street on fire and 12[redacted] Nahale Street destroyed (01:17).

78 Figure 4.3.1.45 Image capture from a civilian video showing fire continuing to advance south along Nahale Street (01:56).

78 Figure 4.3.1.46 Image capture from civilian video shows 12[redacted] Nahale engulfed in flames. The fire does not advance beyond the fence of 12[redacted] Nahale Street (02:30).

79 Figure 4.3.1.47 Image capture from civilian video showing the grass fire east of the end of Wahikuli Road. The fire is advancing north and backing east (mauka) upslope (05:35).

80 Figure 4.3.1.48 Image capture of civilian video showing a second view of the grass fire backing upslope, just east (mauka) of the end of Wahikuli Road (05:35).

80 Figure 4.3.1.49 Image capture from civilian video showing the Kaiāulu o Kupuohi apartment building on fire (05:35).

80 Figure 4.3.1.50 Image capture of civilian video showing another image of the Kaiāulu o Kupuohi apartment building on fire (05:59).

81 Figure 4.3.1.51 Image showing the grass fire backing upslope from Wahikuli Road (near the water tank) to Kaʻanapali (05:59).

81 Figure 4.3.1.52 Aerial image after the fire that shows where structure-to-structure fire spread ceased.

82 Figure 4.3.1.53 A second aerial view showing where the grass fire spread was stopped.

82 Figure 4.3.1.54 An aerial image showing where the southern spread of grass fires was stopped.

83 Figure 4.3.1.55 An aerial image showing where the southern building to building fire spread ceased.

208 Figure 4.3.3.1 Traffic Congestion Points (August 8, 2023 05:00 – 11:00).

210 Figure 4.3.3.2 Traffic Congestion Points (August 8, 2023 11:00 – 15:00).

212 Figure 4.3.3.3 Traffic Congestion Points (August 8, 2023 15:00 – 16:30).

218 Figure 4.3.3.4 Traffic Congestion Points (August 8, 2023 16:30 – August 9, 2023 01:00).

221 Figure 4.3.3.5 Maui Police Department Preliminary After-Action Recovery Report, page 63. Victims and recoveries by type.

222 Figure 4.3.3.6 Maui Police Department Preliminary After-Action Recovery Report, page 54.

223 Figure 4.3.3.7 Maui Police Department Preliminary After-Action Report, page 47. Maps of Victim Recoveries, Map Legend 1.

224 Figure 4.3.3.8 Maui Police Department Preliminary After-Action Report, page 48. Maps of Victim Recoveries, Map 1.

225 Figure 4.3.3.9 Maui Police Department Preliminary After-Action Report, page 49. Maps of Victim Recoveries, Map 2.

Lists of Figures

226 Figure 4.3.3.10 Maui Police Department Preliminary After-Action Report, page 50. Maps of Victim Recoveries, Map 3.

227 Figure 4.3.3.11 Maui Police Department Preliminary After-Action Report, page 51*. Maps of Victim Recoveries, Map 4.

228 Figure 4.3.3.12 Maui Police Department Preliminary After-Action Report, page 52. Maps of Victim Recoveries, Map 5.

229 Figure 4.3.3.13 Maui Police Department Preliminary After-Action Recovery Report, page 53. Maps of Victim Recoveries Map Legend 2.

233 Figure 4.3.4.1 Hawaiian Electric Response to Downed Equipment.

237 Figure 4.3.5.1 Estimated Water Volume Stored by Maui County Department of Water Supply on August 8, 2023.

238 Figure 4.3.5.2 Damaged Fire Hydrant 126 at the Intersection of Paunau Street and Pupu Place.

259 Figure 4.3.7.1 Source: excerpt from “HI-EMA Administrator Timeline” document.



EXECUTIVE SUMMARY

On August 8-9, 2023, the historic town of Lahaina, Hawai‘i, suffered a devastating fire that ranks among the deadliest in U.S. history. A confluence of environmental and geographic factors, combined with preparedness and response conditions, enabled the fire to rapidly intensify into an urban conflagration (extensive fire that causes significant destruction), resulting in 101 confirmed fatalities, widespread destruction of homes and businesses, and catastrophic impacts on the community.

In August 2023, shortly after the fire, the Hawai‘i Department of the Attorney General (DOAG) contacted the Fire Safety Research Institute (FSRI), a part of UL Research Institutes (ULRI) for subject matter expertise. After a site visit and initial consultation with FSRI experts in Lahaina, Hawai‘i Attorney General (AG) Anne E. Lopez engaged FSRI to conduct a comprehensive independent analysis of the Lahaina fire. This report focuses on the events that occurred prior to, during, and immediately following the Lahaina fire, such as preparedness efforts, weather and its impact to infrastructure, and other fires occurring on Maui for the time period beginning at 14:55 (2:55 p.m. HST) on August 8, 2023, and concluding at 08:30 (8:30 a.m.) on August 9, 2023. Data from the three (3) other Maui fires is also included in specific sections to give context to the situation in Lahaina.

FSRI conducted an extensive data collection effort to establish a comprehensive timeline and fact base around the Lahaina fire. This report pieces together a detailed timeline of preparedness efforts, fire progression, evacuation activities, emergency response, and fire suppression actions based on a comprehensive array of data sources including radio communications and transcripts, video, images (still images or image capture from digital videos), emergency logs, technical discussions (TDs) with authorities and residents, text and phone logs, email records, automatic vehicle location applications, social media posts, witness accounts, and corroborated personal experiences. Mapping and analysis illustrate how the fires moved from the wildland into Lahaina's neighborhoods, rapidly transforming from a grassland fire into a catastrophic urban conflagration.

Data collection for this report consisted of gathering all known available facts relating to the August Lahaina fire as well as the preparedness efforts by the Maui Fire Department (MFD), Maui Police Department (MPD), Maui Emergency Management Agency (MEMA), and state, federal and private cooperating agencies. These facts included time-stamped conditions (i.e., damage to buildings due to wind, fire, smoke, fallen trees and utility poles, traffic, etc.) and actions (i.e., evacuation, fire suppression, rescues, etc.). Data requests were prioritized by their value in establishing an event timeline and understanding the facts of the conditions existing prior to and during the incident. This data offers the most precise representation of the fire's rate of spread through Lahaina and the corresponding response efforts.

FSRI's goal is to thoroughly document the facts around this tragic event to allow for subsequent analysis and lessons learned. While this report does not analyze causation, it lays the critical foundation for examining the policies, practices, preparedness, and response that will ultimately improve public safety and resilience against similar fire disasters. This document is the first in a series of independent reports that will provide a complete timeline—based on voluminous evidence and contemporary fire science—of the August 2023 Lahaina fire on Maui; an exhaustive analysis of contributing factors to the horrible outcome; and finally, a forward-looking report with actionable recommendations to help prevent future tragedies.

Summary of the Lahaina Fire

In the days preceding August 8, 2023, Maui found itself in the crosshairs of a potential disaster. As Hurricane Dora approached from the south, passing approximately 500 miles offshore, it created a pressure gradient that meteorologists warned would bring damaging winds, low humidity, and an elevated risk of wildfires to the island. Recognizing the impending threat, several organizations, including the National Weather Service (NWS), the Maui County Department of Fire and Public Safety, the Maui County Emergency Management Agency (MEMA), and the Hawai‘i Emergency Management Agency (HI-EMA), issued numerous alerts about the possibility of high winds and extreme fire danger on August 8, 2023. In anticipation of the hazardous conditions, MEMA partially activated the Emergency Operations Center (EOC) on the evening of August 7, 2023.

During the early morning of August 8, 2023, the predicted high winds arrived across central and western Maui. Trees toppled, utility poles fell, and power lines were downed, blocking critical roadways and making evacuation challenging.

Enabled by the dry fuels, sustained winds, and the dense urban landscape, a fire that began near the Lahaina Intermediate School spread rapidly, overwhelming initial efforts to contain it. The origin of the Lahaina fire can be traced back to 06:35 (6:35 a.m.), when a fast-moving brush fire, later dubbed the "Lahaina AM fire," ignited near Ku‘ialua Street and Ho‘okahua Place. Intense winds, rocky terrain, a ravine, and utility poles with overhead electrical wires in the fire area would also complicate fire suppression efforts. Firefighters responded to the scene, employing private bulldozers and water tankers to construct perimeter lines and soak the fire area with water. They later reported that the fire was extinguished and returned to quarters at 14:17 (2:17 p.m.).

At 14:55 (2:55 p.m.), the "Lahaina PM fire" or "Ku‘ialua fire," was reported at the same location as the earlier fire. This time, fueled by sustained high winds, the fire spread rapidly. Embers carried by the wind ignited unburned grassland areas downwind from the initial fire location and continued to spread, reaching homes and other structures. From there, the fire spread through direct flame contact, radiant heating, and flying embers. The high winds, funneling the fire into Lahaina Town and towards the Pacific Ocean, created a conflagration that overwhelmed the town's limited evacuation routes, some of which were blocked by downed utility poles and electrical lines. At times, people were forced to use the ocean for safe refuge.

Hawai‘i Route 3000 (Lahaina Bypass), a primary evacuation route, was among the roadways impacted. Smoke, pushed low to the ground by the wind, made visibility difficult and soon overwhelmed the efforts of police and firefighters to evacuate the area. Many residents found themselves trapped, unable to escape the advancing flames and thick, blinding smoke. On Lahainaluna Road, vehicles became stranded and civilians were trapped by the rapidly encroaching fire. A similar scenario played out north on Kahua Street, where the fire's path of destruction would claim numerous lives. Responders and residents created several alternate evacuation routes by opening locked gates and clearing access to dirt roads in the area.

As the fire was moving quickly and roadways remained blocked, several crews of firefighters became trapped near Pauoa Street by the advancing fire and were overwhelmed by flames. Fire apparatus became entangled by power lines

or were unable to evacuate the area due to obstructions–and had to be abandoned, further hampering efforts to combat the growing blaze. One (1) firefighter rescued seven (7) colleagues, including an unconscious officer who required urgent medical attention. Numerous firefighters administered emergency care to the officer.

No longer just a wildfire, the fire had also become an urban conflagration, consuming more buildings than the firefighters were able to protect. Burning structures, vehicles, and vegetation all produced embers and became sources of radiant heat and flames. The fire quickly spread across Honoapi‘ilani Highway (Hwy-30) and all the way to the ocean's edge.

As homes and other buildings burned, the water pipes failed and water flowed unrestricted. Pressure in the water mains dropped to the point that there was no water coming from fire hydrants in some parts of Lahaina.

In the aftermath of this catastrophe, questions linger about the adequacy of warning systems, evacuation planning, and the preparedness of communities for such extreme fire events. The tragedy serves as a sobering reminder that the threat of grassland fires, wildfires, and wildfire-initiated urban conflagrations, fueled by climate change and urban encroachment into wildland areas, is a reality that must be addressed with the utmost urgency and diligence–not just in Hawai‘i, but around the globe.

While the physical scars of this disaster will take time to heal, the emotional toll on the people of Lahaina and the wider Maui community will be felt for generations to come. As the island and the nation mourn the lives lost, the focus must also turn to learning from this tragedy, strengthening emergency response capabilities, and building more resilient communities that can withstand the increasing challenges posed by a changing climate and the ever-present threat of wildfires.

An Incident Analysis Report in Phase 2, outlining FSRI’s independent analysis of these events, will follow the initial report. It will provide detail on conditions influencing the original fire situation, attempts to stop its rapid progression through Lahaina Town, evacuation efforts, as well as suppression analysis, electrical power status, burnover assessment, communication effectiveness, and structural damage analysis. Incident analysis will incorporate science and evidence-based analyses with information from FSRI’s fire dynamics research, local subject matter experts, industry standards and best practices, and the collective experiences of FSRI’s research team.

The Forward-Looking Report developed in Phase 3 of this independent analysis will help answer critical questions about, “How do we prevent this from happening again?” This Phase 3 report will have several discrete and interrelated components including a standards of cover analysis to assess the capabilities of the Maui County Fire Department, a community risk assessment to analyze natural and human caused risks to Maui, community risk reduction planning to help mitigate risk, and a review of fire and building codes.



INTRODUCTION

The fires that occurred on August 8, 2023, and August 9, 2023, on Maui resulted in significant loss of life and property damage. A total of 101 fatalities have been confirmed in Lahaina, with two (2) additional individuals still reported as missing by the Maui Police Department (MPD).[1]

Despite the devastation, numerous acts of heroism and community cooperation were observed. Residents assisted in fire fighting and evacuation efforts, utilizing resources such as garden hoses, portable pumps, and pool water to protect homes. Rescues were conducted by both civilians and first responders, often extracting individuals from dangerous conditions involving heavy smoke, flying embers, and active fires. Law enforcement officers attempted to evacuate residents while contending with hazards such as downed power lines, broken utility poles, and debris obstructing roadways. Firefighters engaged the fires from precarious positions and, after hydrants were depleted, used personal vehicles to transport evacuees to safety.

The Native Hawaiian concept of “laulima”, emphasizing familial cooperation, was prevalent, with residents aiding neighbors and strangers alike. However, the loss of elders (the term Kupuna is most commonly used in Hawai‘i), revered knowledge bearers in Polynesian cultures, was particularly impactful.

This document is the first in a series of independent reports that will provide a complete timeline—based on voluminous evidence and contemporary fire science—of the August 2023 Lahaina fire on Maui; an exhaustive analysis of contributing factors to the horrible outcome; and finally, a forward-looking report with actionable recommendations to help prevent future tragedies. This report honors those who perished and remain missing.

1.1 Fire Safety Research Institute’s (FSRI) Responsibility

The Fire Safety Research Institute (FSRI)[2], part of UL Research Institutes[3] (ULRI), is a leading independent safety science organization with a global footprint and a lineage dating back to the formation of Underwriters Laboratories (UL) in 1894. Fire safety was an initial catalyst for the formation of UL, and FSRI was the first research institute to be incorporated within ULRI.

In August 2023, shortly after the tragic Lahaina fire on Maui, the Hawai‘i Department of the Attorney General (DOAG)[4] contacted FSRI for subject matter expertise in the wake of this horrific event. After a site visit and initial consultation with FSRI experts on the fireground, Hawai‘i Attorney General (AG) Anne E. Lopez engaged FSRI to conduct a comprehensive independent analysis.[5]

FSRI is widely recognized as the premier fire safety science organization in the world. The organization advances fire safety knowledge to address the world’s unresolved fire safety risks and emerging dangers through advanced science, rigorous research, extensive outreach, and education. Drawing on the resources of ULRI’s global network of scientists and safety professionals, FSRI is uniquely positioned to apply science to complex real-world challenges.

Most importantly, FSRI’s independent assessment of the August 2023 Lahaina fire is informed by the best-available science on fire dynamics, relevant subject matter experts located in Hawai‘i and beyond, and the FSRI team’s 200-plus years of collective experience researching, responding to, managing, and recovering from major fire incidents around the globe.

[1] *https://www.capitalgazette.com/2024/02/13/police-confirm-identity-of-101st-victim-of-huge-maui-wildfire/*
[2] *https://fsri.org/*
[3] *www.ul.org*
[4] *www.ag.hawaii.gov*
[5] *Department of the Attorney General News Release, August 31, 2023*

FSRI is humbled to assist the State of Hawai‘i with this important analysis, which has implications across Maui Nui (the islands that make up Maui County, including Maui, Moloka‘i, Lāna‘i, Kaho‘olawe, and the islet of Molokini), the broader Hawaiian Islands, and so many other communities worldwide.

1.2 Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) Responsibility

Given the historic impact of the Lahaina fire, the federal Bureau of Alcohol, Tobacco, Firearms and Explosives[6] (ATF) immediately responded with its National Response Team (NRT) to assist the Maui County Department of Fire and Public Safety with determining the origin and cause of the August 2023 Maui fires.[7]

The ATF’s role in such investigations is to help local officials identify the initial point of origin and cause of a fire. FSRI experts met with the ATF NRT on Maui and received a detailed briefing on the progress of its analysis. As a federal agency, the ATF only releases its findings to Maui County, the requesting locality.

The ATF NRT departed Maui on August 30, 2023, and provided the Maui County Department of Fire and Public Safety (MFD) with the information it compiled. The ATF investigation is ongoing and a date of report release has not been announced.

1.3 FSRI Analysis of Structure-to-Structure Fire Spread in Lahaina Town

The initial focus of FSRI’s analysis was to comprehensively describe the progression of the fire that destroyed much of Lahaina Town on August 8, 2023, and August 9, 2023, starting where the origin and cause investigation concludes.

From evidence gathered across Maui, informed by FSRI’s extensive experience and research in fire dynamics, especially structure-to-structure fire spread, much of the fire behavior in Lahaina transcended its initial wildland-urban interface (WUI) character to become an even more devastating urban conflagration with alarming speed arising from wind-driven flames and embers.

While the Lahaina fire’s origin was in a WUI setting mauka of Lahaina town (on the mountain side), once it crossed the Hawai‘i Route 3000 (Lahaina Bypass) and ignited the first structures, its primary fuel became structural components and contents, with additional fire spread through grass- and vegetation-covered interstitial areas, driven by extraordinary weather conditions.

FSRI and its partners have multiple research projects underway that are directly relevant to the complex fire progression scenario in Lahaina. For example:

- Development of an Interactive Database of Contemporary Material Properties for Fire Modeling[8]
- Firebrand Ignition of Building Materials[9]
- Firebrand Showers Impacting Roofs[10]
- Heat Transfer and Fire Damage Patterns on Walls for Fire Model Validation[11]
- Heat Transfer from Structure Fires[12]

[6] *www.atf.gov*
[7] *ATF News Release, August 30, 2023 https://www.atf.gov/news/pr/atf-national-response-team-departs-maui-consolidates-info-maui-fire-department*
[8] *https://fsri.org/research/development-interactive-database-contemporary-material-properties-fire-modeling*
[9] *https://fsri.org/research/firebrand-ignition-building-materials*
[10] *https://fsri.org/research/firebrand-showers-impacting-roofs*
[11] *https://fsri.org/research/heat-transfer-and-fire-damage-patterns-walls-fire-model-validation*
[12] *https://fsri.org/research/heat-transfer-structure-fires*

INTRODUCTION

Beyond this research and an intensive review of the relevant academic literature, the FSRI team has engaged directly with subject matter experts across Hawai'i, to better understand the local factors influencing fire dynamics on Maui.

This interaction includes, but is not limited to:

- Hawai'i Division of Forestry and Wildlife (DOFAW)[13]
- Hawai'i Wildfire Management Organization (HWMO)[14]
- National Weather Service (NWS) Forecast Office Honolulu, HI[15]

1.4 Scope of the Analysis Performed by FSRI

Given the scale of the August 2023 tragedy in Lahaina, the scope of FSRI's comprehensive independent analysis consists of three (3) discrete phases, as stated by the DOAG on August 31, 2023, and described in the balance of this section.[16]

Phase 1: Fact-finding about how the fire incident unfolded.

The Comprehensive Timeline presented in this report was compiled from a wide range of data sources, including: FSRI researchers' direct field observations across Lahaina; information from responding Maui County agencies; and exhaustive interviews with residents, survivors, family members, government officials, and first responders.

This data was then compiled into a spreadsheet which shows the Lahaina fire's progression and identifies responders' contemporaneous events and actions. To see the complete dataset, visit https://ag.ha - waii.gov/maui-wildfire-investigation-resources-page/ and https://doi.org/10.54206/102376/VQKQ5427.

This report focuses on the time period beginning at 14:55 on August 8, 2023, and concludes at 08:30 on August 9, 2023, and includes the relevant events that occurred prior to and during this time, such as preparedness efforts, weather and its impact to infrastructure, and other fires occurring on Maui.

Data from the three (3) other Maui fires is also included in specific sections to give context to the situation in Lahaina. An example of this is where Hawai'i Division of Forestry and Wildlife (DOFAW) resources assigned to Olinda, Kula, and the Pūlehu-Kīhei fires are shared to show the high demand for wildland firefighting resources on the island on August 8, 2023 (see section 4.3.11).

The resulting timeline is *the foundation of the analysis* for FSRI's work in Phase 2.

Phase 2: Analysis of the data, determining how various fire protection systems functioned in this fire incident.

The *Incident Analysis Report* developed in Phase 2 of FSRI's independent analysis will provide detail on conditions influencing the original fire situation, attempts to stop its rapid progression through Lahaina Town, and evacuation efforts. This phase will use science and evidence-based analyses with information from FSRI's cutting-edge fire dynamics research, local subject matter experts, industry standards and best practices, and the collective experiences of FSRI's team.

Phase 3: Best practices that incorporate additional data and recommendations for Hawai'i to act toward prevention.

The *Forward-Looking Report* developed in Phase 3 of this comprehensive independent analysis will help answer critical questions about, *"How do we prevent this from happening again?"*

Phase 3 will have several discrete and interrelated components, described in the following paragraphs.

[13] *https://dlnr.hawaii.gov/dofaw/*
[14] *https://www.hawaiiwildfire.org/*
[15] *https://www.weather.gov/hfo/*
[16] *Department of the Attorney General News Release, August 31, 2023 https://ag.hawaii.gov/wp-content/uploads/2023/08/News-Release-2023-42.pdf*

- **Standards of Cover (SOC) Analysis**

A standards of cover (SOC) analysis will be developed, using data provided by Maui County and analyzed using state-of-the-art operations research modeling techniques —to determine the level of fire protection resources (i.e., fire apparatus and personnel) needed for the MFD to meet applicable national standards for "all hazards" fire and emergency response across its entire area of responsibility.

- **Community Risk Assessment**

A community risk assessment (CRA) will be performed, using data from Maui County and a wide array of complementary sources, to assess the level of risk from all hazards (i.e., fire, flood, tsunami, etc.) throughout Maui Nui, with special emphasis on WUI fires.

- **Community Risk Reduction Planning**

Using a wide range of approaches to engage directly with communities across Maui County, community risk reduction planning will be conducted to help develop realistic fire prevention and risk reduction strategies for residents, businesses, and visitors.

- **Fire and Building Code Review**

At the request of the MFD, FSRI will perform a review of existing fire and building codes, in concert with the International Code Council (ICC). This review will engage code officials and other relevant groups across Maui and the entire State of Hawai'i.



2.0 Background

2.1 Description of Area–Fire Environment

Several factors interact to comprise the wildfire-prone nature of Maui. These factors that contribute to wildfire occurrence and spread include a combination of biophysical characteristics of the natural environment (topography, climate/weather, vegetation, and natural resource management) and the built environment (land use and development patterns). An overview of these and other factors provide a baseline for understanding of the fire environment on Maui. Comprehensive discussions of these factors at a regional level are included in several existing localized wildfire plans:

- Western Maui Community Wildfire Protection Plan[17]
- South Maui Community Wildfire Protection Plan[18]
- Upcountry Maui Community Wildfire Protection Plan[19]
- Leeward Haleakalā Community Wildfire Protection Plan[20]

An overview for the entirety of Maui is provided below.

2.1.1 Physical Characteristics

Maui is the second largest island in the state of Hawai'i and was formed by two (2) volcanoes merging—Haleakalā to the east (10,023 ft. elevation) and Mauna Kahālāwai (also known as the West Maui Mountains, 5,788 ft. elevation) to the west. The island is 48 miles long and 26 miles at its widest, comprising a total of 728 square miles. The two (2) mountain areas are connected by a broad lowland isthmus. Like the rest of Hawai'i, Maui's significant elevation changes from sea level to mountain peaks and its exposure to northeast trade winds for the majority of the year, contribute to a complex pattern of localized microclimates, ecosystems, and wildland-urban development patterns. (Figures 2.1.1.1 and 2.1.1.2).

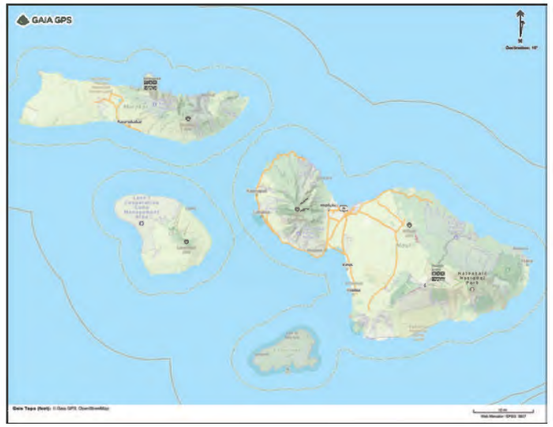


Figure 2.1.1.1 Maui Nui (the islands that make up Maui County, including Maui, Moloka'i, Lāna'i, Kaho'lawe). *Source: Gaia GPS.*



Figure 2.1.1.2 Maui Island. Source: Gaia

[17] https://dlnr.hawaii.gov/forestry/files/2024/01/Western-Maui-CWPP.pdf
[18] https://dlnr.hawaii.gov/forestry/files/2018/04/2016_SouthMauiCWPP_HWMO.pdf
[19] https://dlnr.hawaii.gov/forestry/files/2018/04/UMCWPPPlanwithappendices161230.compressed.pdf
[20] https://dlnr.hawaii.gov/forestry/files/2023/10/LH-CWPP-2020_FINAL-w-appendices-compressed.pdf

2.1.2 Climate and Weather [21, 22]

Hawai'i lies on the northern margin of the tropics (just below the Tropic of Cancer). Over 2,000 miles from any continental land mass, the climate of the archipelago is greatly influenced by the surrounding Pacific Ocean. Hawaii's warmest months are August and September, and its coolest months are February and March, reflecting the effects of seasonal lag in the ocean's temperature. For most of Hawai'i, there are two (2) seasons. The winter season takes place between November to April; summer is May to October. Hawaiian references to these seasons of winter and summer use the words "ho'oilo" and "kau," respectively.[23]

The tall mountains of Mauna Kāhalāwai and Haleakalā on Maui have associated topographic features that include peaks, valleys, ridges, saddles, and slopes. These features influence every aspect of its weather and climate as well as fire behavior.

Across Maui, there is high variability in rainfall. Maui receives most of its rainfall on its north and east flanks via northeasterly trade winds and orographic precipitation. The southern and western sides of Maui are drier due to the "rain shadow" effect caused by the mountain shielding of those leeward sides, also referred to as the "orographic effect." Altitude also plays a role in rainfall gradients. Annual rainfall is highest in the upper crests and ridges and lowest in the leeward lowlands, as presented in Figure 2.1.2.1.[24]

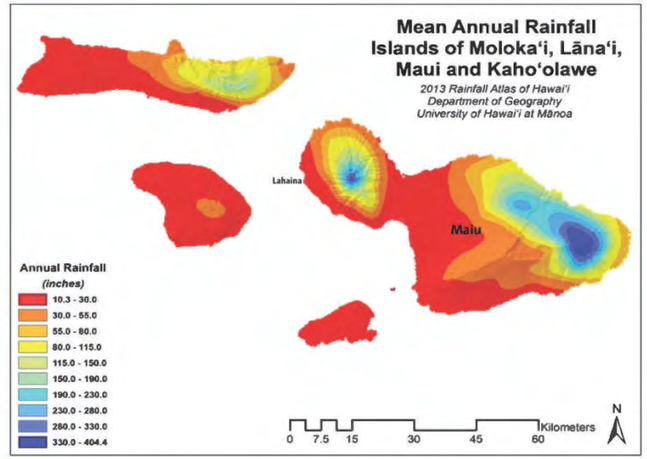


Figure 2.1.2.1 Mean Annual Rainfall Islands of Moloka'i, Lāna'i, Maui, and Koho'olawe / 2013 Rainfall Atlas of Hawai'i. Department of Geography. University of Hawai'i at Mānoa.

[21] Giambelluca, T.W., Q. Chen, A.G. Frazier, J.P. Price, Y.-L. Chen, P.-S. Chu, J.K. Eischeid, and D.M. Delparte, 2013: Online Rainfall Atlas of Hawai'i. Bull. Amer. Meteor. Soc. 94, 313-316, doi: 10.1175/BAMS-D-11-00228.1. http://rainfall.geography.hawaii.edu/howtocite.html
[22] National Weather Service, National Oceanic and Atmospheric Administration. Climate in Hawai'i. Based on a condensed chapter on Hawaii's climate from the Second Edition (University of Hawai'i Press, 1983) of the "Atlas of Hawai'i," authored by Saul Price, former Hawai'i State Climatologist and Staff Meteorologist for the National Weather Service Pacific Region. https://www.weather.gov/hfo/climate_summary
[23] Prevailing Trade Winds: Weather and Climate in Hawai'i, Edited by Marie Sanderson. University of Hawai'i Press. February 1994.
[24] Frazier, A. G., and Giambelluca, T. W. (2017), Spatial trend analysis of Hawaiian rainfall from 1920 to 2012. Int. J. Climatol., 37(5), 2522-2531. doi: 10.1002/joc.4862

2.1.3 Wind, Storms, and Fire Behavior

Wind Patterns

In general, winds on Maui originate from three (3) main sources: persistent northeast trade winds that typically dominate conditions from May to September, bringing cool, moist air from the ocean onto the windward slopes; southwesterly Kona winds that occasionally occur during the winter months, typically from October to April when the trade winds weaken or reverse due to passing storm fronts; and rare wind events from hurricanes and tropical storms passing through Hawaiian waters, including periodic downslope wind events. In general, the trade winds are more persistent in summer (90–92%) than in winter (50%).[7,25] High wind warnings (sustained wind speeds of 40 mph with 60+ mph gusts) are typically issued during winter storms or tropical storms.[26] Localized thermally-driven land-sea breezes can also impact near-shore areas.

The State of Hawai'i Hazard Mitigation Plan (2018) provides a detailed description of the hazard profile of these wind patterns.[27] The graph in Figure 2.1.3.1 (shown right) demonstrates the distribution of high wind events according to month.

Historical Accounts of Wind on Maui

Virtually all island habitats, including Hawai'i, are prone to potentially devastating ocean-borne winds. There are many names for and meanings of wind in Hawaiian culture. Relevant to the grassland fire events of August 2023 on Maui are the Kaua'ula[28] winds, which impact the west side of Maui in the Lahaina-Wahikuli region. This periodic wind phenomenon has been noted from historical times. One such account of a historical wind event in this area is shown right.[29]

Wind and Fire Behavior

The wind patterns on Maui influence fire behavior by affecting intensity, direction, and rate of spread. Wildfires have occurred under both typical conditions and rare weather and/or wind events. Wildfires on Maui do not occur exclusively during high wind events, nor do they occur exclusively during downslope wind events. While wildfires are directly influenced by wind speed and direction, valleys and canyons on Maui frequently channel winds, accelerating fire spread and intensifying fire behavior as winds funnel through narrow passages or flow around objects.

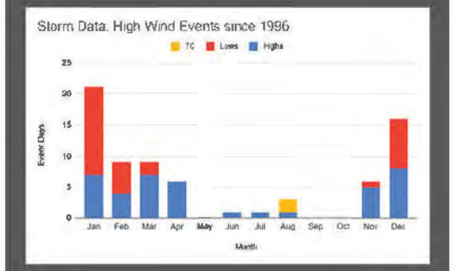


Figure 2.1.3.1 Distribution of source of high wind events in Hawai'i. Source: Bravender, I. NOAA National Weather Service. "TC" contributions are considered to be when an area is not within the high wind field of a tropical cyclone, but effects such as down-sloping winds on the periphery of a tropical cyclone prompted the NWS to issue a High Wind Warning. "Lows" are events associated with low pressure, and "Highs" are strong trade wind events caused by high-pressure systems.

From Kaua'ula[30] Valley blows a wind made famous in mele (songs) for its power of destruction. It was known to blow with hurricane force in the 1800s and has been clocked at over 120 miles per hour. Coming from Iao Valley over Pali Kāhili, down Kaua'ula Valley, the Makani Kaua'ula (Sacred Battle Wind) could blow from Honokowai to Waikapū, tearing down everything in its path. In 1858 it famously tore off the stone steeple and half the roof of the Waine'e Church. A hundred years later, in 1951, it completely demolished the second church, built in 1894 by H. P. Baldwin to replace the original structure burned out by anti-Royalists in 1893.

Mrs. Ka'ae (Aunty Kai) reported that the people were given a warning when the hurricane winds would blow...

– *Michelle Anderson.* The Storied Places of West Maui: History, Legends, and Place Names of the Sunset Side of Maui, 2016

Links Between Storms and Wildfire

While storms can also bring heavy rainfall, particularly wet seasons can worsen fire risks in subsequent dry seasons. This occurs due to the accumulation of vegetation (fuel loading) during the wet season, locally referred to as "green up" events. When the next dry period ensues, this excess fuel desiccates and becomes highly flammable standing fuel, intensifying the potential for wildfires.[31,32]

Seasonality of Fires[33,34]

Fires can occur any time of year, but annual rainfall seasonality and El Niño-driven drought events are the key area of fire activity across all of Hawai'i, including Maui. The annual cycle, which includes a wet season that promotes fuel accumulation and a pronounced dry season that allows fuels to cure, contributes greatly to the risk of fire ignition and spread. El Niño events greatly exacerbate dry/wet season patterns, often increasing rainfall at the start of the event followed by severe, region-wide drought.

Links Between Hurricanes and Wildfire

Several recent examples of the profound link between proximate hurricanes and wildfires have been recorded. For instance, in 2018, the low relative humidity (RH) and strong winds, connected to Hurricane Lane's nearby passing drove several wildfire events across Hawai'i, including one (1) in Lahaina, Maui, that burned 2,100 acres, 21 structures, and 27 vehicles.[35] Just a few weeks earlier from August 5-8, 2018, the Keauhou Ranch Fire burned over 3000 acres, as Hurricane Hector (100 knots 959 millibars) passed about 160 nautical miles south of the Big Island (Hawai'i). Nearly 9,000 acres burned in Mākaha Valley & Wai'anae Valley (Wai'anae Kai Baby Girl Fire) around August 5-6, 2018.

The effects of hurricane-wildfire connections have been scientifically studied. For example, in 2020, an analysis of hurricane winds and their relationship to fire was published by a team of researchers from the University of Hawai'i.[36] It details the compounding hazards of rain-driven flooding, heavy winds, and multiple fires that were produced by Hurricane Lane in 2018. The study concluded that both fire and rain severity were influenced by the hurricane environment and local topographic features. Conditions at the edge of the storm resulted in dry windy weather conducive to fire, while closer to the storm center, the incredibly moist atmosphere lifted by Hawaii's mountains brought intense, long-lasting rainfall.[37]

Fire Danger Weather and Red Flag Warnings[38]

The National Weather Service[39] issues fire weather planning forecasts daily with event-driven updates issued as necessary:

Red Flag Program:

Forecasters will issue Fire Weather Watches/Red Flag Warnings when the combination of dry fuels and weather conditions support extreme fire danger and/or fire behavior. Extreme fire behavior in Hawai'i is typically characterized by a wind-driven fire with high rates of spread that create control difficulties. Red Flag event criteria consist of both fuel and weather parameters and is primarily based on fuel and weather data from the Honolulu International Airport (PHNL).

[27] Sonia P. Juvik, James O. Juvik, and Thomas R. Paradise. Atlas of Hawai'i 2nd Edition. University of Hawai'i Press. p. 65
[26] Based on discussion with several representatives from NOAA-National Weather Service, Honolulu, January 2024.
[27] 2018 State of Hawai'i Hazard Mitigation Plan. Section 4. https://dod.hawaii.gov/hiema/files/2018/06/Draft-Section-4_10-High-Wind-Storms.pdf
[28] Pukui-Elbert Hawaiian Dictionary defines Kaua'ula as: "A strong mountain wind, often destructive, at Lahaina, Maui. Lit., the red rain [referring to red soil washed away by a storm]." https://wehewehe.org/gsdl2.85/cgi-bin/hdict?e=q-11000-00---off-0hdict--00-1----0-10-0---0---0direct-10-ED--4--textpukuielbert%2Ctextmamaka----0-1l--11-en-Zz-1---Zz-1-home-kauaula--00-3-1-00-0--4----0-0-11-00-0utfZz-8-00&a=d&d=D72691
[29] Anderson, M. The Storied Places of West Maui: History, Legends, and Place Names of the Sunset Side of Maui. University of Hawai'i Press. (2016) p.23
[30] Anderson, M. The Storied Places of West Maui: History, Legends, and Place Names of the Sunset Side of Maui. University of Hawai'i Press. (2016) p.23

[31] Wildfire Challenges Today. Pacific Fire Exchange webpage. https://pacificfireexchange.org/resource/hawaii-fire-challenges-today/
[32] Changing Climate and Wildfire in Hawai'i. Climate Change Series September 2022. Pacific Fire Exchange. https://pacificfireexchange.org/resource/changing-climate-wildfire-in-hawaii-current-observations-future-projections/
[33] Wildfire in Paradise - Management Context & Challenges. Pacific Fire Exchange. https://pacificfireexchange.org/wp-content/uploads/2022/07/WildfireInParadise_WUIContext_2018.10.01.pdf
[34] Trauernicht, C. 2019. Vegetation-Rainfall interactions reveal how climate variability and climate change alter spatial patterns of wildland fire probability on Big Island, Hawai'i. Science of the Total Environment 650:459-469
[35] Maui County After Action Report and Improvement Plan for 2018-8-18 Tropical Cyclone Lane. Prepared by County of Maui Emergency Management Agency 2019. https://www.scribd.com/document/680401526/2018-Maui-wildfires-after-action-reportfifrom_embed
[36] Nugent, A. D., R. J. Longman, C. Trauernicht, M. P. Lucas, H. F. Diaz, and T. W. Giambelluca, 2020: Fire and Rain: The Legacy of Hurricane Lane in Hawai'i. Bull. Amer. Meteor. Soc., 101, E954–E967, https://doi.org/10.1175/BAMS-D-19-0104.1
[37] https://Hawaii.edu/epscor/hurricane-lane-brought-fire-and-rain-to-hawai'i/
[38] https://www.weather.gov/media/hfo/Firewxops.doc
[39] Fire Weather Operations Plan. National Weather Service Forecast Office in Honolulu, Hawai'i, Brenchley, Wroe, and Bravender. June 2018 Update. https://www.weather.gov/media/hfo/Firewxops.doc

BACKGROUND

The Keetch-Byram Drought Index (KBDI), which is derived from temperature and rainfall data at the PHNL, is used to diagnose fuel conditions. A Red Flag event will be triggered for leeward portions of the state when all three (3) of the following criteria are met for two (2) hours or more during any part of a day at the PHNL:

1. KBDI ≥ 600
2. Minimum RH ≤ 45 % (two hours or more)
3. Wind ≥ 20 mph (≥ 17 kt) (two hours or more)

Fire Weather Watch:
Fire Weather Watches are issued to alert fire and land management agencies to the possibility of Red Flag conditions beyond the first forecast period (12 hours). The watch can be issued 18 to 96 hours in advance of the expected onset of criteria.

Red Flag Warning:
A Red Flag Warning is used to warn of an impending or occurring Red Flag event. Its issuance denotes a high degree of confidence that weather and fuel conditions consistent with Red Flag event criteria are occurring or will occur in 48 hours or less.

2.1.4 Vegetation and Fuels

Since Maui covers a vast stretch of topographic and climatic characteristics, a complex mosaic of land cover types exists. Vegetation generally follows a pattern of horizontal lines of vegetation zones, a consequence of rainfall and weather gradients. Higher elevations contain mixed native watershed forests. A patchwork of native mesic ecosystems, active or fallow agricultural lands, and limited development occupy mid-elevation areas. In many leeward areas, the vegetation in mid-to- lower elevations include mixed grass-shrublands dominated by introduced, fire-prone species. Invasive grasses and shrubs are especially prolific on fallow former agricultural lands, unmanaged vegetated corridors, and vacant/unmanaged lots. Developed areas are planted predominately with ornamental landscaping.

Grass-Fire Cycle–Fuel Loads

Fuels build up quickly on unmanaged lands due to a year-round growing season and highly competitive nature of the invasive grass and shrub species that have taken hold across Hawai'i. Warm temperatures year-round and ample annual rainfall result in rapid fuel accumulation and very high fine fuel loads.[40] The potential to carry fire for fine fuel types, such as the invasive grasses described above, is highly sensitive to quick and relatively small fluctuations in RH. Many fire managers in Hawai'i consider an RH of 60 percent or less to be a threshold for high fire potential.[41] Also utilized is the tracking of long-term 12-month rainfall yields, as this is a primary indicator of dry season fuel loads.

2.1.5 Hawai'i Fire History

Wildfires are increasing in frequency, size, and severity on all islands in Hawai'i. Wildfires in the islands were once limited to those caused by active volcanic eruptions and infrequent dry lightning strikes. Nearly all fires in Hawai'i are now human-caused, and they often pose threats to communities and natural and cultural resources.[42] With the combination of annual dry seasons and episodic droughts, high density of human-caused ignitions, and vast areas of unmanaged fuels, human-caused wildland fire has become a frequent hazard and disturbance throughout the state.[43]

[40] Trauernicht, et al. 2015. The scale and context of wildfire in Hawai'i. Pacific Science 69:427-447; and Minton. 2006. Fire, erosion, and sedimentation in the Asan-Piti watershed and War in the Pacific NHP, Guam. Pacific Cooperative Studies Unit, University of Hawai'i at Mānoa, Department of Botany. PCSU Technical Report, 150. https://www.fs.usda.gov/psw/publications/giardina/psw_2015_giardinao01_trauernicht.pdf
[41] Wildfire in Paradise - Management Context & Challenges. Pacific Fire Exchange. https://pacificfireexchange.org/wp-content/uploads/2022/07/WildfireInParadise_WUIContext_2018.10.01.pdf
[42] Summary of Fire Past and Present. Pacific Fire Exchange. https://pacificfireexchange.org/region/Hawaii/
[43] Challenges to Rapid Wildfire Containment in Hawai'i. Draft. C.Trauernicht, L.X.Gollin, M.P. Lucas, and C.P. Giardina. University of Hawai'i, Mānoa. College of Tropical Agriculture and Human Resources. Cooperative Extension. https://www.nrem-fire.org/_files/ugd/81f7ef_569d0cfb41443078o6fe8d8c9391cbd.pdf

Across Hawai'i, the number of acres burned has increased three-fold in the last two (2) decades. (Figure 2.1.5.1).

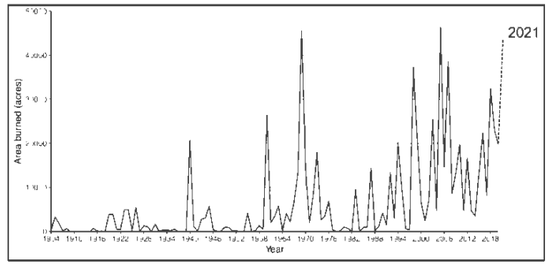


Figure 2.1.5.1 Wildfire Occurrence In Hawai'i. 1904–2021 (Credit: C. Trauernicht & HWMO).

Wildfire Ignitions

Approximately 99 percent of wildfires in Hawai'i are caused by human activity.[44] Natural causes of ignition are very rare, with lava restricted to active flows on Hawai'i Island and lightning strikes accounting for less than 0.2 percent of attributed wildfire causes.[45] The numbers of ignitions that require a fire suppression response have increased over the last several decades across Hawai'i islands on both (Figures 2.1.5.2 and 2.1.5.3) and are taking place throughout the year on all islands on both windward and leeward sides. Spatial patterns of prior wildfires reveal that ignitions are most frequent in developed areas, but most areas that burn large acreage occur in dry non-native grasslands and shrublands (Figure 2.1.5.4 – see following page). The four (4) densest areas of ignition on Maui are West Maui, South Maui (Kīhei to Kaupō), Kahului, and the corridor between the central-north shore to Upcountry Maui (Figure 2.1.5.5 – see following page).

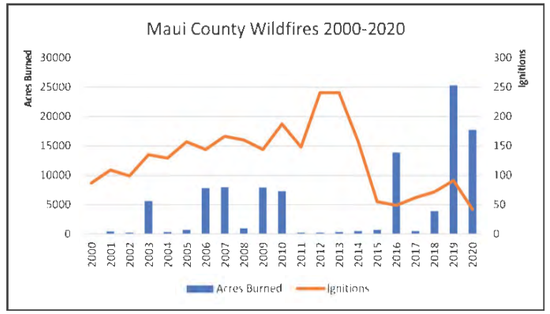


Figure 2.1.5.2 Maui County Wildfire Ignitions and Acres Burned by Year. 2000-2020. From 2016 to 2020 there was an inverse relationship between acres burned and ignitions. A. Bare and C. Trauernicht. Pacific Fire Exchange. Data Source: C. Trauernicht and Hawai'i Wildfire Management Organization. 2023.

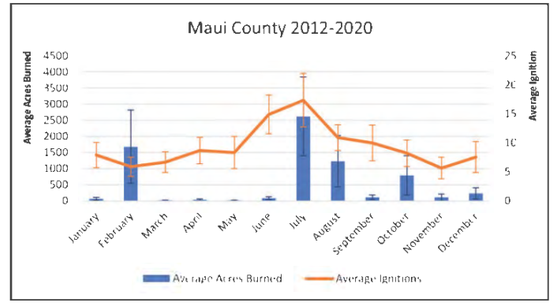


Figure 2.1.5.3 Maui County Ignitions and Acres Burned by Month. 2012–2020. Data indicates the greatest number of ignitions occurring during summer months. A. Bare and C. Trauernicht. Pacific Fire Exchange. Data Source: C. Trauernicht and Hawai'i Wildfire Management Organization. 2023.

[44] Trauernicht, C., E. Pickett, C.P. Giardina, C.M. Litton, S. Cordell, A. Beavers, A. 2015. The contemporary scale and context of wildfire in Hawai'i. Pacific Science 69:427-444 Friday, J.B., S. Cordell, C.P. Giardina, F. Inmahn-Narahari, N. Koch, J.K. Leary, C.M. Litton, C. Trauernicht. 2015. Future directions for forest restoration in Hawai'i. New Forests 46:733-746
[45] Trauernicht, C., E. Pickett, C.P. Giardina, C.M. Litton, S. Cordell, A. Beavers, A. 2015. The contemporary scale and context of wildfire in Hawai'i. Pacific Science 69:427-444 Friday, J.B., S. Cordell, C.P. Giardina, F. Inmahn-Narahari, N. Koch, J.K. Leary, C.M. Litton, C. Trauernicht. 2015. Future directions for forest restoration in Hawai'i. New Forests 46:733-746

BACKGROUND

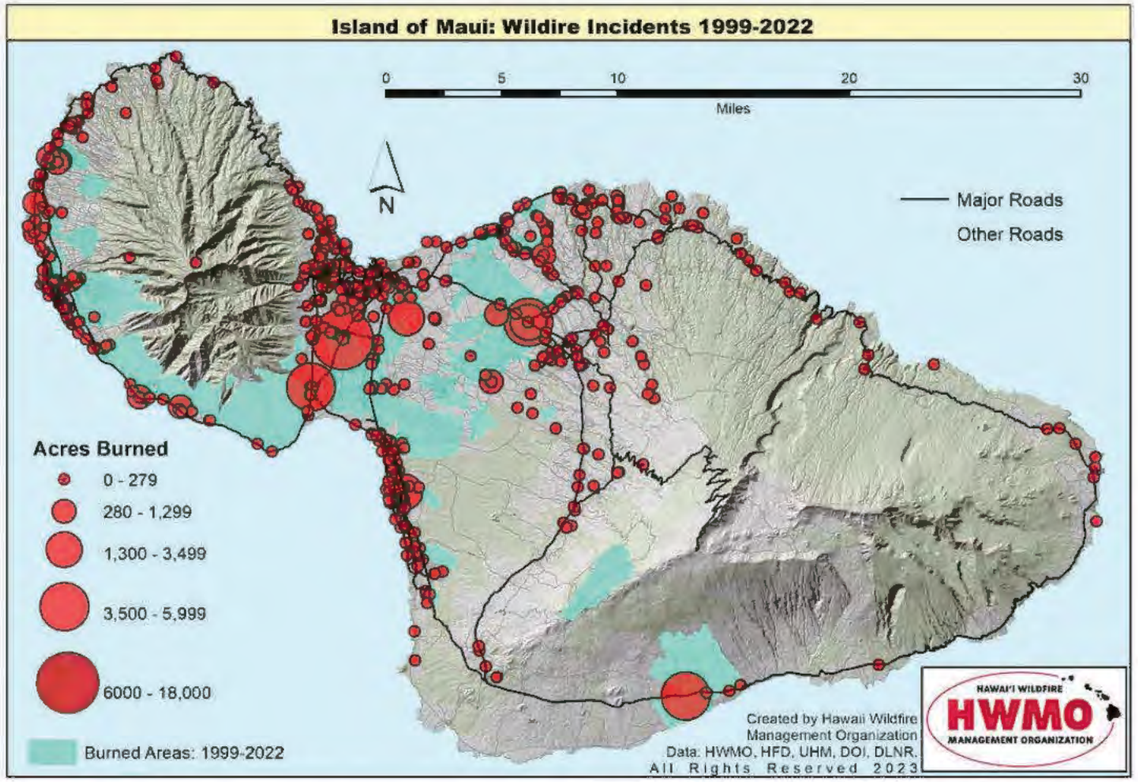
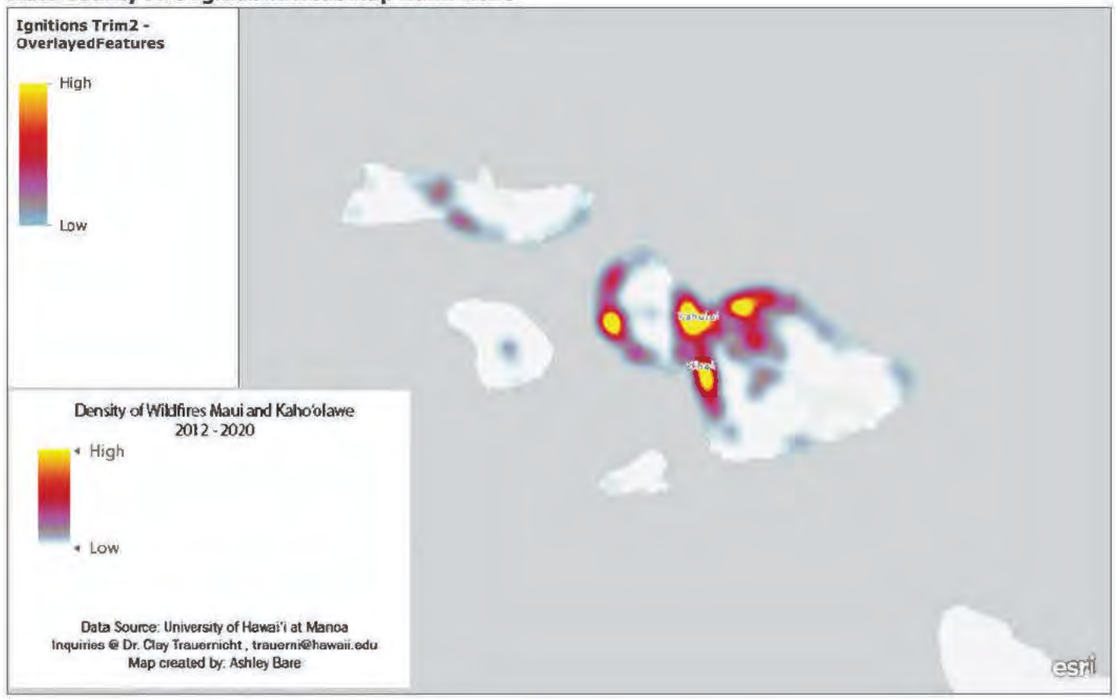


Figure 2.1.5.4 Maui Ignition Locations and Large Fire Burned Areas. 1999–2022. O. Smith. Hawai'i Wildfire Management Organization. 2023.

Maui County Fire Ignitions Heat Map 2012-2020



Esri, TomTom, Garmin, SafeGraph, FAO, METI/NASA, USGS, EPA, USFWS | United States Geological Survey (USGS); Hawaii Statewide GIS Program | Esri, TomTom, Garmin, SafeGraph, FAO, METI/NASA, USGS, EPA, USFWS

Figure 2.1.5.5 Density of Wildfires on Maui and Kaho'olawe. 2012–2020. A. Bare and C. Trauernicht. Pacific Fire Exchange. Data Source: C. Trauernicht and Hawai'i Wildfire Management Organization. 2023.

2.1.6 Land Use

Land uses on Maui are organized and zoned as agricultural, conservation/natural resources, urban, and rural districts. Each of these contributes to, or is impacted by wildfire, as detailed below.

Land Use: Agriculture
Agriculture has historically been a vital component of Maui's economy, and according to the Maui County General Plan 2030: Maui Island Plan[46], it will continue to be an important industry from an economic, social, and environmental perspective: "Although Maui's agriculture has evolved over the years, its importance remains constant." Agriculture is embraced on Maui as being an important agriculture include the higher costs of land, water rights and availability, social changes, and affordable housing.[47]

According to the 2020 Update to the Hawaii Statewide Agricultural Land Use Baseline[48], of all the Hawaiian Islands, the island of Maui has seen the most dramatic changes to its agricultural landscape between 2015–2020. The final closure of the Hawaiian Commercial & Sugar Company (HC&S) in 2016 removed 38,810 acres of sugarcane production from the island, contributing to an overall decline in cropped acreage of 82%. Diversified agriculture is now the largest crop on Maui, (Figure 2.1.6.1), which increased by 115%, followed by pineapple, which dropped by 12 percent down to 959 acres.[49]

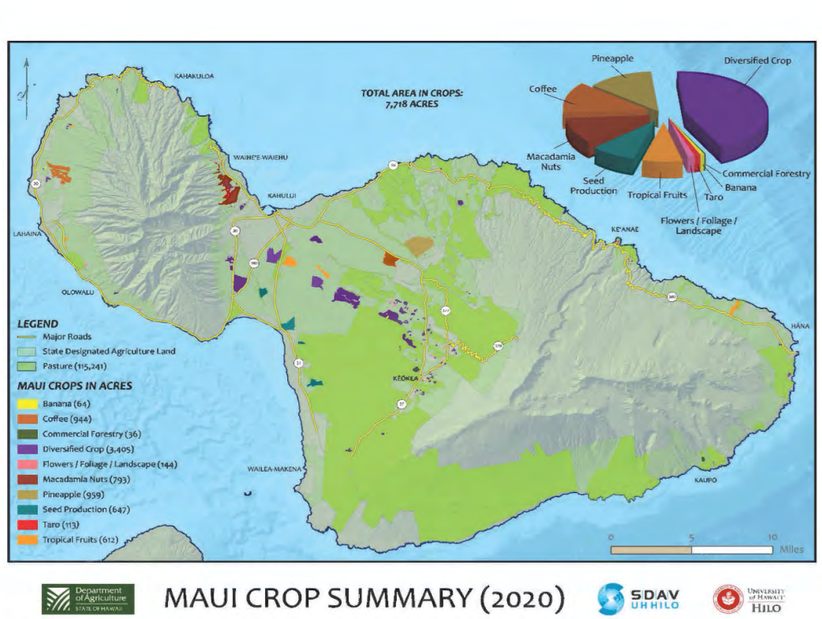


Figure 2.1.6.1 Maui Crop Summary. 2020. Hawai'i Department of Agriculture Update to the Hawai'i Statewide Agricultural Land Use Baseline. Source: 2020 Update to the Hawai'i Statewide Agricultural Land Use Baseline.

[47] Maui County General Plan 2030. Maui Island Plan, p. 7-2. https://www.mauicounty.gov/DocumentCenter/View/84682/Chapter-7?bidId=
[48] 2020 Update to the Hawai'i Statewide Agricultural Land Use Baseline https://hdoa.hawaii.gov/wp-content/uploads/2022/01/2020_Update_Ag_Baseline_all_Hawaiian_Islands_v5.pdf
[49] 2020 Update to the Hawai'i Statewide Agricultural Land Use Baseline. Prepared for Hawai'i Department of Agriculture. Prepared by University of Hawai'i at Hilo. Spatial Data Analysis & Visualization Research Laboratory. https://hdoa.Hawaii.gov/wp-content/uploads/2022/01/2020_Update_Ag_Baseline_all_Hawaiian_Islands_v5.pdf

Links Between Agriculture and Wildfire
There are direct links between changes in land use, the abandonment of active agriculture, and wildfire occurrence statewide. Hawaii's spike in wildfires and their growth over time, closely follows land use changes and agricultural decline.[50] Active agriculture (irrigated managed crops, large-scale or traditional localized farming, or grazing) has long served as an effective and essential landscape scale wildfire mitigation tool[51] with multiple additional community benefits across Hawai'i (i.e., jobs, food security, etc.). The removal of active agriculture and the subsequent accumulation of highly combustible standing dead fuel on unmanaged lands is leading to more and larger fires.

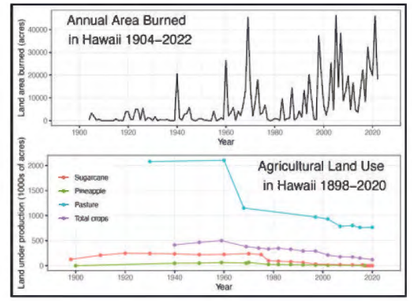


Figure 2.1.6.2 Hawai'i Fire History and Agricultural Decline (Credit: Trauernicht & HWMO).

This shift from active agricultural use to now-unmanaged regions has been especially prevalent on Maui, where in 2019, over 19,300 acres burned across 14 incidents. Nearly all of these wildfires occurred in the recently abandoned agricultural fields of central Maui. Substantial rainfall the winter prior, followed by summertime drought and record heat, fueled the 8,000-acre Waiko Road fire on July 12, 2019, which was Maui's largest wildfire on record at that time.[52] The August 2023 fires also took place in former agricultural lands where the accumulation of invasive and fine fire fuels is high. See Figures 2.1.6.2 and 2.1.6.3 for burn scars and their underlying land use.

Land Use: Conservation and Natural Resources
On Maui Island, over 50 percent of the lands are in the Conservation District. These four (4) areas have the most conservation lands: West Maui and Wailuku-Kahului, which share the West Maui Mountains, and East Maui and Makawao-Pukalani-Kula, which share the slopes and summit of Haleakalā Crater.[53]

Three (3) watershed partnerships exist on the island of Maui. They include the Mauna Kahālāwai Watershed Partnership,[54] East Maui Watershed Partnership,[55] and the Leeward Haleakalā Watershed Restoration Partnership.[56] Each is a voluntary alliance of both public and private landowners committed to the common value of protecting forested watersheds for water recharge, conservation, and other ecosystem services through collaborative management.

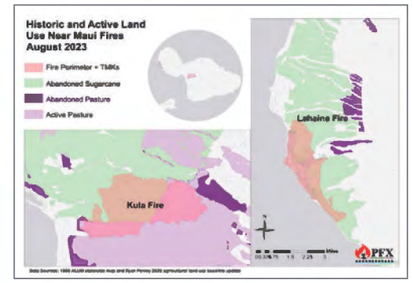


Figure 2.1.6.3 Historic and Active Land Use Maui Fires. 2023 (Credit: UH Wildland Fire). Tax Map Key (TMK) data showing individual pieces of property within the fire perimeter.

[50] https://pacificfireexchange.org/wp-content/uploads/2023/08/Historic_active_landuse_mauifires2023-1.png
[51] Kirk W. Davies, Katie Wollstein, Bill Dragt, Casey O'Connor, Grazing management to reduce wildfire risk in invasive annual grass prone sagebrush communities, Rangelands, Volume 44, Issue 3, 2022, Pages 194–199.
[52] Abandoned Agriculture in 2019 is Hawaii's Fire Problem. Pacific Fire Exchange. Wildfire Review Series.
[53] http://lhwrp.org/
[54] http://www.westmauiwatershed.org/
[55] http://eastmauiwatershed.org/
[56] http://lhwrp.org/

BACKGROUND

Watershed plans have been created for the West Maui Mountains Watershed,[57] Pōhākea Watershed,[58] the Southwest Maui Watershed,[59] and the Ma'alaea Watershed.[60] These watershed management plans aim to protect sensitive watershed resources and to restore resources that have already been degraded by agriculture; urbanization; and damaging events,[61] including fire.

Additional relevant guiding documents for natural resource management on Maui include:

- Hawaii Forest Action Plan[62]
- Kahana, Honokahua and Honolua Watersheds Characterization Report, and Wahikuli-Honokōwai Watershed Characterization Report[63]
- West Maui Mountains Watershed Partnership Weed Management Plan[64]
- West Maui Watershed Study, Prepared by U.S. Army Corps of Engineers, for State of Hawai'i Department of Land and Natural Resources, Division of Aquatic Resources[65]

There are two (2) nationally protected areas on Maui: Haleakalā National Park and Keālia Pond National Wildlife Refuge. State conservation lands, including forest and water reserve areas, are under the control of the Department of Land and Natural Resources (DLNR). Forest reserves include: Hāna Forest Reserve, Kahikinui Forest Reserve, Kamehamenui Forest Reserve, Kīpahulu Forest Reserve, Ko'olau Forest Reserve, Kula Forest Reserve, Makawao Forest Reserve, Waihou Spring Forest Reserve, and West Maui Forest Reserve. Each of these has a management plan.[66]

Links Between Conservation, Natural and Cultural Resources, and Wildfire

Many areas on Maui provide critical habitat for threatened and endangered species. Because Hawaii's ecosystems are not fire adapted, once an area burns, it is frequently replaced by fire prone exotic species, which promotes land- scape conversion through the grass-fire cycle described above. Wildfires also burn soil and cause lasting changes, leaving soil hydrophobic and less able to absorb water and recharge aquifers. Heavy rain events after fires also cause erosion that sloughs off topsoil, leaving some areas completely denuded and unable to support vegetation. Post-fire erosion fills streams with sediment, depositing it in the ocean. This sedimentation smothers coral reefs, negatively impacting nearshore water quality, fisheries, and coral health.[67]

Forest loss from wildfires and subsequent increased downstream sediment deposition to nearshore reefs have important implications for cultural and civic resources, recreation, food resources, and cultural practices. These negative impacts are particularly acute in Hawai'i given the sensitivity of native ecosystems to fire disturbance, short ridge to reef linkages between terrestrial and marine ecosystems,[68] the dependence of Hawaii's tourism economy on natural resource quality and desirability, and on the tight integration of Hawaiian history and cultural connection to land and water.

Hawaiian history and lore are filled with images, stories, and deities related to volcanic fire and the symbolism of destruction and birth from that volcanic fire. However, with the rapid increase in modern, human-caused fires over the last several decades, cultural practices and resources have experienced negative impacts. Unlike indigenous uses of fire in continental fire-adapted ecosystems–where systematic and regular burns were used for millennia as a tool for forest health, regeneration, and swidden agriculture–the intentional use of fire in Hawai'i was largely limited to the clearing of lowland agricultural fields, cooking, the burning of waste, and small ceremonial practices. Since Hawaiian forests are less adapted to fire and are often destroyed when burned, the cultural ramifications of increased wildfires in Hawai'i are significant. These impacts include the loss of cultural sites and landmarks and the loss of native ecosystems that provide the natural resources used for sustenance, traditional Hawaiian practices, and a sense of history and place. This has major implications for Hawaiian cultural identity. Land ('āina), water, and animals are essential to Hawaiian culture:

> **" 'Āina is a living and vital part of the Native Hawaiian cosmology and is irreplaceable. The natural elements–land, air, water, ocean–are interconnected and interdependent. To Native Hawaiians, land is not a commodity; it is the foundation of their cultural and spiritual identity as Hawaiians. The 'āina is part of their 'ohana, and they care for it as they do for other members of their families. For them, the land and the natural environment are alive, respected, treasured, praised, and even worshiped."**
>
> – Professor Pualani Kanaka'ole Kanahele, Kumu Hula[69]

Land Use: Rural [70]

As a result of their strong connection to historic communities and agricultural land uses, rural settlement patterns on Maui typically consist of small towns, low-density residential development, open space, and an agricultural landscape. Rural areas on Maui contain a mix of natural landscapes and productive agricultural lands and possess a high concentration of environmental and cultural resources. Population growth, development pressures, and decreasing agricultural activities have initiated a shift within Maui's rural landscapes toward lower-density residential sprawl. As of 2020 on Maui, 14.6 percent of the population lives in areas classified as rural.[71] Rural districts on Maui allow for low-density development that preserves the country character of the area, allows for small-scale agricultural operations, and serves as a transition between urban density development and agricultural lands.[72]

Land Use: Urban[73]

Maui is the second-most urban island in the state, with approximately 11 percent of its 750,000 acres carrying that designation, making it the third most populated. The three (3) primary urban centers on Maui, measured by the regional distribution of commercial jobs, are Wailuku-Kahului (44 percent), Kīhei-Mākena (18 percent), and West Maui (28 percent). Together, these three (3) communities represent 90 percent of all commercial jobs in Maui Nui (the islands that make up Maui County, including Maui, Moloka'i, Lāna'i, Kaho'olawe, and the islet of Molokini). The island's primary commercial airport, harbor facility, and hospital are located in Kahului. Kahului also supports the island's primary industrial zones, large retail centers, and shopping malls. The island's civic center is located in nearby Wahikuli. Kīhei-Mākena and West Maui hold the island's major resort destination areas.

[57] *West Maui Mountains Watershed Management Plan by US Army Corps of Engineers, for State of Hawai'i Department of Land and Natural Resources, Division of Aquatic Resources.*
[58] *Pōhākea Watershed Management Plan. https://www.mauiwatershed.org/maalaea*
[59] *Southwest Maui Watershed Management Plan. https://www.mauiwatershed.org/home*
[60] *Ma'alaea Watershed Management Plan. https://www.mauiwatershed.org/maalaeawatershed*
[61] *https://www.mauiwatershed.org*
[62] *https://dlnr.hawaii.gov/forestry/files/2013/09/Hawaii-Forest-Action-Plan-2016-FINAL.pdf*
[63] *Kahana, Honokahua and Honolua Watersheds Characterization Report, and Wahikuli-Honokōwai Watershed Characterization Report. https://www.westmauir2r.com/*
[64] *West Maui Mountains Watershed Partnership Weed Management Plan by US Army Corps of Engineers, for State of Hawai'i Department of Land and Natural Resources, Division of Aquatic Resources.*
[65] *West Maui Watershed Study, Prepared by US Army Corps of Engineers, for State of Hawai'i Department of Land and Natural Resources, Division of Aquatic Resources. https://www.poh.usace.army.mil/Portals/10/docs/Civil%20Works/West%20Maui%20Watershed%202021/2023%20West%20Maui%20WMP-Final%20Report.pdf?ver=LpXdfFUZlvArD2tJWw9tyQ%3d%3d*
[66] *State Forest Reserve Management Plan website: https://dlnr.hawaii.gov/forestry/frs/reserves/maui-nui/*
[67] *Fact Sheet: After Fire, First Things First. Pacific Fire Exchange. After-Fire Action Series Resource 1. August 2023. https://pacificfireexchange.org/resource/after-fire-first-things-first/*
[68] *Challenges to Rapid Wildfire Containment in Hawai'i. Draft. C.Trauernicht, L.X.Gollin, M.P. Lucas, and C.P. Giardina. University of Hawai'i, Mānoa. College of Tropical Agriculture and Human Resources. Cooperative Extension. https://www.nrem-fire.org/_files/ugd/81f7ef_569dd0cfb4144307806fe8d8c9391cbd.pdf*
[69] *https://www.resilientmauinui.org/pages/sustainability-resiliency-native-Hawaiian-culture*
[70] *Maui County General Plan 2030. Maui Island Plan, p. 7-12-13 https://www.mauicounty.gov/DocumentCenter/View/84682/Chapter-7?bidId=*
[71] *Hawai'i Data Collaborative. Covid-19 Highlights Vulnerability of Rural Hawai'i. Joyce Lee-Ibarra, JLI Consulting LLC https://www.hawaiidata.org/news/2020/4/20/covid-19-highlights-vulnerabilities-of-rural-Hawaii#:~:text=Overall%2C%208.1%20percent%20of%20Hawaii%27s,percent—live%20in%20rural%20areas.*
[72] *Chapter 19.29 Maui County Code, in Maui County General Plan 2030. Maui Island Plan. Table 7-1. State and County Regulatory Controls for Rural Lands. P. 7-12.*
[73] *Maui County General Plan 2030. Maui Island Plan, p. 7-18 .*

Links Between the Built Environment and Wildfire
Over the years since wildfires began increasing on Maui, they have threatened lives, homes, and human health. Many neighborhoods on Maui have unmanaged/untended fire fuels interspersed within developed areas; homes built with combustible materials; and subdivisions designed with minimal setbacks, egress routes, water resources, and firefighting access. On several occasions, these factors have contributed to fire spread through communities and into surrounding areas and loss of structures. Air quality during fires is greatly reduced from smoke, and wind-borne dust from burned lands and soil is easily lifted into the air in heavy winds, sometimes for weeks to months after a wildfire event.

Wildfires also impact economic and municipal infrastructure and activities. Burned soil from wildfires decreases groundwater recharge, which can affect drinking water supplies. As noted above, post-fire rain events cause erosion that damages nearshore resources, which can have effects on one of the area's primary economic bases—coastal and marine-based tourism, as well as resident and visitor recreational activities. Traffic and road closures during fire events and post-fire flooding can block access routes, keeping people from their homes and work, and are costly to local governments. Finally, agricultural, ranching, and energy production (e.g., Auwahi Wind Farm, Hawaiian Electric) all face disruptions in operations during wildfire events and have had to deal with damaged infrastructure.

Resilience to wildfire and other natural hazards, the management of natural and cultural resources, and plans and goals for the built environment can be found in the following Regional Community Development Plans:

- Kīhei - Mākena
- Pā'ia - Ha'ikū
- Wahikuli - Kahului
- Makawao - Pukalani - Kula
- Hāna
- West Maui
- Maui County Resolution No. 13-13 contains the order of the Community Plan updates.

2.2 Power and Water Infrastructure

2.2.1 Hawaiian Electric

Hawaiian Electric produces and distributes electrical power to Maui. Hawaiian Electric serves 95 percent of Hawaii's 1.4 million residents on the islands of O'ahu, Maui, Hawai'i, Lāna'i, and Moloka'i. Electricity is distributed by overhead transmission lines in many parts of Lahaina. Newer developments, such as the Kupuohi Street industrial park, homes on Komo Mai Street, the community of Kahoma Village, the Hawaiian Homes neighborhood off of 'Aipuni Street, and some streets on the south end, receive their electricity via an underground distribution system. More information regarding Hawaiian Electric's undergrounding efforts is included in their website.[74]

In 2019, the Maui Electric and Hawai'i Electric Light brands were formally changed to Hawaiian Electric.[75] The acronyms "HECO" and "MECO" are still used locally to refer to this organization and appear in transcribed sections of this report.

[74] *Undergrounding Utility Lines | Hawaiian Electric*
[75] *Maui Electric and Hawaii Electric Light to be renamed Hawaiian Electric*

2.2.2 Department of Water Supply

The Department of Water Supply is an agency of the County of Maui. Its mission is to provide clean water efficiently. The Department of Water Supply provides water to approximately 36,400 customer accounts on Maui and Moloka'i.[76]

Maui County Water System in Lahaina
Drinking water is provided to the Lahaina area by the Maui County Department of Water Supply. In Maui County, Hawai'i, as well as the rest of the United States, drinking water may be used by people and communities for drinking, showering/bathing, flushing toilets, washing clothes, watering plants and lawns, washing vehicles, firefighting, filling swimming pools, and many other things.

The Maui County Department of Water Supply has two (2) drinking water treatment plants that produce drinking water for the Lahaina area. Although the storage and distribution systems for these two (2) drinking water treatment facilities are connected, there is no interconnection with other parts of the Maui County water system or other smaller water providers in the Lahaina area. Maui County Department of Water Supply meets current design and capacity standards for the Lahaina and the Māhinahina treatment, storage, and distribution systems in terms of water treatment capacity and water storage required.



https://www.khon2.com/local-news/maui-electric-and-hawaii-electric-light-to-be-renamed-hawaiian-electric/#:~:text=Starting%20in%20January%2C%20Maui%20Electric,differences%20besides%20the%20name%20change.
[76] *https://www.mauicounty.gov/126/Department-of-Water-Supply.*

LAHAINA DRINKING WATER TREATMENT PLANT

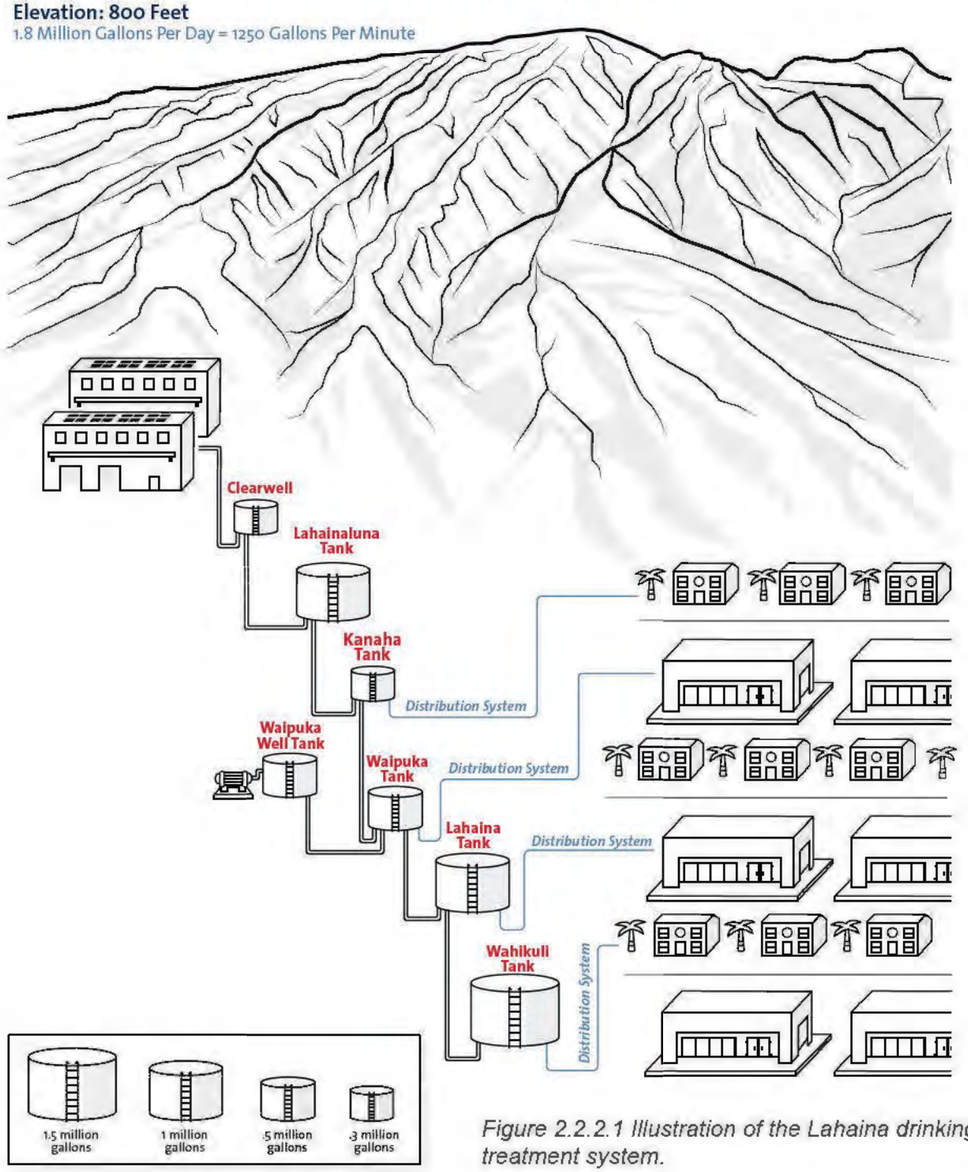


Figure 2.2.2.1 Illustration of the Lahaina drinking water treatment system.

[This is a representation of the system configuration.]

Drinking Water Treatment, Storage, and Distribution Systems

The Lahaina treatment plant (Figure 2.2.2.1), located near Lahainaluna High School, has a capacity of 1.8 MGD (million gallons per day, 1,250 gpm). The Māhinahina treatment plant, located near the Kapalua Airport, has a capacity of 2.0 MGD (1,390 gpm). These two (2) drinking water treatment plants are also supplemented by a system of three (3) small groundwater well/tank combinations that increase water production.

The Kanaha Stream is the source water for the Lahaina drinking water treatment plant (elevation approximately 800 feet). Water is treated by sedimentation, microfiltration, and disinfection. The disinfected water is pumped into the Lahainaluna Tank which completes the drinking water treatment process at this plant.

This treated water is then conveyed by gravity from the Lahainaluna Tank to four (4) storage tanks in the Lahaina distribution system with a total storage volume, including the Lahainaluna Tank, of 4.1 Million Gallons (MG). Pumps are not used within the Lahaina system once treated water leaves the plant. All storage tanks are filled by gravity, and distribution system pressures are the result of elevation change within the system and water level in the storage tanks.

BACKGROUND

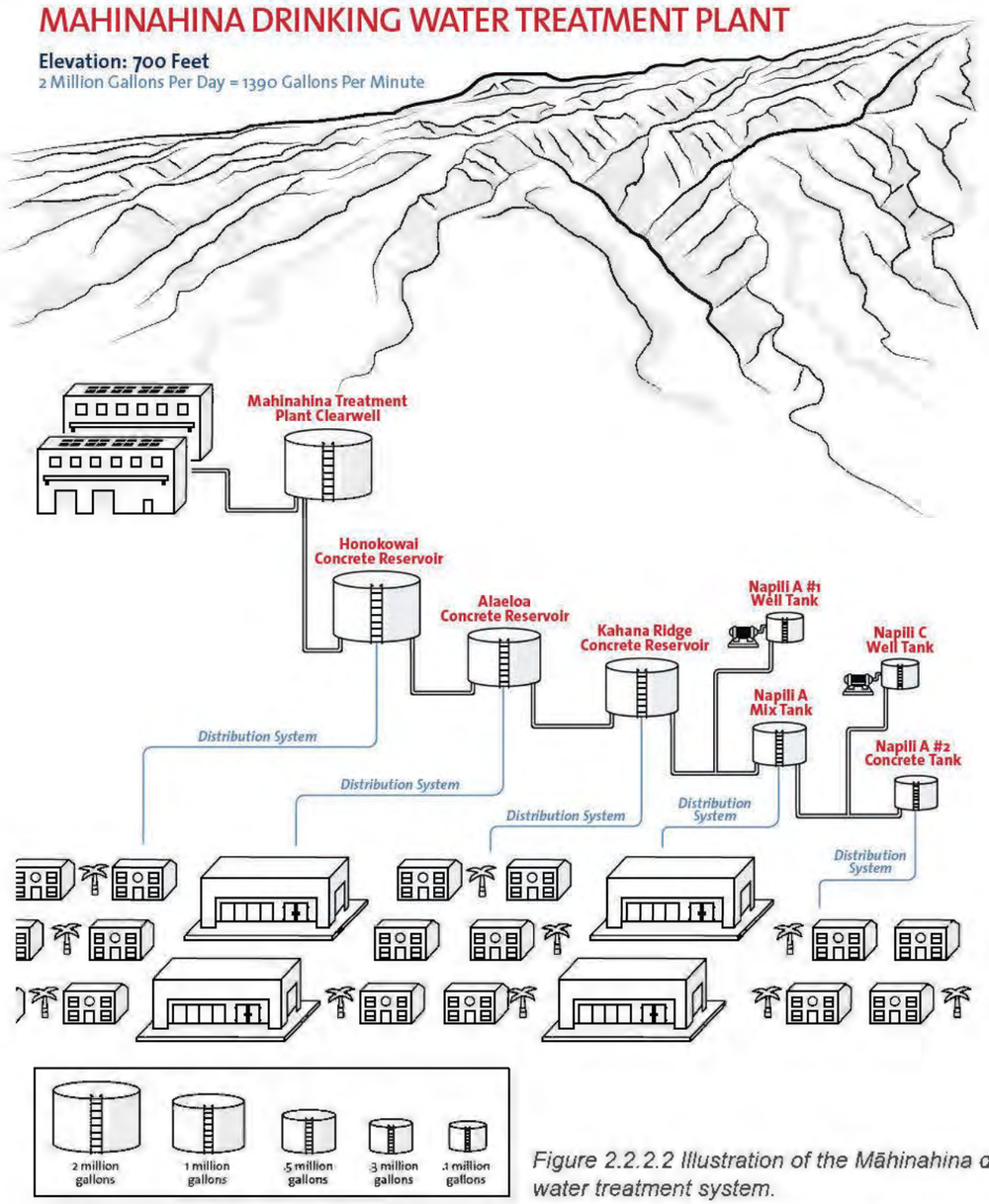


Figure 2.2.2.2 Illustration of the Māhinahina drinking water treatment system.

[This is a representation of the system configuration.]

The Māhinahina drinking water treatment plant, located near the Kapalua Airport, is at an elevation of approximately 700 feet (Figure 2.2.2.2). Source water for this system is surface runoff entering a 20 MG raw water pre-sedimentation/ equalization reservoir. The water is then treated by rapid mixing, flocculation, dual-media deep bed filtration, and disinfection. The disinfected water passes through a two (2) MG clearwell before entering the rest of the storage and distribution system. The Māhinahina storage and distribution system has six (6) storage tanks with a total volume of 6.2 MG (including the clearwell). As in the Lahaina system, pumps are not used to provide pressure or move drinking water within the Māhinahina distribution system. All pressure is a result of elevation change and water tank/reservoir water levels.

The Māhinahina system to the north and the Lahaina system to the south are connected using water lines located along Lower Honoapi'ilani Road and Honoapi'ilani Highway (Hwy-30). Again, pressure generated in the drinking water distribution systems is a result of elevation change and water tank/reservoir levels. Pumps are not used to provide pressure within either the Lahaina or Māhinahina drinking water storage and distribution systems.

2.3 Wildfire Prevention and Preparedness Organizations and Efforts

2.3.1 Maui Wildfire Task Forces

Across Maui, several local/regional fire task forces exist to collaboratively discuss, coordinate, and implement on-the-ground wildfire mitigation and preparedness projects. Composed of fire and emergency response agencies, as well as additional local partners, organizations, and community representatives, these task forces work on issues and goals specific to their focal areas. They include the West Maui Fire Task Force, South Maui Fire Task Force, and Leeward Haleakalā Fire Task Force.

2.3.2 Maui Fire Department Fire Prevention Bureau

The MFD Fire Prevention Bureau works to abate fire and life-safety hazards before they can cause injury and property damage. Focal services include fire education programs to increase the public's awareness of fire safety, including an annual fire safety program for Maui County Schools and the Smoke Alarm Maui Program. Other focal services include fire investigation, reviewing building plans and permits for fire safety, and issuing several special permits.

2.3.3 State Department of Land and Natural Resources–Division of Forestry and Wildlife (DLNR-DOFAW)

DLNR-DOFAW is statutorily mandated to take measures for the prevention of wildland fires within DLNR-DOFAW managed lands and to cooperate with county and federal fire agencies in developing plans and programs for prevention assistance of wildfires on additional lands. DLNR-DOFAW is involved with and committed to the following community risk reduction initiatives: supporting the development and action plans of Community Wildfire Protection Plans, locally administering the U.S. Forest Service Wildland-Urban Interface grant program, serving as the state liaison for the Firewise USA® community risk reduction program (in partnership with Hawai'i Wildfire Management Organization (HWMO)), and administering State Legislature Grant-In-Aid awards given to local organizations who are working on wildfire-related projects (in 2021, these included HWMO and Ka'ala Farm, Inc.).

2.3.4 Hawai'i Wildfire Management Organization (HWMO)

HWMO is a nonprofit organization founded in 2000 to focus on wildfire prevention, planning, and mitigation and the development of Hawai'i-specific wildfire information. The organization serves as a hub of wildfire information, risk reduction, and project assistance across Hawai'i. HWMO supplements and complements agency wildfire efforts, aims to meet community hazard reduction needs, and coordinates/leads multi-jurisdictional and multi-partner wildfire projects. HWMO develops and offers educational wildfire prevention, preparedness, and planning workshops for diverse audiences and stakeholder groups; leads the development of Community Wildfire Protection Plans and fire management plans; serves as the lead coordinator for the Firewise USA® program (in partnership with DLNR-DOFAW); facilitates several regional wildfire coordinating groups and multi-partner projects; and implements cross-boundary fuels management projects. On behalf of Hawai'i, HWMO partners closely with the Cohesive Wildland Fire Management Strategy team and the Fire Adapted Communities Learning Network. HWMO also works together with the University of Hawai'i to implement the Pacific Fire Exchange project (PFX), a fire science communication project that develops, collates, and shares best available wildfire information on behalf of a broad partnership that includes DLNR-DOFAW, United States Department of Agriculture Forest Service, county fire departments, and other forestry and fire entities.

2.3.5 University of Hawai'i at Mānoa College of Tropical Agricultural and Human Resources (UHM-CTAHR)

UHM-CTAHR has several researchers, extension specialists, and some graduate students who synthesize and develop new information on topics pertaining to wildfire. Faculty expertise includes range management, forestry, ecology, social science, and fire science which has contributed to a range of wildfire-related products such as fuels data, maps, risk models, and other information. HWMO and UHM-CTAHR Cooperative Extension partner to implement the PFX project. PFX is a fire science communication project that works to improve the availability and sharing of fire science relevant to the Pacific Island region to support and inform the wildfire mitigation work of land managers and emergency responders.

2.3.6 National Weather Service[77] (NWS)

The NWS Forecast Office[78] in Honolulu, Hawai'i provides forecasts, watches, warnings, and consultation services for the prevention, suppression, and management of forest and rangeland fires in the State of Hawai'i. The forecast office is located on the campus of the University of Hawai'i at Mānoa in the Hawai'i Institute for Geophysics (HIG) building.

The NWS issues a standard fire weather planning forecast daily with event-driven updates issued as necessary. Fire Weather Watches and Red Flag Warnings are issued to alert land management agencies to the potential for widespread ignitions or control problems with existing fires. Spot forecasts for government agencies involved in fighting currently burning wildfires or soon-to-be ignited prescribed burns are provided on request.

Hawaiian Fire Weather Products Available: [79]

- Fire Weather Planning Forecast
- Graphic Forecast with Fire Weather Parameters (RH, Transport Winds, Mixing Heights)
- NWS Spot Forecast Request for Hawai'i–Request a Spot Forecast Online
- NWS Spot Request Instructions
- Hawai'i Remote Automatic Weather Stations (RAWS) Data
- Fire Weather Operations Plan Updated: June 2018
- Hawai'i Fire Weather Program Information
- National Fire Weather Program

Together, all of the above entities participate in and support the multi-agency statewide Wildfire and Drought Lookout! awareness and preparedness campaign each year; conduct wildfire hazard assessments (often in partnership with one another); and collaborate whenever possible on education, planning, and wildfire mitigation projects.

[77] *About the NWS. https://www.weather.gov/about/*
[78] *Fire Weather Operations Plan. National Weather Service (NWS) Forecast Office in Honolulu, Hawai'i. National Oceanic and Atmospheric Administration. Brenchley, Wroe, and Bravender. June 2018 Update. https://www.weather.gov/media/hfo/Firewxops.doc*
[79] *Hawaiian Fire Weather Products. National Weather Service, National Oceanic and Atmospheric Administration Webpage. https://www.weather.gov/hfo/firewx*

2.4 Emergency Response Organizations

2.4.1 Maui County Emergency Services and Public Safety

Maui County Emergency Services and Public Safety include the Maui Fire Department (MFD) and Maui Police Department (MPD). MFD resources and equipment are spread across the entire county and are made available when needed if they are not already in use. MFD has 14 fire stations across Maui County. There are ten (10) fire stations on the Island of Maui. Initial response to the majority of wildfires (as well as all medical and other emergencies) is the responsibility of MFD.[80]

MPD has six (6) districts and police stations located in Wailuku (headquarters), Lāna'i, Hāna, Lahaina, Moloka'i and Kīhei, serving 29 motorized "beats." The Maui County 911 center ("Central") is part of the MPD Communications Section. Central is responsible for 911 emergency call-taking and dispatch, answering non-emergency calls, as well as answering and assisting with police administrative calls for Maui County (including a secondary location on Moloka'i for coverage of Moloka'i and Lāna'i). Central dispatches MPD, MFD, and emergency medical services for AMR ("Med Comm"). During incidents, Central is responsible for incident coordination, personnel tracking, and may assist with resource requests from field personnel (e.g., requesting Hawaiian Electric's assistance).

2.4.2 State: Hawai'i Department of Land and Natural Resources-Division of Forestry and Wildlife (DLNR-DOFAW)[81]

DLNR-DOFAW responds to wildfire events on state lands and provides additional wildland firefighting assistance when state lands are threatened and/or mutual aid agreements are invoked. In the early 1980s, a map of each county was delineated to depict areas where the Division of Forestry and Wildlife (DOFAW) has primary fire responsibility, areas where it could respond mutually with other firefighting agencies, and areas out of its jurisdiction (color-coded white in Figure 2.4.2.1). DOFAW was granted authority to respond to fires in the white areas only under specific conditions (i.e., extreme threats to public safety, local resources fully committed, extreme fire behavior, etc.), through the appropriate channels, and if its resources are available. In order for DOFAW to respond to fires in the white areas, the request for assistance must come from the County Civil Defense/Emergency Management Agency through the Hawai'i Emergency Management Agency (HI-EMA). The request can also come directly from the MFD to DOFAW. The map in Figure 2.4.2.1 from DLNR-DOFAW demonstrates the independent and shared response zones of each agency:



Figure 2.4.2.1 Island of Maui Fire Response Zones. 2022 (Source: DLNR-DOFAW).

[80] https://www.mauicounty.gov/1460/Fire-Public-Safety
[81] https://dlnr.Hawaii.gov/forestry/fire/response-maps/

2.4.3 Federal: The Department of the Interior (DOI)

Within Hawai'i and the Pacific Islands, the DOI has established a single interagency wildland fire program serving the National Park Service and U.S. Fish and Wildlife Service. The staff are located on the Island of Hawai'i and serve the 34 National Parks and National Wildlife Refuges scattered across the Pacific, including Haleakalā National Park and Keālia Pond located on the Island of Maui. Specifically on Maui, the U.S. Fish and Wildlife Service maintains a Type Six (6) wildland fire engine which is staffed by employees from Hawai'i Island when fires occur. Ongoing hazardous fuels treatments with the highest risk of fire are occurring on federal lands on Maui.

2.4.4 Maui Emergency Management Agency (MEMA)

The MEMA utilizes emergency management principles to protect all persons within Maui County and achieve whole community resiliency. This includes planning, preparing, and coordinating emergency management operations in meeting disaster situations and coordinating post-disaster recovery operations.[82] MEMA maintains and staffs the emergency operations center (EOC) when activated.

2.4.5 Hawai'i Emergency Management Agency (HI-EMA)

The HI-EMA plans for and responds to both natural and human-caused emergencies. These include emergencies resulting from all hazards, from tsunamis, wildfires, and hurricanes to incidents involving hazardous materials or nuclear power. The agency prepares and implements a statewide Comprehensive Emergency Management Plan, and routinely conducts extensive exercises to test state and county emergency response capabilities.

including the four county emergency management agencies–Hawai'i County Civil Defense, Maui Emergency Management Agency, City and County of Honolulu Department of Emergency Management, and Kaua'i Emergency Management Agency–and the Federal Emergency Management Agency (FEMA).

After an incident, HI-EMA conducts damage assessment surveys and advises the Governor on whether to declare an emergency and seek federal relief funds. The agency maintains a primary Emergency Operations Center (EOC) in Diamond Head Crater, Honolulu. HI-EMA also operates the State Warning Point (SWP), a state emergency communications center staffed 24 hours, 7 days a week. The center maintains statewide communications with county emergency officials and other partners.

Organized within the State of Hawai'i Department of Defense, HI-EMA has a total authorized strength of approximately 60 full-time employees. HI-EMA is responsible for a wide range of functions supporting the entire State of Hawai'i and its comprehensive emergency management program.[83]

2.4.6 Heavy Equipment Contractors

Private heavy equipment contractors provide direct and indirect fire line construction during wildland firefighting operations on Maui. Dozers, excavators, loaders, and water tenders (referred to as water tankers in Maui)[84] are owned and maintained by construction companies supporting a variety of different industries. These private companies make their equipment available for wildland firefighting upon request by MFD and DOFAW, or they can also self-dispatch and report to the incident commander on scene. These resources can be used on county, state, federal, and private land fires. The private companies invoice the county or state (depending on land ownership) for the number of hours worked at the conclusion of the incident.[85]

[82] https://www.mauicounty.gov/2452/About-MEMA
[83] https://dod.Hawaii.gov/hiema/
[84] https://www.nifc.gov/resources/equipment/water-tenders
[85] Information provided by DOFAW Maui Unit Leader.

DATA COLLECTION

3.0 Data Collection

The objective of the data collection process is to gather all available facts relating to the August 8, 2023, Maui wildfires as well as the preparedness efforts that occurred prior. Although FSRI's data collection included information related to the weather conditions that contributed to all of the August 8, 2023, fires, the evacuation and fire suppression efforts focused only on the Lahaina Fire incident from August 8 to August 9, 2023. These facts consist of time stamped conditions (i.e., damage to buildings due to wind, fire, smoke, fallen trees and utility poles, traffic, etc.) and actions (i.e., evacuation, fire suppression, rescues, etc.) as evidenced by images (still photos or videos), radio communications recordings, radio transcripts, witness statements, text and phone logs, email records, technical discussions (TDs) with individuals, and any other form of data. Data requests were prioritized by their value in establishing an event timeline and understanding the facts of the conditions existing prior and during the incident. Data points were cross referenced and further supported by the collective dataset.

The information request process was agreed upon by Maui County Department of Corporation Counsel (Maui Corp Counsel) and FSRI. Initially, the process consisted of FSRI requesting information via email direct to Maui Corp Counsel, with copies to the leader of the county department possessing the data, and Maui Corp Counsel's outside counsel. Maui Corp Counsel maintained a Google Sheets request and production log where all activity was tracked and communicated. The Google Sheets log was shared with FSRI. Maui Corp Counsel and FSRI communicated specific needs and concerns mostly using the comments tool within the Google Sheets log. Maui Corp Counsel delivered products to FSRI via Google Drive.

3.1 Written Requests for Information

At the request of Maui Corp Counsel, FSRI emailed requests in small segments. The initial requests for information were centered on learning incident facts through radio communication logs, transcripts, recordings, and other preparedness and response time stamped data. This was necessary to prepare the FSRI team for technical discussions with responders, cooperators, government leaders, and evacuees as well as establish a timeline of events. FSRI emails requesting information from Maui Corp Counsel are documented in the appendices.

FSRI also emailed requests for information to agencies and organizations not affiliated with Maui County. These organizations included the United States Coast Guard (USCG), HI-EMA, Hawai'i Department of Health, Hawaiian Electric, Hawai'i DOFAW, HWMO, American Medical Response (AMR), and NWS (Honolulu). FSRI members followed up with several in-person and virtual meetings to learn details of the agency/organization participation. This method of requesting information from non-Maui County organizations was maintained throughout the data collection process.

On November 29, 2023, Maui Corp Counsel required FSRI to discontinue requesting information via email in favor of subpoenas prepared by the AG. At the same time, Maui Corp Counsel also requested that all communications be exclusively between Maui Corp Counsel and the AG. FSRI and the AG prepared subpoenas for new requested information and for information previously requested but pending fulfillment.

See table 6.1 in the Appendix for details regarding the subpoenas (collected as of March 29, 2024). FSRI received written records in many different forms. Most organizations responded to requests via a returned email with attached documents (e.g., Microsoft Excel, Microsoft Word, and Adobe Portable Document Format (PDF)), or narrative form within an email. Larger documents were shared via a virtual data locker. Maui Corp Counsel records were received mostly in PDF form. Because PDFs are images rather than letters and numbers that can be read by a computer the data had to be converted to a usable format. Where possible, data extraction tools were used to transfer information into Excel spreadsheets. This only worked for PDFs containing information that was organized in columns and rows or where the images (i.e., letters and numbers) were legible. Even the best scraping tools produced errors requiring correction by FSRI team members. The FSRI team manually converted hundreds of pages of documents due to scraping tools being unable to reliably convert the information into Excel in an automated fashion.

3.2 Radio Communications

Maui County 911 calls and MFD and MPD field radio communication recordings were received in short segments, ranging from a few seconds to a couple minutes. FSRI personnel with specific emergency responder expertise listened to 48 hours of radio transmissions on multiple channels and transcribed the information to a spreadsheet. Due to some recordings having multiple channels, a quality control transcriber ensured that the critical operational periods of August 8–9, 2023, were accurately transcribed. This enabled FSRI to have reasonable confidence that all communications provided were evaluated for critical content needed to capture time stamped events thoroughly and accurately.

3.3 Site Visits

Visits to the exclusion zone of the Lahaina Fire started late August 2023 and extended through January 2024. Arriving early ensured researchers had ample opportunity to collect data as close as possible to the actual event. Visits in September through November focused on capturing high-definition imagery (stills and videos) of each undamaged, damaged, and destroyed structure. The impact of wind, fire, smoke, and fire suppression on structures was captured for each street within Lahaina. The remaining vegetative fuel component of the burn was also evaluated as was the east side (mauka) of the fire's perimeter, capturing the burn to unburned interface, typically referred to as, "black to green." The FSRI team also surveyed the area via helicopter, capturing aerial imagery of all burned and adjacent unburned areas.

3.4 Technical Discussions (TDs)

TDs are in-person meetings with individuals and groups designed to learn what they experienced and observed during an incident. For this study, TDs were restricted to those impacted by the August 8, 2023, Lahaina Fire (i.e., residents) and those responsible for preparedness and response.

From September through November 2023, FSRI engaged in more than 100 TDs to capture their experiences. Most often, these meetings took place in hotels where fire-displaced residents were temporarily living. For those still able to occupy their homes–those just outside of the burn area–the meetings took place on their properties. FSRI walked streets and talked with residents willing to answer questions about the incident and about their experiences. Many shared in detail while offering photos and videos via AirDrop. Sharing large files through AirDrop preserved important metadata, including date, time and geographical location of where the media was captured.

DATA COLLECTION

Interactions with residents were not restricted to personal contact. The questions asked of residents were also provided via FSRI fliers that included a virtual link where they could submit responses and upload images. The fliers were printed in English, Hawaiian, Chinese, Japanese, Tagalog, Ilocano, Marshallese, Chuukese, Tongan, and Spanish to address the diverse population of Lahaina. Fliers were also distributed at the Disaster Recovery Center located at the Lahaina Civic Center, and other locations where residents were living and receiving care.

TDs with Maui County's current and retired employees were conducted by two (2) to five (5) FSRI representatives. FSRI representatives were chosen based on their relevant backgrounds and expertise. For example, fire department technical discussions were conducted by FSRI personnel having fire service backgrounds. Discussions were also attended by a Maui Corp Counsel attorney; a labor representative (for represented employees only); and most times, Maui outside counsel from McCorriston Miller Mukai MacKinnon LLP.[86]

Most TDs with Maui County current and retired employees were conducted in small group settings in Maui; however, due to work schedules and relocations, some were with individuals. Most took place in Maui County buildings, six (6) were held in State buildings, and one (1) was in a hotel. Some former Maui County employee TDs were completed off island if the individual moved to another area.

TDs for MPD and MFD personnel were conducted in the same fashion. FSRI personnel asked questions, and responses were captured by a FSRI note taker using a laptop, on a recording device, and on hard copies of Lahaina maps using different colored pens to identify fire progression, unit location, and tasks performed and observed.

The majority of Maui County personnel attended TDs without personal notes or reference materials. Some MPD officers referenced their official submitted reports.

TDs with Maui Emergency Management Agency (MEMA), HI-EMA, elected officials, and Maui Water were conducted similarly but did not include maps.

FSRI requested and selected participants for TDs to ensure a comprehensive understanding of the critical events. Invitations were extended to key individuals and groups based on their vital roles or leadership positions during the incident.

Engaging individuals as close to the time the incident occurred as possible was desired to improve the recall of events they experienced. FSRI conducted TDs with each of the following agencies at their first availability (Table 3.4.1).

In addition to formal TDs, FRSI personnel also arranged in-person and virtual meetings with members of HWMO, NWS, and DOFAW. These meetings were essential to learning about the history of Hawai'i wildfire and the ongoing efforts to manage it.

[86] *McCorriston Miller Mukai MacKinnon https://www.m4law.com/*

Table 3.4.1 Technical Discussions Conducted by FSRI.

TECHNICAL DISCUSSIONS			
Party	**Interview(s)**	**Format**	**Date(s)**
MFD	MFD Assigned units	Groups of 3–5 per session	October 21-November 1, 2023
	Fire 2 and Fire 3	Together	
	Other chief officers	Individually	
Government Officials	Governor Josh Green	Staff	November 30, 2023
	Lt. Governor Sylvia Luke	Staff	
	Mayor Richard Bissen	Counsel	December 4, 2023
HI-EMA	Major General (MG) Kenneth Hara	Counsel	December 1, 2023
	James Barros	Staff	
MPD	MPD Assigned Officers	Individually	January 2-12, 2024
Water Department	Water Department Staff	Individually	January 22-24, 2024
MEMA	MEMA Staff	Individually	January 23 - 31, 2024
Maui Dispatcher	Maui Dispatch Staff	Individually	January 23, 2024

TIMELINE OF EVENTS

4.0 Timeline of Events

Throughout the report, time is identified in a 24-hour format that includes two-digits for hour, colon/separator, and two (2) digits for minutes. (i.e., 14:00 is 2:00 p.m. HST).

- The Composite Timeline includes information from multiple agencies and organizations and records of significant events ranging from pre-fire activities on August 7, 2023, through the response effort at 08:30 on August 9, 2023.
- The Pre-Fire Timeline addresses preparation, weather conditions, organizational structures, staffing, and other aspects of the pre-fire situation.
- The Operational Timeline contains the events of the response.

Points of Reference:

- Pre-fire: Events occurring before 06:30 HST on August 8, 2023
- Lahaina AM fire: Fire occurring August 8, 2023, between 06:34 and 14:17
- HST Lahaina PM fire (Kuʻialua fire): Fire occurring August 8–9, 2023, between 14:55 and 06:00 HST

The timelines are displayed by organization, date, time, event description, and source (e.g., where the information was taken from). A comprehensive timeline consisting of all organizations represented within this report can be found online https://ag.hawaii.gov/maui-wildfire-investigation-resources-page/ and https://-doi.org/10.54206/102376/VQKQ5427.

Note: Not all organizations that assisted or cooperated in the pre-fire events and response efforts are included in the timeline. This is not to de-emphasize their importance or the impact they had on saving lives and property. The organizational timelines were created from facts that were provided by the organization or that were available via public-facing websites or social media sites at the time this report was published.

4.1 Summary of August 8, 2023, and August 9, 2023, Maui Fires

High winds and low relative humidity set the stage for multiple events (Figure 4.1.1) on August 8, 2023.



Figure 4.1.1 Map of Maui, showing the location and extent of the four fires over the August 8, 2023, and August 9, 2023, incident.

At 00:22, the Olinda (Figure 4.1.2) fire started at 21[redacted] Olinda Road, Makawao. It quickly grew into a large fire that threatened lives and structures and required a sizable response over the next few days.

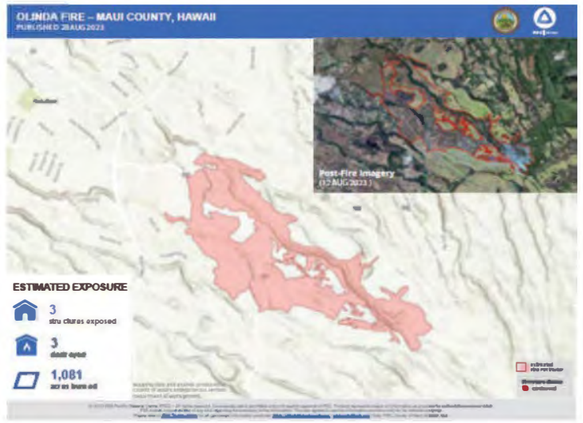


Figure 4.1.2 Map of the Maui County showing the extent of the Olinda fire, including statistics (lower left inset) and post-fire image (upper right inset). Source: Pacific Disaster Center.

A few hours later, at 06:35, the Lahaina AM fire (Figure 4.1.3), a fast-moving brush fire, broke out near Kuʻialua Street and Hoʻokahua Place, across from Lahaina Intermediate School. This fire was reported as contained a few hours later.

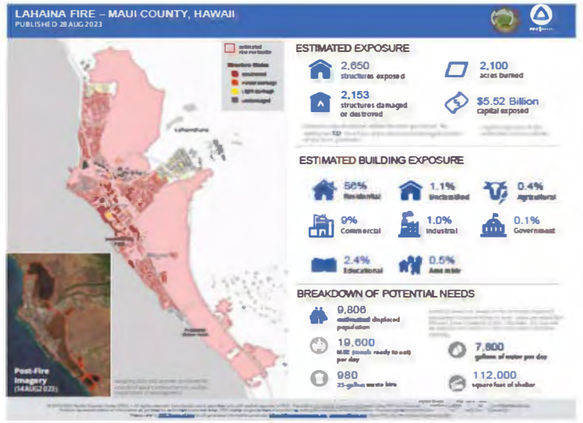


Figure 4.1.3 Map of the greater Lahaina area of Maui County showing the extent of the Lahaina fire, including statistics (right inset) and post-fire image (lower left inset). Source: Pacific Disaster Center.

At 11:27, a third wildfire (the Kula fire (Figure 4.1.4) broke out at [redacted] Kualono Place, Kula and remained active and uncontained for over a week. The Olinda and Kula fires eventually came to be known as the Upcountry fires. At 14:55, The Lahaina PM fire (the Ku'ialua fire) was reported from 7[redacted] Ku'ialua Street, Lahaina. This was the same location as the Lahaina AM fire and is the fire that would eventually destroy a substantial portion of Lahaina Town.

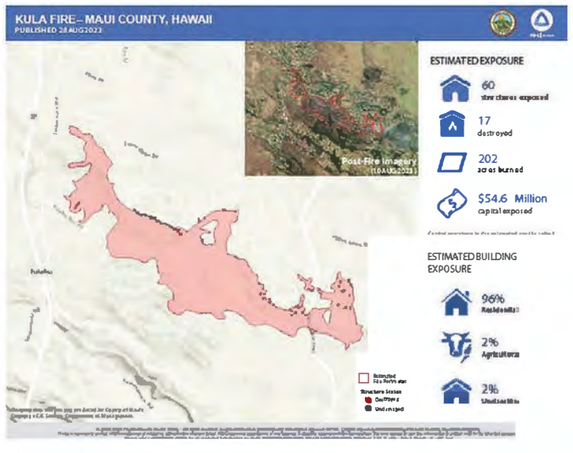


Figure 4.1.4 Map of the Maui County showing the extent of the Kula fire, including statistics (lower left inset) and post-fire image (upper right inset). Source: Pacific Disaster Center.

Finally, the Pūlehu fire (Figure 4.1.5) started at 18:01 at Pūlehu Road and ʻŌpalipali Place in Kula. This fire eventually burned over 3,000 acres and required many days to contain. During the Lahaina PM fire, emergency responders were engaged with multiple fires and continued to respond to new incidents across the island.

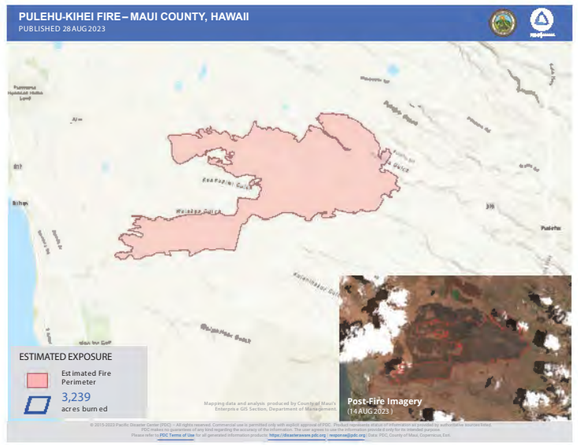


Figure 4.1.5 Map of Maui County showing the extent of the Pūlehu-Kīhei fire, including statistics (lower left inset) and post-fire image (lower right inset). Source: Pacific Disaster Center.

4.2 Pre-Fire Events

4.2.1 Weather Alerts National Weather Service (NWS)

NWS Forecast Office Honolulu, Hawai'i is responsible for all Hawaiian Island weather forecasting. NWS distributes forecasts in different forms called products. The weather forecast products leading up to the Maui wildfires on August 8, 2023, were distributed via the Area Forecast Discussion (routine, four (4) times a day), Fire Weather Planning (routine, once (1) a day), Red Flag Warning/Fire Weather Watch (as needed), and High Wind Watch/Warning/Advisory (as needed). These products related to weather potentially impacting Maui on August 8, 2023, were released over several days prior to August 8, 2023, via NWS established public facing channels.[87] NWS Forecast Office Honolulu also participated in conference calls to further explain the forecast products.

The following is a summary of NWS's forecast products pertaining to Hurricane Dora, high wind, and fire weather. For the complete list of NWS's forecast products on August 8, 2023, and August 9, 2023, see Table 6.2 in the Appendix.

On August 1, 2023, NWS issued an Area Forecast Discussion that predicted the arrival of increased trade wind speeds and dry air associated with the passage of Hurricane Dora. The forecast also mentioned the possibility of Red Flag conditions by early the next week.

On August 3, 2023, an NWS Area Forecast Discussion mentioned the possibility of high winds over and downwind of terrain. The discussion specifically mentioned the possibility of severe fire weather development early in the coming week.

On August 4, 2023, the NWS Honolulu forecaster sent an email to Hawai'i fire contacts predicting strong and dry winds Monday and Tuesday of the following week and warning that NWS Honolulu would issue a Fire Weather Watch over the weekend. The forecaster recognized that this much notice of such a warning was rare. The Honolulu NWS forecaster made a presentation on the Dora-related weather at a meeting organized that day by HI-EMA.

On August 5, 2023, the NWS revised its level of concern for fire weather and predicted that Monday and Tuesday of the next week would present critical fire weather with Tuesday predicted as especially dry.

On August 6, 2023, the NWS issued an Area Forecast Discussion that predicted critical fire weather conditions beginning Monday, August 7, 2023. Dry air and low humidity were also predicted for Tuesday, August 8, 2023. High Wind Watches were issued for portions of Lāna'i, Maui, and the Big Island (Hawai'i), and Red Flag Warnings were issued for the leeward portions of the Hawaiian Islands at 03:33 on August 6, 2023. Lahaina and Ka'anapali were specifically mentioned.

[87] *https://www.weather.gov/about/warning-dissemination*

On August 7, 2023, the NWS restated wind and Red Flag Warnings and predicted markedly stronger winds and low humidity and made predictions of damaging wind levels.

Early in the day (03:00 to 09:30) on August 8, 2023, the NWS reiterated its wind and Red Flag Warnings and predicted the development of wind gusts up to 60 mph.

See Appendix Table 6.2 for a spreadsheet of NWS products released prior to the Lahaina PM fire on August 8, 2023. The table includes specific NWS forecast products addressing the weather that contributed to the August 8, 2023, Maui Wildfires; NWS social media posts; and other direct contacts made by NWS to explain the forecasts. Note that the forecast information represented in this table does not include all mentions of Hurricane Dora, high winds, fire weather, etc. Products were captured using Iowa Environmental Mesonet,[88] and due to many of the products being disseminated several times a day and at times there being little change from one forecast to another, the table does not include all NWS releases. Instead, the table includes the communications that highlight forecasted weather conditions that most contributed to the August 8, 2023, Maui wildfires.

Maui Emergency Management Agency (MEMA)

On August 6, 2023, MEMA issued wind watch notices beginning Monday, August 7, 2023, through Facebook and Twitter/X for areas of several Hawaiian Islands, specifically mentioning Maui. A Facebook posting specifically mentioned a Fire Weather Watch for the leeward portions of all Hawaiian Islands. MEMA advised that residents should watch for updates to the fire weather predictions.

On August 7, 2023, MEMA communicated through social media channels, such as Facebook and Twitter/X, that a Red Flag Warning had been issued for the leeward portions of all Hawaiian Islands through Wednesday, August 9, 2023.

The Maui County Fire Department also warned of high winds, high surf, and Red Flag weather in Facebook and Twitter/X posts on August 7, 2023.

See Appendix Table 6.3 for social media posts regarding forecasted weather from MEMA, Maui County, and Maui 24/7. Although not an exhaustive accounting of social media activity, the table includes a relevant representational sample of critical announcements.

4.2.2 Staffing and Preparedness

Hawai‘i Emergency Management Agency (HI-EMA)

The HI-EMA administrator is Major General Kenneth Hara, who also serves as The Adjutant General for the state’s Department of Defense (i.e., Army and Air National Guard). The HI-EMA administrator who manages the agency’s daily operations is Colonel (Ret.) James Ds. Barros, who started in that role on February 1, 2023.

[88] https://www.weather.gov/about/warning-dissemination

HI-EMA’s State Warning Point (SWP) in Honolulu is staffed 24-hours a day, 7 days a week for 365 days a year with a minimum of two (2) personnel who monitor a wide variety of information sources to maintain situational awareness across the Hawaiian Islands and beyond, since events around the Pacific basin can pose serious threats to the State of Hawai‘i. To understand what’s happening across the entire state, the SWP relies heavily on incoming communication and reports from county emergency management agencies.

The State Emergency Operations Center (SEOC) is typically unstaffed unless an impending or ongoing disaster situation creates a need for statewide coordination of emergency response and recovery resources. For major events, HI-EMA has divided its overall staffing complement into two (2) emergency response teams (ERTs) (blue and orange) that, when activated, can bring approximately 30 personnel into the SEOC for around-the-clock operations. (Figure 4.2.2.1).

ERT Roster

OPERATIONS CHIEF: Brian Fisher	**PLANNING CHIEF:** Niea Gardner	**LOGISTICS CHIEF:** Jackie Russell	**FINANCE & ADMIN CHIEF:** Helen Au	**OPERATIONS CHIEF:** Jacob Bateman	**PLANNING CHIEF:** Kelsey Yamanaka	**LOGISTICS CHIEF:** Ryan Hirae	**FINANCE & ADMIN CHIEF:** Gay Takai
DEPUTY: Francis Kau	**DEPUTY:** VACANT	**RESOURCE MANAGEMENT:** Shaun Brown	**TIME / COST / PROCUREMENT:** Joanna Chang	**DEPUTY:** VACANT	**DEPUTY:** Jeff Wong	**RESOURCE MANAGEMENT:** Seddrick Hartanto, Antonio Harvey	**TIME / COST / PROCUREMENT:** Janice Leung
RFI / RFA MANAGER: Garret Garadie	**RESOURCE UNIT:** Leah Boisvert	**IT / COMMUNICATION** Justin Post	**CLAIMS / COMPENSATION:** Wesley Wakamura	**RFI / RFA MANAGER:** Lalo Medina	**RESOURCE UNIT:** VACANT	**IT / COMMUNICATION** Nathan Garret, Emerson Ibera	**CLAIMS / COMPENSATION:** Radford Real
HAWAII COUNTY: Peter Kawamura	**SITUATION UNIT:** Casey Kunimoto	**EARLY WARNING / SIRENS:** David Yamada, Jack Machida	**FRONT DESK:** Julang Chen, Mary Hatch	**HAWAII COUNTY:** Dawn Shinsato	**SITUATION UNIT:** Jinna Park	**EARLY WARNING / SIRENS:** Mark Nonaka, Eric Shimabuku	**FRONT DESK:** Linda Okamoto, Carmela Vigue
MAUI COUNTY: Julie Fujimoto	**DOCUMENTATION UNIT:** Lori Miyashita, Sarah Hutchinson			**MAUI COUNTY:** Lauren Mark	**DOCUMENTATION UNIT:** Lily Liu, Puanani Akaka		
C&C HONOLULU: Darrick Ching	**RECOVERY:** Lorinda Wong-Lau			**C&C HONOLULU:** Coleen Yoshina	**RECOVERY:** Susan Meade		
KAUAI COUNTY: Paul Hoe	**FUTURE PLANNING** **INFRASTRUCTURE:** Jonah Yano, Chad Satterfield **HUMAN SERVICES:** Debbie Dickinson **EMERGENCY SERVICES:** Zeph Mckee			**KAUAI COUNTY:** Jennifer Robertson, Rebeca Osorno	**FUTURE PLANNING:** **INFRASTRUCTURE:** Jonathan Hui, John Vierra Jr. **HUMAN SERVICES:** Kyle Tucker **EMERGENCY SERVICES:** Trina Nakamura		
OPERATIONS: Richard Largo	**GIS SUPPORT:** VACANT			**OPERATIONS:** VACANT	**GIS SUPPORT:** VACANT		
	DEMOBILIZATION: VACANT				**DEMOBILIZATION:** VACANT		

AS OF: 02JUN2023

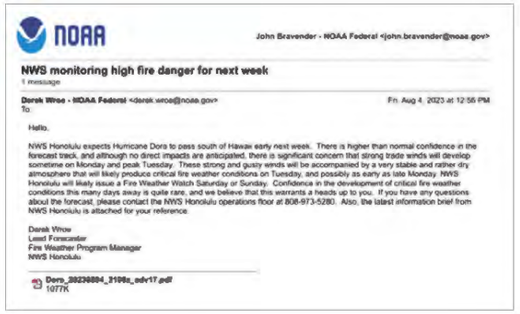
Figure 4.2.2.1 HI-EMA ERT Roster, June 2, 2023.

During the first week of August 2023, HI-EMA was tracking Hurricane Dora’s approach, and from August 2, 2023, the SEOC was enhanced with a two (2)-person crisis action team (CAT); assigning a CAT is essentially the first step in activating the SEOC.

As weather forecasts began to suggest that the main body of the hurricane would not directly impact the Hawaiian Islands, HI-EMA’s attention shifted to the threat of high winds and potential WUI fires.

TIMELINE OF EVENTS

The NWS Honolulu Field Office (HFO) issued a weather warning on August 4, 2023 (Figure 4.2.2.2), to multiple state/local agencies and organizations across Hawai'i, including HI-EMA, with a notice about high winds and impending "critical fire weather" conditions.



NOAA

John Bravender - NOAA Federal <john.bravender@noaa.gov>

NWS monitoring high fire danger for next week

1 message

Derek Wroe - NOAA Federal <derek.wroe@noaa.gov> Fri, Aug 4, 2023 at 12:56 PM
To:

Hello,

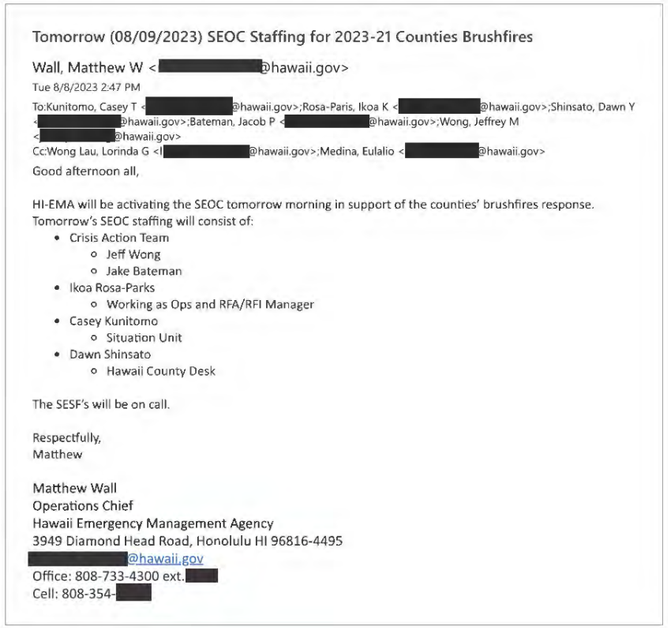
NWS Honolulu expects Hurricane Dora to pass south of Hawaii early next week. There is higher than normal confidence in the forecast track, and although no direct impacts are anticipated, there is significant concern that strong trade winds will develop sometime on Monday and peak Tuesday. These strong and gusty winds will be accompanied by a very stable and rather dry atmosphere that will likely produce critical fire weather conditions on Tuesday, and possibly as early as late Monday. NWS Honolulu will likely issue a Fire Weather Watch Saturday or Sunday. Confidence in the development of critical fire weather conditions this many days away is quite rare, and we believe that this warrants a heads up to you. If you have any questions about the forecast, please contact the NWS Honolulu operations floor at 808-973-5280. Also, the latest information brief from NWS Honolulu is attached for your reference.

Derek Wroe
Lead Forecaster
Fire Weather Program Manager
NWS Honolulu

Dora_38238804_9196z_adv17.pdf
107TK

Figure 4.2.2.2 NWS HFO "Critical Fire Weather" Message, August 4, 2023.

As fires on the Big Island and the Upcountry fires on Maui became an increasing concern on August 8, 2023, HI-EMA began preparing to bring additional staff into the SEOC (Figure 4.2.2.3).



Tomorrow (08/09/2023) SEOC Staffing for 2023-21 Counties Brushfires

Wall, Matthew W <[redacted]@hawaii.gov>
Tue 8/8/2023 2:47 PM
To:Kunitomo, Casey T <[redacted]@hawaii.gov>;Rosa-Paris, Ikoa K <[redacted]@hawaii.gov>;Shinsato, Dawn Y <[redacted]@hawaii.gov>;Bateman, Jacob P <[redacted]@hawaii.gov>;Wong, Jeffrey M <[redacted]@hawaii.gov>
Cc:Wong Lau, Lorinda G <[redacted]@hawaii.gov>;Medina, Eulalio <[redacted]@hawaii.gov>

Good afternoon all,

HI-EMA will be activating the SEOC tomorrow morning in support of the counties' brushfires response.
Tomorrow's SEOC staffing will consist of:

- Crisis Action Team
  - Jeff Wong
  - Jake Bateman
- Ikoa Rosa-Parks
  - Working as Ops and RFA/RFI Manager
- Casey Kunitomo
  - Situation Unit
- Dawn Shinsato
  - Hawaii County Desk

The SESF's will be on call.

Respectfully,
Matthew

Matthew Wall
Operations Chief
Hawaii Emergency Management Agency
3949 Diamond Head Road, Honolulu HI 96816-4495
[redacted]@hawaii.gov
Office: 808-733-4300 ext.[redacted]
Cell: 808-354-[redacted]

Figure 4.2.2.3 SEOC Staffing Email, August 8, 2023.

In the overnight hours between August 8, 2023, and August 9, 2023, as reports started arriving at HI-EMA about conditions in Lahaina, the SEOC went to partial activation.

After the tragic situation in Lahaina became apparent to HI-EMA during the early morning hours of August 9, 2023, the SEOC became fully activated and was expanded with staffing from multiple state and federal agencies to help coordinate resources for the ongoing Maui response and recovery efforts. HI-EMA also sent a three (3)-person incident management team (IMT) to the Maui County EOC on August 10, 2023, and has maintained that resource ever since.

Maui Emergency Management Agency (MEMA)

MEMA is responsible for staffing the Maui Emergency Operations Center (EOC). The number of staff members assigned to the EOC is dependent on the demands of the incident or preparedness efforts required for an impending incident due to forecasted weather.

On and before August 8, 2023, MEMA full-strength staffing consisted of an Administrator and eight full time direct reports. The eight personnel were assigned to perform in a variety of roles during an EOC activation, including operations, planning, logistics, recovery, communications technology, and public information. Personnel are assigned radios and cell phones to be able to monitor situations when away from the EOC.

MEMA maintains a weekly, rotating on-call rostered staff duty officer. The staff duty officer is expected to maintain readiness response capability and is the first person expected to report to the EOC should an incident occur. The administrator is responsible for designating who can serve as a staff duty officer based on experience and requisite knowledge. Prior to being rostered as a staff duty officer there are some mandatory training requirements, including attending state-level training for use of the statewide notification networks (Emergency Alert System (EAS), Hawai'i Warning System (HAWAS), etc.). During the period prior to August 8, 2023, Colleen Hauptman was the staff duty officer.

On August 7, 2023, two (2) MEMA members were unavailable for EOC staffing. MEMA Administrator Herman Andaya was attending the Pacific Partnership Conference on O'ahu with other emergency managers from the state of Hawai'i and the federal government, and Josh Aquinde, Staff Specialist III, was fulfilling his National Guard responsibilities.

MEMA partially activated the EOC with two (2) individuals on August 7, 2023, at 21:00 to monitor the high winds and Red Flag weather conditions forecasted by NWS and to prepare for a potential emergency. Senior MEMA member Paul Coe assumed the role as EOC Director. Colleen Hauptman was also assigned to staff the EOC and assisted with monitoring conditions. The partial activation extended to August 8, 2023, at 16:30 when it was fully activated.

Maui Police Department (MPD)
MPD has six (6) districts and police stations located in Wailuku (headquarters), Lānaʻi, Hāna, Lahaina, Molokaʻi and Kīhei, serving 29 motorized "beats" (Figure 4.2.2.4) Prior to the wind and fire events of August 8, 2023, MPD had staffing levels that were consistent with normal day-to-day operations. This includes 296 sworn and 96 civilians serving in six districts and stations.[89] This staffing represents a 25 percent vacancy in sworn personnel (400 sworn is fully staffed) and 34 percent vacancy in civilian positions. More specifically, within the civilian ranks, there is a 51 percent vacancy in dispatch overall.[90]

MPD staffing chart for Lahaina (District 4), dated August 1, 2023, identified 45 total personnel assigned to this location. The staffing chart indicated there was an allocation for 53 personnel, showing the Lahaina location had eight (8) vacancies. The Lahaina District fielded the following personnel:

- 1 Captain
- 1 Office Operations Assistant
- 1 Lieutenant
- 6 Sergeants
- 34 Police Officers (1 vacancy for Community Policing Officer and 4 vacancies for Police Officers)
- 1 Evidence Custodian
- 4 Public Safety Aide (3 vacancies)

MPD has 24-hour, 365-day coverage each year. Personnel assigned to patrol work one (1) of two (2) 12-hour shifts:

- Alpha shift (Dayshift): 06:00-18:00
- Bravo shift (Graveyard): 18:00-06:00

No additional personnel were added to the patrol shifts on August 7, 2023.



Figure 4.2.2.4 MPD station locations. Source: Maui County. Credit: FSRI.

[89] http://www.mauipolice.com/uploads/1/3/1/2/131209824/pre_aar.pdf
[90] http://www.mauipolice.com/uploads/1/3/1/2/131209824/mpd_strategic_plan_2023_-_2028.pdf

Maui Fire Department (MFD)
The MFD serves all of Maui County, including the islands of Maui, Molokaʻi, and Lānaʻi.

MFD provides services to the community through a network of ten (10) fire stations on Maui itself, with three (3) stations on Molokaʻi and one (1) on Lānaʻi. The department also staffs 12 Ocean Safety lifeguard towers on beaches throughout Maui (Figure 4.2.2.5).

The department is staffed with a total of 430.5 full-time equivalent positions across all three (3) islands. MFD firefighters assigned to emergency response work a rotating three (3) shift schedule with 24-hour on-duty shifts.

The MFD operates two (2) fire stations in the Lahaina community:

- The Lahaina Fire Station is located at 1860 Hwy-30 near the Lahaina Civic Center. The station houses Engine 3, staffed each day with four (4) firefighters; Ladder 3, staffed with four (4) firefighters; Tanker 3, staffed with one (1) firefighter; and Battalion Chief 2, staffed with one (1) command officer.
- The Nāpili Fire Station is located at 4950 Hanawai Street, near the intersection of Hwy-30 and Nāpilihau Street. The station houses Engine 11, staffed each day with four (4) firefighters, and Mini 11, cross-staffed with Engine 11.

The next closest MFD fire stations are the Kahului Fire Station located at 200 Dairy Road, the Wailuku Fire Station located at 21 Kinipōpō Street, and the Kīhei Fire Station located at 11 Waimāhaʻihaʻi Street. All three (3) are approximately 30 minutes from Lahaina when traveling in typical road traffic conditions for responding fire apparatus.

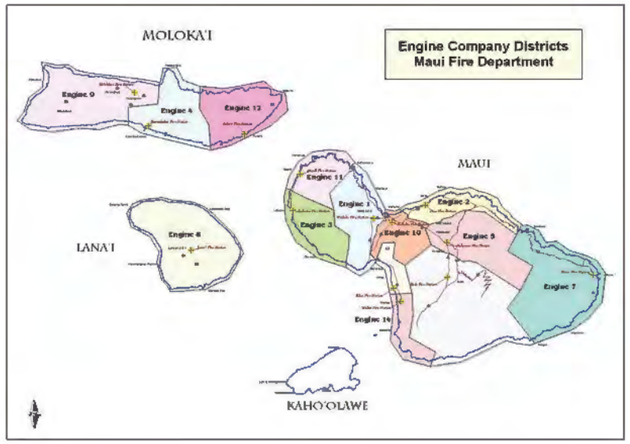


Figure 4.2.2.5 MFD engine company districts. Source: Maui County.

Fire and rescue air operations are provided by contracted helicopter services based at the Kahului Airport.

The MFD has mutual aid agreements with the fire departments providing services to the Kahului Airport and the Kapalua Airport located near Lahaina.

On August 7, 2023, the fire department was staffed for normal operations. With Fire Chief Bradford Ventura (Fire 1) away on the mainland, Deputy Chief Gavin Fujioka (Fire 2) was the senior leader on duty.

Dispatch
Central staff are trained in call-taking (e.g., answering emergency, non-emergency, and MPD administrative calls), and are cross-trained to dispatch and monitor incidents for police, fire, and emergency medical response units. Each dispatcher is trained to staff the terminals and radio channels. Staffing may rotate on a daily basis.

Central is located at Wailuku Police Station. On the island of Maui, Central has five (5) radio consoles–including a dispatch terminal, three (3) call taking terminals, and one (1) training terminal that can be put into use if needed. Staffing on the island consists of a supervisor and three (3) dispatchers. This is considered "normal" staffing on a day-to-day basis. The supervisor has the ability to take over the radio to provide relief for a dispatcher or to answer calls during increased call volume, as needed. Central personnel are split into two (2) shifts (i.e., First Watch and Second Watch). Due to staffing shortages, dispatchers work five (5) or six (6) 12-hour shifts per week. First Watch is typically from 06:30 to 18:30, and Second Watch covers from 18:30 to 06:30.

Dispatch services for Molokaʻi and Lānaʻi are covered by a satellite location on the island of Molokaʻi. Molokaʻi has one (1) dispatcher responsible for emergency, non-emergency, and police administrative calls for Molokaʻi and Lānaʻi. Depending on call volume and caller location, it is possible for Molokaʻi to receive calls from the other islands within the county and the state.

Hawaiian Electric
Hawaiian Electric maintains a fleet of more than 70 vehicles to maintain electrical infrastructure on the island of Maui. These light, medium, and heavy vehicles are assigned to Transmission and Distribution Operations as well as Substation and Meter Substations. Going into the evening of August 7, 2023, operations and dispatch staffing was according to normal operations. Personnel worked their assigned shifts and other personnel were available for after hour call back as needed.

Department of Water Supply
The Department of Water Supply maintains 15 certified operators to draw from to staff the two (2) water treatment facilities located in West Maui. The West Maui water treatment facilities were staffed as per normal operational demands on the morning of August 8, 2023. Deputy Director James Langraf signed in on the Maui EOC log on August 8, 2023 at 08:30.[91]

Hawaiʻi Division of Forestry and Wildlife (DOFAW)
According to the DOFAW Maui Unit Leader, DOFAW was staffed normally on August 8, 2023 (Table 4.2.2.1), with fire suppression equipment inventory outlined in Table 4.2.2.2.

Table 4.2.2.1 Hawaiʻi Division of Forestry and Wildlife (DOFAW) Personnel on August 8, 2023.

DOFAW Personnel On Duty
August 8, 2023

Number	Qualification/Role
38 available district staff	District staff trained to operate equipment and perform in wildland firefighting operational roles. Includes 6–7 members of the District IMT–Command and General staffing
~20+ additional staff	Access to out-of-district personnel from Oʻahu, Hawaiʻi island, and Kauaʻi (w/in 24 hours from request) for fire crew, IMT, fallers, CDL, etc.

Table 4.2.2.2 Hawaiʻi Division of Forestry and Wildlife (DOFAW) Fire Suppression Equipment Inventory on August 8, 2023.

DOFAW Fire Suppression Equipment Inventory
August 8, 2023

Type of Equipment	Quantities
Heavy equipment	• One (1) Type II Dozer (Komatsu D61 EX) • Two (2) backhoes (CAT 416)
Engines	• Three (3) Type IV M62s • One (1) Type IV Model 5 • Three (3) Type VI (F450/F550) • Four (4) 150–300 gallons slip-on units
Helicopter	Access to on-island contract vendor (Windward Aviation) helicopters • Four (4) Type III helicopters • One (1) Type II helicopter (MFD Air 1)
Tankers/Water Tenders	• Type 1 (4,000 gallons; 6x6) • Type 3 (1,000 gallons; 6x6)
Firefighting Equipment/ Small Engine	• One (1) skid steer masticator • Two (2) medium diameter capacity mobile chippers • Four (4) portable helicopter mop-up tanks • Two (2) portable 6' high helicopter dip tanks (3,500 gallons each) • Two (2) 4x4 UTV w/ 60–100 gal slip-on high psi pump • Two (2) ultra striker portable pumps • Chainsaws of various sizes and capacities

[91] *Department of Water Supply Lahaina and Māhinahina Water Treatment Facility Operations and Emergency Plan 2021.*



Figure 4.2.3.1 Image capture of civilian video showing westbound traffic on Lahainaluna Road between Kale Street and Pauoa Street taken August 8, 2023 at 09:07.



Figure 4.2.3.2 Civilian photo of a utility pole blocking Hwy-30 at the Lahaina Civic Center. Taken August 8, 2023.

4.2.3 Pre-Fire Utility and Structure Damage/Destruction

Prior to the vegetation fires reported at 06:55 and 14:55 on August 8, 2023, Lahaina sustained widespread damage due to high winds. Utility poles broke in half, and some fell to the ground blocking roads. Electrical lines were draped across major egress routes, roofs were blown off structures, and mature trees were toppled to the ground. Traffic congestion through Lahaina increased throughout August 8, 2023, as roads became impassable due to downed utility poles, electrical lines, and trees. This report will not include an exhaustive list of all damage sustained, which is beyond the scope of this Phase One (1) Timeline report. The following images are examples of the extent of the damage. These images are representative of the damage seen but multiplied across the greater Lahaina region.

Impact of Downed Utility Poles on Traffic and Evacuation Routes

The high winds impacted the above-ground electrical and communications infrastructure throughout Lahaina. Many large utility poles supporting multiple lines broke, resulting in the posts and wires blocking roads or being close enough to the road to impede the flow of traffic (Figure 4.2.3.1). This was most evident on Hwy-30, where several critical intersections were impacted by compromised utility equipment (Figure 4.2.3.2). The combination of traffic signals not working and blocked streets from utility poles and trees made for difficulties in traveling through Lahaina, even before the Lahaina PM fire response. The added vehicles evacuating at the onset of the Lahaina PM fire would ultimately challenge most evacuation routes leading out of Lahaina (Figure 4.2.3.3).

Compromised Structures

The strong winds in Lahaina on August 8, 2023, resulted in structural damage even before the fire, generating forces great enough to rip roofs from structures, tear awnings from buildings, dismantle fences and loft household belongings into the air and toward downwind structures and utilities (Figure 4.2.3.4). Airborne materials (projectiles) may impact structures with enough force to compromise the building envelope, through broken windows or displaced vents. Resident videos showed outdoor furniture and play equipment being blown about the streets. One (1) image (Figure 4.2.3.5) showed a large trampoline entangled in overhead electrical lines. Others show substantial roofing damage in residential and commercial structures. A compromised building envelope ultimately created pathways for embers to enter structures.

4.3 Fire and Response Timeline

The Fire and Response Timeline section is largely focused on the facts about the Lahaina AM and PM fires. The impact the Olinda, Kula, and Pūlehu fires had on the Lahaina PM fire response will be explored in the Phase 2 report of this analysis.

The Fire and Response section includes data from time-stamped events indicating the fire's path of travel, resident evacuation and rescue efforts, and fire suppression activities. Much of this information was gathered from pictures, video, radio communications, automatic vehicle locating (AVL) applications, text messages, social media posts, emails, and corroborated personal experiences. This data provides the most accurate picture of how fast the fire moved through Lahaina and details the response effort of agencies playing a role in handling the emergency.

West Maui did not have a Remote Automated Weather Station (RAWS) on August 8, 2023, thus, there were no recorded weather measurements in this portion of the island. The Maui RAWS closest to Lahaina is not a good comparison because it is not positioned on a southwest slope. A Hawaiian Island RAWS that likely provides the best indication of conditions in Lahaina is Kohala Ranch (KHRH1). It is located on the leeward side of the Big Island (Hawai'i), on a southwest slope. This RAWS recorded some of the highest wind speeds of all Hawaiian Island RAWS on August 8, 2023. From 11:35 to 16:35 the average wind speed was 40 mph, the average wind gusts were 70 mph, and the highest recorded gust was 82 mph at 16:35. The winds measured in Kohala track with what was experienced in Lahaina. See Appendix Table 6.4 for the KHRH1 RAWS data.



Figure 4.2.3.5 August 8, 2023, at 07:01. Civilian image of trampoline in overhead electrical lines at Dickenson Street and Mill Street.

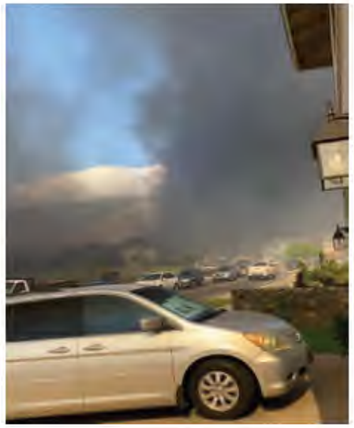


Figure 4.2.3.3 Civilian image taken August 8, 2023, at 16:11 showing westbound traffic on Komo Mai Street toward Kuhua Street and Keawe Street.

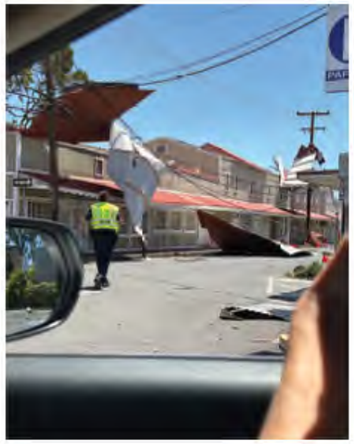


Figure 4.2.3.4 August 8, 2023, at 13:46. Civilian photo of roof damage, looking west down Lahainaluna Road from Luakini Street.

TIMELINE OF EVENTS

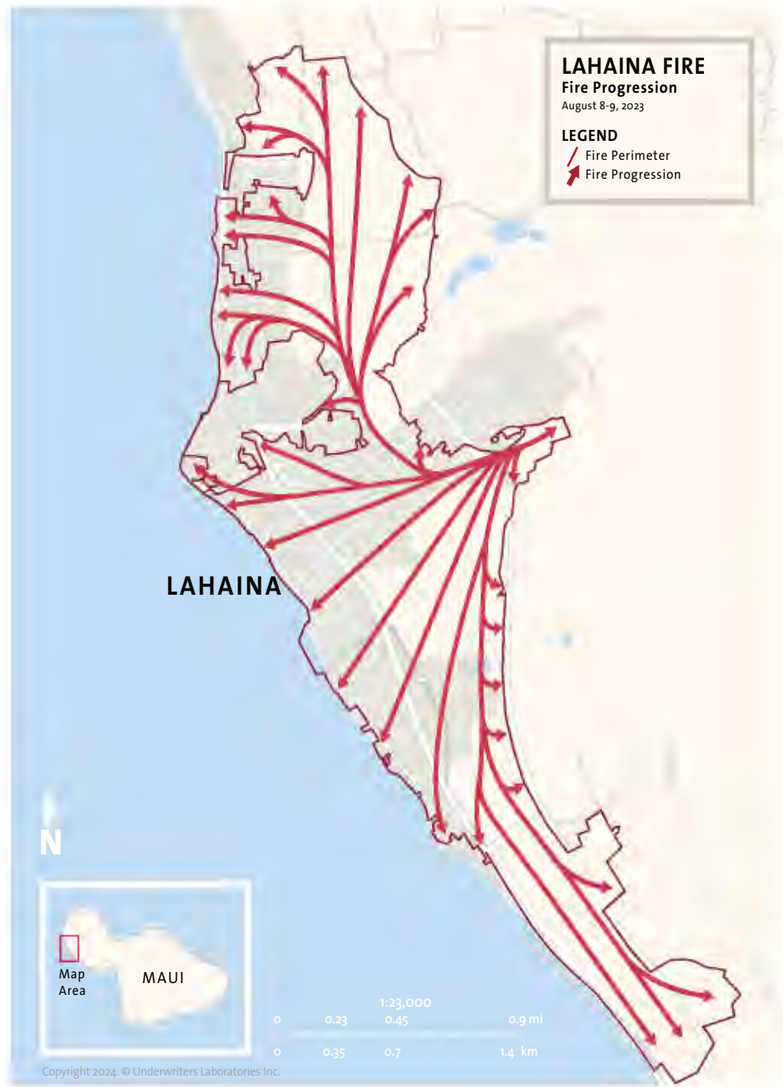
4.3.1 Fire Progression

A detailed summary of the fire progression timeline and facts impacting the fire progression are presented in this section. A fire progression map shown in Figure 4.3.1.1 shows a summary of the fire spread from the time period of 14:55 on August 8, 2023, through 06:07 on August 9, 2023. The final fire perimeter is indicated by the red outline. Section 6.13 in the Appendix shows specific data and sources of the data that support the fire progression map. Figure 4.3.1.2 shows each of the data points on the map with its respective time stamp. The data points located outside of the fire perimeter represent the location the data was captured from. In many cases observations were made from a safe location, with an observation into the fire perimeter. Details about the observations are explained in the following sections and in the Appendix. Fire spread data presented in this report was collected from dispatch records, MFD radio recordings, MFD fire incident reports, MPD radio recordings, pictures and videos from civilians, MPD body worn camera footage, 911 call recordings, and technical discussions with MPD and MFD personnel. All this data was cross referenced and further supported by the collective dataset. Technical discussions with MPD and MFD were used to validate timeframes noted by image timestamps or dispatch records.

Fire spread within the built environment is driven by three (3) mechanisms: direct flame contact, radiant heat, and embers (Figure 4.3.1.3 on the following page). Direct flame contact can occur when fire spreads through continuous fuel, vegetative or otherwise, to the building or when separation between a burning object and a target (such as a burning structure near another structure that has not yet caught fire) is less than the flame length. This results in flames touching the structure. If burning fuels are not close enough to allow direct flame contact, they can heat a building by radiation which may cause it to ignite. Embers, also referred to as firebrands, are generated by burning fuels and transported by wind, causing ignitions beyond the fire perimeter. Spot fires ignited by embers can cause direct flame contact or radiant heating of structures in the built environment. Embers can also enter the building through vents, windows, and/or openings caused by wind damage that may ignite the structure and cause it to burn from the inside out.

Fire can spread along fuels at the perimeter of the property, such as fences and sheds to fuels closer to the home, such as outdoor furniture and ornamental vegetation. Building features, such as roofs, eaves, vents, siding, doors, and windows, may also provide pathways for structures to ignite. Fuels in the built environment, including vehicles, liquified propane gas (LPG) tanks, structures, and household belongings, can generate more intense flames and embers compared to vegetative fuels. In (sub)urban communities, homes are closely spaced and may have continuous (or nearly continuous) fuels between them, which can lead to conflagration with built-environment dominant fuels.

Figure 4.3.1.1 Comprehensive fire progression map of the greater Lahaina and western Maui areas. Arrows indicate the general direction of fire spread based on the data collected. The fire's progression and speed was influenced by direct flame contact, radiant heating, and wind-driven embers from all of the fuel in the fire's path.



TIMELINE OF EVENTS

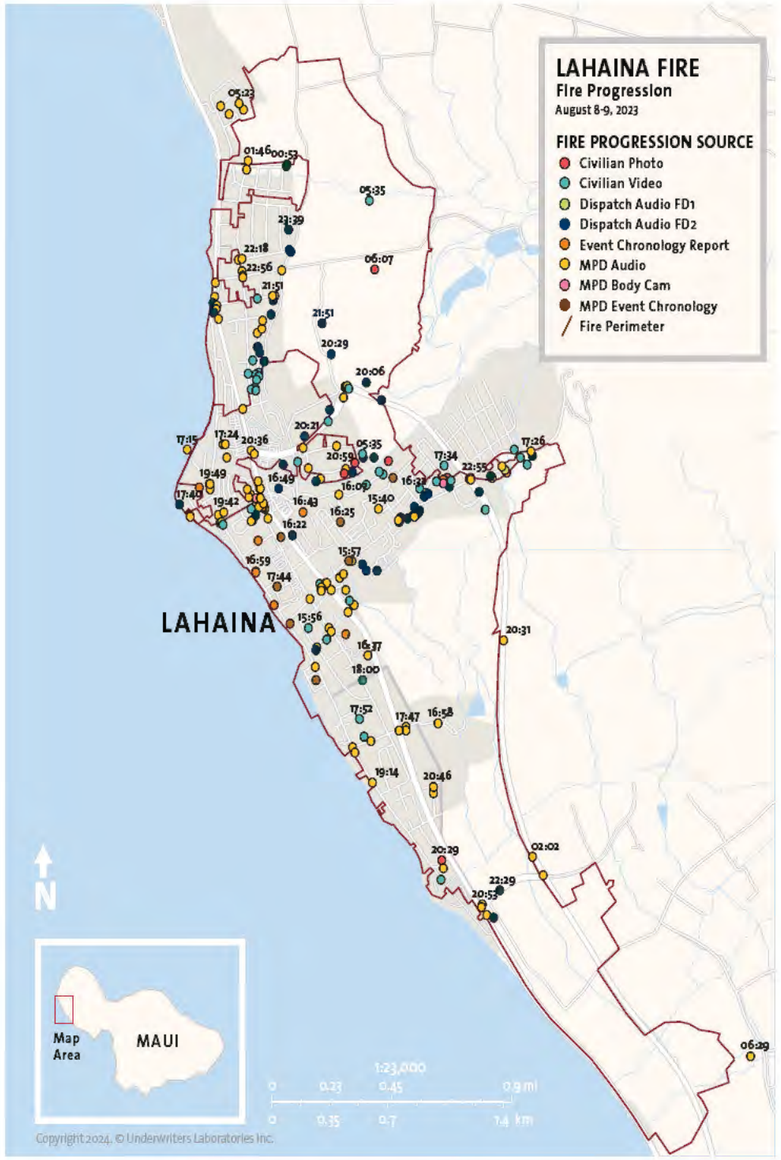
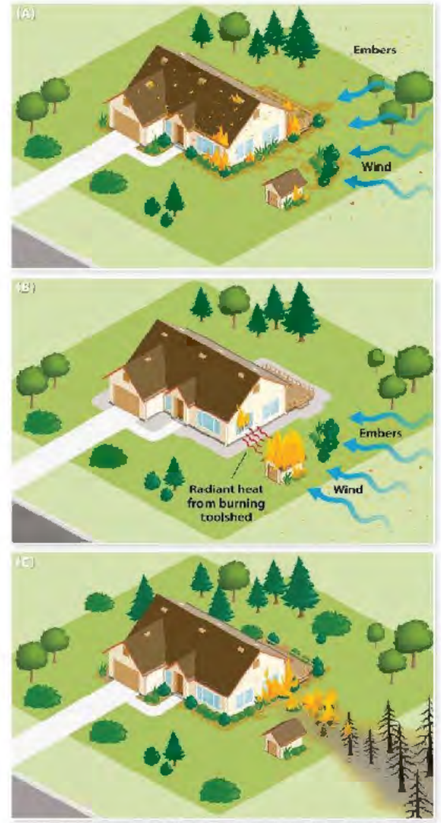


Figure 4.3.1.2 Fire progression map of western Maui with detailed data from various sources. Detailed maps in the following sections will discuss the points and times with more specificity.

How embers advance fire spread.

There are three (3) stages in the life cycle of embers: generation, transport, and accumulation/deposition, which may result in ignition[93]. Burning fuels generate embers when particles break off due to ambient wind and buoyant fire-induced plumes. Characteristics of embers which relate to transport and ignition potential depend on the type of fuel (vegetative or structure). Embers are lofted by the fire plume and/ or carried by ambient wind, traveling relatively short (feet) to long (more than a mile) distances. After embers land, they can accumulate in areas driven by wind eddies at obstructions (e.g., where a wall meets the ground) and along rough surfaces (e.g., mulch). If accumulated embers have enough energy and land on a receptive (i.e., combustible) fuel, they can cause it to ignite, creating a spot fire. Since embers can be lofted above the flames and travel ahead of the fire front, they can cause spot fires remote from the burning material that produced them. This mechanism can lead to discontinuous fire spread, resulting in unburned fuel islands.

Additional analysis–including the impact of suppression efforts by the fire depart- ment, police department, private water tankers, and civilians; fire burning over civilians and/or firefighters; evacuation routes affected by fire and/or smoke; and wind, fuels, and terrain–will be included in a subsequent report.

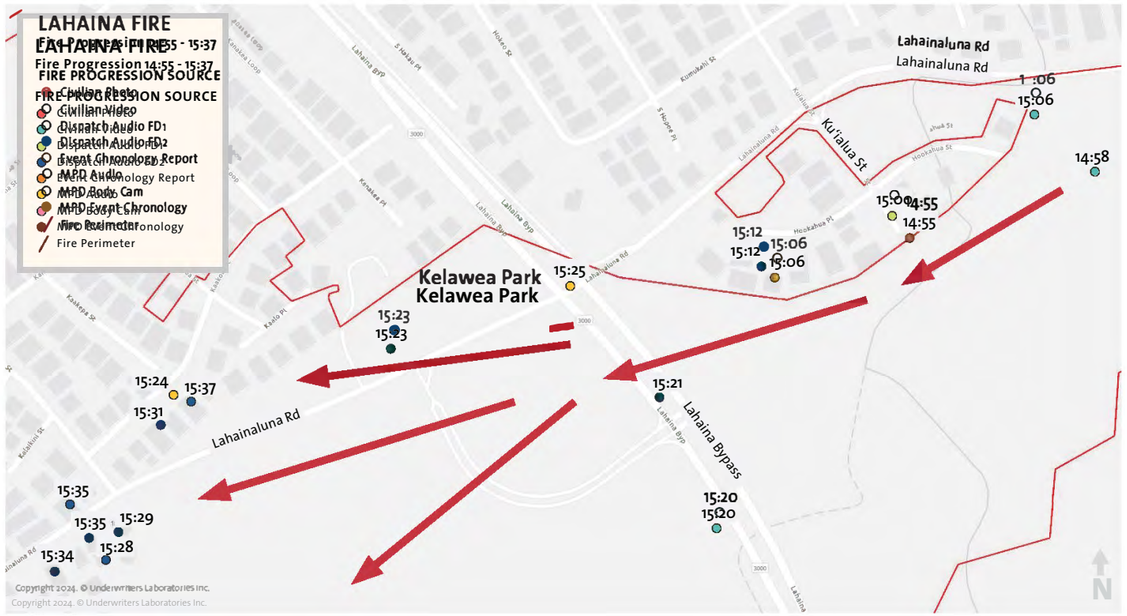


Incorporating fire safe concepts requires preparing for three different types of fire exposures: embers (A), radiant heat (B), and direct flame contact (C).

Figure 4.3.1.3 Building ignition mechanisms from fire exposures: embers, radiant heat, and direct flame contact. Source: Reducing the Vulnerability of Buildings to Wildfire: Vegetation & Landscaping.[92] 2021.

[92] https://anrcatalog.ucanr.edu/Details.aspx?itemNo=8695
[93] Manzello SL, Sayaka S, Gollner MJ, Fernandez-Pello AC. (2020) Role of firebrand combustion in large outdoor fire spread. Progress in Energy and Combustion Science. https://doi.org/10.1016/j.pecs.2019.100801

TIMELINE OF EVENTS


LAHAINA FIRE
Fire Progression 14:55 - 15:37
FIRE PROGRESSION SOURCE
Civilian Photo
Civilian Video
Dispatch Audio FD1
Dispatch Audio FD2
Event Chronology Report
MPD Audio
MPD Body Cam
MPD Event Chronology
Fire Perimeter
Lahainaluna Rd
Kelawea Park
Lahaina Bypass
Ku'ialua St
Kaka'ako Loop
Kenaka Loop
Kauakaua St
Kaaka Pl
Kaaka Pl
Kauhola St
Kamakali St
Hoohaha St
Hoohaha Pl
Kuialua Rd
Ahuli St
Kaaka Pl
Kaaka St
Kaaka Pl
Kaaka Pl
Kauakaua St
Kaaka St
Kaaka Pl
Kaaka Pl
Kaaka Pl

TIMELINE OF EVENTS



Figure 4.3.1.6 provides an overview of fire progression from 15:38 through 16:08. At 15:38, multiple 911 callers indicated that their homes, fences and sheds were on fire near Paunau Street (4[redacted] and 4[redacted] Pā'ū'ū Place). At 15:40, an MPD officer (499) advised of fire in the brush at 4[redacted] Kauhi Place, approximately 1,000 ft west (makai) of the structure fires MFD was working on. The combination of structure-to-structure fire spread due to the homes and other structures being very close together, combined with many ladder fuels, such as vehicles, fences, trees, shrubs, sheds, propane tanks, additional outbuildings, etc. caused the fire to spread rapidly ahead of suppression efforts. Embers from numerous burning fuels were being carried by the strong wind ahead of the structure fires, causing spot fires in grass, shrubs, trees, and other fuels around and in homes.

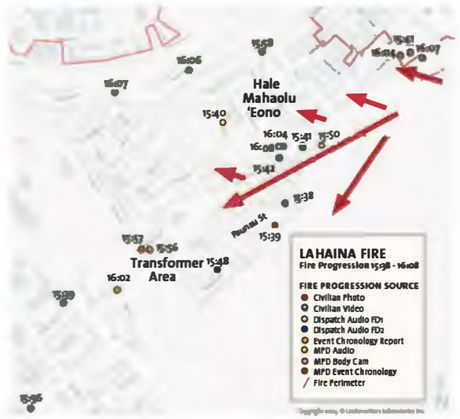


Figure 4.3.1.6 Fire progression map showing fires in or near the Lahainaluna Road area from 15:38 through 16:08.

With many structures on fire, the smoke thickened, and the plume could be seen making its way all the way to the ocean. The heavy wind drove the smoke to the ground, limiting the visibility of those in the path. Civilian pictures and videos show the northern and southern bounds of the smoke plume. At 15:39, a civilian video shows that the smoke was moving past the smokestack and toward the Outlets of Maui. At 15:43, MPD officer 4SA2 advised that the smoke was getting "pretty bad" at Lahainaluna and Hwy-30. A civilian video shows the southern border of the smoke plume at the northern end of the harbor at 15:56. On the northern side, a civilian video captured the smoke plume passing over 3[redacted] Komo Mai Street at 16:06. Figure 4.3.1.7 shows an approximation of the smoke plume at approximately 16:00.

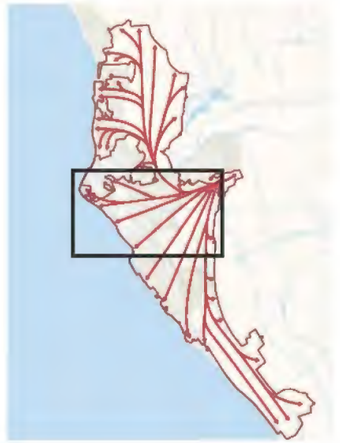


Figure 4.3.1.7 Smoke boundary map of the greater Lahaina area at approximately 16:00.

The fire continued to spread quickly west (makai) on Lahainaluna Road. At 15:41, MFD command advised of several houses catching fire west (makai) on Lahainaluna Road, toward Kelawea Street and at 15:42, confirmed the fire was all the way down to Kelawea Street. An MPD officer indicated that the fire had reached the transformer area, across from the intersection of Lahainaluna Road and Kuhua Street, at 15:56. One (1) minute later, another caller to 911 advised that the fire was starting up at Lahainaluna Road and Kuhua Street. At 15:48, a 911 caller stated her yard was on fire at 4[redacted] Pauwala Place.

While the fire was spreading from structure-to-structure and spotting ahead of the structure fire by embers carried by the wind toward the ocean, the fire continued to burn across the grasses to the south and west. The fire spread west of the Lahaina bypass and south toward the Lahaina Recreation Center (off of Shaw Street, east of Hwy-30).

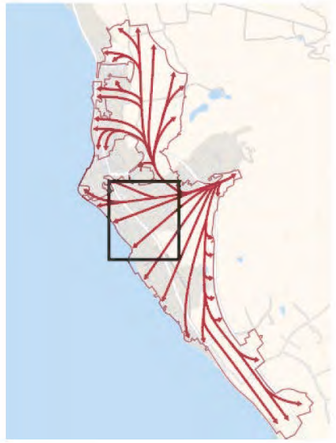
At 15:58, there was a dispatch report of a house on fire behind 8[redacted] Lu'i Street on Kalena Street. At the same time, there was a report that the house at 8[redacted] Lu'i Street at the intersection with Kalena Street was fully involved in fire. This indicates that the fire spread north in addition to west. At 16:04, a county water works truck was reported to be on fire adjacent to 6[redacted] Ka'alo Place. This truck was the easternmost vehicle or structure damaged by fire north of Lahainaluna Road. At the same time, another vehicle fire was reported at the Hale Mahaolu 'Eono senior living center at Lahainaluna Road and Kelawea Street. By 16:08, MPD officers confirmed that the fire had reached Hale Mahaolu.





After start of Lahaina PM fire

TIMELINE OF EVENTS



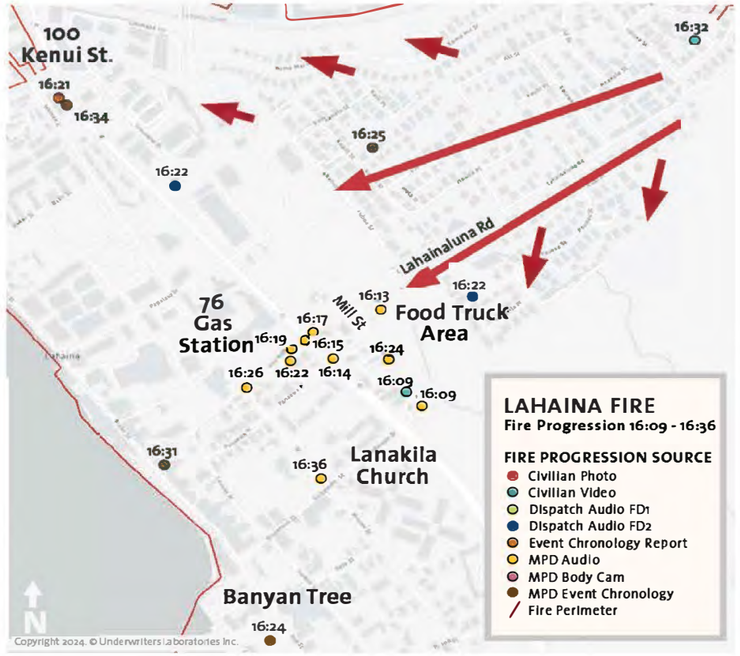


Figure 4.3.1.8 Map showing fire progression in the Lahainaluna Road, Dickenson Road, and Hwy-30 area from 16:09 through 16:36.

As depicted in Figure 4.3.1.8, at 16:09, MPD Officer 401 reported that the fire had reached Mill Street. At 16:13, MPD Officer T22 reported that the fire had reached the food truck area at the corner of Lahainaluna Road and Mill Street. At 16:14, MPD Officer 4SA2 reported that the fire was burning the grass in the median of Hwy-30 and was in the area between Lahainaluna Road and Dickenson Road. At 16:17, MPD Officer 415 advised of the first fire to spot on the west (makai) side of Hwy-30, followed by MPD Officer 4SA2 advising of another fire by the 76 gas station on the northwest corner of the intersection of Lahainaluna Road and Hwy-30.

Engine 1, Engine 6, Wildland 6, and Relief Engine 1 were operating on Pauoa Street south of Lahainaluna Road. They declared emergency traffic (i.e., critical life safety radio communications that take priority over all other transmissions) at 16:17, and at 16:22, they became trapped by the fire conditions and other vehicles trying to evacuate. Video from the firefighters shows many structures on fire in the area and embers being driven through their location by strong winds.

At 16:24, a civilian reported a fire by the “Big Banyan Tree.” This location is 1.3 miles from the area where the fire originated. Also, at 16:24, Officer 401 radioed, “We might have one (1) fatality, homes rear of Mill Street.” This indicates that immediately dangerous to life and health (IDLH) fire conditions had progressed to the area of Mill Street and Hwy-30.

While the fire was spreading rapidly toward the ocean (head of the fire), the perimeter also began to widen. A civilian video taken from 8[redacted] Kanua Street at 16:32 shows numerous houses on fire on Ka‘akepa Street. This allowed additional heat and embers to be forced west and north by the winds.

At 16:26, Officer 415 radioed that there were numerous poles on fire and houses catching fire on Waine‘e Street. The same officer advised that there was a fire next to the [Maria] Lanakila Church and that Dickenson and Wainee‘s were engulfed at 16:36. At the same time, numerous calls were coming in to advise of fire further north on Waine‘e Street at Kenui Street, the back of 1[redacted] Kenui Street. There was also a call for a pavilion on fire at 10[redacted] Waine‘e Street at the same time. Simultaneously, there were reported fires along approximately 0.6 miles (3,200 feet) of Waine‘e Street.

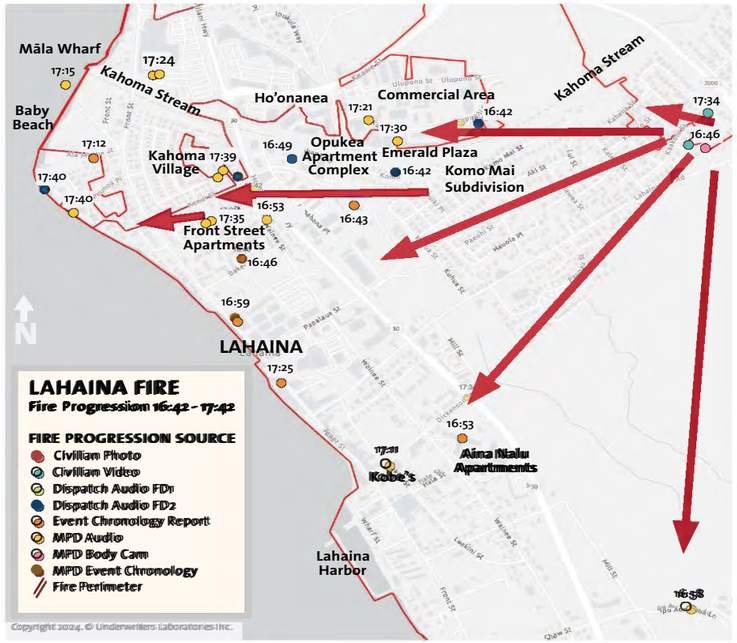
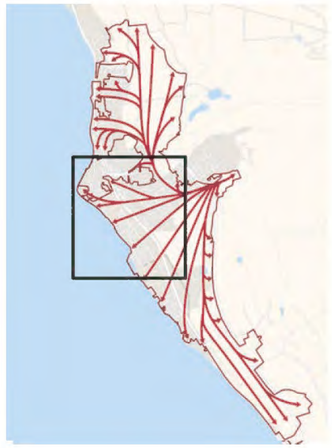


Figure 4.3.1.9 Fire progression map showing particularly fierce fire spread in the Waine‘e Street area from 16:42 through 17:42.



TIMELINE OF EVENTS



After start of Lahaina PM fire

Figure 4.3.1.9 (on a previous page) provides an overview of fire progression from 16:42 through 17:42. At 16:42, there were two (2) reports of fires on the north side of Kahoma Stream. RE11 radioed to command that they had fallen back to Foodland Farms and that multiple structures in the Komo Mai subdivision were on fire. The second report was from MFD Command to E11 advising that there was a vacant lot on fire between 2[redacted] and 1[redacted] Kupuohi Street. Right on the other side of Kahoma Stream from the Ho'onanea at Lahaina condominiums, RE11 reported at 16:49 that the Opukea apartment complex had cars on fire, and the fire was extending to the building.

On the south flank of the fire, a "large fire" was reported at Aina Nalu apartments (660 Waine'e Street) at 16:53. Five (5) minutes later, an unknown MPD Officer advised that the fire was coming by the shelter for the unhoused, located east (mauka) of Lahaina Recreation Center on Shaw Street. This indicated that the fire continued to spread south from the area of Lahainaluna Road and the Bypass through the grasses and brush to the area of the Lahaina Recreation Center.

At 16:59, there was a report of a house on fire at 9[redacted] Front Street. MPD Officer 415 radioed that the former Kobe's restaurant was on fire, along with that area of Waine'e Street, at 17:11. At 17:12, palm trees were reported to be on fire near [redacted] Ala Moana Street, and at 17:15, MPD officer 4B31 advised that Māla Wharf was on fire. These reports indicate that the fire had spread to the ocean from at least Māla Wharf at the north to Lahaina Harbor at the south with structures on fire throughout the area.

From 17:21 to 17:30, several more fires were reported in the commercial area on the north side of Kahoma Stream. MPD Officer 4SA2 advised that the Island Grocery Depot (58 Kupuohi Street) was starting to catch fire, and the fire was spreading toward the Minit Stop (10 Kupuohi Street). He also advised that there was a truck fully engulfed at 190 Kupuohi Street. At 17:26, MPD Officer VOP8 advised that there was a flare up (10 ft by 10 ft) above where the fire started and across from the middle school. At 1730, MPD Officer 4K14 advised that there were a couple of structures and vehicles on fire near Emerald Plaza.

At 17:31, E11 advised of a single-family residence's roof on fire in Kahoma Village. This was the second house from the corner of Hwy-30 and Kenui Street. A civilian video shows several houses on fire at 17:34 near 6[redacted] Ka'akolu

Street. Across from Kahoma Village, the Front Street Apartments were catching fire at 17:35, according to MPD Officer 4A30. At 17:40, a civilian reported a fire starting in the area of Baby Beach. At 17:42, an MPD Officer advised that there was a house fully engulfed at Front Street and Ala Moana Street. At 17:43, MPD Officer 4B10 advised that visibility was getting poor in Kahoma Village, indicating that the fire was widening toward the north.

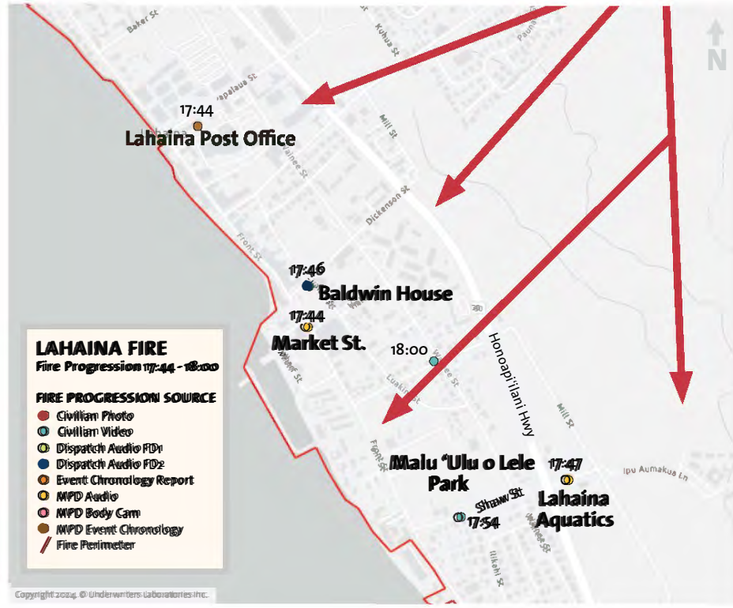




Figure 4.3.1.10 Southern flank of fire showing fire progression from 17:44 and 18:00.

On the south flank of the fire (Figure 4.3.1.10), at 17:44, a civilian reported that the Lahaina Post Office was on fire as well as the Outlets of Maui and several vehicles in the area. MPD Officer 418 advised that Front Street was on fire all the way down to Market Street, Baldwin House was on fire, and the road was not passable. Further south of this area, MPD Officer 415 radioed that the Lahaina Aquatic Center area was catching fire at 17:47. Five minutes later (17:54), a civilian shot a video from 1[redacted] Shaw Street showing a tree on fire in the Malu 'Ulu o Lele Park. Just after this, MPD Officer 415 advised, "We're engulfed from H-Piilani down to Front Street by Shaw Street. Both sides."

TIMELINE OF EVENTS



Figure 4.3.1.11 Image capture from a civilian video recorded from 1[redacted] Shaw Street looking north showing fire progression from Waine'e Street to Front Street (18:00).

(Below: represents the camera operator's approximate visual scope.)

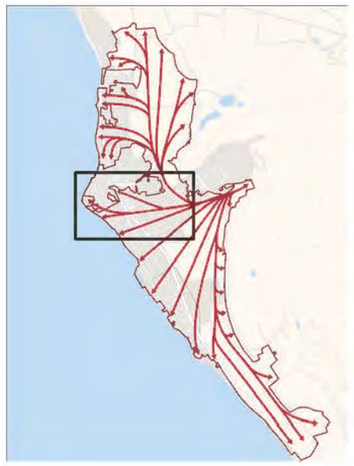


A civilian video shows the fire progressing at 18:00 from Waine'e Street to Front Street along Prison Street. It also shows the edge of the thick smoke plume moving toward the ocean (Figure 4.3.1.11).

On the northern flank of the fire (Figure 4.3.1.12), Hwy-30 was impassable at Kenui Street due to fire conditions at 17:55, per MPD Officer 4A20. Just west of there, a structure was on fire at Front Street and Kai Pali Place per MPD Officer T34 at 17:58. On the other side of Kahoma Stream, at 18:02, MPD Officer 4A20 advised that the fire was approaching the cannery and that the grass on the side of the cannery was on fire and heading toward the structure. The fire spread from the area where the bridge crosses over the



Figure 4.3.1.12 Fire progression map of the northern flank of the fire from 17:55 to 18:18.



Kahoma Stream, near the end of Komo Mai Street along grasses and fence, to two (2) structures in the apartment complex along Kahoma Stream. From these two (2) buildings, the fire spread via grasses and shrubs behind the Starbucks and across the Hwy-30 to the grass adjacent to the Cannery Mall. The fire stopped in the grass and did not extend further (Figure 4.3.1.13).



Figure 4.3.1.13 Map of fire progression showing fire spread from the Kahoma Stream area, near the end of Komo Mai Street along grasses and fence to two (2) structures in the apartment complex along Kahoma Stream and beyond, eventually terminating near the Cannery Mall.



After start of Lahaina PM fire



TIMELINE OF EVENTS





Between 18:05 and 18:18, several civilian videos show fire spreading through Komo Mai Street and across the Kahoma Stream in the industrial area. There were spot fires near 2[redacted] Kupuohi Street. At 18:14, a civilian video shows that the wind drove house fires from the east end (mauka) of Komo Mai Street all the way down to the west end (makai) of Komo Mai Street (Figures 4.3.1.14 through 4.3.1.17).



Figure 4.3.1.14 Image capture from a civilian video of the far west end (makai) of Komo Mai Street (18:14). (Inset on left: represents the camera operator's approximate visual scope.)



Figure 4.3.1.15 Image capture from a civilian video of the west end (makai) of Komo Mai Street (18:14). (Inset on left: represents the camera operator's approximate visual scope.)



Figure 4.3.1.16 Image capture from a civilian video of the west end (makai) of Komo Mai Street (18:14). (Inset on right: represents the camera operator's approximate visual scope.)

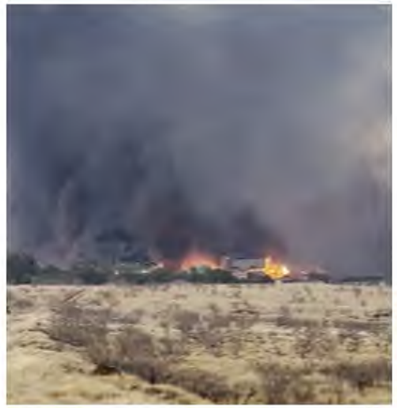


Figure 4.3.1.17 Image capture from a civilian video of the east end (mauka) of Komo Mai Street (18:14). (Inset on right: represents the camera operator's approximate visual scope.)





TIMELINE OF EVENTS





At 18:18, a civilian video shows that material and vehicles were on fire between 1[redacted] and 1[redacted] Kupuohi Street, and just after that, MFD Command requested RE1 to check out the area of Tamura's Fine Wine and Liquors store and the new apartment buildings at the top of Kupuohi Street for fires in and around these buildings. At 18:12 and 18:18, civilian video shows fire spreading through Front Street Apartments with house fires all the way down Kenui Street, from Hwy-30 to Front Street and Kai Pali Place (Figures 4.3.1.18 and 4.3.1.19).



Figure 4.3.1.18 Image capture from a civilian video taken at Front Street Apartments on Kenui Street East (18:12). (Inset on left: represents the camera operator's approximate visual scope.)



Figure 4.3.1.19 Image capture from civilian video taken of Front Street near Kenui Street West (18:18). (Inset on left: represents the camera operator's approximate visual scope.)



Figure 4.3.1.20 Map of fire progression from multiple fires from 18:28 through 19:38 in the southern area of the fire.

From 18:28 to 19:38, there were several fire progression reports in the southern area of the fire (Figure 4.3.1.20). A civilian video taken from Pualei Drive in the Puamana community shows the southernmost vantagepoint of the fire with heavy smoke moving east (mauka) to west (makai), just north of this location (Figure 4.3.1.21).



Figure 4.3.1.21 Image capture from a civilian video taken from Pualei Drive in the Puamana community and showing the southernmost vantage point of the fire with heavy smoke moving east (mauka) to west (makai) and imaged facing north (18:28). (Inset on right: represents the camera operator's approximate visual scope.)







Another civilian video recorded at 18:47 near Shaw Street and Front Street shows 1[redacted] Shaw Street (Salvation Army Building) well involved in fire as well as another structure on fire just north on Front Street. (Figures 4.3.1.22 and 4.3.1.23).

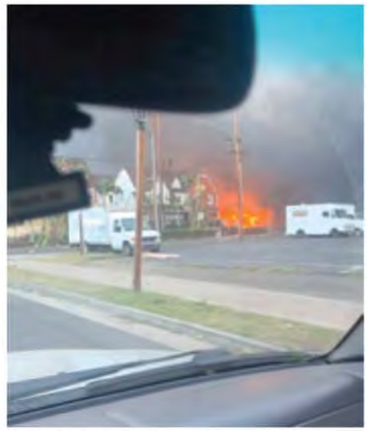


Figure 4.3.1.22 Image capture from a civilian video taken near Shaw Street and Front Street showing a structure on 505 Front Street on fire. The same video shows 1[redacted] Shaw Street (Salvation Army Building) well involved in fire (18:47). (Inset on left: represents the camera operator's approximate visual scope.)





Figure 4.3.1.23 A civilian image taken near Shaw Street and Front Street showing another structure (near the Salvation Army building) on fire just north on Front Street (18:47). (Inset on left: represents the camera operator's approximate visual scope.)

At 19:00, MPD Officer 4B10 advised that Front Street and Shaw Street down to Front Street and Māla was engulfed in flames and at 19:10, radioed concern that fire was about to jump into Lahaina Recreation Center. Shortly after, MPD Officer 6B40 advised that there was zero visibility by the Front 505 Shops [Shops at 505] (at 19:11) and that the 400 block of Front Street was impassable (at 19:14). At 19:38, on the other end of Shaw Street near the Highway, MPD Officer 4Z20 advised the fire "jumped" Shaw Street to the south and the fire was extending into the neighborhood (Figure 4.3.1.20).

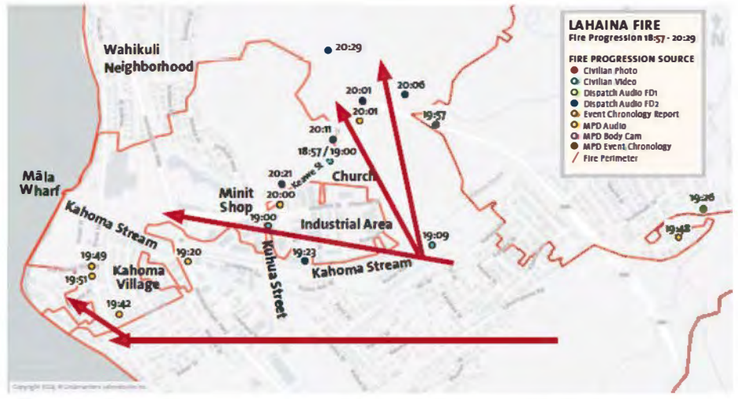


Figure 4.3.1.24 Fire progression map from 18:57 through 20:29 showing fire spread in the Kahoma region, spreading west and north.

Figure 4.3.1.24 provides an overview of fire progression in the Kahoma region from 18:57 through 20:29. At 18:57, a civilian video taken from Keawe Street shows that the wind shifted to blow north causing the smoke plume to cover most of the industrial area. The edge of the smoke plume was now over the church at 1[redacted] Ulupono Street. Another civilian video shows spot fires in the trees at 19:00 along Kuhua Street behind [redacted] Kupuohi Street (Figure 4.3.1.25).



Figure 4.3.1.25 Image capture from civilian video showing spot fires in the trees along Kuhua Street, behind [redacted] Kupuohi Street (19:00). (Inset on right: represents the camera operator's approximate visual scope.)



After start of Lahaina PM fire









At 19:23, RE1 was operating a structure fire at [redacted] Kupuohi Street. The fire ignited the warehouse at this location, which was in line with the embers that started the spot fires along Kuhua Street.

At 19:26, a civilian video taken near the location of the fire's origin pans the area west (makai) down Lahainaluna Road and south toward the Puamana community (Figure 4.3.1.26). Structures can be seen on fire across the entire pan of the video and embers can be seen being generated close to the video as grass and shrubs continue to burn, aided by the wind (Figures 4.3.1.26 through 4.3.1.32).

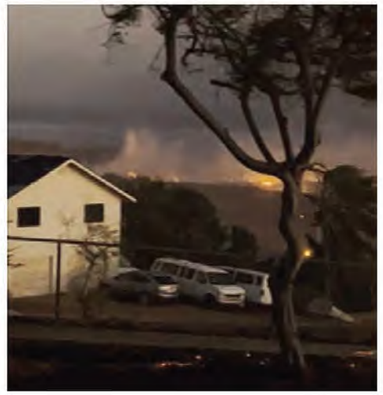


Figure 4.3.1.26 Image capture from a civilian video of the view from Lahainaluna Road (near Niheu Street) looking south (home in the foreground is on Ho'okahua Street). (19:26). (Inset on left: represents the camera operator's approximate visual scope.) (Inset on left: represents the camera operator's approximate visual scope.)



Figure 4.3.1.27 Image capture from a civilian video showing another view from Lahainaluna Road looking southwest (homes in the foreground is on Ho'okahua Street) (19:26). (Inset on left: represents the camera operator's approximate visual scope.) (Inset on left: represents the camera operator's approximate visual scope.)



Figure 4.3.1.28 Image capture from a civilian video taken from Lahainaluna Road looking southwest toward Ku'ialua Street showing multiple spot fires (19:26). (Inset on right: represents the camera operator's approximate visual scope.) (Inset on right: represents the camera operator's approximate visual scope.

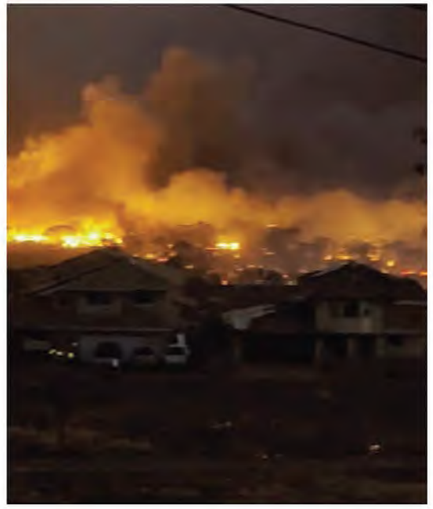


Figure 4.3.1.29 Image capture from a civilian video from Lahainaluna Road showing multiple spot fires on Ku'ialua Street (19:26). (Inset on right: represents the camera operator's approximate visual scope.)







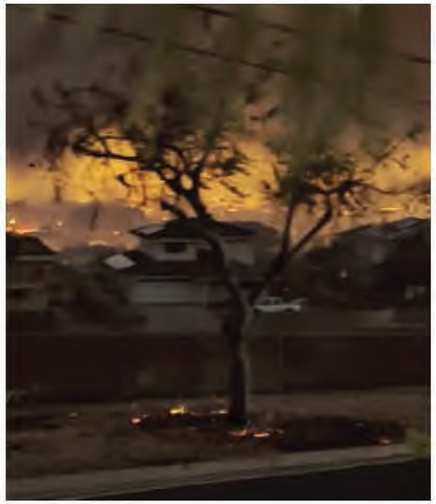


Figure 4.3.1.30 Image capture from a civilian video of a fifth view from Lahainaluna Road (toward Ku'ialua Street) showing a burned tree with surrounding embers in the foreground, indicating that the fire has just swept through (19:26). (Inset: on left represents the camera operator's approximate visual scope.)





Figure 4.3.1.31 Image capture from a civilian video of another view from Lahainaluna Road showing multiple spot fires looking west (19:26). (Inset on left: represents the camera operator's approximate visual scope.)



Figure 4.3.1.32 Image capture from a civilian video of another view from Lahainaluna Road showing multiple spot fires looking west (19:26). (Inset on right: represents the camera operator's approximate visual scope.)





Figures 4.3.1.26 through 4.3.1.32 Composite image of captures from a civilian video from Lahainaluna Road looking west (19:26). (Inset on right: represents the camera operator's approximate visual scope.)



At 19:42, the fire continued to burn in the area west (makai) of Kahoma Village. At 19:49, MPD Officer T34 advised that the fire was burning along Front Street south of Ala Moana Street. He also stated, "The back of 11[redacted] Front Street is on fire, coming from Māla Wharf, guess it jumped Ala Moana from the back." Between spot fires ignited by embers and structure-to-structure fire spread, the fire burned several homes along the ocean between Kenui Street and Ala Moana Street. The damage to Māla Wharf was caused by embers, as there was no connection of burning fuels.

TIMELINE OF EVENTS



After start of Lahaina PM fire

The structure fires did not extend north of Ala Moana Road or west (makai) of Front Street in the area of Māla Wharf. The original fire at Māla Wharf was reported at 17:15, and it continued to burn up until at least 19:51.

At 19:57, E3 and T3 were trying to coordinate the control of the fire that was burning in the grasses north of the Kahoma Stream, heading toward Keawe Street and the Lahaina Bypass (Figure 4.3.1.24 on page 64). The fire burning in the area of Keawe and Kuhua Street by the Minit Shop was also increasing in size per MPD Officer S40, and the visibility was reported as "very bad" and "the fire is right on it now" at 20:00. At this time, the medics also advised dispatch that the fire was moving quickly toward Keawe Street and the Lahaina Bypass, and MPD Officer 4B30 advised that the fire was creeping toward Wahikuli. At 20:06, E3 advised that the fire had jumped the Lahaina Bypass and was above Wahikuli and headed north. At 20:11, RE14 arrived on scene at the area of Keawe Street and the Lahaina Bypass and advised that the fire had jumped the road from south to north. At 20:29, RE14 advised that the fire was north of Oil Road and was making its way into Wahikuli. (Note: According to Google Maps, Oil Road is the dirt road at the far east end of Puʻukoliʻi Road in the Kāʻanapali area. However, emergency responders and residents also referred to Oil Road as the dirt road located east of, and behind the homes located on Ipukula Way, from Keawe Street to the Civic Center. For this analysis, Kuhua Street is on the south side of Keawe Street, and Oil Road is on the north side.)



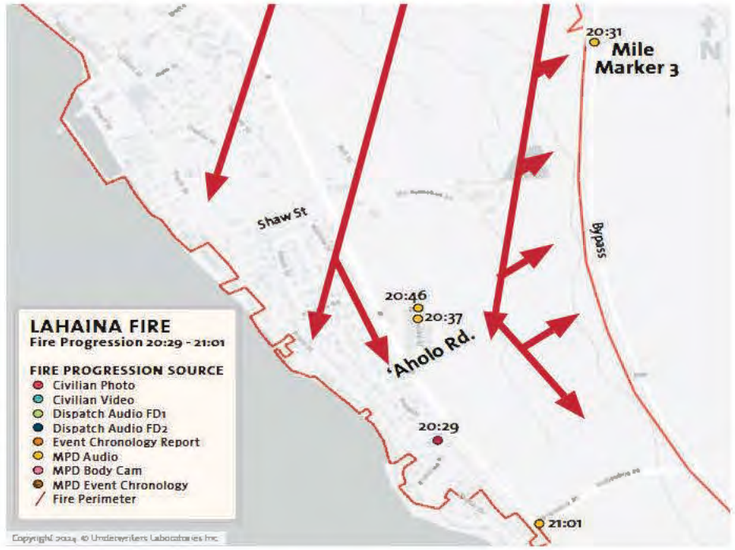


Figure 4.3.1.33 Fire progression map from 20:29 through 21:01 showing the fire spreading south.

While the fire was spreading north toward Wahikuli, it also continued to push south (Figure 4.3.1.33). The south flank burned back against the wind in the grass toward the Lahaina Bypass south of Lahainaluna Road (Figure 4.3.1.33). The fire was also spreading through the structures south of Shaw Street and down toward the Puamana community. A civilian photo taken at 20:29 shows the fire impacting structures in the area of Hwy-30 and ʻAholo Road (Figure 4.3.1.34).





Figure 4.3.1.34 Civilian image taken at Front Street and Hwy-30 looking north toward ʻAholo Street with a bystander in the foreground (20:29). (Inset on right: represents the camera operator's approximate visual scope.)

At 20:31, MPD Officer 6B41 advised that the fire was creeping up to the top of the bypass in the area of Mile Marker 3. At 20:37, an unknown MPD officer advised that the fire was starting to cross over into the structures at Aulike Street. By 20:46, MPD Officer 4A40 advised that there were a few houses engulfed on Aulike Street and Leoleo Street. At 21:01, MPD Officer 4B30 advised that the fire was within 200 yards of Hōkiokio Place.



After start of Lahaina PM fire

TIMELINE OF EVENTS



Figure 4.3.1.35 shows the north and west fire progression from 21:25 through 22:29. At 21:25, RE1 advised that the fire was fast-moving and that it looked like it was approaching Akeke Place off of Kahoma Street. RE1 repositioned from Kapunakea Street toward Kahoma Street and advised that the fire was impacting the homes on the east (mauka) side of Kahoma Street.

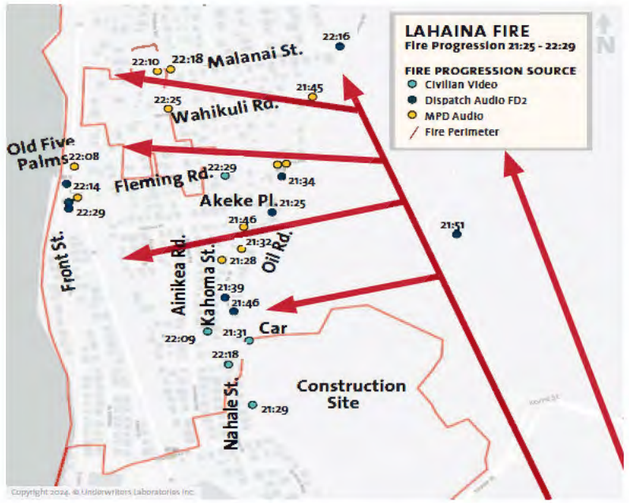


Figure 4.3.1.35 Fire progression map from 21:25 through 22:29 showing the fire spreading west and north.

A civilian video taken from the area of Nahale Street shows the fire wrapping around the east (mauka) and north sides of the construction site that is north of Keawe Street (Figure 4.3.1.36).





Figure 4.3.1.36 Image capture from civilian video of the fire wrapping around the east (mauka) and north sides of the construction site north of Keawe Street (21:29). (Inset on left: represents the camera operator's approximate visual scope.)

At 21:31, the same civilian walked up Oil Road, and their video shows the vehicle fire at the northwest corner of the construction site that is extending to the brush across Oil Road (Figure 4.3.1.37).

The car was located behind 13[redacted] Kahoma Street. At 21:32, MPD Officer 4B10 explained that there was zero visibility in the area of Kahoma Street and that there was fire behind the houses. A minute later, Officer 4Z20 advised that the fire was behind 1[redacted] Fleming Road and advancing quickly. At 21:36, the Water Supply Group Supervisor advised via MFD radio that there was a car on fire on Oil Road that is spreading the fire across to the homes west (makai) of that location. By 21:46, the Water Supply Group Supervisor radioed that six (6) buildings were fully involved in fire on Kahoma Street.

At 22:08, MPD Officer 415 advised that the fire impacting the Wahikuli area was making its way to Hwy-30. This indicates that the fire was spreading quickly from east (mauka) to west (makai) through the homes. A civilian video taken from the cul-de-sac on Nahale Street at 22:09 shows that the fire moved from east (mauka) to west (makai) in the area of Kahoma Street (Figure 4.3.1.38).



Figure 4.3.1.38 Image capture from civilian video taken from the Nahale Street cul-de-sac looking north (22:09). (Inset below: represents the camera operator's approximate visual scope.)





Figure 4.3.1.37 Image capture from civilian video of a fully engulfed car on Oil Road (21:31). (Inset below: represents the camera operator's approximate visual scope.)





After start of Lahaina PM fire

TIMELINE OF EVENTS



At 22:14, the MFD Structure Group Leader advised that the fire was beginning to spot in the area of Fleming Road and Front Street. There were trees on fire at that location. The fire continued to spread south toward Kapunakea Street and north toward Wahikuli Road driven by the wind gusting from east (mauka) to west (makai) and slightly north. At 22:18, MPD Officer 4Z20 advised that they were at the intersection of ʻAinakea Road and Malanai Street, and the fire was getting close to Wahikuli Road. At 22:25, the same officer radioed that the fire had reached Wahikuli Road at ʻAinakea Road. A civilian video taken from 1[redacted] Wahikuli Road shows the fire moving east (mauka) to west (makai) down Fleming Road at 22:29 (Figure 4.3.1.39). At the same time, MPD advised that the old Five Palms/Chart House restaurant, the building where Front Street and Hwy-30 come together, was on fire.

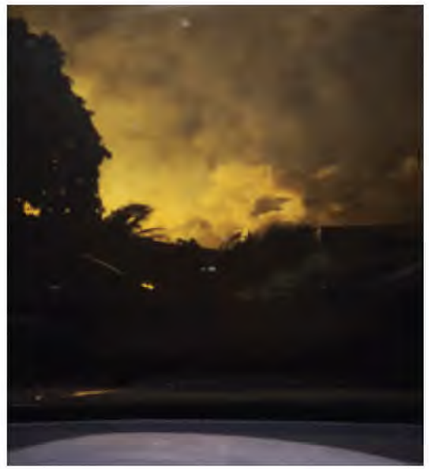


Figure 4.3.1.39 Civilian image showing fire moving east (mauka) to west (makai) down Fleming Road (22:29). (Inset on left: represents the camera operator's approximate visual scope.)

On the south side of the fire (Figure 4.3.1.40 on next page), MPD Officer W2 advised that the fire had jumped Hōkiokio Place at 22:29. At 22:41, Engine 11 advised command that the fire had jumped Hōkiokio Place and was making its way west (makai) toward the Puamana community. At 23:01, MPD Officer 4B30 advised that the fire was moving slowly south and was nearing the Puamana community. There was little fire progression reported in the south until August 9, 2023, at 02:02, when MPD Officer W2 reported that the fire jumped east (mauka) of the Lahaina Bypass on Hōkiokio Place.

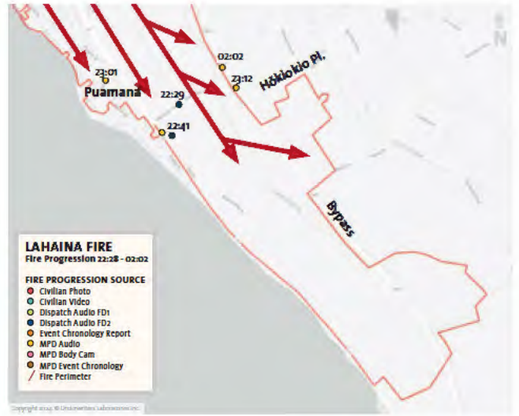


Figure 4.3.1.40 Fire progression map from 22:28 through 02:02 showing the fire spreading south to southeast.

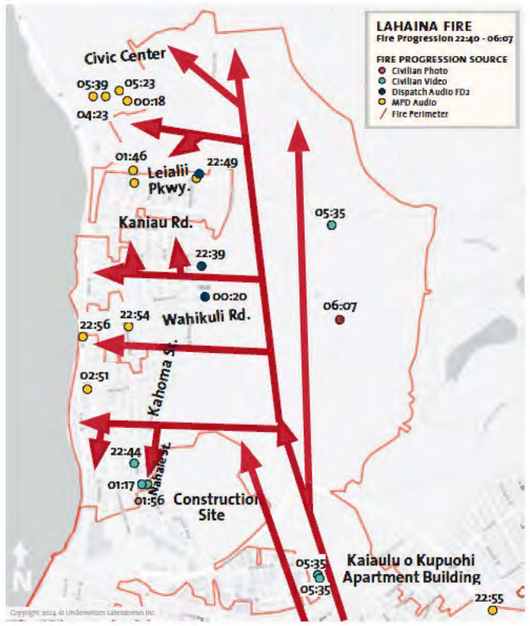


Figure 4.3.1.41 Fire progression map from 22:40 through 06:07 showing the fire spreading west and north.

TIMELINE OF EVENTS

8 HRS

After start of Lahaina PM fire

On the northern end of the fire, the fire continued to spread structure-to-structure, aided by a wind that was east (mauka) to west (makai) and north (Figure 4.3.1.41 on previous page). At 22:40, MPD Officer 4Z20 advised that the fire was still south of Wahikuli Road and ʻAinakea Road. A civilian video taken from 12[redacted] Nahale Street at 22:44 shows the fire moving from east (mauka) to west (makai) and progressively igniting 12[redacted] Kahoma Street, 12[redacted] Kahoma Street, 12[redacted] Kahoma Street, 1[redacted] Hiki Place, 1[redacted] Hiki Place, and 1[redacted] Hiki Place (Figure 4.3.1.42). At 22:49, MPD Officer 415 radioed that the fire was approaching Leialiʻi Parkway. At 22:54, MPD Officer 4Z20 advised that the fire had crossed Wahikuli Road and was headed north. At 23:39, the MFD Support Group Leader advised that the brush was on fire above Malanai Street, and the fire was making its way to Kaniau Road, impacting several homes in that area.





Figure 4.3.1.42 Image of fires at Kahoma to Hiki Place (22:44). (Inset on left: represents the camera operator's approximate visual scope.)



TIMELINE OF EVENTS



After start of Lahaina PM fire





Fire Progression: August 9, 2023

The civilian at 12[redacted] Nahale Street continued to video the fire moving toward his home. At 23:59, 12[redacted] and 12[redacted] Nahale Street were on fire, and at 00:33, 12[redacted] Nahale Street caught fire. At 01:17, the homes in the area of 12[redacted] 'Ainakea Road were burning. At 01:56, the home at 12[redacted] Nahale Street caught fire (Figures 4.3.1.43 through 4.3.1.45).



Figure 4.3.1.43 Image capture from civilian video of fire at 12[redacted] Nahale Street (23:59). (Inset on left: represents the camera operator's approximate visual scope.)

Figure 4.3.1.44 Image capture from a civilian video showing a close up view of 12[redacted] Nahale Street on fire and 12[redacted] Nahale Street destroyed (01:17). (Inset on left: represents the camera operator's approximate visual scope.)





Figure 4.3.1.45 Image capture from a civilian video showing fire continuing to advance south along Nahale Street (01:56). (Inset on right: represents the camera operator's approximate visual scope.)



As the fire moved south, the wind shifted to blow in a more northerly direction, and the fire spread in this area stopped. A video at 02:30 shows the fire burning the fence of 12[redacted] Nahale Street, but it did not ignite the home (Figure 4.3.1.46).



Figure 4.3.1.46 Image capture from civilian video shows 12[redacted] Nahale engulfed in flames. The fire does not advance beyond the fence of 12[redacted] Nahale Street (02:30). (Inset on right: represents the camera operator's approximate visual scope.)



TIMELINE OF EVENTS

10 HRS

After start of Lahaina PM fire

At 00:18, MPD Officer 401 advised that the fire was slowly creeping toward the police station. At 00:20, Mini 1 was advised that the fire was at Malanai Street and that they should leave the area. At 00:53, MPD advised that they had embers reaching Leialiʻi Parkway, and at 01:46, MPD Officer 418 advised that the flames were 100 yards south of Leialiʻi Parkway. Shortly after that, MPD Officer 401 radioed that the fire was slowly surrounding Leialiʻi Village at 01:54.

MPD Officer 401 provided several updates overnight. At 02:51, they advised that the flames were still east (mauka) of the highway, except for the area near Fleming Road where they crossed over. At 04:23, they advised that the smoke was engulfing the Civic Center and the Police Station, and at 05:23, the fire appeared to have gone around the buildings in the Civic Center complex. At 05:39, MPD officer 401 confirmed the fire did not affect the police and fire stations, and the fire was moving up the mountain.

Early in the morning, at 05:35 through 06:07, a civilian took video from a dirt road east (mauka) of the Wahikuli area. The video shows the north flank of the fire in the grasses from Wahikuli Road toward the Civic Center (Figures 4.3.1.47 and 4.3.1.48).





Figure 4.3.1.47 Image capture from civilian video taken showing the grass fire east of the end of Wahikuli Road. The fire is advancing north and backing east (mauka) upslope (05:35). (Inset on left: represents the camera operator's approximate visual scope.)



Figure 4.3.1.48 Image capture of civilian video showing a second view of the grass fire backing upslope, just east (mauka) of the end of Wahikuli Road (05:35). (Inset on right: represents the camera operator's approximate visual scope.)



The video also pans south to show the Kaiāulu o Kupuohi apartment building on fire (258 Kupuohi Street) and numerous structures on fire in the Wahikuli area (Figures 4.3.1.49 and 4.3.1.50).





Figure 4.3.1.49 Image capture from civilian video showing the Kaiāulu o Kupuohi apartment building on fire (05:35). (Inset on right: represents the camera operator's approximate visual scope.)





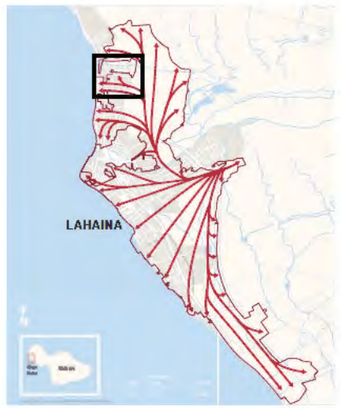
Figure 4.3.1.50 Image capture of civilian video showing another image of the Kaiāulu o Kupuohi apartment building on fire (05:59). (Inset on right: represents the camera operator's approximate visual scope.)

TIMELINE OF EVENTS



15 HRS

After start of Lahaina PM fire



Other photos from the same area show a portion of the north flank of the fire burning from Wahikuli Road (near the water tank) to Kā'anapali (Figure 4.3.1.51).



Figure 4.3.1.51 Image showing the grass fire backing upslope from Wahikuli Road (near the water tank) to Kā'anapali (05:59). (Inset on left: represents the camera operator's approximate visual scope.)

At approximately 05:00, MFD repositioned resources to stop the forward progress of the fire in the northern end of the Wahikuli neighborhood and the surrounding grass fires (Figures 4.3.1.52 and 4.3.1.53). On the southern end of the fire, at 06:29, MPD Officer S2 advised of flames about 200 yards from 1[redacted]Haniu Street. MFD positioned resources to stop the spread of fire to the south before it reached the homes in the area of Kai Hele Kū Street (Figures 4.3.1.54 and 4.3.1.55).



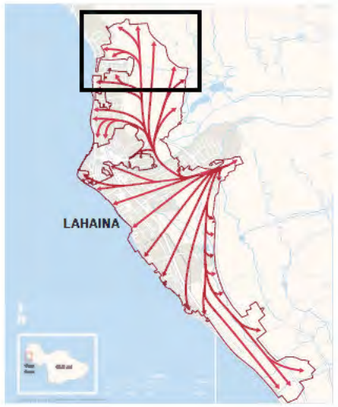
Figure 4.3.1.52 Aerial image after the fire that shows where structure-to-structure fire spread ceased. Source: Google. The final perimeter overlay (red line) was added with PowerPoint Freeform: Shape and based on GIS perimeter used for Figure 4.3.1.2 and is subject to some error/difference from the GIS perimeter.

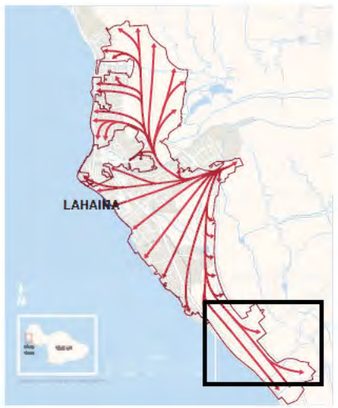


Figure 4.3.1.53 A second aerial view showing where the grass fire spread was stopped. Source: Google. The final perimeter overlay (red line) was added with PowerPoint Freeform: Shape and based on GIS perimeter used for Figure 4.3.1.2 and is subject to some error/difference from the GIS perimeter.



Figure 4.3.1.54 An aerial image showing where the southern spread of grass fires was stopped. Source: Google. The final perimeter overlay (red line) was added with PowerPoint Freeform: Shape and based on GIS perimeter used for Figure 4.3.1.2 and is subject to some error/difference from the GIS perimeter.





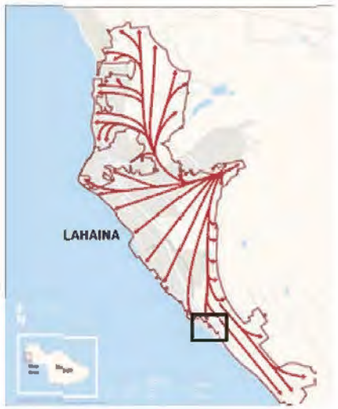




Figure 4.3.1.55 An aerial image showing where the southern building-to-building fire spread ceased. Source: Google. The final perimeter overlay (red line) was added with PowerPoint Freeform: Shape and based on GIS perimeter used for Figure 4.3.1.2 and is subject to some error/difference from the GIS perimeter.

4.3.2 Maui Fire Department (MFD) Response

Staffing

On August 7, 2023, and the morning of August 8, 2023, MFD was staffed as normal.

On August 7, 2023, MFD B-Watch was on duty as scheduled. Frontline apparatus were assigned and staff responded to the Olinda fire at 00:22 on August 8, 2023. B-Watch personnel also responded to the Lahaina AM fire at 06:55 on August 8, 2023.

Around 07:00 on August 8, 2023, A-Watch reported for duty to find frontline apparatus deployed. Some were able to staff the available relief apparatus and others were instructed to relieve crews on scene.

Battalion Chief 3 (BC3) was called in to assist with running 911 operations and reported for duty at 07:30 on August 8, 2023. Fire 3 (F3–Assistant Chief of Operations) authorized BC3 to staff relief apparatus. As staff reported for duty, they were assigned to relief apparatus and deployed. BC3 was staffing to optimize district coverage island wide and address specific needs for the fires.

While A-Watch resources remained on scene at the Lahaina AM fire, B-Watch returned to the station and went off duty. Personnel assigned to west Maui fire stations received emergency call back notifications around 16:30.

An overview of the MFD shift schedule is provided in Table 4.3.2.1. See the Lahaina Fire Staffing Matrix in the Appendix 6.12 for unit-level staffing and crew exchange during the incident.

Table 4.3.2.1 MFD Shift Schedule August 7, 2023, through August 10, 2023.

MFD Shift Schedule August 7, 2023 – August 10, 2023		
B-Watch	A-Watch	C-Watch
(8/7–8/2023)	(8/8–9/2023)	(8/9–10/2023)
07:00–07:00	07:00–07:00	07:00–07:00

Fire Incident Management Organization

The rapid spread of fire over the large geographical area of Lahaina/West Maui created a dynamic situation where the fire incident management organization changed several times due to changing conditions and locations of impact. The Incident Commander (IC) operated exclusively from their battalion vehicles throughout the incident. The initial fire IC was BC5, who maintained command until approximately 21:46 when he transferred command to BC4, when they were face-to-face off of Keawe Street. Fire resources remained on one (1) radio channel for the duration of the Lahaina incident.

A division is typically designated for a geographic location, whereas a group is designated to perform task-related or tactical functions. During the Lahaina fire incident, the ICs attempted to scale the fire incident management organization and mobilize/demobilize divisions/groups as needed.

Individual resources (e.g., an engine, utility, private tanker, aircraft rescue firefighting unit (ARFF), etc.) were assigned to a division/group, and each division/group had a designated supervisor/leader.

During the August 8, 2023, Lahaina fire, the following divisions/groups were utilized, although these designations and units assigned change with the event (see Table 4.3.2.2).

Table 4.3.2.2 MFD Incident Management Assignments on August 8, 2023, and August 9, 2023.

MFD Incident Management Assignments

DATE	TIME	ASSIGNMENTS
August 8, 2023	06:44	E3 officer establishes Lahaina Command
August 8, 2023	06:50	BC5 assumes Lahaina Command from E3 officer
August 8, 2023	09:27	BC5 transfers Lahaina Command back to E3 officer
August 8, 2023	14:17	E3 officer releases units and returns to quarters
August 8, 2023	15:01	E11 officer establishes Ku'ialua Command
August 8, 2023	15:10	BC5 assumes command from E11 officer
August 8, 2023	15:59	South Division (E6 with WL6, E1 and RE1 assigned)–Units operating in the area of Pauoa Street south of Lahainaluna Road. Geographical boundaries not identified.
August 8, 2023	16:13	West Division (E11 with E3 and RE11 assigned, changed to E3 with E11 and RE11 assigned)–Units operating in the area of Ka'akolu Street north of Lahainaluna Road. Geographical boundaries not identified.
August 8, 2023	20:43	Structure Group (U5 with L3 and E3 initially assigned, E1 added, RE11 added, Aircraft Rescue and Firefighting (ARFF) units added, RE1 started reporting to Structure Group but no record of being officially assigned)–Units continued to change within the Group. Throughout the dispatch record, units refer to being Structure Group or Structure Protection Group, and even units assigned to Support Group stated they were doing structure protection and/or triage.

continued

MFD Incident Management Assignments
continued

DATE	TIME	ASSIGNMENTS
August 8, 2023	20:47	Water Supply Group (Comms 2–Officer).
August 8, 2023	20:51	Bypass Group (RE14 with U5 and E11/Mini11) –Specific function and geographic area not identified.
August 8, 2023	20:53	Support Group (U3 with U3B, and E6 (in SUV) assigned, Mini1 also used in Support Group function)–"Your assignment is to assist with support where you can, evacuation, all fire and structure protection."
August 8, 2023	21:46	BC4 assumes Lahaina Command from BC5
August 8, 2023	22:12	Bypass Group transferred to E11 when roads became impassable. Bypass Group covered the area south of Fleming Road, and the staging point was the Bypass and Hōkiokio Place. E11 had Mini11 and four (4) private tankers assigned.
August 9, 2023	00:35	Support Group reassigned to U3B with E6, Mini6, E1, E3A and Kapalua ARFF also assigned to U3B. "Your assignment is support function and then gear up for evacuation for the next neighborhood north."
August 9, 2023	05:36	North Division (units assigned not identified, geographical boundaries not identified.)
August 9, 2023	06:33	South Division (E3A with E11, Mini11, RE14, Mini 1, T3, and four (4) private tankers initially assigned)–Units operating in the area of south Lahaina. Geographical boundaries not identified.

Red Text: Indicates Lahaina AM fire.

Resource Assignments

Frontline apparatus are fully equipped for their task-specific functions, unless otherwise noted (e.g., hoseline, supply line, nozzles, water appliances, rescue tools, ladders, portable/individual radios/riding position, self-contained breathing apparatus (SCBA)/each riding position, wildland hose, emergency shelters, flotation devices, basic emergency response medical equipment, etc.).

TIMELINE OF EVENTS

Throughout the Lahaina fire, the amount of equipment, as well as the personnel, changed dynamically. Several units were destroyed (as noted), many units had to abandon equipment to make emergency evacuations, and other units scouted for and retrieved equipment as the incident evolved. Staffing numbers changed as injuries occurred (including a mayday event indicating an immediate life threat), additional personnel responded to assist, and shifts changed throughout the extended operational period. Also, apparatuses of all types were used to effect rescues and transport citizens away from the smoke and fire, so vehicle occupancy changed throughout. The resource assignments outlined in Table 4.3.2.3 indicate the number of individuals assigned to each vehicle, as reported by responding crew members, over the course of the events of August 8, 2023, and into the morning of August 9, 2023.

Table 4.3.2.3 MFD Resource Assignments on August 8, 2023.

MFD Resource Assignments
August 8, 2023

Station Assignment	Unit Identifier & Abbreviation	Equipment Type	Water Capacity (gal)	Minimum Staffing	Staffing on 8/8	Apparatus Notes	Equipment	Damage (Pre-Existing or Incident-Related)
Fire Station 1 (FS1) – Wahikuli	Engine 1 (E1)	Type 1	750	4	4	Frontline unit	Fully equipped	Engine was destroyed by fire.
Fire Station 1 (FS1) – Wahikuli	Mini 1 (Mini1)	Type 6	400	0	1 --- 7 --- 4*	Cross-staffed by E1 crew (and later E6 crew) as incident needs dictated	Not specified	Mini1 became entangled in power lines and other debris and was left at the corner of Shaw & the Highway. A firefighter reporting to duty stopped and helped free the unit as E1 & E6 crew arrived in MPD SUV with downed firefighter. Mini1 was placed back in service with a crew of 7 until E6 crew of 3 moved to a BC SUV.
Fire Station 1 (FS1) – Wahikuli	Relief Engine 1 (RE1)	Type 1	750	0	4	Used for up-staffing during Lahaina fires (also used as reserve for frontline unit)	Hose packs No other equipment specified	None noted. Top deck gun was torn off, and engine experienced an air leak during evacuation from the neighborhood but was able to maintain 90 psi. RE1 continued to be used through 8/8 and 8/9.
Fire Station 3 (FS3) – Lahaina	Engine 3 (E3)	Type 1	750	4	4	Frontline unit	Fully equipped	None noted.
Fire Station 3 (FS3) – Lahaina	Wildland 3 (WL3)	Type 6	400	0	1 --- 2*	Cross-staffed with E3 or L3 as incident needs dictated	Basic wildland complement	Utility pole came down trapping WL3. When crews returned it had been destroyed by fire.
Fire Station 3 (FS3) – Lahaina	Ladder 3 (L3)	105-foot Rearmount	500	4	4	Frontline unit	Fully equipped	None noted

**Staffing changed dynamically throughout the incident.*

continued

MFD Resource Assignments
August 8, 2023 – continued

Station Assignment	Unit Identifier & Abbreviation	Equipment Type	Water Capacity (gal)	Minimum Staffing	Staffing on 8/8	Apparatus Notes	Equipment	Damage (Pre-Existing or Incident-Related)
Fire Station 3 (FS3) – Lahaina	Tanker 3 (T3)	Type 1 Water Tender	2000	1	1	Frontline Unit	Not specified	T3 windows would not roll up, which exposed the driver to heavy smoke and flying embers during the course of the day. 15:27 T3 inoperable until 15:32 due to mechanical problems.
Fire Station 3 (FS3) – Lahaina	Utility 3 (U3)	Tow vehicle, 4x4 pick up	N/A	0	1 ---- 3*	None noted	Officer filled the truck with spare SCBA cylinders, radios, radio batteries, water, and other support items for delivery to field personnel.	None noted
Fire Station 3 (FS3) – Lahaina	Utility 3B (U3B)	Lifeguard truck		0	1 --- 3*	Extended cab, four (4)-door Equipped with emergency lights, No sirens, mobile radio	Crew equipped with one (1) portable radio, wildland snubber bag, handlines, and tools from FS3. Retrieved 40 gpm nozzle from a tanker later in the incident.	None noted
Fire Station 6 (FS6) – Kīhei	Engine 6 (E6)	Type 1	750	4	5 ---- 4*	Frontline unit	Fully equipped	E6 experienced mechanical problems and was abandoned. It was recovered on 8/9 and retrieved for repair.
Fire Station 6 (FS6) – Kīhei	Wildland 6 (WL6)	Type 6	Not specified	0	1	Basic wildland firefighting complement	Not specified	WL6 became trapped by a downed utility pole and was tangled in wires. It was recovered in operable condition on 8/9 and placed in service.
Fire Station 11 (FS11) – Nāpili	Engine 11 (E11)	Type 1	750	4	4 ----- 6*	Frontline unit	Fully equipped	None noted
Fire Station 11 (FS11) – Nāpili	Relief Engine 11 (RE11)	Type 1	750	4	4	Used for up-staffing during Lahaina fires (also serves as reserve for frontline unit).	Stocked with mobile radio, basic complement of hoseline, supply line, and appliances. Unit did not have SCBAs, portable radios, or emergency medical response equipment. Crew added additional rolls of 1.5" and 2.5" hoseline, one (1) portable radio.	None noted
Fire Station 11 (FS11) – Nāpili	Mini 11 (Mini11)	Type 6	350	0	1 ---- 2*	Cross-staffed by E11 crew	Not specified	Mini11 pump experienced pump failure (unclear if this was before or during the incident) but responded with E11 for the duration of the incident.
Fire Station 10 (FS10) – Kahului	Utility 5 (U5)	Skid mount brush truck	250	0	5 ---- 4*	Brush truck	No SCBA, limited EMS equipment	None noted

**Staffing changed dynamically throughout the incident.*

continued

Table 4.3.2.3 MFD Resource Assignments on August 8, 2023 (continued).

MFD Resource Assignments
August 8, 2023

Station Assignment	Unit Identifier & Abbreviation	Equipment Type	Water Capacity (gal)	Minimum Staffing	Staffing on 8/8	Apparatus Notes	Equipment	Damage (Pre-Existing or Incident-Related)
Fire Station 10 (FS10) – Kahului	Relief Engine 14 (RE14)	Type 1	750	0	4	None noted	Not specified	None noted
Fire Station 10 (FS10) – Kahului	Battalion 3 (BC3)	SUV	N/A	1	3 ---- 2 --- 1*	None noted	Not specified	Vehicle broke down responding to the mayday/CPR in progress on Shaw Street. Personnel moved to another BC vehicle that was delivered to scene by MFD personnel responding to the incident.
Fire Station 3 (FS3) – Lahaina	Engine 3A (E3A)	Lifeguard Truck	N/A	0	4 --- 1	None noted	PA system No other equipment specified	None noted
Fire Station 3 (FS3) – Lahaina	Battalion 4 (BC4)	SUV	N/A	1	1	None noted	Not specified	None noted
Fire Station 3 (FS3) –	Battalion 5 (BC5)	SUV	N/A	1	1 --- 2 --- 1*	BC5 was in a reserve BC SUV on 8/8	No incident command board	None noted
Lahaina ARFF	Not reported	Firefighting Apparatus	Not reported	Not reported	Not reported	Not reported	Not reported	Not reported

**Staffing changed dynamically throughout the incident.*



TIMELINE OF EVENTS

The resource assignments outlined in Tables 4.3.2.4 to 4.3.2.18 indicate the dispatches, actions, and reports over the course of the events of August 8, 2023, and into the morning of August 9, 2023, from technical discussions with responding crew members, dispatch records, fire incident reports, and/or radio traffic. In the resource assignments that follow, when timestamp line is gray, there was no information to report or the unit did not exist at that time.

Table 4.3.2.4 MFD Incident Management Assignments for Engine 3 (E3) on August 8, 2023, and August 9, 2023.

Date/Time	MFD Resource Assignments: Engine 3 (E3)
August 8, 2023 06:00–08:00	05:16 E3 dispatched for a service call near Kuʻialua Street and Lahainaluna Road. E3 reports a snapped pole with low-hanging wires across Kuʻialua Street, not impacting Lahainaluna Roazd. MECO* was contacted but no ETA provided. 06:34 E3 B-Watch was dispatched to Kuʻialua Street across the street from Lahaina Intermediate School for multiple calls of a brush fire. 06:42 E3 reported a 500 by 500 brush fire, winds blowing about 30 mph north, approaching the houses. E3 reported they would attack the fire from the top side and defend the homes. E3 crew used a hand held anemometer (wind meter) and measured wind speeds at 40 mph with 60 mph wind gusts. 06:44 E3 established Lahaina Command. 06:50 Battalion Chief 5 (BC5) assumed Command. 07:17 E3 reported that the east (mauka) and heel of the fire looked good, and they were mopping up. 07:51 BC5 reported that A-Watch personnel from Fire Station 3 (FS3) were heading to the scene. A-Watch personnel arrived on scene in a MFD utility truck to relieve B-Watch personnel on scene (They reported no obstructions driving up.). B-Watch crew returned to the station in the utility truck. E3 officer (A-Watch) walked the burned area and saw where fire had come through. E3 officer noted that power lines had already come down along the gulch (behind structures located on Hoʻokahua Street), and the standing lines were swaying in the wind. He advised the crew not to stand under the power lines. Fire had been knocked down so E3 continued to mop up. They had one (1) line off and were using tank water.
08:00–10:00	08:02 Central dispatched E3 for a smoke call in Kahana. They responded and found it was steam from an exhaust vent at the pumphouse, so they canceled other responding units while they finished investigating. 08:34 E3 left the pumphouse to return to the Lahaina brush fire. E3 was delayed by traffic. E3 returned to the cul-de-sac on Hoʻokahua Street and hooked up to the hydrant. They stretched a horizontal standpipe (2.5" hoseline with a wye operating 2 handlines) up the hill (east/mauka side) while RE11 was pulling lines down (west/makai side) to the bottom edge of where the fire had reached. Crew noted it was much more windy than the average day; the wind seemed to be blowing generally in the direction toward the ocean. 09:27 BC5 returned Command to E3 officer. 09:59 E3 reported they were still mopping up the Lahainaluna brush fire (Lahaina AM fire). Crew recalled they worked the upper area for about two (2) hours, covering and dumping water across the area. They had access within the entire perimeter except for a small area at the bottom of the gulch. Around that time, a Truth Excavation (TruX) dozer was cutting a fireline in the area through the gulch near the end of Kuʻialua. TruX is one of several private companies that provides heavy equipment to support the MFD during incident response. TruX had a tanker and two (2) dozers operating at this incident. E3 officer was unsure when, or at what point, TruX left.
10:00–12:00	
12:00–14:00	12:06 E3 reported the area was secure and they were awaiting the arrival of MECO.* 12:21 Ladder 3 (L3) was dispatched to Niheu Street for lines down. E3 canceled L3, and two (2) members of E3 responded in Wildland 3 to assess. Multiple poles (4–5) had snapped–lines were down on roofs and backyards along the whole block (8[redacted]–8[redacted] Niheu Street). WL3 crew went to all houses impacted, knocked on doors, and advised residents to take caution.

*Now known as Hawaiian Electric.

TIMELINE OF EVENTS

Date/Time	MFD Resource Assignments: Engine 3 (E3)
12:00–14:00	WL3 went back and rejoined E3 as they continued mopping up the (Lahaina AM fire). E3 crew was still waiting for MECO.* A MECO* worker arrived in a pickup truck. E3 officer asked if lines were de-energized, but a MECO rep on scene could not confirm that lines were de-energized.
14:00–16:00	14:17 E3 advised that MECO* was working on the powerline situation along Nihue, and the Lahainaluna fire (Lahaina AM fire) was extinguished, and they were returning to FS3. 14:55 E3, Tanker 3 (T3), BC5, and Engine 11 (E11) dispatched for numerous calls for a fire at a cul-de-sac at the end of the Ku'ialua Street (near Lahainaluna Road and the Bypass). E3, T3, and WL3 respond. 15:02 E3 reported power lines down at Kapunakea Street and Papalaua. Crew recalled that these power lines had not been down before. It seemed like the wind had increased. 15:04 E3 reported they were arriving on scene. E3 went up Lahainaluna toward Bypass and planned to cut it off from the dirt road east (mauka) of the Bypass by the water tank. E3 recalled instructing WL3 and T3 to get up the dirt road because the engine was not able to. There was a lot of smoke and bad visibility. E3 officer was on foot to recon, but conditions were too bad and he had to jump in WL3. He could see where fire had burned to the edge. The only visible flame was backing into the gulch. WL3 staged on the dirt road behind 7[redacted] Ho'okahua Place, and T3 was in front of WL3. All crew members stated they had never felt winds like that before. 15:09 E11 reported a shed on fire. E3 reported to Command (E11) that the E3 operator was responding alone until additional personnel were available. 15:17 E3 operator (in E3) responded to 7[redacted] Ho'okahua Place and hooked up to a hydrant. E3 operator recalled PD was on scene attempting to extinguish the shed fire with garden hoses. E3 operator used the redline to attack the fire. The shed had a heavy fuel load (including a motorcycle) and was close to a structure (no fire extension had occurred.). PD left at this point. E3 operator remained on scene for an extended period.

**Now known as Hawaiian Electric.*

Date/Time	MFD Resource Assignments: Engine 3 (E3)
14:00–16:00	When BC assigned WL3 to hit the fire where it jumped the Bypass at Kelawea Mauka Makai Park, WL3 staged on Lahainaluna Road (below the park, closer to the back of the structures) and pulled lines to the west (makai) side of the park (near 5[redacted]-5[redacted] Ka'akolu). E3 officer walked out to do recon and saw a structure had smoke coming off the roof. E3 officer called E3 operator on the radio; E3 operator was doing structure protection, so E3 officer requested an available engine. E11 responded but stopped en route at another structure fire. 15:37 E3 officer reported a structure fire at 5[redacted] Ka'akolu. E3 officer advised that they only had WL3 on scene and they needed another engine for fire attack. 15:47 E3 operator asked if they should relocate E3 back to the Lahainaluna fire, and E3 officer affirmed. E3 operator recalled setting up a garden hose directed on the shed fire, leaving lines open, and returning to meet E3 crew/WL3.
16:00–18:00	Per E3 crew, E3 reunited around 16:00. 16:11 Central advises that MECO* reported that power was shut off. 16:12 E11 reported that they were with E3 at Ka'akolu Street and Kalena Street. Per E3 crew, E3 met with E11 at Ka'akolu Street. E3 used a 4" supply hose from E11 and hooked to the same hydrant as E11. E3 crew did not see any civilians in this area. As crews were operating, a powerline came down and draped across the road. Fire was steadily impinging, so E3 crew abandoned the hoselines and went one (1) block over between Ka'akolu Street and Kanua Street to attempt another fire stop. E3 recalled vehicle traffic and one (1) structure fire along Kahako Street. E3 stopped along Kahako Street and connected to the hydrant. They still had good water pressure; however E3's deck gun malfunctioned. E11 came up Ka'akepa Street and turned down Kahako Street past E3. E3 officer was monitoring egress and crew safety. 16:32 Command (BC5) advised the cut-off point would be Kahoma Stream.

Red text: Indicates that the power supply is cut off.

**Now known as Hawaiian Electric.*

TIMELINE OF EVENTS

Date/Time	MFD Resource Assignments: Engine 3 (E3)
16:00–18:00	16:37 E11 reported E11 and E3 crews were accounted for (Personal Accountability Report (PAR)). 16:46 E3 crew advised they were above Lahainaluna packing up hose. Per E3 crew, E3 reloaded the hoseline and tried to get WL3, but a pole was now down blocking the road, and they could not retrieve WL3. Kahako Street was blocked, so E3 went down Kahena Street with L3 in front of them. 17:08 Command (BC5) requested E3 check for E1 and E6. E3 reported they had multiple lines down and were having trouble with egress. E3 advised they would try to make it to Lahainaluna Road to recon. E3 sized up the area around Luʻi Street; one (1) house was on fire, and they determined that area was the flank of the fire. E3 crew used a 2.5" handline to knock down the structure fire at 8[redacted] Luʻi Street. They experienced intense wind gusts that carried embers, ash, and debris. E3 crew members took shelter behind the apparatus at some points. E3 crew recalled seeing a huge line of smoke traveling horizontally over Lahaina to the ocean. Embers carried from wind were igniting spot fires all around the houses. E3 crew used 2–3 packs of 50' of 2.5" hose to knock down fires between houses near 5[redacted] Kahena Street and Kalena Street and knock down fire at 3[redacted] Komo Mai Street and 3[redacted] Komo Mai Street. The hydrant at Komo Mai Street still had good pressure. However, as the crew was doing exposure protection, the water pressure started sputtering. E3 had to shut down the lines because intake pressure had dropped significantly, and the supply hose was getting soft. E3's egress plan was to drive down Komo Mai Street, which the crew could still see down at that point. It appeared that the fire had not yet crossed Kahoma stream at the top of Komo Mai Street, but fire continued spotting through the neighborhood. E3 and L3 drove down Komo Mai Street and had to cut a fence post and street sign in order to get out because poles were down and blocking the street.
18:00–20:00	Central dispatched a structure fire on Kupuohi Street (Emerald Plaza). At 19:48, E3 saw fire in the brush, and they determined the next stop would be at Keawe Street and the Bypass.

Date/Time	MFD Resource Assignments: Engine 3 (E3)
18:00–20:00	E3 set up in the parking lot at [redacted] Ulupono Street (Church of Jesus Christ of Latter-day Saints), but the hydrant in this location had no water available. Wind was intense with extreme gusts causing smoke, ash, and embers to be widely dispersed.
20:00–22:00	At 20:06 E3 Officer reports the fire jumped the bypass above Wahikuli heading north. E3 relocated to Foodland to try to refill tank. Hydrant was very slow–this was very unusual. E3 went up Oil Road (no access issues at this point) to the Wahikuli area and stopped at the top of Fleming to see if the hydrants had water. When the hydrant was opened it began "sucking air", they had never seen this before. 20:07 E3 officer reported that PD may be needed for evacuation of Wahikuli area and Command (BC5) acknowledged. 20:31 E3 reported they were checking the Wahikuli neighborhood and that the fire had not yet reached the area. E3 crew advised Command (BC5) that the new construction site [off Oil Road] looked like it could provide a buffer and allow them to make a stand. 20:32 E11 advised the fire had jumped the road [Keawe Street] and was burning north. E11 advised they would relocate to Oil Road near the new apartment complex once conditions on Keawe Street became passable. 20:33 E1 reported that E1 and RE1 were standing by at the entrance to Oil Road. 20:39 U3B reported 3 Alpha tankers were working along Oil Road and the Wahikuli Road gate was open. E3 advised the construction area encompassed a large area "where nothing can burn" and that the Alpha tankers should focus on the strip of brush on fire between the construction site and Oil Road. U3B advised they would relay the information to the Alpha tankers.

TIMELINE OF EVENTS

Date/Time	MFD Resource Assignments: Engine 3 (E3)
20:00–22:00	20:43 E3 advised they were "scalping" the brush above Wahikuli but a dozer line was needed above Wahikuli. Command (BC5) advised he would make the request to the EOC but that it would "be a while." E3 advised that the hydrants were dry and that they anticipated, if the wind continued, the fire was going to come around the construction site and impact Wahikuli. Command (BC5) advised E3 would be Structure Group with L3 and U5 reporting to E3. Command (BC5) advised it would be three (3) hours minimum before a dozer could respond. 20:58 E3 reported they were driving through Wahikuli neighborhood announcing evacuations using the engine's public announcement system. A relief crew of five (5) in a lifeguard utility truck met E3 crew at ‘Ainakea Road and Kapunakea Street. E3 crew relocated into the Lifeguard utility truck, using designator E3A, and the relief crew went into service as E3. 21:34 Central reported flames behind 1[redacted] Fleming Road. E3/Structure Group advised they were located at the top of Fleming and the fire appeared to be off of Akeke Place. 21:35 E3 advised RE1 to standby at Akeke Place. 21:36 E3/Structure Group advised that a vehicle was on fire on Oil Road and it was causing "all the problems on Kahoma and Akeke." E3 assigned T3 to respond on Oil Road to extinguish the vehicle fire. E3 officer recalled that the attack plan was to spread units out, with apparatus staged on Kahoma, Kapunakea Street and Akeke Place, to contain the spread, but the wind was causing the fire to move too fast and there was no water supply. E3 crew recalled spot fires were happening throughout the fire due to "softball and basketball" sized embers. The embers were causing structures to ignite, and the fire was then spreading from structure-to-structure. 21:37 E3/Structure Group assigned Airport Fire to stage at the top of Hawaiian Homes and report if the fire was spreading in that direction. 21:39 RE1 advised Kahoma Street was heavily impacted on the mauka side and they had to abandon their position.

Date/Time	MFD Resource Assignments: Engine 3 (E3)
20:00–22:00	E3/Structure Group advised RE1 to stage at the top of Fleming Road. 21:52 RE11 advised fire was spreading from structure-to-structure and they were not making any impact. RE11 advised they had to abandon the area. E3/Structure Group acknowledged. RE1 advised they made access to a residence on Malolo Place but the resident was combative and they were unable to evacuate the resident. RE1 advised they had relocated to Kahoma Street and were experiencing "heavy ember wash." 21:53 E3/Structure Group requested MPD assistance to evacuate the combative resident.
22:00–00:00	E3 crew recalled they did not want to become trapped in the neighborhood and had to retreat to the Highway. They tried to access Front Street to assist with evacuations, but the smoke and road conditions were too severe, and they had to retreat back to the Highway. 22:05 RE1 reported a resident on Wahikuli Road was refusing to leave. E3 advised RE1 to head toward the Highway and evacuate as much as possible. E3 crew recalled poles along the highway began to lean forcing them to retreat north past Fleming Road on the highway. 22:25 Central advised that per MPD the fire jumped the highway south of Fleming Road in multiple spots with fires extending up to Wahikuli Road. 22:34 Command (BC4) advised any units operating between Keawe Street and Fleming Road to exit the area immediately. 22:47 E3/Structure Group advised all units assigned to Structure Group to relocate to Fire Station 3. 23:29 E3/Structure Group advised all units assigned to Structure Group to stage at the Highway near Halelo Street. 23:34 Command (BC4) advised Fire Station 3 was being abandoned and all units should relocate to the Highway immediately.

TIMELINE OF EVENTS

Date/Time	MFD Resource Assignments: Engine 3 (E3)
August 9, 2023 00:00–02:00	00:25 Command (BC4) assigned E3 and Structure Group units to meet with RE14 and make a plan for the next stand. E3 crew recalled a plan was made to make a stand in the Kāʻanapali area (which was the next neighborhood expected to be impacted). The Structure Group was dissolved and units were spread out throughout the neighborhood. Crews hooked up to hydrants (water supply was good) and stretched lines. E3 crew recalls spending hours in the area. At some point in the early morning the winds died down and the fire never reached their location.
02:00–04:00	*Remained in Kāʻanapali Golf Estates.*
04:00–06:00	04:55 Command (BC4) assigned all units in the Ka'anapali Golf Estates area to relocate to the Civic Center. 05:19 U3B/Support Group assigned E3 to work with RE11 above Fire Station 3 to attack fire spreading behind /mauka of the station. 05:24 Command reassigns U3B to North Division with RE11, E3 and L3 reporting to North Division.
06:00 – 08:00	E3 crew recalled shift exchange occurred on scene at approximately 07:30. *07:44 E3 reported they were ready for reassignment with a crew of 3.*
08:00 – 10:00	
10:00 – 12:00	



TIMELINE OF EVENTS

Table 4.3.2.5 MFD Incident Management Assignments for Wildland 3 (WL3) on August 8, 2023, and August 9, 2023.

Date/Time	MFD Resource Assignment: Wildland 3 (WL3)
August 8, 2023	06:43 WL3 responded with Ladder 3 (L3) (split crew).
06:00–08:00	WL3 crew recalled turning down Ku‘ialua Street, and fire was starting to come down Lahainaluna Road and Ho‘okahua Place. WL3 turned down the cul-de-sac of Ho‘okahua Place and could see light, flashy fuels catching fire and that the fire was moving quickly. WL3 hooked to a hydrant on Ho‘okahua Place and pulled a 1.5" hoseline behind the houses to protect exposures. A private tanker was behind them trying to wet down the same area. 07:48 Command (BC5) reported the situation was looking pretty good.
08:00–10:00 10:00–12:00	08:01 WL3 reported they were on the west (makai) flank of the fire, which they reported to be looking “pretty cool.” They reported they were still working with L3 crew and had lines in place, but they were ready for reassignment. WL3 remained on scene with Engine 3 (E3).
12:00–4:00	12:21 L3 got dispatched to 9[redacted] Niheu Street for lines down. E3 canceled L3, and two (2) members of E3 responded in WL3 to assess. Multiple poles (4-5) had snapped, and lines were down on roofs and backyards along the whole block of Niheu Street. WL3 crew went to all houses impacted, knocked on doors, and advised residents to take caution. WL3 went back and rejoined E3 as they continued mopping up.
14:00–16:00	14:55 Engine 3 (E3), Tanker 3 (T3), Battalion Chief 5 (BC5), and Engine 11 (E11) dispatched for numerous calls for a fire at cul-de-sac at the end of the Ku‘ialua (near Lahainaluna and the Bypass). E3, T3, and WL3 responded. WL3 responded with a split crew from E3. E3 instructed WL3 and T3 to get up the dirt road (access behind 7[redacted] Ho‘okahua Place) because the engine was not able to. There was a lot of smoke and bad visibility. E3 officer went on foot to recon, but conditions were too bad, and he had to jump in WL3. He could see where fire had burned to the edge, but the only visible flame was backing into the gulch.

Date/Time	MFD Resource Assignment: Wildland 3 (WL3)
14:00–16:00	WL3 staged on the dirt road behind 762 Ho‘okahua Place. T3 was in front of WL3. E3 crew was using redline from WL3. E3 FF recalled heavy smoke conditions and saw flames going down along the dirt road, heading downhill toward the houses. E3 FF focused the hoseline on the houses and recalled seeing other MFD apparatus working on the east (mauka) side.
16:00–18:00	BC5 called WL3 and assigned them to go hit the fire where it jumped the Bypass at Kelawea Mauka Makai Park. WL3 staged on Lahainaluna Road (below the park, closer to the back of the structures) and pulled lines to the west (makai) side of the park (near 5[redacted]-5[redacted] Ka‘akolu). 16:11 Central advises that MECO* has reported that power is shut off. 16:46 After conditions worsened, E3 crew tried to retrieve WL3, but the pole was now down, and they had to abandon WL3. WL3 apparatus caught fire in that location and was inoperable for the remainder of the incident.
18:00–20:00 20:00–22:00 22:00–00:00	[redacted]
August 9, 2023	
00:00–02:00 02:00–04:00 04:00–0600 06:00–08:00 08:00–10:00 10:00–12:00	

Red text: Indicates that the power supply is cut off.
**Now known as Hawaiian Electric.*

Table 4.3.2.6 MFD Incident Management Assignments for Ladder 3 (L3) on August 8, 2023, and August 9, 2023.

Date/Time	MFD Resource Assignment: Ladder 3 (L3)
August 8, 2023 06:00–08:00	06:43 L3 reported they were responding to the Lahainaluna Fire. L3 and Wildland 3 (WL3) (split crew) met up with Engine 3 (E3). 07:07 L3 reported the west (makai) side of the fire had been controlled, and they were ready for assignment. Command (BC5) assigned L3 to check on houses west (makai) of the fire. 07:19 L3 reported they had limited access and would be tied in with E3 to set up the aerial ladder for exposure protection. L3 worked with E3 to set up a horizontal stand-pipe (2.5" hoseline connected to a gated wye, which handlines can attach to). 07:48 Command (BC5) reported the situation was looking pretty good, and L3 and WL3 were ready for assignment. 07:29 Command (BC5) advised L3 to swap crews with Relief Engine 11 (RE11), a relief unit with limited equipment that is unable to respond to medical calls. L3 was assigned to provide district coverage.
08:00–10:00	08:01 WL3 reported they were on the west (makai) flank of the fire, which they noted to be looking “pretty cool.” They reported they were still working with L3 crew and had lines in place, but they were ready for reassignment.
10:00–12:00 12:00–14:00	L3 returned to service to provide district coverage. L3 ran numerous calls, including snorkelers in distress, water craft in distress, structural damage to houses due to wind, utility poles snapped, and medical calls.
14:00–16:00	15:10 Battalion Chief 5 (BC5) called for L3 to respond to the second Lahainaluna fire (originally dispatched at 14:55 near Ku‘ialua Street). L3 crew recalled there were numer-ous lines and poles down west (makai) of Keawe, so they had to cut through the Safeway parking lot (earlier in the day, this area had been navigable). 15:18 L3 arrived at Lahainaluna Road and the Bypass. L3 crew recalled pulling a 200' 1.75" handline in an attempt to

Date/Time	MFD Resource Assignment: Ladder 3 (L3)
14:00–16:00	stop the fire from jumping the east (mauka) side of the Bypass to the west (makai). L3 crew was still in wildland gear. L3 crew recalled the wind was so intense that when they opened the door to exit the vehicle, the wind broke the door guard, causing it to swing open past 90 degrees. The crew also recalled the wind causing their helmets to blow off, despite having their chin straps secure. The fire quickly impinged on their location and the crew took shelter on the driver’s side of L3. The crew “shoved” the hose back in and turned west down Lahainaluna Road. 15:23 Command (BC5) told L3 the fire had jumped over Lahainaluna, and L3 was assigned to address the grassy area in Mauka Park (Kelawea Mauka Makai Park). L3 reported they were responding west down Lahainaluna from the Bypass. 15:28 L3 reported an exterior structure fire at Dickenson Street off the side of Lahainaluna. L3 reported they were establishing a water supply and would start a fire attack. L3 crew recalled their wildland gear was not providing enough protection from radiant heat, so they switched into structural firefighting gear. 15:34 L3 EMERGENCY TRAFFIC-L3 reported a victim trapped at 5[redacted] Lahainaluna Road. Engine 11 (E11) responded. 15:36 Command (BC5) assigned L3 to evacuate two (2) victims from 5[redacted] Lahainaluna Road. 15:41 L3 reported that two (2) individuals had been removed, and primary search was complete (no other victims found). Command (BC5) advised he had the rescued civilians and was transporting them to medics. Command (BC5) reported multiple structures were on fire and fire was progressing towards L3’s location. L3 recalled abandoning the hoselines. They recalled seeing “fire running through the houses like dominoes.” Command (BC5) instructed L3 to move down to Kelawea Street and Lahainaluna Road to attack a house on fire. L3 crew recalled hooking up to a hydrant near Dickenson and Lahainaluna and laying a horizontal standpipe (2.5" hoseline with gated wye and with two (2) 1.75" handlines) to attempt to stop the fire from burning west of Dickenson.

TIMELINE OF EVENTS

Date/Time	MFD Resource Assignment: Ladder 3 (L3)
14:00–16:00	15:49 L3 reported they had civilians in their apparatus. L3 crew recalled unknown MFD members placing a family of seven (7), including a baby, in their cab. L3 operator provided oxygen and a non-rebreather mask for the baby. L3 and Command (BC5) coordinated to meet up so civilians could be transferred to Command (BC5). L3 raised the aerial and tried to protect the houses on the east (mauka) and west (makai) sides of Dickenson. Around this time, L3 recalled seeing two (2) private vehicles evacuating off Dickenson, and another victim was placed in the cab of L3. L3 crew recalled fire spotting due to high wind gusts and large fire brands. L3 crew recalled roofs catching fire and fire from structures extending to unoccupied parked vehicles. L3 crew recalled limited to no visibility due to strong wind with extreme gusts.
16:00–18:00	16:10 L3 reported good water pressure and one (1) civilian sheltering in their truck. L3 requested that MECO* shut down power to the “whole area.” 16:11 Central advises that MECO* reported that power was shut off. 16:32 PRIORITY TRAFFIC Command (BC5) advised all units to evacuate the Lahainaluna subdivision. Command (BC5) noted that a cut-off point would be established on the Nāpili side of Kahoma Stream. L3 crew abandoned their lines and lowered the aerial. L3 crew reversed down Kelawea from Aki Street to Lu‘i Street to access Komo Mai Street. L3 crew used a 1.5" handline to extinguish hot spots around the houses at the end of the cul-de-sac by Lu‘i Street and Komo Mai Street. L3 operator raised the aerial, but the master stream was ineffective due to strong wind and gusts dispersing the stream. Around this time, E3 arrived, and the officers of E3 and L3 had a face-to-face conversation. L3 and E3 performed coordinated fire attack along Komo Mai Street. Around 16:55, L3 crew heard the fire had jumped Hwy-30 and was impacting the apartments near the Aina Nalu resort. The crew were in disbelief and shocked at how the fire was spreading.

Red text: Indicates that the power supply is cut off.
**Now known as Hawaiian Electric*

Date/Time	MFD Resource Assignment: Ladder 3 (L3)
16:00–18:00	17:02 Engine 6 (E6) member operated the emergency button and called a mayday. L3 crew heard transmission. L3 was still attacking fires along Komo Mai Street, but the apparatus continued to take heat, and the crew continued to be pushed west (makai) by the fire spread. 17:26 L3 advised E3 that they had a structure fire “coming up behind” them. E3 was assigned to scout the area of Lahainaluna for E6 and E1. Neither E1 nor E6 were responding to radio traffic from Command (BC5), and their location was unknown.
18:00–20:00	18:27 L3 advised that hydrants were starting to get low on water pressure. Command (BC5) advised they had communication with a Goodfellows tanker that had set up in their area. 18:57 E3 radioed L3 and asked the status of water pressure in L3’s area (on Komo Mai Street). E3 reported, “We pretty much got nothing over here.” L3 crew responded, “Yeah, we got barely enough.” E3 advised they would be picking up their hoselines and changing location to a different cul-de-sac (in the Lahainaluna neighborhood), and L3 responded they would be doing the same if they could not maintain water pressure. L3 crew recalled their apparatus began taking heat and the water pressure was insufficient. L3 crew recalled assisting E3 with picking up their hoselines while L3 operator lowered the aerial. L3 proceeded straight down Komo Mai Street, allowing E3 to pass them (L3 crew was still sheltering one (1) civilian in their cab–a female in her late 60s with burns on both arms.). At this point, L3 recalled there was no traffic on the road. L3 followed E3 down Komo Mai Street. As L3 crew traveled down Komo Mai Street, they were surprised to encounter numerous structures that had burned to the ground on both sides of the street. L3 operator lived on Komo Mai Street, and he saw that his home was completely destroyed (his two (2) dogs had been inside, but his wife had gone to work on the other side of the island). At the bottom of Komo Mai Street, the road was blocked, so L3 crew had to use a rotary saw (K12) to cut a street sign and a tree in order to egress out of the neighborhood.

TIMELINE OF EVENTS

Date/Time	MFD Resource Assignment: Ladder 3 (L3)
18:00–20:00	19:27 L3 met up with E3 near Island Grocery on Kupuohi Street in the industrial park. L3 and other MFD crews attacked fires in Emerald Plaza within the Kupuohi industrial park. L3 crew pulled into the parking lot of 95 Kupuohi Street, and L3 operator raised the aerial. L3 connected to the hydrant in the parking lot and recalled the water pressure “was not ideal.” They directed the master stream through the upper windows of the building, but the water supply quickly became inadequate. 19:56 L3 requested a utility for transfer of the civilian they had evacuated approximately five (5) hours prior.
20:00–22:00	20:07 Command (BC5) assigned Utility 3 (U3) to meet with L3 and retrieve the civilian. 20:43 L3 was assigned to the Structure Group with E3 and Utility 5 (U5). At 21:05, L3 returned to Fire Station 3 (FS3) to refuel. L3 remained at FS3 awaiting relief crew. 21:36 L3 was assigned to stage near Kahoma Street and Fleming Road. 21:46 Dispatch from BC4: BC4 was assuming Lahaina Command, and BC2 was 911. 21:56 L3 reported they were in staging at the top of Fleming Road. L3 moved to stage at Wahikuli Road and ‘Ainakea Road, where L3 officer had a face-to-face conversation with another MFD officer. There was no water supply and there was concern about power lines falling in the area so, it was determined that L3 would return to FS3 to stage.
22:00–00:00	22:40 L3 reported they were staging at FS3. 23:34 Command (BC4) orders all units at FS3 to abandon the station and to stage near Halelo Street and Hwy-30 immediately due to the fire rapidly spreading north.

Date/Time	MFD Resource Assignment: Ladder 3 (L3)
August 9, 2023 00:00–02:00	00:25 All Structure Group units (including L3) were assigned to the Kā‘anapali area designated as the next cut-off point. Relief Engine 14 (RE14) reported that the fire appeared to be heading in that direction, and there was good water supply in the hydrants in that area. Area now designated as the Summit Group under the supervision of U3. L3 recalls having good water pressure from the hydrants and being able to set up an aerial master stream to pre-treat structures in that area. 01:57 U3 passed command of Summit Group to L3 so U3 can assist with evacuations/moving people. L3 confirmed and assumed command of Summit Group.
02:00–04:00	L3 remained in the Ka‘anapli area as Summit Group leader with other MFD apparatus.
04:00–06:00	04:55 All units staging in the Kā‘anapali Golf Estates area (Summit Group) were reassigned to report to the Civic Center. The fire spread had slowed, and tactics were being reevaluated. 04:58 L3 was assigned to respond to regroup at Leiali‘i Parkway. 05:16 L3 reported they were approaching the post office near Leiali‘i Parkway, and they were instructed to stage in that location. 05:24 L3 responded to assist with brush fire above (mauka) FS3. L3 operator recalled dropping off crew member(s) to assist with fire attack, while L3 operator shuttled water from Hanaka‘ō‘ō Park (Canoe Beach) to crews operating above FS3 using L3’s 440-gallon tank.
06:00–08:00	06:18 L3 reported the fire attack crew had run out of hose-line, and the fire had made its way north (mauka) of their location. They reported they were relocating because the next wind shift could cause the fire to bear down on them. 07:24 L3 reported they were returning with water to the fire above FS3 and they were sending an airport Aircraft Rescue and Firefighting (ARFF) unit to assist with water supply. U3B reported an Alpha tanker and D9 dozer were there attacking the fire and cutting fire lines.

Date/Time	MFD Resource Assignment: Ladder 3 (L3)
06:00–08:00	At 07:25, E11 reported good progress was being made on the north flank. 07:50 L3 was told by U3B they could return to FS3. L3 crew was relieved.
08:00–10:00	
10:00–12:00	

Table 4.3.2.7 MFD Incident Management Assignments for Engine 11 (E11) and Mini 11 on August 8, 2023, and August 9, 2023.

Date/Time	MFD Resource Assignment: Engine 11/Mini 11 (Responded Together)
August 8, 2023	06:43 E11 marked en route to a brush fire near Lahaina Intermediate School per Engine 3 (E3) request. E11 positioned at cul-de-sac of Ku‘ialua Street, connected to the hydrant, and stretched handlines. E11 crew recalled E3 had already knocked down a bulk of the fire. 06:57 E11 reported they would be providing structure protection and triage from Ku‘ialua Street and Ho‘okahua Place/Street. E11 worked on the west (makai) side of Ku‘ialua Street, wetting down steaming dead wood and grass. E11 and Ladder 3 (L3) stretched a horizontal stand-pipe (2.5" hose to a gated wye^ connecting two (2) 1.5" handlines). E11 crew recalled heavily saturating the area along with E3 and L3 (07:22). 07:26 E11 A-watch crew took RE11 to relieve E11 B-Watch crew on scene of the Lahaina brush fire. B-Watch personnel swapped into RE11.
06:00–08:00	
08:00–10:00	Units remained on scene flowing water and protecting structures. 08:38 E11 was released from the scene and returned to Fire Station 11 (FS11) for district coverage.

Date/Time	MFD Resource Assignment: Engine 11/Mini 11 (Responded Together)
10:00–12:00	E11 ran calls for structural damage, wires down, and other miscellaneous service calls.
12:00–14:00	
14:00–16:00	14:55 Central dispatched E3, Tanker 3 (T3) and Battalion Chief 5 (BC5) to a fire on Ku‘ialua Street with flames seen. E11 was mobile in the area of Keawe and BC5 directed E11 to respond to the fire. E11 responded and reported smoke visible at 14:57. 15:00 E11 was the first unit on scene and reported a 20' x 100' brush fire on the north flank near houses. E11 recalled turning off Lahainaluna onto an access road before Ku‘ialua Street. E11 reported they were deploying a hoseline to extinguish the fire heading west toward the Bypass. E11 established Ku‘ialua Command. 15:01 Central from E11, “let’s go ahead and set up command, Ku‘ialua Command on FD2.” E11 officer recalled E3, T3, and Wildland 3 (WL3) arriving on scene, and he had a face-to-face conversation with WL3 operator. E11 officer assigned E3, T3, and WL3 to return to the MECO* dirt road (where they had been on the first Lahaina fire) to try to knock down the fire. E11 officer recalled large embers being lifted by the wind and being blown past their location causing the fire to start to run toward the Bypass. 15:06 E11 radioed for evacuation of houses south [of that location]. 15:10 BC5 arrived on scene and assumed command from E11. 15:18 E11 reported the fire was moving very rapidly toward the Bypass. 15:21 E11 reported the fire jumped the Bypass and was heading west (makai) toward the shore and toward Lahainaluna Road. E11 instructed dispatch to have MPD shut down

TIMELINE OF EVENTS

Date/Time	MFD Resource Assignment: Engine 11/Mini 11 (Responded Together)
14:00–16:00	down the Bypass. E11 officer recalled the smoke was lying horizontally (due to the sustained severe wind), causing limited visibility. 15:28 E11 officer heard L3 report a structure was being impacted on Dickenson Street off of Lahainaluna Road. E11 officer instructed the E11 crew to cut and abandon the hose-lines so they could reposition further down Lahainaluna Road. E11 crew was met with parties evacuating and E11 directed them to head east (mauka) out of the way of the wind and fire. E11 was unable to pass L3 on Lahainaluna Road, so they turned down Kalena Street and turned around, facing Lahainaluna Road, to maintain the ability to egress. At that point, E11 crew recalled seeing houses igniting off on Ka‘akolu Street. 15:44 E11 connected to a hydrant and pulled the large diameter preconnect 2.5" handline up Ka‘akolu Street and deployed a second 1.75" preconnect handline to the corner of Kalena Street and Lahainaluna Road for another structure fire. E11 crew recalled seeing structure-to-structure fire spread, and they had to reposition up Kahako Street to the corner of Kanua Street, positioning the apparatus facing west (makai) for rapid egress if necessary. E11 crew re-established water supply and used the engine’s deck gun and 2.5" handline to try to extinguish the fire on the interior of a structure. E11 crew recalled the water having little to no effect on the fire. 15:51 Command (BC5) gave E11 the order to evacuate and cut/abandon hoselines. E11 officer had a face-to-face conversation with E3 and relayed the evacuation order. E11 crew evacuated via Ka‘akepa Street to Kahako Street to Kalena Street and out to Lu‘i Street to Komo Mai Street. As E11 left the neighborhood, they used the engine’s PA system to broadcast an immediate evacuation notice. E11 crew was able to assist several citizens evacuate the area.
16:00–18:00	16:11 Central advises that MECO* reported that power was shut off. 16:13 Command (BC5) assigned E11 to West Division and assigned E3 and Relief Engine 11 (RE11) to them.

Red text: Indicates that the power supply is cut off.
**Now known as Hawaiian Electric*

Date/Time	MFD Resource Assignment: Engine 11/Mini 11 (Responded Together)
16:00–18:00	E11 crew traveled through Emerald Plaza, hitting hot spots, and noted that the structures had not been impacted. E11 crew saw embers being carried by the wind and saw fire in the sewer system at one point. E11 crew emptied their tank in the area and relocated to Safeway to refill. 17:31 While at Safeway, E11 crew picked up two (2) additional MFD crew members that had arrived in a BC vehicle (the BC vehicle was left at the Cannery Mall by two (2) responding MFD personnel who joined E11 crew). E11 relocated to Hwy-30 and Kenui Street, where they used booster lines to extinguish walls on fire that were threatening Kahoma Village structures. A single structure was on fire at the edge of Kahoma Village (near the corner of the Hwy and Kenui Street). Using E11’s bumper turret and with the assistance of T3 and a private tanker, they were able to prevent further fire spread. 17:42 E11 reported Mini11 pump was inoperable, and they were relocating further down to Front Street and Kenui Street to try to establish a cut-off point. E11 staged on Front Street and began attacking the fire as best they could. 17:50 E11 reported to Command (BC5) that they were fighting a fire at [redacted] Ala Moana. E11 recalled extinguishing the fire on Ala Moana where an ohana dwelling (secondary structure) had ignited. E11 crew then moved to Kai Pali Place west of Front Street, where at least two (2) structures were on fire. E11 crew attacked the fire, but the winds were so strong any fire attack was ineffective. E11 crew recalled that no matter how much water they dumped on the fires, it seemed to make no difference; the fires kept reigniting.
18:00–20:00	E11 crew saw fire further down by Front Street Apartments. They repacked their hoseline and relocated to Kenui Street and Front Street in an effort to keep fire from spreading south of Kenui Street. Along the way, they extinguished vehicle fires that were igniting due to wind-driven ember cast. Trees and brush along Ala Moana and Kenui were igniting, and E11 crew recalled seeing the fire spreading west (makai). E11 crew recalled redirecting people evacuating the area toward the Cannery Mall for safety.

TIMELINE OF EVENTS

Date/Time	MFD Resource Assignment: Engine 11/Mini 11 (Responded Together)
18:00–20:00	18:54 E11 advised they received an MPD report of eight (8) people trapped at Bubba Gump restaurant. Due to the condition of Front Street past Kenui, it was determined that E11 would not be able to access the location. Utility 3B (U3B) reported they would respond. 19:04 E11 crew tried to use Mini11 pump but it remained inoperable. 19:06 E11 launched a fire attack at Front Street Apartments, but they reported seeing fire spread from one building to another, and they realized they would not be able to stop the progression. E11 crew recalled seeing the fire from one (1) building hit the other buildings as the wind was blowing generally from east (mauka) to west (makai). E11 crew recalled the fire would creep north when the wind would shift. 19:18 E11 reported they relocated near Island Grocery. 19:23 Command (BC5) advised E11 to remain at that location, protect the exposure, and support Relief Engine 1 (RE1) crew who were attempting to extinguish a commercial structure fire in Emerald Plaza. E11 crew recalled a masonry fire wall protected Island Grocery while E11 assisted RE1 with water supply. 19:36 E11 reported to Command (BC5) that they were fighting a truck on fire next to a warehouse on Kupuohi Street. E11 reported that they were with Mini1 (staffed by Engine 1 and Engine 6 (E1 and E6) personnel), E3, and L3. E11 advised Command (BC5) they were available for reassignment if needed.
20:00–22:00	20:06 E3 reported a brush fire jumped the Bypass above Wahikuli, behind Foodland Farms on the east (mauka) side of Oil Road. 20:15 E11 notified Command (BC5) that they were proceeding to that location to assist. E11 recalled meeting up with E3 in the parking lot of the Church of Jesus Christ of Latter-Day Saints to try to stop fire progression. E11 crew recalled the attempt being successful. E11 then left that location and repositioned along the Bypass.

Date/Time	MFD Resource Assignment: Engine 11/Mini 11 (Responded Together)
20:00–22:00	20:29 E11 reported fire jumped the road north at Keawe and was heading toward Wahikuli. E11 advised evacuation of the Wahikuli subdivision. Command (BC5) relayed the evacuation notice to Fire 4. 20:51 Command (BC5) assigned Relief Engine 14 (RE14) as Bypass Group with RE11 and Utility 5 (U5) as resources. 21:13 E11, assigned to Bypass Group under RE14, assisted with fighting the brush fire west (mauka) of the Bypass near Keawe. Command (BC5) advised Bypass Group that four (4) private tankers were en route with an ETA of 30 minutes. 21:42 E11 reported the four (4)-story building in the Emerald Plaza industrial area was fully engulfed. 21:46 BC4 to Dispatch: BC4 was assuming Lahaina Command, and BC2 was 911.
22:00–00:00	22:12 E11 officer recalled the fire that started behind Emerald Plaza, south of the Bypass, spotted, and was starting to move north. RE14, U5, and a private tanker relocated to attack the fire and stop further progression. RE14 passed Bypass Group to E11, who was staging at the Bypass near Keawe. E11 had radio communications with RE14 about the condition of roadways. E11 expressed concern that the fire was moving faster through the structures along the lower road than the grass, and E11 officer was concerned about getting trapped while moving through that area. 22:21 E11 reported that they were at the corner of Keawe Street Extension and the Bypass, and all fire activity appeared to be west (makai) of their location. E11 officer relayed that RE14, U5, and the private tanker used a dirt road (Oil Road) to try to attack the fire, but they had to exit on Wahikuli Road. E11 reported they were ready for reassignment. 22:27 Command (BC4) advised E11 to stand by to monitor and that they would be used as a contingency for the south end. E11 officer recalled they could not make it back safely north toward FS3 because poles and power lines were down, blocking the right hand turn at Keawe onto the Hwy. E11 coordinated with the private tanker that arrived at their location (it had the capability to supply E11.). Three other

TIMELINE OF EVENTS

Date/Time	MFD Resource Assignment: Engine 11/Mini 11 (Responded Together)
22:00–00:00	private tankers, equipped with turrets, were still en route. 22:29 Command (BC4) assigned E11 and the private tanker to take the Bypass and check on the status of Hōkiokio Place. 22:41 E11 reported that the fire jumped Hōkiokio Place and was heading west (makai) toward the Puamana community. E11 reported the tanker needed to fill at Hōkiokio Road and E11 would advise further. 22:47 All other units were instructed to abandon their locations to regroup at FS3 to coordinate the location of the next cut-off point. E11 officer realized that there was not a passable route and they were the only fire apparatus available to cover the southern division. The three (3) incoming tankers were assigned to E11 and remained in the southern area. 22:49 E11 relayed they would remain in the area to provide fire protection, but they were in need of diesel fuel. E11 crew recalled hydrants at Kai Hele Kū Street and Hōkiokio Place still had water. The water pressure was low, but it was enough to fill the tanks of E11 and the private tankers. During this time, E11 was also dispatched to miscellaneous service calls in that area. 23:15 Command (BC4) advised E11 was the only unit south of Fleming Road, and they were low on fuel. Command (BC4) advised they may have limited response capacity. Command (BC4) advised E11 it was unlikely they would be able to deliver diesel fuel. Command (BC4) advised E11 to get to the safest location possible in case they run out of fuel.
August 9, 2023 00:00–02:00	E11 continued to monitor the Bypass. E11 officer recalled that from the Bypass to Keawe Street was clear (at Keawe Street and Hwy-30 they could not make a right-hand turn due to wires down). The Bypass was clear south to Hōkiokio Place. E11 crew recalled the fire would spot east (mauka) of the Lahaina Bypass, but E11 and the private tankers were

Date/Time	MFD Resource Assignment: Engine 11/Mini 11 (Responded Together)
August 9, 2023	able to mitigate those fires.
00:00–02:00	E11 crew parked E11 at Hōkiokio Place and the Lahaina Bypass to ensure the fire did not jump the road, and they used Mini11 to retrieve hoselines from accessible locations. 00:41 E11 reported there had been a shift in the wind, blowing on shore and causing fire to spot east (mauka). E11 and private tankers extinguished the spot fires between Hōkiokio Place and Kai Hele Kū Street. 01:27 E11 requested radio batteries from the Support Group. E11 officer relayed that they had run out of radio batteries. Support was not able to make it to E11 location due to numerous roads blocked by downed power lines.
02:00–04:00	02:01 E11 reported fire approximately 200 yards away from and approaching Hōkiokio Place. E11 performed structure triage and reported that the homes had good defensible spaces but they needed tankers to return to the area and they needed radio batteries and diesel fuel. E11 officer advised that the E11 low fuel light had illuminated, but he believed they would be able to get to FS3 or Nāpili if the roads became passable. 02:09 Command (BC4) advised E11 that the roads continued to be impassable, and E11 should head south to a safe location and stage.
04:00–06:00	05:02 E11 advised they were responding to a trailer in Launiupoko Beach Park with lines down, propane tanks, and fire approaching. The trailer was off Kai Hele Kū Street between the Bypass and lower Hwy. Dispatch advised E11 should use Waianukole Street (street identified on county parcel map, located off Kai Hele Kū Street between Hwy-30 and the Bypass) north for access. E11 advised they could not make access due to downed power lines. 05:48 Central advised that Engine 3A (E3A) confirmed roads were passable to the fire station and E11 should return to the station to refuel, restock, and rehab. 05:51 Command (BC4) advised MPD reported a fire on the east (mauka) side of the Bypass, 100-150 yards from Kai Hele Kū Street. E11 responded they were headed that way

Date/Time	MFD Resource Assignment: Engine 11/Mini 11 (Responded Together)
04:00–06:00	to deal with it. 05:55 E11 advised they were running out of water, and the east-side (mauka-side) fire was growing. E11 advised using air support as soon as they became available. Command (BC4) advised helicopters would not be able to fly for approximately 30–40 minutes, but they would respond as soon as they were able. 06:05 Command (BC4) advised E11 to return to FS3 to refuel. E11 Officer recalled they returned to FS3 where they were relieved by E11 C-Watch personnel.

^Gated wye is a type of firefighting hose valve with gateable valves on each outlet, which gives the firefighter maximum control over the water flow.

Table 4.3.2.8 MFD Incident Management Assignments for Relief Engine 11 (RE11) on August 8, 2023, and August 9, 2023.

Date/Time	MFD Resource Assignment: Relief Engine 11* (RE11) (No structural response capability–limited hoseline, no SCBA, no portable radios)
August 8, 2023 06:00–08:00	07:25 RE11 reported to Central that they were responding to the Lahaina fire. RE11 officer advised Command (BC5) that RE11 was staffed with oncoming A-Watch personnel. They advised Command (BC5) they did not have a full complement of structural firefighting equipment. 07:29 Command (BC5) directed them to report to the cul-de-sac at Ku‘ialua Street to meet up with Ladder 3 (L3). RE11 A-Watch personnel recalled when they arrived on scene that it seemed most of the fire had been knocked down. B-Watch officer had face-to-face briefing with oncoming A-Watch officer. RE11 (now staffed by B-Watch personnel) remained on scene. A-Watch personnel took over staffing E11.

**While most reserve apparatus is staged at FS10, FS11 and FS3 each have a reserve engine at the firehouse. RE11 is housed at FS11, but it is not equipped with a full complement of structural firefighting (e.g., hose packs, nozzles, etc.) or medical equipment.*

Date/Time	MFD Resource Assignment: Relief Engine 11* (RE11) (No structural response capability–limited hoseline, no SCBA, no portable radios)
08:00–10:00	08:15 RE11 was directed to respond to a call for smoke at the water treatment plant. They responded with Engine 3 (E3) and Wildland 3 (WL3). E3 arrived on scene and confirmed it was a false alarm. E3 canceled other units. RE11 returned to the area of Ku‘ialua Street and remained on scene hitting hot spots and wetting down the area. 09:27 BC5 transferred Lahaina Command to E3, and E3 remained on scene with RE11.
10:00–12:00	10:20 RE11 was released from the incident. E3, Tanker 3 (T3), and a private tanker remained on scene continuing to wet down the area. 10:21 RE11 reported they were going to remain available. RE11 advised they had no structural or medical response capability. 10:21 BC5 instructed RE11 to stop at the fire station and pick up the complement of medical gear from BC5’s SUV prior to returning to Fire Station 11 (FS11). 10:37 RE11 reported they were leaving the scene and heading to Fire Station 3 (FS3) to pick up emergency medical response (EMR) equipment. BC5 and RE11 communicated via radio, and it was determined RE11 was going to remain at FS3 for any reported brush fire calls. B-Watch officer recalled returning to the station in RE11. RE11 B-Watch officer left for the day, and a B-Watch firefighter became the acting officer of RE11. A firefighter from A-watch joined the RE11 crew.
12:00–14:00	RE11 remained available for response from FS3.
14:00–16:00	14:55 Central received numerous calls for a fast-spreading fire at the end of the cul-de-sac of Ku‘ialua Street with flames seen. 14:58 BC5 directed Central to add RE11 to the response. E3 advised RE11 to take the Bypass due to numerous power lines down on the Hwy. 15:12 Command (BC5) directed RE11 initially to respond to 7[redacted] Ho‘okahua Place to assist MPD officers on scene trying

TIMELINE OF EVENTS

Date/Time	MFD Resource Assignment: Relief Engine 11* (RE11) (No structural response capability–limited hoseline, no SCBA, no portable radios)
14:00–16:00	to extinguish a shed fire near a house. 15:18 RE11 reported they were in the area where the fire was about to jump the Bypass to Lahainaluna. Command (BC5) directed RE11 to hit the fire from there. Command (BC5) reassigned E3 to the shed fire. 15:26 RE11 moved their lines to extinguish fire in the park area (Kelawea Mauka Makai Park). 15:29 RE11 announced Priority Traffic and reported they had a structure with fire on the roof with a second structure potentially involved. RE11 reported they had hooked up to a hydrant and were stretching lines. RE11 recalled they went down Lahainaluna Road to Kalena Street and then reversed down Ka'akolu Street and backed into Ka'alo Place (a cul-de-sac). There was a hydrant at that location with good water pressure. RE11 crew pulled a 1.75" preconnect handline and started attacking the fire between 6[redacted] and 6[redacted] Ka'alo Place. RE11 crew recalled the shed in the SW corner of 6[redacted] Ka'alo was fully involved and was spreading to the trees and brush. As they knocked down that fire, the shed behind 6[redacted] Ka'alo Place ignited. The shed at 614 Ka'alo Place started to impact the roof of 6[redacted] Ka'alo Place (due to topography, 6[redacted] Ka'alo Place sat 3–4' lower than 6[redacted] Ka'alo Place). RE11 crew's hoseline could not reach 6[redacted] Ka'alo Place. A resident was also on scene using a garden hose to mitigate the fire.
16:00–18:00	16:11 Central advises that MECO^ reported that power was shut off. 16:13 RE11 officer reported to Command (BC5) they were actively fighting two (2) structure fires on the cul-de-sac of Ka'alo Place. 16:26 Fire 3 (F3) reported to Command (BC5) that the entire neighborhood, including between Lahainaluna Road and Keawe Street up to the Industrial area, needed to be evacuated. RE11 crew recalled hearing three (3) long air horn blasts, the signal for immediate evacuation. RE11 crew cut the lines but

Red text: Indicates that the power supply is cut off.
^ Now known as Hawaiian Electric.

Date/Time	MFD Resource Assignment: Relief Engine 11* (RE11) (No structural response capability–limited hoseline, no SCBA, no portable radios)
16:00–18:00	grabbed the appliances (nozzles). They were unsure of why the evacuation tone had sounded until they pulled out and saw Engine 11 (E11) attempting a fire attack on multiple houses using the engine's deluge gun. They noted multiple other structures in the smoke's path were also fully engulfed. 16:31 RE11 reported to Command (BC5) that they were going to pull back to the Lahaina or Nāpili side of the Kahoma Stream bed and use that as a cut-off point. RE11 went down Kanua Street to Kahako Street. RE11 crew recalled the neighborhood was full of people; many residents were standing in their front yards or using garden hoses to wet down houses and extinguish spot fires. RE11 crew recalled there were some language-barrier challenges as they made evacuation notifications. RE11 crew reported Kanakea Loop was congested with parked vehicles making the road very narrow and difficult to navigate. RE11 crew recalled seeing a house engulfed in fire on Kahena Street. 16:34 RE11 crew heard the radio traffic regarding Lahainaluna Road being blocked in multiple locations. RE11 scouted the route down to the cul-de-sac off Lu'i Street and Komo Mai Street. RE11 recalled the area was still relatively clear. RE11 went back up Kahena Street to loop around again and continue evacuations. 16:34 RE11 crew reported their only means of egress was going to be Kahena Street, and they were advising residents to exit off that route. During their second trip down Kahena Street, RE11 crew continued down Komo Mai Street where they encountered several houses fully engulfed in fire. The visibility had decreased to almost zero. They were able to take Komo Mai Street to Kuhua Street and onto Keawe Street. 16:42 RE11 reported to Command (BC5) that they had fallen back to Foodland Farms and that multiple structures in the Komo Mai subdivision were on fire. RE11 recalled working within that neighborhood to make evacuation notices. RE11 recalled some residents were resistant to evacuate.

TIMELINE OF EVENTS

Date/Time	MFD Resource Assignment: Relief Engine 11* (RE11) (No structural response capability–limited hoseline, no SCBA, no portable radios)
16:00–18:00	16:49 RE11 officer reported to Command (BC5) that they could see from across Kahoma Stream the Opukea apartments starting to be impacted due to extension on the exterior from vehicle fires adjacent to the building. RE11 advised the area should be evacuated. RE11 recalled they had to stop at Cannery Mall to refill their tank, and they recalled having good water pressure at that time. 16:59 RE11 assisted E11 and Mini11 with extinguishing a wall on fire threatening Kahoma Village with some extension into the ravine. RE11 advised they had to abandon their hose, so they were operating with limited suppression equipment. 17:02 RE11 reported Front Street was impassable due to traffic. RE11 crew recalled they repositioned near the Hoʻonanea subdivision to address fire on the Kahoma Stream side of the property, since a vinyl fence was systematically catching fire traveling down the edge of Kahoma Stream. Command (BC5) assigned one (1) incoming tanker to that location and another tanker to assist E11 in Kahoma Village.
18:00–20:00	18:00 RE11 crew reported they were still along the back corner of the Hoʻonanea complex trying to mitigate fire spread and protect Keawe roadway for the medic units. 18:05 Command (BC5) assigned Mini1 (staffed by four (4) members of Engine 1 (E1) and three (3) members of Engine 6 (E6) due to loss of E1 and E6 rigs during the Lahainaluna Road burnover event) to assist RE11. Mini1 also did not have a full complement of structural firefighting equipment. RE11 and Mini1 relocated to 181 Kupuohi Street to knock down fire near that location and mitigate hot spots. 19:01 RE11 reported to Command (BC5) they were working in the Emerald Plaza area. RE11 officer reported that Hoʻonanea had been mitigated as best they could and that the auto sprinklers had activated.

Date/Time	MFD Resource Assignment: Relief Engine 11* (RE11) (No structural response capability–limited hoseline, no SCBA, no portable radios)
18:00–20:00	19:15 Battalion Chief 4 (BC4) arrived with callback relief personnel, and crew swap of RE11 occurred on scene in Emerald Plaza. At this time, three (3) RE11 firefighters reached their 36-hour shift limit (one was AO). They were relieved by one (1) officer and three (3) firefighters. One (1) RE11 firefighter remained on duty (A-Watch is their regular day, and they were riding extra on August 8, 2023). 17:25 RE11 reported they were ready for assignment. They were assigned to check the Aina Nalu Apartments off Waineʻe Street. RE11 crew recalled they tried several routes trying to gain access to Waineʻe Street but were unable to do so due to downed power lines and heavy fire conditions. RE11 officer recalled they were almost able to make it to Kenui Street. They picked up a civilian walking in the area, dropped them off at Keawe and Hwy-30, and returned to Keawe. 19:51 RE11 reported they were heading to assist E3 with fire attack and structure protection near the Church of Jesus Christ of Latter-Day Saints. RE11 officer recalled heavy smoke and fire conditions at the east end of Ulupono Street. The large white apartment building at the east end of Ulupono Street was engulfed in flames. They met up with several other MFD apparatus and effected evacuations of the area.
20:00–22:00	20:06 E3 reported the fire had jumped the Bypass east (mauka) of Wahikuli and was heading north. RE11 was assigned to head to that location. 20:11 Relief Engine 14 (RE14) advised that, as they turned down Keawe, the fire jumped Keawe from south to north, headed in the direction of the apartments under construction (east (mauka) of Oil Road). Command (BC5) advised RE11, E3, and T3 were en route to that location. RE11 crew positioned along Oil Road with T3 and used the redline and a 1.5" handline to mitigate fire spread in the brush and grass along Oil Road. RE11 officer recalled they were managing the fire pretty well until they ran out of water.

TIMELINE OF EVENTS

Date/Time	MFD Resource Assignment: Relief Engine 11* (RE11) (No structural response capability–limited hoseline, no SCBA, no portable radios)
20:00–22:00	20:21 RE11 reported they were about to lose the corner of Oil Road east (mauka) by Ipukula Way, and they needed a tanker. Command (BC5) advised that two (2) tankers were en route to that location. RE11 officer recalled that the tankers arrived within approximately five (5) minutes. Neither tanker had a radio, and the operators seemed inexperienced with fire attack. RE11 officer recalls the tankers having minimal impact as the fire head continued to advance toward homes. RE11 retreated to refill their tank, but the hydrant in the Foodland Farms shopping center was dry. 20:49 Command (BC5) requested a Condition/Actions/Needs (CAN) report from RE11. RE11 reported they were looking for a viable water source, and they were at the Civic Center with T3. 21:07 RE11 reported they had refilled their tank and were ready for assignment. Command directed RE11 to return to FS3 for a face-to-face conversation. 21:15 Support Group requested additional apparatus to help evacuate people from Front Street. RE11 was assigned to respond. RE11 officer recalled visibility by Front Street was “less than five (5) inches.” The fire had jumped to the west (makai) side, and structures on Front Street were fully involved, but some people were still refusing to evacuate. RE11 continued to Māla Wharf looking for people to evacuate. RE11 recalled they were reassigned to FS3. RE11 tried to refill their tank while there but the hydrant was only producing “a trickle.” RE11 officer recalled RE11 got blocked in by the evacuation traffic at the Civic Center. 21:26 Command (BC5) assigned RE11 to report to E3 as part of the Structure Group. RE11 was assigned to head to Kapunakea Street and the Kahoma Street area to assess conditions. RE11 reported there were heavy fire conditions along Kahoma Street. RE11 pulled 2–2.5" handlines and made an attack near 13[redacted] Kahoma Street. Despite putting large amounts of water on the fire, structures started to catch

Date/Time	MFD Resource Assignment: Relief Engine 11* (RE11) (No structural response capability–limited hoseline, no SCBA, no portable radios)
20:00–22:00	both south and west (makai). RE11 crew recalled other MFD units and an Airport Rescue Firefighting Apparatus (ARFF) unit were operating in the area as well. They were trying to make a stand and stop fire progression within the neighborhood. 21:46 BC4 to Dispatch: BC4 was assuming Lahaina Command, and BC2 was 911. 21:52 RE11 reported that they were not making any impact on the structures, and the fire “is going one after another.” RE11 reported they had to pull out of the area. RE11 crew recalled they had to extinguish vehicle fires and other flare ups in order to egress the neighborhood. RE11 reported staging along the highway.
22:00–00:00	22:14 Structure Group assigned RE11 to respond to Front Street near Fleming Road for a fire attack. RE11 reported they were out of water. 22:47 RE11 reported they were abandoning their position and heading to FS3. Structure Group advised all units to regroup at FS3. RE11 crew received a report that there was a working hydrant at Canoe Beach. RE11 went to that location and was able to fill the RE11 tank (they noted that there were other MFD apparatus there as well). 23:45 RE11 reported they were staging on Hwy-30 above Canoe Beach.
August 9, 2023 00:00–02:00	RE11 crew recalled around this time a decision was made to relocate apparatus into Kā‘anapali, which had working hydrants and was expected to be the next location impacted.
02:00–04:00	RE11 crew recalled setting up on Anapuni Loop, connecting to a hydrant and laying a 2.5" horizontal standpipe (hoseline with a gated wye that branches off to 2 - 1.5" handlines). RE11 remained in that location for some time, with other MFD units spread throughout the neighborhood, prepared to make a coordinated attack.

Date/Time	MFD Resource Assignment: Relief Engine 11* (RE11) (No structural response capability–limited hoseline, no SCBA, no portable radios)
04:00–06:00	04:54 RE11 reported that the fire still appeared to be a good distance from their location.
06:00–08:00	04:55 Command (BC4) recalled all units in the Golf Estates Area to report to the Civic Center. 05:16 Utility 3B (U3B) requested a suppression unit with sufficient water supply to respond to the top parking lot above FS3 to address a spreading brush fire. RE11 was assigned to assist. RE11 crew recalled they were assigned with L3 to stop the north flank of the fire, west to east above the Civic Center. RE11 crew recalled they laid 1500' of 1.5" hoseline and apparatus was shuttling water to them. The crew recalled the sun was coming up around this time. They could not reach the top area of fire spread, so they disconnected the lines (left them in place), relocated up to Pu‘ukoli‘i Road, and came back down Old Stuart Road. At the corner of Pu‘ukoli‘i Road and Old Stuart Road, RE11 crew met up with a HECO^ rep who told them all lines had been de-energized. RE11 pulled 500-600' of 1.5" hoseline and was able to mitigate the fire. A D9 dozer was brought to their location and cut a line north above Old Stuart Road down to the Civic Center. They also coordinated with a private dozer operator to make additional fire stops.
08:00–10:00	08:31 RE11 demobilized and returned to Fire Station 10 (FS10) where another crew was waiting to staff RE11.

**While most reserve apparatus is staged at FS10, FS11 and FS3 each have a reserve engine at the firehouse. RE11 is housed at FS11, but it is not equipped with a full complement of structural firefighting (e.g., hose packs, nozzles, etc.) or medical equipment.*

^Now known as Hawaiian Electric.

Table 4.3.2.9 Maui Fire Department (MFD) Incident Management Assignments for Engine 6 (E6) on August 8, 2023, and August 9, 2023.

Date/Time	MFD Resource Assignment: Engine 6 (E6)
August 8, 2023 06:00–08:00	06:47 E6 dispatched to assist Engine 3 (E3) for a fire off of Lahainaluna Road. 06:49 E6 advised they were responding with Wildland 6 (WL6). E6 crew consisted of three (3) B-Watch crew members and one (1) member of the oncoming A-Watch shift. WL6 was driven by an E6 B-Watch crew member. 07:23 Command (BC5) assigned E6 and WL6 to respond to Tanker 3’s (T3) position to assist with stretching lines and fire attack. E6 Crew responded along a dirt road above the Bypass behind the houses. They recalled an MFD tanker and private tanker(s) were on scene. The bulk of the fire had been knocked down and crews appeared to be “mopping up.” 07:45 E6 reported they had established a wet line about 100' in and that a dozer was on scene. 07:57 Command (BC5) advised that E11 would be taking over for E6, and E6 crew could return to their district. E6 and WL6 returned to quarters.
08:00–10:00	E6 continued to run numerous calls within their district. E6 officer noted the extreme weather conditions including whitecaps covering the ocean and water spouts in multiple locations.
10:00–12:00	
12:00 -14:00	
14:00–16:00	15:30 Battalion Chief 3 (BC3) requested E6 be added to Lahaina fire to assist. 15:32 E6 reported they are responding with WL6 to Lahaina. 15:51 Command (BC5) instructed E6 & WL6 to access Lahainaluna Road from Hwy-30, not the Bypass, and to turn onto Kelawea Street to address structures in that area. E6 crew recalled there was heavy traffic on the highway due to HECO* lane closures. HECO* crews were working on downed

TIMELINE OF EVENTS

Date/Time	MFD Resource Assignment: Engine 6 (E6)
14:00–16:00	poles and power lines. MPD was directing traffic and allowed the responding units to get through. 15:56 Command (BC5) assigned E6 to be South Division (SD) and warned that there were extreme fire conditions. E6 requested clarification on where to focus exposure protection and establish a cut-off point. Command (BC5) advised he did not have a visual, but to proceed to the area around Paunau Street. E6 copied and advised Command (BC5) that WL6 was with them and Engine 1 (E1) was also responding. 15:59 Command (BC5) assigned Relief Engine 1 (RE1) to E6 as part of SD.
16:00–18:00	16:00 E6 advised RE1 to access Lahainaluna Road from Hwy-30. E6 advised MECO* had the road barricaded, but they will let emergency traffic through. 16:11 Central advised that MECO* reported that power was shut off. 16:05 E6 crew reported trying to evacuate cars off of Pauoa Street. E6 crew recalled that around this time, approximately 30-40 percent of the houses in the area had active fire. E6 attempted to make a fire attack on a house fire at the corner of Lahainaluna Road and Pauoa Street, but the engine turret was ineffective due to extreme wind. E1, Mini1, and RE1 arrived on scene. E6 stretched a 200' of 1.5" pre-connected handline, but the stream was ineffective due to wind. E6 officer told the crew to disconnect the line to allow them to relocate and residents to evacuate. E6 officer had a face-to-face conversation with E1 officer to coordinate efforts. Communications were very difficult due to the severity of the wind. E6 officer had a face-to-face with RE1 crew member and advised them to abandon their location (off Lahainaluna Road) to allow traffic to pass. RE1 was also positioned under a monkeypod tree with a large, broken branch hanging perilously over the rig. 16:17 E6 EMERGENCY TRAFFIC E6 advised all units assigned to SD to evacuate positions to allow residents to evacuate.

Red text: Indicates that the power supply is cut off.

**Now known as Hawaiian Electric.*

continued

Date/Time	MFD Resource Assignment: Engine 6 (E6)
16:00–18:00	16:20 RE1 advised they abandoned their location. They were trying to evacuate, but a "warehouse" fell over and was blocking Lahainaluna Road. 16:22 E6 advised Command (BC5) that they were stuck on Pauoa Street unable to egress, and there were residents in the path of the fire. At this time, another unit reported that electrical components had fallen on WL6 at Pā'ū'ū Place and Paunau Street, and a pole was blocking the road perpendicularly. 16:27 WL6 operator reported trying to push the pole out of the road so other apparatus can get through. A hydrant had sheared from the base, and water was hitting WL6, which was covered in electrical lines. E6 officer physically moved the power lines to allow WL6 operator to exit the vehicle and rejoin E6 crew. 16:29 E6 reported they had to abandon WL6. E6 crew recalled reversing down Pā'ū'ū Place to turn around and exit the way they entered (Pauoa Street and Lahainaluna Road). At the corner, they maneuvered around E1 (which was facing south on Pauoa in front of the Kaunoa Senior Center) and attempted to push debris and abandoned vehicles to make egress onto Lahainaluna Road. E6 crew recalled the debris "was as high as the truck." 16:35 RE1 reported to E6 that they found an open spot for egress, and RE1 instructed E6 to follow them. E6 copied the transmission. Around this time, E6 crew recalled reversing back down Pauoa Street looking for an egress point until E6's transmission failed and the vehicle would not shift into reverse. E6 was positioned nose-to-nose with E1 in front of parking lots to the Kaunoa Senior Center when they made the decision to shelter in place (the parking lots provided an approximately 50-60' buffer of open space.). E6 crew recalled that Mini1 was in one of the parking lots of the Kaunoa Senior Center. E1 was taking heavy heat. E6 had approximately 0.25 tank of water and they sprayed down multiple vehicles on fire due to flames impinging on E1. Just before running out of water, E6 officer instructed the crew to wet down E6. The wind was so intense it was spraying the solid stream sideways. E6 crew sheltered inside of E6, but it became hotter inside the cab than outside, even though the

continued

Date/Time	MFD Resource Assignment: Engine 6 (E6)
16:00–18:00	ground outside was causing their boots to melt. Around this time, E6 officer recalled being overcome by heat and losing fine motor skills (he had trouble changing the air cylinder of his SCBA, and his crew had to help him.). E6 crew member, still in wildland gear, was burned by coming in contact with the window while sitting in the interior of the cab. 16:47 E6 reported they were unsure if they would be able to hold their position and they were in need of assistance. Around this time, E6 crew member recalled exiting the cab of E6 to retrieve extra cylinders from exterior compartments of E6, and he noted that one (1) compartment door had melted shut. He retrieved as many cylinders as he could and put them in the interior of E6. The crew was not communicating in an effort to conserve air. E6 crew member exited E6 to go check Mini1's operability. Mini1 was operable, and E6 firefighter was able to drive over a curb, through debris, in between E1 and E6. He tried honking the horn to get the attention of all crew on scene, but he had very little visibility, and there was no response. 17:02 Central advised Command (BC5) that E6 was calling a mayday on the emergency channel and that the portable radio emergency alert button had been activated. Despite multiple attempts, Command (BC5) was unable to contact E6. E6 firefighter (who drove away in Mini1–see Mini1 chronology) returned in an MPD SUV and pulled up beside E1 and E6. All eight (8) crew members, including the unresponsive member of E6, were loaded into the MPD SUV (after removing MPD equipment and their SCBAs), and E6 firefighter took the same route in zero visibility back to Shaw Street and the highway. The crew unloaded the unresponsive member of E6 and began CPR. 17:11 Command (BC5) reported CPR in progress at the intersection of Shaw and the highway. 17:22 medics were reported to be on scene, and they transported an unresponsive E6 member to the hospital. E1 and E6 (with assistance from an off-duty firefighter sitting in traffic) were able to free the debris impeding Mini1.

Date/Time	MFD Resource Assignment: Engine 6 (E6)
18:00–20:00	18:05 E1 reported that E1 (crew of four (4) and E6 (with a crew of three (3) loaded into Mini1 and redesignated the unit as E1 in Mini1 (see Mini 1 chronology for further actions).
20:00–22:00	
22:00–00:00	
August 9, 2023	
00:00–02:00	
02:00–04:00	
04:00–06:00	
06:00–08:00	
08:00–10:00	
10:00–12:00	

Table 4.3.2.10 Maui Fire Department (MFD) Incident Management Assignments for Wildland 6 (WL6) on August 8, 2023, and August 9, 2023.

Date/Time	MFD Resource Assignment: Wildland 6 (WL6)
August 8, 2023	E6 officer (A-watch) recalls knowing about the fire up country and that the conditions were expected to be hotter, drier, and windier throughout the day. WL6 was put into service to run medical calls in case it was needed to respond to a wildland call at some point.
06:00–08:00	06:49 WL6 (driven by one (1) Engine 6 (E6) crew member) responded with E6 to assist Engine 3 (E3) with a brushfire near the Bypass and Lahainaluna Road. 07:23 Command (BC5) assigned E6 and WL6 to respond to Tanker 3 (T3) positions to assist with stretching lines and fire attack. 07:57 Command (BC5) advised E6 (and WL6) to return to their district.

TIMELINE OF EVENTS

Date/Time	MFD Resource Assignment: Wildland 6 (WL6)
08:00–10:00	WL6 remained available for district coverage.
10:00–12:00	
12:00–14:00	
14:00–16:00	15:32 WL6 responded with E6 to Lahaina. One (1) member of E6 drove WL6 and three (3) members on E6. 15:51 Command (BC5) instructs E6 & WL6 to access Lahainaluna Road from Hwy-30, not the Bypass, and to turn onto Kelawea Street to address structures in that area. E6 crew recalled there was heavy traffic on the highway due to HECO* lane closures. HECO* crews were working on downed poles and power lines. MPD was directing traffic and allowing the responding units to get through. 15:56 Command (BC5) assigned E6 to be South Division (SD) and warned that there were extreme fire conditions. E6 requested clarification on where to focus exposure protection and establish a cut-off point. Command (BC5) advised he did not have a visual but to proceed to the area around Paunau Road. E6 copied and advised Command (BC5) that WL6 was with them and E1 was responding.
16:00–18:00	16:11 Central advises that MECO* has reported that power is shut off. 16:17 E6 EMERGENCY TRAFFIC E6 advised all units assigned to SD to evacuate positions to allow residents to evacuate. 16:21 E6 advised WL6 to follow E6 as they tried to egress. 16:22 E6 advised Command (BC5) that they were stuck on Pauoa Street unable to egress, and residents were in the path of the fire. At this time, another unit reported that electrical components had fallen on WL6 at Pā‘ū‘ū Place and Paunau Street, and a pole was blocking the road perpendicularly. 16:27 WL6 reported he had tried to push the pole out of the road so other apparatus could get through. A hydrant had sheared from the base, and water was hitting WL6, which was covered in electrical lines. E6 officer physically moved the power lines to allow the WL6 operator to exit the vehicle. 16:29 E6 reported they had to abandon WL6.

Red text: Indicates that the power supply is cut off.
**Now known as Hawaiian Electric.*

Date/Time	MFD Resource Assignment: Wildland 6 (WL6)
18:00–20:00	[redacted]
20:00–22:00	
22:00–00:00	
August 9, 2023	
00:00–02:00	
02:00–04:00	
04:00–06:00	
06:00–08:00	
08:00–10:00	
10:00–12:00	

Table 4.3.2.11 Maui Fire Department (MFD) Resources Assignments for Engine 1 (E1) on August 8, 2023, and August 9, 2023.

Date/Time	MFD Resource Assignment: Engine 1 (E1)
August 8, 2023	STATION COVERAGE
06:00–08:00	
08:00–10:00	
10:00–12:00	
12:00–14:00	
14:00–16:00	15:34 Battalion Chief 3 (BC3) told Central to send E1 to the Lahainaluna fire (Lahaina PM fire). E1 recalled splitting the crew and responding with Mini1 (two (2) crew members in E1 and two (2) crew members in Mini1). En route, E1 crew recalled seeing heavy black smoke that

TIMELINE OF EVENTS

Date/Time	MFD Resource Assignment: Engine 1 (E1)
14:00–16:00	was “laying down pretty good.” En route to the fire, E1 crew encountered electrical workers conducting repairs near Hwy-30 and Hōkiokio, and they saw MPD as they approached Lahainaluna Road and Mill Street. At this point, people were still evacuating Lahainaluna Road and the surrounding neighborhood. 15:57 Command (BC5) assigned E1 to Engine 6 (E6) as part of South Division (SD) on Lahainaluna Road. E1 crew recalled seeing E6 fighting a structure fire near the corner of Lahainaluna Road and Pauoa Street. E6 and E1 officer had face-to-face conversation. E6 officer tasked E1 with traveling up Pauoa to Paunau to see if they could make a stop further up the neighborhood. E1 crew recalled the houses in the Paunau area being heavily impacted. Visibility became greatly reduced, so they couldn’t see anything past the initial houses, and they knew further up was a loss. E1 crew recalled there were many vehicles trying to turn from Paunau onto Lahainaluna Road. E1 crew recalled pulling a 1.75" handline to mount a fire attack for one of the houses on fire.
16:00–18:00	16:11 Central advises that MECO* has reported that power is shut off. 16:17 E6 (SD) EMERGENCY TRAFFIC all units assigned to SD were told to evacuate their positions to allow private vehicles to egress. 16:26 E1 reported they have not been able to evacuate the neighborhood. E1 crew recalled they tried to exit at Paunau and Lahainaluna Road, but traffic was backed up. They turned around, which took a lot of time due to the narrow roads and parked vehicles (unoccupied). Occupied vehicles attempting to evacuate were backed up on both Paunau and Lahainaluna Road. E1 officer tried to direct traffic to get more vehicles out. 16:27 Command (BC5) reported that SD units would have to fall back to Hwy-30 from the bottom of Paunau. 16:32 E6 reported that SD was going to anchor and shelter in place along Paunau because upper and lower Paunau were both blocked at Lahainaluna Road.

Red text: Indicates that the power supply is cut off.
**Now known as Hawaiian Electric.*

Date/Time	MFD Resource Assignment: Engine 1 (E1)
16:00–18:00	16:33 E1 confirmed they would be sheltering in place. E1 officer recalled most communications between the crews were being done face-to-face because there was a lot of radio traffic, and the wind was extremely loud. E1 crew decided to shelter in place at the Kaunoa Senior Center parking lot–they ended up facing E6 (E1 and E6 were nose-to-nose in front of the two (2) parking lots in front of Kaunoa Senior Center, and Mini1 was parked in the parking lot next to the Kaunoa Senior Center.). Visibility was poor and getting worse, E1 crew recalled “there were moments where it was blacked out like midnight... It was so dark, you couldn’t even see flame.” E1 crew recalls cell phones and mobile maps were not working. They tried to use street maps to locate an alternate egress. E1 crew prepped the turrets and hoselines and prepared for direct flame impingement. E1 crew pulled 1.5" handline, but it was so hot the line burst (double jacketed hose). E1 crew decided to shelter inside E1. The house in front of E6 started deteriorating (this was the house E1 initially tried to attack), and the Kaunoa Senior Center quickly caught fire and had a large fuel load. This increased the heat E1 was taking. E1 crew recalled that the interior of the engine cabin became “as hot as an oven” so they retreated to the exterior. E1 crew laid on the ground on the leeward side of E1 (E1 was facing south on Pauoa Street, so the pump panel was on the east/mauka side). E1 officer recalled making numerous attempts to call for assistance over the radio, but transmissions were not going through. 17:02 Central reported that E6 called a mayday, and the emergency alert button on a portable radio had been activated. Neither central nor Command (BC5) could get through to E6 crew. 17:04 Command (BC5) called E1 over the radio multiple times without a response. E1 firefighter recalled seeing one (1) member of E6 outside of their apparatus. He was not wearing an SCBA and seemed disoriented. E6 crew member sat down by a curb and would not respond to E1 crew members. E1 firefighter grabbed disoriented E6 member, and they rejoined the rest of E1

TIMELINE OF EVENTS

Date/Time	MFD Resource Assignment: Engine 1 (E1)
14:00–16:00	was “laying down pretty good.” En route to the fire, E1 crew encountered electrical workers conducting repairs near Hwy-30 and Hōkiokio, and they saw MPD as they approached Lahainaluna Road and Mill Street. At this point, people were still evacuating Lahainaluna Road and the surrounding neighborhood. 15:57 Command (BC5) assigned E1 to Engine 6 (E6) as part of South Division (SD) on Lahainaluna Road. E1 crew recalled seeing E6 fighting a structure fire near the corner of Lahainaluna Road and Pauoa Street. E6 and E1 officer had face-to-face conversation. E6 officer tasked E1 with traveling up Pauoa to Paunau to see if they could make a stop further up the neighborhood. E1 crew recalled the houses in the Paunau area being heavily impacted. Visibility became greatly reduced, so they couldn’t see anything past the initial houses, and they knew further up was a loss. E1 crew recalled there were many vehicles trying to turn from Paunau onto Lahainaluna Road. E1 crew recalled pulling a 1.75" handline to mount a fire attack for one of the houses on fire.
16:00–18:00	16:11 Central advises that MECO* has reported that power is shut off. 16:17 E6 (SD) EMERGENCY TRAFFIC all units assigned to SD were told to evacuate their positions to allow private vehicles to egress. 16:26 E1 reported they have not been able to evacuate the neighborhood. E1 crew recalled they tried to exit at Paunau and Lahainaluna Road, but traffic was backed up. They turned around, which took a lot of time due to the narrow roads and parked vehicles (unoccupied). Occupied vehicles attempting to evacuate were backed up on both Paunau and Lahainaluna Road. E1 officer tried to direct traffic to get more vehicles out. 16:27 Command (BC5) reported that SD units would have to fall back to Hwy-30 from the bottom of Paunau. 16:32 E6 reported that SD was going to anchor and shelter in place along Paunau because upper and lower Paunau were both blocked at Lahainaluna Road.

Red text: Indicates that the power supply is cut off.
**Now known as Hawaiian Electric.*

Date/Time	MFD Resource Assignment: Engine 1 (E1)
16:00–18:00	16:33 E1 confirmed they would be sheltering in place. E1 officer recalled most communications between the crews were being done face-to-face because there was a lot of radio traffic, and the wind was extremely loud. E1 crew decided to shelter in place at the Kaunoa Senior Center parking lot–they ended up facing E6 (E1 and E6 were nose-to-nose in front of the two (2) parking lots in front of Kaunoa Senior Center, and Mini1 was parked in the parking lot next to the Kaunoa Senior Center.). Visibility was poor and getting worse, E1 crew recalled “there were moments where it was blacked out like midnight... It was so dark, you couldn’t even see flame.” E1 crew recalls cell phones and mobile maps were not working. They tried to use street maps to locate an alternate egress. E1 crew prepped the turrets and hoselines and prepared for direct flame impingement. E1 crew pulled 1.5" handline, but it was so hot the line burst (double jacketed hose). E1 crew decided to shelter inside E1. The house in front of E6 started deteriorating (this was the house E1 initially tried to attack), and the Kaunoa Senior Center quickly caught fire and had a large fuel load. This increased the heat E1 was taking. E1 crew recalled that the interior of the engine cabin became “as hot as an oven” so they retreated to the exterior. E1 crew laid on the ground on the leeward side of E1 (E1 was facing south on Pauoa Street, so the pump panel was on the east/mauka side). E1 officer recalled making numerous attempts to call for assistance over the radio, but transmissions were not going through. 17:02 Central reported that E6 called a mayday, and the emergency alert button on a portable radio had been activated. Neither central nor Command (BC5) could get through to E6 crew. 17:04 Command (BC5) called E1 over the radio multiple times without a response. E1 firefighter recalled seeing one (1) member of E6 outside of their apparatus. He was not wearing an SCBA and seemed disoriented. E6 crew member sat down by a curb and would not respond to E1 crew members. E1 firefighter grabbed disoriented E6 member, and they rejoined the rest of E1

Date/Time	MFD Resource Assignment: Engine 1 (E1)
16:00–18:00	sheltering in place. E1 crew recalled an MPD SUV suddenly pulling up next to them being driven by a member of E6. Disoriented E6 crew member collapsed before making it inside the SUV. The seven (7) crew members from E1 and E6 loaded the unresponsive member and themselves into the SUV (three (3) in front, three (3) in back, and two (2) in the hatch area) They had to remove their SCBA in order to fit. E1 crew did not recall the evacuation route, but they did recall E1 was not on fire when they left; it was still intact. E1 crew recalled encountering heavy heat and smoke down the highway all the way. The highway was backed up traveling north, so they took the oncoming lane (there were no cars in those lanes). The smoke cleared up near Shaw Street. That's where they stopped, removed the unresponsive crew member, and started CPR. 17:11 Central reported CPR in progress at Shaw and the highway. Central reported medics were on scene at 17:22. Medic unit transported unresponsive E6 crew member to the hospital.
18:00–20:00	18:05 E1 officer advised four (4) members from E1 and three (3) remaining members of E6 will be operating out of Mini1 using the designator E1. E1 was out of service due to fire damage and was abandoned on Pauoa Street. The rest of the chronology for E1 falls under Mini1.
20:00–22:00	[redacted]
22:00–00:00	
August 9, 2023	
00:00–02:00	
02:00–04:00	
04:00–06:00	
06:00–08:00	
08:00–10:00	
10:00–12:00	

Table 4.3.2.12 Maui Fire Department (MFD) Incident Management Assignments for Mini 1 on August 8, 2023, and August 9, 2023.

Date/Time	MFD Resource Assignment: Mini 1
August 8, 2023	[redacted]
06:00–08:00	
08:00–10:00	
10:00–12:00	
12:00 -14:00	
14:00–16:00	15:34 Battalion Chief 3 (BC3) told Central to send Engine 1 (E1) to the Lahainaluna Road fire. E1 and Mini1 (split crew with two (2) E1 members in E1 and two (2) E1 members in Mini1). Mini1 followed E1 to Lahainaluna Road and Pauoa Street. E1 officer and Engine 6 (E6) officer had a face-to-face conversation. Crew recalled E1 and Mini1 went up Pauoa and Paunau, but fire conditions were too severe, and both units had to turn around. Mini1 crew recalled deploying a hoseline off E1 to attack a house on fire on the corner of Pauoa (possibly 7[redacted] Pauoa) that was not yet fully involved. Almost immediately after pulling the hoseline, an evacuation order was issued by E6. Mini1 crew recalled that at least four (4) houses on Pauoa and one (1) house on Pauwala Place were all on fire, but the smoke made it very difficult to see where exactly the fire was. Mini1 crew recalled experiencing "rolling blackouts due to heavy smoke." Mini1 crew recalled E1 and Mini1 trying to return to Lahainaluna Road via Pauoa, but it was blocked by cars trying to exit onto Lahainaluna Road.
16:00–18:00	16:11 Central advises that MECO* has reported that power is shut off. 16:47 E6 reported they were unsure if they would be able to hold their position, and they were in need of assistance. Around this time, E6 crew member recalled exiting the cab of E6 to retrieve extra cylinders from exterior compartments of E6, and he noted that one (1) compartment door had melted shut. He retrieved as many cylinders as he could and put them in the interior of E6.

Red text: Indicates that the power supply is cut off.
**Now known as Hawaiian Electric.*

TIMELINE OF EVENTS

Date/Time	MFD Resource Assignment: Mini 1
16:00–18:00	The crew was not communicating in an effort to conserve air. Another E6 crew member saw Mini1 in the parking lot of the Kaunoa Senior Center, and he exited E6 to go check for air cylinders. When he approached Mini1 he realized it was operable. E6 firefighter was able to drive over a curb, in between E1 and E6. He tried honking the horn to get the crew's attention, but did not get a response. There was also limited visibility due to smoke. He knew Lahainaluna was blocked so he went around the traffic by driving over a concrete barrier, over downed power lines, over a short rock wall, through debris, and through the yard of the HECO* substation to make it to Hwy-30. Mini1 operator stated that he made several attempts to call a mayday via radio but was unsure if transmissions were being received. 17:02 Central advised Command (BC5) that E6 was calling a mayday on the emergency channel and that the portable radio emergency alert button had been activated. Despite multiple attempts, Command (BC5) was unable to contact E6. Mini1 operator (E6 firefighter) recalled encountering heavy traffic along Hwy-30 to Shaw Street. He encountered a police officer directing traffic at the Hwy and Shaw Street where smoke conditions and visibility were better. He recalled removing his SCBA and called another mayday. He told the MPD officer multiple MFD crews were in trouble, and Mini1 was compromised (It had power lines, debris, and a shopping cart wrapped around the axles and wheel wells.). MPD officer advised Mini1 operator/E6 FF to take the MPD SUV. Mini1 operator took the MPD SUV and returned along the same route back to retrieve E1 and E6 crew members. Mini1 operator/E6 FF recalled the visibility was so poor he could not tell where the flames were or what structures were on fire. He found his way back to the substation yard, went over the rock wall and concrete barriers, and pulled up beside E1 and E6. All eight (8) crew members, including an unresponsive member of E6, were loaded into the MPD SUV (after removing MPD equipment and their own SCBAs), and Mini1 operator/E6 FF took the same route in little to zero visibility back to Shaw Street and the highway. The crew unloaded the unresponsive member of E6 and began CPR. 17:11 Command (BC5) reported CPR in progress at the intersection of Shaw Street and the highway.

Date/Time	MFD Resource Assignment: Mini 1
16:00–18:00	17:22 Medics were reported to be on scene, and they transported an unresponsive E6 member to the hospital. E1 and E6 (with assistance from an off-duty firefighter sitting in traffic) were able to free the debris impeding Mini1.
18:00–20:00	Mini1 became E1 Designator (For the purpose of tracking resource type accurately within this document, E1/Mini1 designator is used to denote E1 crew on Mini1 apparatus.). 18:05 E1 officer advised four (4) members from E1 and three (3) remaining members of E6 would be operating out of Mini1 using the designator E1. E1/Mini1 (E1 and E6 crew) recalled turning into a neighborhood to fill the tank of E1/Mini1 (400 gallon capacity[94]). 18:12 RE11 requested assistance from E1/Mini1 along Kupuohi Street. E1/Mini1 met RE11 near the Minit Stop at 10 Kupuohi Street. E1/Mini1 crew recalled using the redline to extinguish spot fires within the industrial park. E1/Mini1 refilled their tank (Water pressure was still good.) and pulled the redline around the back of the buildings north of Kahoma Stream. 18:15 E1/Mini1 requested additional personnel, 2.5" hose, 1.5" hose, and full SCBA cylinders. E1/Mini1 crew recalled traveling into Emerald Plaza where water supply was limited. E1/Mini1 crew saw multiple spot fires and vehicle fires as they looped around Kupuohi Street and Ulupono Street. Due to limited water they were not able to engage in structural firefighting. They were able to refill the tank of E1/Mini1 "a few times," but the water pressure was very low and slow. E1/Mini1 crew recalled RE11 operating in and around the same area. While operating in the Emerald Plaza area during this time, E1/Mini1 crew recalled seeing fires on the roof of some of the buildings, but none were fully engulfed. Visibility in this area was clear. The crew recalled the winds were still blowing in a westerly (makai) direction and were still very strong and steady with severe gusts that made it hard to stand.

[94] https://skeeteremergencyvehicles.com/maui-co-fire-rescue/

TIMELINE OF EVENTS

Date/Time	MFD Resource Assignment: Mini 1
20:00–22:00	20:10 Command (BC5) requested the location of E1/Mini1. E1/Mini1 reported they were in Emerald Plaza. E1/Mini1 advised that the hydrants were down in that area. Command (BC5) reported that he would come to the location to pick up remaining E6 crew members and redistribute them. The three (3) members of E6 crew were picked up by F2 and transferred to a BC SUV, while E1 (crew of four (4)) remained in Mini1. 20:29 E1/Mini1 reported staging at the bottom of Kupuohi (at the intersection of Keawe and Oil Road). E1/Mini1 crew recalled that Relief Engine 1 (RE1) was in staging with them, and they saw private tankers (three (3) or four (4)) wetting down the area along Oil Road (20:37). 20:53 E1/Mini1 was assigned to the Support Group to assist Utility 3 (U3) with evacuating civilians being evacuated on foot from Front Street. U3 advised the best access point was Waine'e Street and Kenui Street. E1/Mini1 operator recalled assisting with loading multiple evacuees onto E1/Mini1 and transporting them to the Lahaina Civic Center. Three (3) E1/Mini1 crew members staged at Fire Station 3 (FS3) to make room for more evacuees. E1/Mini1 operator made multiple trips in E1/Mini1 to transfer evacuees from the area of Front Street/Waine'e & Kenui to the Civic Center. 21:01 Command (BC5) reported a dozen people at Bubba Gump needing transport to the Civic Center. E1/Mini1 operator made multiple trips to assist with evacuations off of Kenui Road. 21:46 BC4 to Dispatch: BC4 was assuming Lahaina Command, and BC2 was 911. 21:53 E1/Mini1 crew reported that medics were abandoning their station near the Civic Center and were heading to the old train station. 21:55 E1/Mini1 asked Command (BC4) if the Civic Center was being evacuated. Command (BC4) could not confirm. 21:58 E1/Mini1 reported a resident was told by the Red Cross that everyone was evacuating north. Fire 4 confirmed that the shelter was being moved from the Lahaina Civic Center to Maui Prep Academy.

Date/Time	MFD Resource Assignment: Mini 1
20:00–22:00	The E1/Mini1 crew members that staged at FS3 relocated to Lahaina Civic Center to assist with loading evacuees into buses for transfer to Maui Prep.
22:00–00:00	22:09 E1/Mini1 operator was called back to meet up with all Support Group units at the Lahaina Civic Center to assist with shuttling evacuees to Maui Prep. 22:45 Once all evacuees were transferred to Maui Prep, units from the Support Group convened at FS3 and had face-to-face communication. E1/Mini1 crew reunited and attempted to suppress fires impacting utility poles, fences, and sheds along Hwy-30 toward Kapunakea using the red line from within the cab. E1/Mini1 crew was able to refill tanks at Canoe Beach, since it still had good water pressure. 23:24 E1/Mini1 was assigned to assist with evacuating the Wahikuli area with E6 and U3. U3 was stuck south of Fleming Road due to obstructions on roadways. E1/Mini1 reported they would drop off three (3) personnel to make room for evacuees and were assigned to start at Malo Street and work east (mauka). E6 was assigned to start at the upper roads near Aa Street. E1/Mini1 operator recalled driving through the neighborhood with sirens and knocking on doors. E1/Mini1 operator reported the wind had died down and the smoke was "going straight up," not "lying down," as it had been before. E1/Mini1 operator recalled the fire on the south side of Wahikuli Road started getting more intense. 23:27 Command (BC4) advised the fire was moving very rapidly toward the north, and the Support Group should consider pulling crews out to find safe refuge. 23:29 All Support Group units (including E1/Mini1) were advised to make last security checks as they pulled back north to stage at Halelo Street in Kā'anapali (other units were already in the area preparing to make a stand). 23:34 Command (BC4) ordered all units to abandon FS3 and to immediately stage at Hwy-30 (north of FS3).

TIMELINE OF EVENTS

Date/Time	MFD Resource Assignment: Mini 1
August 9, 2023 00:00–02:00	00:20 An MFD officer called E1/Mini1 operator and advised the fire was at Malanai Street, so E1/Mini1 was advised to leave the area immediately. E1/Mini1 advised there were a couple of streets left as E1/Mini1 made egress. 01:11 E1/Mini1 was reassigned to the Support Group and was assigned to head back to the Leialiʻi area to make checks of the Hawaiian Homes neighborhood. E1/Mini1 reported they would start close to the fire and work away from it, making checks. E1/Mini1 recalled seeing 3–4 other engines making fire stops along ʻAipuni and Hanohano Street. E1/Mini1 crew recalled the wind was not as strong as earlier, but fire was still spreading from house to house. E1/Mini1 crew recalled houses on ʻAipuni and ʻAinakea Road were starting to catch. E1/Mini1 pulled hoselines and hit what fires they could. 01:21 Central received a call from Coast Guard Honolulu reporting there were 50 people requiring evacuation near the Waikiki Brewing Company. E1/Mini1 reported they would drop off personnel and E1/Mini1 operator would head toward Kenui to assist with transfer of individuals. 01:24 Support requested E1/Mini1 crew in Mini1 to extinguish a telephone pole on fire near the old Five Palms/Chart House restaurant and a pallet on fire next to the Safeway. 01:40 E1/Mini1 crew in E1/Mini1 reported they were unable to address the pallet fire and they were heading to drop off personnel to help with transport of civilians. Support copied and reported there were about 40 more near shore who would be walked out to a collection point in Longs parking lot. 01:53 E1/Mini1 operator reported staging along Kapunakea Street. E1/Mini1 was requested at Kapunakea Street and Front Street, where approximately 60 people needed to be transferred to the post office collection point where buses were being used to transfer people to Maui Prep.
02:00–04:00	02:58 Command (BC4) advised Canoe Beach would be the next collection point due to numerous road closures due to debris, poles, and power lines. E1/Mini1 was directed to transport additional civilians from Longs to Canoe Beach.

Date/Time	MFD Resource Assignment: Mini 1
02:00–04:00	03:17 E1/Mini1 operator reported picking up the rest of the crew from the Lahaina police station and going to assess a Matson container fire in close proximity to the Safeway.
04:00–06:00	04:22 E1/Mini1crew assigned to extinguish pole fires from Kapunakea to Fleming Road to preserve road access. 04:28 E1/Mini1 crew assigned to respond to a fire at Ala Moana Street. E1/Mini1 responded to Ala Moana to provide exposure protection. E1/Mini1 tank refilled and Support Group assigned E1/Mini1 to Leialiʻi Parkway to assess a brush fire above the post office. 05:42 E1/Mini1 reported they were going to refill their tank and then return to Leialiʻi Parkway where fire was progressing. E1/Mini1 crew recalled driving around ʻAipuni into the cul-de-sac. E1/Mini1 pulled a handline between houses and extinguished hot spots in the backyard that backed up to the houses on Kaniau Road (most of the houses on Kaniau Road had burned and were smoldering). E1/Mini1 recalled the wind had let up but it was still blowing in the same direction, toward the west (makai).
06:00–08:00	06:25 Support Group reported that Hawaiian Homes area was looking good, and E1/Mini1 and T3 could be reassigned. 06:35 E1/Mini1 reassigned to South Division (SD) and was advised to stage at an access road near Hōkiokio Place and the Bypass to prepare to engage. E1/Mini1 recalled meeting up with a relief engine near Kai Hele Kū Street and Haniu Street. The crews pulled a 1.5" line off the engine and the red line off E1/Mini1 to stop the fire's progression toward the Launiupoko subdivision. At this time, Air 1 was able to fly and make water drops, and a private dozer was also working to construct a fire line.
08:00–10:00	~08:30 E1 C-Watch crew arrived in a lifeguard vehicle and relieved E1 A-Watch crew on scene at Kai Hele Kū Street.

Date/Time	MFD Resource Assignment: Mini 1
08:00–10:00	Three (3) A-Watch crew members returned to Fire Station 1 (FS1) in the lifeguard vehicle, and one (1) A-Watch member remained. En route back to FS1, the crew stopped at E1 and saw that it had been destroyed.
10:00–12:00	

Table 4.3.2.13 MFD Incident Management Assignments for Relief Engine 1 (RE1) on August 8, 2023, and August 9, 2023.

Date/Time	MFD Resource Assignment: Relief Engine 1 (RE1)
August 8, 2023	
06:00–08:00	
08:00–10:00	
10:00–12:00	
12:00–14:00	
14:00–16:00	RE1 was staffed by a callback crew of four (4). Personnel met at Fire Station 10 (FS10) and prepared RE1 for service. 15:58 RE1 reported they were near Olowalu and were available for assignment. Command (BC5) instructed RE1 to respond to Lahainaluna Road from below and assigned them to South Division (SD) under Engine 6 (E6). 16:00 E6 advised RE1 to come up Lahainaluna Road from Hwy-30. E6 advised MECO* had barricaded the road at that intersection but were allowing emergency vehicles to pass.
16:00–18:00	16:08 RE1 advised they were coming up Lahainaluna Road and were encountering heavy smoke.

Date/Time	MFD Resource Assignment: Relief Engine 1 (RE1)
16:00–18:00	RE1 crew recalled that, as they traveled up Lahainaluna Road, the road was heavily congested with cars trying to travel down Lahainaluna Road. RE1 crew recalled MPD trying to direct traffic off of Lahainaluna Road at Hwy-30. As they traveled through the neighborhood, they saw lines of cars from each of the side streets trying to exit onto Lahainaluna Road. They noticed multiple sporadic fires (e.g., a car, shed, tree). The visibility was still okay, and nothing had been fully engulfed, but they could see the fire spreading. They were not yet aware of the severity of the wind. RE1 crew recalled they pulled in behind E6 (Engine 1 (E1) was in front of E6) on Pauoa Street. RE1 officer and E6 officer had a face-to-face discussion. RE1 crew recalled being told to deploy lines. The crew deployed two (2) 150' 1.75" preconnect handlines. As they were operating outside the vehicle, they experienced the strong wind, with one (1) member being blown over onto the ground. RE1 crew recalled visibility went from mostly clear to barely visible within minutes. Gusts of wind decreased visibility to zero. RE1 crew recalled houses on the north side of Lahainaluna Road starting to quickly ignite due to extension from a 40' shipping container that was on fire. RE1 crew saw a vehicle drive into the container on fire due to lack of visibility. Cars stacked behind the crash and no one would reverse, so no one could get out. RE1 crew recalled the road had become completely blocked. RE1 had flames 20–30' blowing over their area. RE1 officer instructed the crew to cut and abandon the hoselines. 16:11 Central advised that MECO* reported that power was shut off. 16:20 RE1 advised E6 they had to evacuate and that Lahainaluna Road was blocked by a structure collapse across the road. RE1 advised they were trying to make their way out. E6, E1, and Mini1 abandoned their positions to try to find egress off Pauoa with RE1 following.

Red text: Indicates that the power supply is cut off.

**Now known as Hawaiian Electric.*

TIMELINE OF EVENTS

Date/Time	MFD Resource Assignment: Relief Engine 1 (RE1)
16:00–18:00	E6 made it to the top of Paunau but advised it was impassable. RE1 reversed and went back the way they came (with E6 behind them). RE1 passed Wildland 6 (WL6), which had pulled off onto a side road, and saw a pole down and wires covering the vehicle. Everyone in RE1 had donned their SCBA (the operator had to take it off at times to try to see anything outside the windshield). RE1 was attempting to find egress at the end of the cul-de-sac off Paunau Street. RE1 crew recalled seeing a victim that had perished in the roadway. 16:27 Command (BC5) advised all SD units to egress at the bottom of Paunau and fall back to Hwy-30, which would be used as a cut-off point. 16:31 RE1 asked E1 for assistance with egress and advised they were taking heat. RE1 turned around in the Kaunoa Senior Center parking lot and did a face-to-face with E1. E1 stated they were going to shelter in place. 16:32 Command (BC5) ordered all units to evacuate Lahainaluna subdivision and establish cut-off points on the Nāpili side of Kahoma Stream. They assigned SD to establish a cut-off along Hwy-30. SD reported they were going to anchor and shelter in place. RE1 left Pauoa Street to find an alternate location to shelter in place. RE1 decided to shelter in Paunau Park. RE1 crew recalled the interior of RE1 got so hot the windows started to crack. The crew was wearing their brush gear with SCBAs within the cab. When there was a moment where the wind decreased, RE1 crew exited the cab. RE1 crew members used the rig's redline to provide protection from several fully engulfed homes, using approximately half a tank of water. RE1 operator looked at his phone, which had lost service, but he was able to pull up a map and saw that Dickenson Street bordered an open area of land. RE1 crew returned to the cab. They had difficulty reversing the rig due to the conditions and poor visibility. One (1) member received a burn to his forehead when trying to look

Date/Time	MFD Resource Assignment: Relief Engine 1 (RE1)
16:00–18:00	out the closed window to help guide RE1 driver. RE1 crew reversed down Pauwala Place, impacting mailboxes, a hydrant, and other debris. The gate on Paunau was not locked, so they were able to cross over Dickenson into the dirt field. 16:35 RE1 called to E6 to follow their directions to an open spot behind them. RE1 called to Command (BC5) but communications were cut off. RE1 crew recalled they got out of the cab in the field, and the wind continued to intensify. RE1 crew member recalled the wind was so strong they had to wait for a lull to open the engine doors and exit the apparatus. The crew exited the super-heated cab and took shelter behind the rig, which was in the open field facing east/mauka. They recalled the wind coming down the mountain and over the engine "sounded like a jet engine." At this point they were still in the wind path, but they were out of the path of the fire and smoke, which was blowing horizontally at ground level. 17:26 RE1 crew advised they had all personnel accounted for, and they were in a safe location in a dirt field by Dickenson and Paunau. 17:43 RE1 reported they were trying to make egress out of the rocky field. RE1 crew recalled they continued up the field, trying to access utility paths, heading east (mauka) to the Bypass. RE1 crew had to use hand tools to clear the path so RE1 could pass at some points. 17:54 RE1 advised Command (BC5) they had made it onto the Bypass and were ready for assignment. Command (BC5) assigned RE1 to make their way down to Front Street to assess the conditions and provide structural protection.
18:00–20:00	18:08 RE1 reported to Command (BC5) while they were refilling their tank at Cannery mall that their unit had developed a major air leak in the braking system, and they needed fresh SCBA cylinders. 18:18 RE1 crew advised they were able to refill and replenish supplies. They reported the air leak was not resolved but the the apparatus was still operable (maintaining <90 psi), and

TIMELINE OF EVENTS

Date/Time	MFD Resource Assignment: Relief Engine 1 (RE1)
18:00–20:00	they were ready for assignment. Command (BC5) assigned RE1 to check the status of the apartment building by Tamuras near Kupuohi Street and Ulupono Street in the Emerald Plaza area. 18:37 RE1 reported there were heavy smoke conditions in that location. RE1 crew recalled extinguishing hot spots and vehicle fires in the area being caused by the ember cast. RE1 encountered a unit fully engulfed at 95 Kupuohi Street that had been impacted by fire crossing Kahoma Stream. RE1 hooked to a hydrant, which had good water pressure, and used a 2.5" handline to spray water into the blown-out windows of the buildings, but their stream was ineffective. Ladder 3 (L3) arrived and began hitting it with their master stream. 19:05 RE1 reported to Command (BC5) that they were able to put the fire out. RE1 advised the structures next to Island Grocery and the buildings across Kahoma Stream had been fully impacted. 19:23 E11 was dispatched to assist RE1 by Island Grocery. RE1 deployed a ground monitor directed at Emerald Plaza A and B.
20:00–22:00	20:10 RE1 advised they relocated to refill at Cannery Mall, and they left L3 who would be picking up. After refilling the tank, RE1 went to stage at Oil Road and Keawe Road due to reports that the fire had jumped Keawe and was burning north behind the construction site and impinging on the Wahikuli neighborhood. 21:05 RE1 was assigned to report to the top of Fleming Road and Oil Road to monitor and stop the fire from jumping west (makai). As the fire started to encroach on the location, RE1 began making evacuations along with MPD, Tanker 3 (T3), and other unknown apparatus. RE1 crew recalled seeing people evacuate by car, bicycle, and on foot. RE1 crew split from T3. RE1 staged at ‘Ainakea Road and Fleming Road and recalled seeing multiple structures burning in the cul-de-sac of Akeke Place.

Date/Time	MFD Resource Assignment: Relief Engine 1 (RE1)
20:00–22:00	21:25 Structure group advised there was a fast-moving fire coming down Akeke Place off Kahoma. 21:28 RE1 relayed to Structure Group that the fire was moving fast and impacting structures east (mauka) on Kahoma Street. Structure Group advised RE1 to not engage. RE1 relayed they were making their way down the tracks. 21:33 RE1 advised they met up with MPD units and evacuated Kahoma Street. 21:39 RE1 reported to the Support Group that Kahoma Street was heavily impacted and they had to abandon their position. Structure Group assigned RE1 to relocate to Fleming Road. A privately owned vehicle (POV) approached RE1 and stated that an individual needed to be rescued. 21:43 RE1 reported an unresponsive person at 1[redacted] Pahalo (later corrected to 1[redacted] Malolo). RE1 crew responded and noted that many of the houses along Kahoma Street had been impacted and the fire was quickly moving from structure-to-structure. The hydrants in the area were dry, so they had no water supply. They encountered a male with an altered mental state who became combative when they tried to remove him from the home. RE1 requested MPD assistance. A medic unit arrived on scene, and RE1 officer had a face-to-face conversation with the medic. 21:46 BC4 to Dispatch: BC4 was assuming Lahaina Command, and BC2 was 911.
22:00–00:00	22:05 RE1 continued evacuating the area and reported another resident refusing to leave at 1[redacted] Wahikuli Road. Relief Engine 14 (RE14) was instructed to evacuate whomever they could and retreat out to Hwy-30. 22:47 RE1 and all Structure Group units were called to regroup at Fire Station 3 (FS3) to refuel and rehab. Chiefs and officers were in the station actively planning next steps.

Date/Time	MFD Resource Assignment: Relief Engine 1 (RE1)
August 9, 2023	00:25 Command (BC4) assigned Structure Group to head north to the neighborhoods in Kā‘anapali, where RE14 had scouted out, and prepare to make the next stand.
00:00–02:00	RE1 crew recalled apparatus establishing defensive positions in the cul-de-sacs throughout the neighborhood in preparation of fire impingement. RE1 crew recalled units staged there until sometime around dawn.
02:00–04:00	
04:00–06:00	05:02 RE1 was reassigned to Leiali‘i Parkway to perform structural triage. RE1 crew recalled spending the morning extinguishing fires and hot spots in and around the structures along ‘Aipuni Street in the Hawaiian Homes area. RE1 used Canoe Beach hydrant since it was the only functioning one.
06:00–08:00	Once the situation seemed to be under control, RE1 refueled at FS3, then drove it back to FS10 where an oncoming crew was waiting to relieve them.

Table 4.3.2.14 MFD Incident Management Assignments for Utility 3 (U3) on August 8, 2023, and August 9, 2023.

Date/Time	MFD Resource: Utility 3 (U3)
August 8, 2023	
06:00–08:00	
08:00–10:00	
10:00–12:00	
12:00–14:00	U3 officer received emergency callback notification. He called Battalion Chief 4 (BC4) (couldn’t reach him), contacted BC-FSO while en route to Fire Station 3 (FS3), and requested where the Command post was. BC-FSO advised he was not sure, but Battalion Chief 5 (BC5) was the Incident Commander (IC).
14:00–16:00	
16:00–18:00	When U3 officer arrived at FS3, he ran into an MFD employee who was experiencing mechanical issues with the light and air truck.
16:00–18:00	U3 officer loaded U3 with approximately 15 spare SCBA cylinders, spare portable radios, and a cooler full of water. U3 officer heads into Lahaina via Hwy-30 towards the fire to search for the IC. He recalled heavy winds and numerous downed poles along the way.
18:00–20:00	18:08 Relief Engine 1 (RE1) reported to Command (BC5) they were refilling their tank at Cannery mall, their unit had developed a major air leak in the braking system, and they needed fresh SCBA cylinders. U3 officer crossed into the Safeway parking lot and came across RE1. He provided them with fresh SCBA cylinders and water. They did not have a clear assignment and were unsure where the Command post was. U3 officer continued to Keawe (Tanker 3 (T3) was filling at the corner) and came to the Komo Mai Street intersection where he had a face-to-face exchange with an MFD member who advised that crews were working in the area of Emerald Plaza. U3 officer continued up Keawe, passed the Bypass and made access to Lahainaluna Road, where he encountered thick black smoke. MPD were already at that location, and he had a brief face-to-face exchange. U3 officer proceeded to try to make it into the town, but access was blocked. He had to back out and turn around. He continued along the Bypass to Hōkiokio Place to Hwy-30, all the way to Shaw Street. He took Shaw Street to Front Street where he was approached by civilians–one (1) was badly burned, and a couple of others were ambulatory and non-critical. 18:39 U3 officer reported he was on Front Street and Shaw trying to get transport for the patients. Command (BC5) advised him to transport the individuals. U3 Officer transported patients to Medic 4’s location.* U3 Officer recalled trying to make access back down Hwy-30 when he encountered U3B and had a face-to-face exchange. U3 provided U3B with a portable radio and two (2) members (riding with six (6), now four (4)) joined U3 officer to establish a crew of three (3).

**Not disclosed in the dispatch record.*

TIMELINE OF EVENTS

Date/Time	MFD Resource: Utility 3 (U3)
18:00–20:00	18:42 U3B reported they have rescued the trapped parties in a van by Territorial Savings Bank, and U3 officer assisted in shuttling people to the Cannery Mall collection point for transfer to the Civic Center shelter. 18:51 U3B reported that they had removed all parties reported trapped at the Territorial Savings Bank and The Coffee Bean. 18:51 U3 officer advised Command (BC5) that he had just come from the area of 505 Front Street, and that was probably the last defensible space, everything else was on fire or was being impacted by heavy smoke. He advised he would be hesitant to commit crews past that location. Command (BC5) copied. U3 officer recalled seeing Relief Engine 11 (RE11) firefighter backing apparatus into a space, fighting a propane fire. He offered them water and SCBA cylinders, but they did not have SCBA packs. 19:18 U3 advised that access for the Ipu Aumakua housing area was beginning to be blocked off and he had hundreds of cars parked there with people walking around. U3 asked Command (BC5) if they should start evacuating. Command (BC5) affirmed. U3 requested MPD assistance. U3 officer began evacuation of all buildings. All individuals had POVs for egress. 19:21 Central advised that MPD were unable to access Ipu Aumakua and U3 advised they were already at the location and concerned they may be trapped. U3 officer scouted a gravel road through the park he could use to egress people out. He did not have to use the access road because MPD was ultimately able to make access to the area to assist with traffic evacuation, and U3 was able to egress. U3 officer saw three (3) males walking towards the fire towards Front Street. U3 officer picked them up and dropped them off out of the smoke and returned to Lahaina town.

Date/Time	MFD Resource: Utility 3 (U3)
18:00–20:00	19:25 Central reported there were two (2) parties trapped in Aina Nalu, and RE11 responded but reported they had no access to Aina Nalu. Command (BC5) advised dispatch to instruct parties to shelter in place.U3 crew heard RE11 was unable to make access to the area, so they responded. U3 officer recalled that they traveled down Shaw and went down multiple cross streets that were blocked by poles and hanging wires (i.e., Waine‘e Street, Luakini, and Prison). The U3 crew continued to the back side of the condos and forced entry into the gate. All buildings were fully involved except for the building west (mauka) along Hwy-30. In the back of the buildings, they found two (2) women sheltering in the pool. 19:38 U3 advised they gained access into Aina Nalu and found two (2) people that they were bringing out. They headed to Hōkiokio Place and encountered the three (3) males again walking towards town. U3 officer instructed them to get in the back of the vehicle. U3 went to the police barricade north of Hōkiokio Place and dropped the three (3) males off past the police barricade so they would not wander back into the fire. They then took the two (2) females to Medic 4 station. U3 firefighter began driving for U3 officer.
20:00–22:00	20:53 Ladder 3 (L3) advised they had a civilian requiring transfer from Emerald Plaza. 20:07 Command (BC5) advised U3 to go to L3 and pick up the civilians needing transport and then communicated with two (2) private tankers operating in Emerald Plaza, who had no radios, to work on the area north of the Bypass. 20:23 U3 reported that their assignment was complete and suggested starting evacuation of the Wahikuli neighborhood. 20:29 Central advised an elderly couple needed rescue from Front Street and Papalaua Street.

TIMELINE OF EVENTS

Date/Time	MFD Resource: Utility 3 (U3)
20:00–22:00	U3 responded to the call for the two (2) trapped elderly patients on Front Street. They went back down Hwy-30, cutting across Safeway. Smoke was impacting structures north of Keawe, but no active flames were seen. They took Kenui where they recalled seeing multiple structures involved, not continuous, all in different stages of burning. They encountered multiple lines down along Waine'e Street and Front Street–between Kenui and Baker–and the road was blocked by flames. The crew parked U3 at Waine'e Street and Kenui. U3 officer and U3 FF proceeded to walk down Waine'e Street while U3 operator remained with U3 awaiting transfer of patients. U3 officer and U3 FF walked along Waine'e Street to find them. They found over a dozen people taking shelter in a parking garage–some were cooperative and some were combative. All were ambulatory and uninjured. The parties were told to continue to shelter in place as they made their way to the sea wall. As they continued to make their way along Papalaua Street, U3 FF recalled there were so many burning buildings that "it was the middle of the night, and it was very bright." He recalled the buildings along Papalaua Street were starting to ignite, but Banana Republic had not been impacted yet. U3 crew were searching for people, shouting, "Fire Department!" along the way. U3 FF saw a hand emerge from the sea wall near Waikiki Brewing, and then people began to emerge–some were ambulatory and some were not. U3 FF recalled seeing one (1) fatality along the wall. U3 FF walked about a dozen people back to the parking area (carrying a three (3)-month-old baby and an elderly woman over his shoulder) and U3 officer stayed and continued to manage the rest of the people along the sea wall. At the parking garage, some people were combative and trying to break into cars. U3 FF told them they had the option to leave. 21:02 U3 officer reported they had transferred 12 to the collection point, and he had another 20 with him. U3B/Support Group advised they were responding on foot to assist. U3B officer and U3B FF responded by foot while U3B operator waited to receive parties at the collection point. U3 and U3B officers had a face-to-face exchange within the parking structure to coordinate rescues.

Date/Time	MFD Resource: Utility 3 (U3)
20:00–22:00	U3 officer and firefighter and U3B officer and firefighter returned to the sea wall where another group of approximately 25 had emerged along the sea wall. These individuals were transported to the Civic Center, passing through Kahoma Village, Front Street, and Safeway to access the Civic Center. 21:10 U3B/Support Group advised they were coming to the collection point with approximately 40 parties and had an ETA of ten (10) minutes. U3, Mini,* a BC vehicle, and U3B were waiting at Waine'e Street and Kenui to begin shuttling parties. U3 operator received the group of people and began shuttling them to the Civic Center while U3 crew stayed to effect additional rescues. U3 operator picked up three (3) additional parties along the way and then returned to the collection point awaiting the next load. U3 crew returned to the sea wall where several others had emerged, and they were guided to the collection point. U3 crew were then told there were more people trapped at Bubba Gump. U3 officer and U3 FF went to Bubba Gump and evacuated seven (7) individuals to the collection point. By the last trip, Banana Republic had caught fire (one of the last buildings standing), and the smoke was laying down. 21:38 U3B/Support Group advised they were headed to the collection point with nine (9) civilians, three (3) of them children, with a ten (10)-minute ETA. U3B operator advised Front Street was starting to get impacted; he was not sure how much longer they were going to be able to access this location. U3B/Support Group advised this was the last trip. At some point, an elderly male outside of the operational area insisted to the U3 officer that additional individuals were trapped behind Bubba Gump. U3 and U3B officers responded, and conditions had deteriorated. U3 officer recalled structures were under heavy fire on the west (makai) side of Hwy-30. U3 went back down Kapunakea Street to Front Street, through Kahoma Village to Kenui. U3 crew took the same path to the sea wall where fire had intensified. They found a wheelchair along the way and brought it along. Once near Front Street, U3 officer traveled south by foot while U3B officer and U3 FF canvased north. U3 officer

TIMELINE OF EVENTS

Date/Time	MFD Resource: Utility 3 (U3)
20:00–22:00	found seven (7) people behind Bubba Gump, including several children. He met back up with the other team who had rescued two (2) invalids, using the wheelchair to help evacuate all parties. All parties were transported to the Civic Center. 21:46 BC4 to Dispatch: BC4 was assuming Lahaina Command, and BC2 was 911. 21:58 U3 crew reported they had dropped off all parties and were staging at Medic 4's location with Engine 6 (E6, in a BC SUV) awaiting reassignment.
22:00–00:00	22:05 Command (BC4) advised that the Civic Center was being abandoned, and numerous parties needed transfer to Maui Prep. U3 responded to assist. 22:52 Comms 2/Water Supply reported parties were trapped without a car at 13[redacted] Keao Street. An unidentified unit tried to make access but was unable to. U3 responded. 23:08 U3 reported they had barely made it through Hwy-30 and were at Kapunakea, noting "it is pretty bad over here." U3 rescued three (3) individuals from Keao Street, and Comms2/Water Supply hailed them down for another patient requiring care and transport. All parties were transferred to the triage area. 23:21 U3 reported they were able to drop the parties for transfer to the shelter and were heading back to the Safeway area awaiting assignment. U3B/Support Group advised they were evacuating and searching for people in the Wahikuli neighborhood. U3 reported they would try to make access to the Wahikuli area. U3 crew recalled they made a trip to Wahikuli and rescued a man, a dog (he had been trying to defend his property), and an elderly couple and older son from Hoapili Street (north of Safeway) to the Civic Center. Then they helped to evacuate the people at the Civic Center up to Maui Prep. They returned and went back through Wahikuli and Hawaiian Homes as the fire continued to spread north, looking for evacuees and notifying parties to "Abandon

Date/Time	MFD Resource: Utility 3 (U3)
22:00–00:00	[their] homes!" They encountered numerous downed poles and heavy smoke in the neighborhood as they traveled down the side streets. They recalled another smaller MFD rig was evacuating the area as well. They made it to Aa Street and 'Aipuni where a man was sheltering in place and said he would leave on his own. They found another male with a dog and transported him to the golf course. U3 officer recalled assisting to load people at the Civic Center with U3 FF while U3 operator shuttled evacuees to Maui Prep. They are unsure of how many trips they made–it was several. 23:54 Command (BC4) disbanded Support Group and assigned U3 to head north into Kā'anapali with Relief Engine 14 (RE14) to do some scouting in preparation for the fire approaching. U3 crew recalled there was no smoke in that area.
August 9, 2023 00:00–02:00	At approximately 00:23, a decision was made to relocate apparatus throughout the Pinnacle neighborhood, the next expected neighborhood to be impacted. During that time, the wind died down, and the fire spread had seemed to slow. 01:10 U3B reported they were going to head back to Leiali'i Parkway in Hawaiian Homes to recheck the area. U3 reported that they had been assigned Summit Group leader in the Pinnacle neighborhood with L3 and RE1 reporting and they would not be able to break away. 01:21 Central advised Coast Guard Honolulu Small Boat (CGSB) was reporting 50 parties requiring rescue by Waikiki Brewing Company near 900 Front Street. Command (BC4) advised that they had affected the rescue of 40 people from that location one (1) to two (2) hours ago, they would be sending one (1) unit to recheck that location. CGSB advised visibility was low, one (1) CG member was responding to check the area via surfboard but they could see people flashing lights so they knew they were there. 01:57 U3 passed Summit Group supervision to L3 to go support rescues from the Front Street sea wall.

Date/Time	MFD Resource: Utility 3 (U3)
02:00–04:00	U3 crew recalled that the fire was well involved throughout the Wahikuli neighborhood at this point, and the Chart House was fully engulfed. They were able to take Kapunakea Street down to Front Street; the fire had died down, but poles and vehicles were still blocking the road. U3B officer had already separated the injured from the uninjured (a total of possibly 50 people) by the northern-most side of the sea wall by Pi Pizzeria (900 Front Street). U3 officer and U3 FF made trips walking groups to Kenui and Front Street, while U3 operator shuttled parties for evacuation to Maui Prep. U3 officer and U3 FF made at least four (4) trips, carrying injured, until all parties had been extricated.
04:00–06:00	U3 crew reunited and returned to check the Hawaiian Homes area. 04:53 U3 reported there was access for suppression vehicles to get into Hawaiian Homes, in and around the Civic Center, and the fire station. U3 reported that Hawaiian Homes did not have water, but there was a weak hydrant at the post office. Command (BC4) copied. 04:55 all units from Summit Group were assigned to report to Fire Station 3 (FS3) to coordinate protection of Hawaiian Homes and Civic Center. 05:54 Command (BC4) assigned U3 to return to FS3 to collect the Pumpkin Tank (water collection device used by air support to perform water drops) and scout a location where it could be set up in anticipation of helicopters being able to fly. U3 recalled setting up the Pumpkin Tank in the Summit area of Kā‘anapali Golf Estates area. U3 returned for FS3 to rehab and shift change.

Table 4.3.2.15 MFD Incident Management Assignments for Utility 3B (U3B) on August 8, 2023, and August 9, 2023.

Date/Time	Resource Assignment: Utility 3B (U3B)
August 8, 2023	
06:00–08:00	
08:00–10:00	
10:00–12:00	
12:00–14:00	
14:00–16:00	
16:00–18:00	
18:00–20:00	U3B started with a crew of five (5) at Fire Station 10 (FS10) where they were assigned a lifeguard utility pickup truck for response. No structural firefighting equipment was available. U3B crew had a police escort to Fire Station 3 (FS3) to stock up equipment. En route to FS3, U3B crew recalled taking the Bypass with no visibility down Lahainaluna Road and active fire along Komo Mai Street. At FS3, they retrieved an additional crew member waiting for assignment, as well as 150' 2.5" hoseline, 150' 1.75" hoseline, and a hydrant wrench (no nozzles were available). As the crew reported into town, they encountered a tanker in the Safeway parking lot, and they were able to obtain an old 40 gpm nozzle. 18:35 U3B officer reported their call sign was 3-Bravo. U3B recalled their first assignment was to respond to Kahoma Village. As they were driving in, the visibility was very poor due to heavy smoke and wind. They encountered wires and utility poles down in the roadways throughout the area. They recalled the wind and the smoke were generally blowing in the direction of the ocean, and the plume almost stretched to Lāna‘i. Occasionally, winds would shift, launching embers into the air and causing other buildings to be impacted. U3B crew recalled “seeing fire everywhere.”

TIMELINE OF EVENTS

Date/Time	Resource Assignment: Utility 3B (U3B)
18:00–20:00	U3B officer met with Command Battalion Chief 5 (BC5) face-to-face and was assigned to fight a structure fire at the southeast corner of Kahoma Village (near the corner of Kahoma Village Loop and Kenui Street). Houses on the east (mauka) side of the highway had heavy fire, and hous south of Kenui (Kenui and Waine‘e Street) had already ignited. U3B crew noted that some residents were evacuating Kahoma Village in their POVs but mostly the neighbor-hood had already been abandoned. U3B crew recalled that MPD were also operating in the neighborhood assisting with evacuation efforts. U3B split the crew into three (3) teams: • Two (2) crew members of U3B crew connected attack lines directly to the hydrant and made a defensive attack on the northwest corner of Kenui Street and Hwy-30. At least one (1) U3B crew member noted there was a Tesla battery wall in the garage. • Two (2) members began doing door knocks throughout the neighborhood notifying residents of the need to immediately evacuate. • Two (2) members took U3B into the Kelawea (east Lahainaluna) neighborhood to try to retrieve any salvage-able equipment from the abandoned apparatus. When they got into the Kelawea area, they noted the impassable roads, heavy winds, and active fire in the area. They did not get out of the vehicle and abandoned the neighbor-hood. U3B FFs rejoined the rest of their crew at Kahoma Village. U3B crew was met with an Alpha Construction water truck, which was tasked with taking over suppression efforts of the structure on fire. 18:38 Central advised Command (BC5) that there were people trapped in a van at the Territorial Savings Bank parking lot (170 Papalaua Street) surrounded by fire. U3B responded to the scene. En route to the location, U3B traveled down Hwy-30 to try to access Papalaua Street, but wires were down, and they had to reverse U3B back to Kenui Street. At the corner of Hwy-30 and Kenui Street. U3B

Date/Time	Resource Assignment: Utility 3B (U3B)
18:00–20:00	met with U3 being operated solely by U3 officer. Two (2) crew members from U3B switched to U3 to assist U3 officer. 18:40 U3B advised Command (BC5) they were traveling down Waine‘e Street (en route to Territorial Savings). U3B officer advised Command (BC5) they triaged Front Street Apartments (2001 Kenui Place) and determined “there is nothing [they could] do here now.” 18:43 Central advised Command (BC5) there were additional parties trapped at The Coffee Bean (878 Front Street). U3B traveled down Waine‘e Street towards Territorial Savings and The Coffee Bean. U3B officer recalled heavy smoke conditions and visible structure fires near 1080 Waine‘e Street down to around 10[redacted] Waine‘e Street. U3B located the van and also encountered approximately 12 other individuals that had sheltered in The Coffee Bean that required evacuation. U3B officer recalled loading the people into the white van, U3B, other MFD units, and MPD vehicles. U3B officer drove the POV white van out of the area (with U3B following), with other units transporting the additional parties. All parties met in the parking lot of Longs where MPD was coordinating transfer to the Civic Center shelter. U3B, now a four (4)-person crew, returned to Kahoma Village to check on the structure they had been fighting, and the fire was still contained. U3B crew then went to check/evacuate the Opukea condo-minium complex at 1300 Limahana Place. They could not access the neighborhood due to blocked roads. U3B crew parked U3B in the Cannery Mall parking lot, near Longs Drugs, and then walked to the fence at Cannery Mall, down Kahoma Stream bed, under the bridge, then up the hill and over the fence into the Opukea complex. They split into two (2)-person crews and began checking the buildings along Limahana Circle. All the buildings were intact, but there was fire activity around the buildings. The crew recalled there was still heavy smoke in the area and visibility was at about 60 percent.

TIMELINE OF EVENTS

Date/Time	Resource Assignment: Utility 3B (U3B)
18:00–20:00	In the northeast corner of Opukea, U3B crew encountered two (2) individuals in a POV and a family of five (5) in another POV sheltering in place. The parties were told to stay in their vehicles while the buildings were checked for other occupants. There were some language-barrier challenges, but U3B crew recalled the individuals being compliant with MFD instructions. U3B crew had flashlights, and they grabbed fire extinguishers as they walked through the buildings. The U3B crew members used the extinguishers to put out hot spots and small flare-ups in front of and inside units where exterior doors had been left open. They recalled the fires were sporadic in nature. Fire alarms were going off but they do not recall sprinklers going off in any of the buildings. Upon completion of the search, U3B crew gathered the parties from their cars and walked them out to Kahoma Stream through an opening in the fence. They walked the group up the stream and into the Walgreens parking lot (342 Keawe Street). One (1) U3B crew member retrieved U3B from Cannery Mall and drove it to pick up the parties and other U3B crew members. All were transported to the Civic Center Shelter. 18:46 U3 advised U3B to meet at Keawe Street and the Bypass where medics were waiting to transport the more seriously injured. U3B confirmed they would meet up with the medics. 18:51 U3B advised Command (BC5) that they had transported 15 people from Territorial Savings Bank/The Coffee Bean, and the crew was now operating in Kahoma Village. U3B returned to Kahoma Village and found a dumpster on fire. They hooked lines to the hydrant to extinguish the fire but there was no water. The southeast building they had been trying to extinguish before was now on fire on the downwind side with a “jet flame” blowing from the structure. The tanker that had been there previously was gone, and U3B had no means of fighting the fire. 18:54 Command (BC5) advised there was a report of people trapped at Bubba Gump. Command (BC5) advised Front Street to Papalaua Street was not possible, and access

Date/Time	Resource Assignment: Utility 3B (U3B)
18:00–20:00	would have to be made via Waine‘e Street to Papalaua Street, but he advised that area was also “pretty sketchy.” 19:06 Utility 3 from 3B: Bubba Gump is gone. Command (BC5): Nobody is in there. U3B to Command (BC5): We just made it there; everything around it and Bubba Gump is gone. Command (BC5): Oh, it burned down? U3B: Yeah, Tommy Bahamas is on fire, ____is pretty much down, and Bubba Gump is gone, the road is getting pretty impassable.
20:00–22:00	20:03 U3B relayed to Command (BC5) that Opukea, where they rescued seven (7) individuals on foot, now had a structure fire in Building 11. 20:03 U3 responded to radio traffic regarding evacuation of the Wahikuli neighborhood. U3B officer relayed he was in the Safeway parking lot with two (2) Alpha tankers that were available to respond. U3B officer recalled driving through Wahikuli making checks along ‘Ainakea Road (could not access Kahoma Street because multiple structures were fully engulfed), but they found no one in the neighborhood. 20:39 U3 reported to Engine 3 (E3) that three (3) Alpha tankers were working off Oil Road, the Wahikuli Road gate was open, and hydrants in the area were dry. E3 asked U3B to relay to Alpha tankers (operators had no radios) that there was access to the construction site, and the Alpha tanker should focus on the “strip of brush between [the construction site] and Oil Road” to prevent fire impingement into the neighborhood. U3B responded they would relay. 20:53 Command (BC5) assigned U3 as Support Group supervisor with U3B and Engine 6 (E6, working out of a reserve BC SUV) assigned. U3 reported he was on Front Street making rescues and was “super gassed.” U3 reported the collection point was Waine‘e Street and Kenui, and U3 operator advised the best access [from the north] was down Front Street.

TIMELINE OF EVENTS

Date/Time	Resource Assignment: Utility 3B (U3B)
22:00–24:00	22:52 Water Supply Group advised U3B/Support Group that there were three (3) people trapped without a car at 13[redacted] Keao Street north of Cannery Mall. U3B/Support Group advised a unit (unknown) was responding. The responding unit advised the roads were impassable, and the individuals should shelter in place. 22:53 Water Supply reported there were two (2) people trapped in a van at the intersection of Kapunakea Street and Hwy-30. U3B/Support Group reported they were responding. Department of Water Supply advised them to be safe and that the roads looked pretty impassable. 22:58 E6 reported that a Maui Prep representative was requesting lighting, as the school had no power, 100 people had been offloaded, and they were being transferred to classrooms. Support responded they would take care of that through F4. 23:06 E6 reported the two (2) buses had been offloaded and asked if they should return to the Civic Center. U3B/Support Group responded they should remain at Maui Prep and asked if Red Cross and Public Works had responded. E6 replied Red Cross was on location but they had not been able to contact F4 to request Public Works. 23:08 U3 reported to U3B/Support Group that they barely made it through Hwy-30, they were at Kapunakea Street, and they had retrieved one (1) person and were trying to access others. U3 reported “it is pretty bad over here.” U3B/Support Group advised they were going above the fire area and would be available to assist. U3B/Support Group advised they should be able to make it to Keawe Street. U3 reported they were able to evacuate everyone and were still making checks. U3 advised Hwy-30 was passable to Safeway “if you go slow and stay on the right-hand side.” 23:18 U3B/Support Group advised E6 (in SUV) to remain at the Civic Center. U3B/Support Group reported Wahikuli Road had structures on fire on one side, but it was passable and they were in the process of loading civilians. U3B/Support Group reported they were going to check the area again and update.

Date/Time	Resource Assignment: Utility 3B (U3B)
22:00–24:00	23:21 U3 reported they were heading back to Safeway and asked if U3B/Support Group needed assistance transporting survivors to the Shelter. U3B/Support Group advised them to stage at Safeway as they were looking for more people. U3 advised they were going to try to make access to the Wahikuli neighborhood to help look for people. U3 confirmed they were on ‘Ainakea Road at 23:24. 23:24 U3B/Support Group requested E6 (in SUV) and E1/Mini1 respond to the Wahikuli area to pick up people that are starting to come out. E1/Mini1 confirmed that they are dropping personnel at FS3 and responding to the Wahikuli area. E6 (in SUV) confirmed they were responding as well. 23:25 U3 advised they went across ‘Ainakea Road, up Wahikuli Road to Oil Road but could not pass. U3B/Support Group advised U3 to start at Malo Street and work outward and for E6 (in SUV) to start at Aa Street and work on the upper roads of Wahikuli. 23:27 Command (BC4) advised U3B/Support Group that the fire was rapidly moving north, and U3B/Support Group should consider making any last-minute security checks, pulling out their units, and finding safe refuge. 23:29 U3 reported they were not able to make it past Fleming Road, as there were multiple structures on fire, and they were making their way back to ‘Ainakea Road. U3B advised all Support Group units to pull back north to FS3 as they made their checks. 23:38 U3 advised they were in the Hawaiian Homes area using the PA and knocking on doors to get everyone out. 23:39 E6 (in SUV) advised they had completed the Wahikuli area west (makai) of Aa Street and could circle back around through Hawaiian Homes. U3 advised they had a civilian they were taking back to FS3, but they had only been able to canvas ‘Aipuni Street 23:39 Command (BC4) advised U3B/Support Group that they had abandoned FS3 and advised Support Group units to report to Hwy-30 north of FS3. U3B/Support Group

TIMELINE OF EVENTS

Date/Time	Resource Assignment: Utility 3B (U3B)
22:00–24:00	advised the brush was on fire east (mauka) of Malanai Street traveling towards Kaniau Road, impacting homes along the top portion of the neighborhood again. 23:48 U3 advised they had extracted one (1) and had reported to staging behind Command (BC4). U3B/Support Group-Supportadvised they were making their way out of Leialiʻi Parkway. 23:53 U3B/Support Group advised Engine 3A (E3A) they were canvasing the top area (near Lokia Street where houses were starting to ignite) and requested E3A (in a lifeguard vehicle) to go down Aa Street. 23:54 Command (BC4) advised U3B he was going to break apart the Support Group to utilize U3 and U3B. U3B advised they were doing one (1) last sweep of Wahikuli and would be ready for reassignment. E3A advised they had people in 17[redacted] Hanohano Street, and they were in the process of collecting them. Command (BC4) advised U3 and U3B to meet up with Relief Engine 14 (RE14) to go north to do some scouting of the area. U3B confirmed they were responding.
August 9, 2023 00:00–02:00	00:05 U3B reported they were delayed in leaving the area because they continued to find people. U3B crew recalled going door-to-door along Aa Street (U3 had a PA, but U3B did not) and evacuated several individuals from that area to FS3 where they were shuttled to Maui Prep. 00:11 E1/Mini1 reported they were on Kuʻuipo Street in Wahikuli, making rounds and evacuating an elderly couple. 00:13 Command (BC4) advised U3B they no longer needed to report to the previous assignment (scouting areas north with RE14). 00:22 U3B advised Command (BC4) they were leaving the Wahikuli area and had civilians to drop off. Command (BC4) advised U3B to bring the civilians to his location on Hwy-30 between the bridge and Kāʻanapali Parkway. 00:35 Command (BC4) advised U3B that he was reassigning them to Support Group with E6, E1/Mini1, E3A (in a lifeguard pick up), and Kapalua ARFF (one (1) of two (2) ARFF units, the second designated as Airport Fire assigned

Date/Time	Resource Assignment: Utility 3B (U3B)
00:00–02:00	to Structure Group) reporting. Command (BC4) advised their assignment was a “support function and then gear up for evacuation for the next neighborhood north.” U3B reported they were leaving FS3 and that the wind had shifted, seemed to be lighter, and was blowing back down west (makai). 00:47 E6 (in SUV) advised U3B/Support Group they had dropped off evacuees, were at ¼ tank of fuel, and ready for reassignment. Support advised E6 (in SUV) to stage in the Kāʻanapali area, conserve fuel, and await reassignment. 01:10 U3B/Support Group advised U3 that they were going to head back to Leialiʻi from Kāʻanapali because Kāʻanapali “look[ed] pretty good right now.” U3 advised Command (BC4) had assigned them to run Summit Group with L3 and RE1 reporting to them so they would not be able to assist. U3B operator dropped off U3B crew with Tanker 3 (T3) at the bottom of Leialiʻi Parkway. T3 was filling off a hydrant at that location, but the water pressure was very low. U3B officer borrowed a Polaris from a FFs house, and he directed resources to the backyards of houses along Kaniau Road. U3B officer recalled two (2) engines assisted and used handlines fed by T3. U3B recalled seeing two (2) houses of ‘Aipuni Street burning (8[redacted] and 9[redacted] ‘Aipuni Street). 01:11 U3B/Support Group inquired if E1/ Mini1 and E3A (in lifeguard vehicle) wanted to head back out to Leialiʻi Parkway to make checks of the neighborhood again. E1 responded they would meet U3B there and they would start close to the fire and work away. E3A asked if 1[redacted] Wahikuli Road had been checked, as someone was inquiring about that residence. U3B/Support Group reported they would try to respond. 01:21 Central advised they received a call from Coast Guard Honolulu, the Coast Guard Maui team was on scene at Waikiki Brewing Company, on Front Street with 50 parties there, and they were requesting MFD assistance to extract those people at 900 Front Street. U3B/Support Group advised they would go check road access by Chart House but advised earlier they had to make their way on foot. E3A (in lifeguard vehicle) advised they would meet U3B by the Chart House to assist. E1/Mini1 advised they would drop off

TIMELINE OF EVENTS

Date/Time	Resource Assignment: Utility 3B (U3B)
00:00–02:00	crew and make their way to Kenui Street to assist with shuttle operation. U3B/Support Group advised they were able to make their way past Chart House, but there was a pole on fire, and if it fell, it would block their egress. Command (BC4) acknowledged. 01:24 U3B/Support Group advised E1/Mini1 crew) to extinguish the pole fire by old Five Palms/Chart House and then extinguish a pallet fire near the Safeway. E1 crew acknowledged. 01:25 Per U3, Command (BC4) advised the call may have been for a rescue that had already taken place and advised U3B to commit one (1) resource to scout. U3B acknowledged and advised they encountered three (3) people near Kahoma Stream Bridge requiring extrication from the area. U3B advised Command (BC4) they had one (1) burn patient requiring transport at Safeway. 01:31 U3B/Support Group asked E3A (in lifeguard vehicle) if they had been able to make it through the area. E3A reported they had not found access due to downed power lines everywhere. 01:33 Command (BC4) advised Coast Guard Honolulu Small Boat (CGSB) that approximately 40 people had been rescued from that area one-to-two (1–2) hours prior, and Command (BC4) asked if they could see people requiring assistance. CGSB advised visibility was limited but they could see people flashing lights, so they knew they were there, and one (1) crew member was going in on a surfboard to try to get people back to a dinghy. 01:34 E3A advised they were able to get through Kapunakea Street and were driving through the Safeway parking lot. U3B/Support Group advised they made it down Front Street and were parked in front of Front Street Apartments, which had already burned. 01:40 E1/ Mini1 advised they were unable to extinguish the pallet fire and they were dropping crew off so E1/Mini1 operator could transport civilians. U3B/Support Group advised they had approximately 40 people offshore that they were going to walk out. Support advised that everyone looked ambulatory, and E3A should respond to Front Street Apartments to help load. 01:44 U3B/Support Group requested F4 to dispatch a bus to transfer evacuees to Maui Prep. Support advised the

Date/Time	Resource Assignment: Utility 3B (U3B)
00:00–02:00	collection point would be the post office. Command (BC4) confirmed that was a safe collection point, and F4 confirmed the request. 01:53 U3B/Support Group advised they had approximately 60 people needing evacuation (instead of 40 estimated by Mini1 at 01:40). 01:59 U3B/Support Group advised they were working with the Coast Guard to reunite a family, coordinating using FD6 radio channel.
02:00–04:00	02:14 E1/Mini1 advised on-shore winds were shifting a structure fire toward Front Street, which would impact egress from the area. 02:23 E3A advised MPD moved the collection point further north due to a pole on fire along Hwy-30 near the post office, which was threatening access. Support advised Battalion Chief 3 (BC3) was checking for alternate access off Keawe Street down Oil Road. 02:26 U3B coordinated with Coast Guard to assist with the rescue and reunification of a family. (Two (2) children had been transferred to Coast Guard vessel). 02:32 BC3 advised they had approximately seven to eight (7–8) civilians in their vehicle that were picked up at Front Street. They advised they were bringing them to the collection point, but they reported it appeared lines had come down by Canoe Beach, and buses were turning around. BC3 advised they would take the civilians directly to Maui Prep and then return. 02:43 U3B/Support Group reported to Command (BC4) that they had transferred a large portion of the group to Longs Drugs (1221 Hwy-30 in Cannery Mall) until alternate transfer plans were in place. They advised they were still working to extricate the non-ambulatory. BC3 advised they were able to transport their group via Oil Road but that it was no longer a viable option, as too many lines had come down. 02:54 E1/Mini1 operator reported Hwy-30 was clear from Kapunakea Street to the post office, but advised units would have to hug the west (makai) side of the road.

TIMELINE OF EVENTS

Date/Time	Resource Assignment: Utility 3B (U3B)
02:00–04:00	02:57 U3B/Support Group advised there was a clear route if transporting patients in the interior of the vehicles from Front Street to north past FS3. Support advised power lines were down but only on the east (mauka) side of the roadway, so the road was accessible from FS3 to Kā‘anapali Parkway where a collection point could be established. E1 crew advised that per MPD, Canoe Beach would be the new collection point for people coming out of Lahaina and that the route was clear from Canoe Beach north. 03:02 U3B/Support Group advised they still had 20–30 people at Longs requiring transfer to a new collection point and requested U3 respond. Command (BC4) advised U3 was being used to transfer injured to the triage point at the train station. BC3 advised the medics had moved the triage point to Fire Station 11 (FS11). Command (BC4) acknowledged. E1/Mini1 operator advised they were en route to assist transfer of people from Longs to the new collection point at Canoe Beach. 03:12 U3B/Support Group advised the children transferred to the Coast Guard vessel had been returned to Māla Wharf via DNLR small boat to be reunited with father prior to transfer to the new collection point. U3B/Support Group officer recalled the group transferred to the collection point ended up being approximately 100 people, some of which had sustained burns or injuries and could not walk (they were carried by MFD personnel). All parties were transferred from the collection point to the medic station or Maui Prep. U3B officer recalled the crew making additional checks along Front Street to the area of Kimo’s (845 Front Street), where fire on the east (mauka) side prevented further searching. 03:17 E1/Mini1 Operator advised they were picking up E1 crew from the police station and would be returning to extinguish a container fire next to Safeway and pole fires. T3 responded to assist. 03:55 U3B/Support Group reported that everyone had been transported to Canoe Beach collection point, and the CGSB would continue to scout for survivors and offload them later. U3B/Support Group advised they were working with T3 at Safeway to extinguish a trailer fire next to the building, and all the hydrants were dry.

Date/Time	Resource Assignment: Utility 3B (U3B)
04:00–06:00	04:15 CGSB advised they transferred two (2) people to DLNR small boat and they would be dropped off at Māla Wharf. U3B/Support Group acknowledged and reported they would be at that location in five (5) minutes. 04:20 U3B/Support Group advised Command (BC4) that the wind shifted and was pushing hard north toward Command’s (BC4) location. Command (BC4) affirmed and reported he was watching it. 04:22 E3A advised U3B/Support Group they had people in POVs in the ballpark and to guide them up toward Kā‘anapali. 04:24 BC5 (with BC3) advised they would pick up the two (2) individuals (plus an additional person CGSB rescued) at Māla Wharf. U3B/Support Group reported they were relocating back to Leiali‘i Parkway. U3B/Support Group advised E1/Mini1 crew) there was a small fire between houses near [redacted] Ala Moana with multiple savable houses. E1/Min1 crew reported they were responding. 04:34 T3 advised U3B/Support Group that the Safeway “container” fire had been extinguished, and they needed to refill. U3B/Support Group advised T3 to bring all personnel and report to Leiali‘i Parkway so they could pull lines from Hawaiian Homes to the Wahikuli side to stop radiant heat from igniting more homes. U3B/Support Group reported that the winds had lightened up, and the smoke was blowing straight up. Support advised T3 to refill at the hydrant by the post office, as all the hydrants in Hawaiian Homes were dry. 04:48 U3B/Support Group advised T3 to report to Hanohano Street, where an exterior deck fire was extending into the eaves of the home. U3B/Support Group advised T3 they needed him to respond before finishing filing (post office hydrant had low pressure, and T3 was filling slowly.). U3B/Support Group requested an engine be dispatched to that location to stop further fire spread into Hawaiian Homes neighborhood. 04:55 U3B/Support Group directed T3 to break away from the hydrant and report to the exterior structure fire on Hanohano Street. 04:58 Command (BC4) directed all units to relocate to Leiali‘i Parkway to assist with structure protection and triage in Hawaiian Homes

TIMELINE OF EVENTS

Date/Time	Resource Assignment: Utility 3B (U3B)
04:00–06:00	05:02 U3B/Support Group directed RE14 to report to Hawaiian Homes and pull a line to the back of 1[redacted] ‘Aipuni Street. U3B/Support Group directed RE1 to provide exposure protection to [redacted] ‘Aipuni Street and advised the house next door had burnt down but was still smoldering. 05:08 E1/Mini1 crew reported they had refilled their tank and were awaiting assignment. U3B/Support Group directed them to Leialiʻi Parkway, where a brush fire was starting just south of the post office. 05:13 U3B/Support Group assigned Airport Engine and assist MFD units operating off Leialiʻi Parkway attacking a grass-fire impinging on homes along the Hwy-30 side. 05:16 U3B/Support Group advised Command (BC4) a suppression unit with sufficient water was needed at the top parking lot for a grass-fire extending above FS3. RE11 reported. U3B/Support Group scouted the area above FS3 and directed E3 to respond to assist RE11. U3B/Support Groupreported they had a favorable wind blowing five (5) mph south. 05:22 Airport Engine reported they were headed to Canoe Beach to refill. U3B/Support Group advised Airport Engine to stay along hwy-30 and extinguish pole fires to keep the roadway open. U3B/Support Group advised L3 to report to the brush fire above FS3 from staging. 05:24 Command (BC4) reassigned U3B to North Division with RE11, E3, and L3 reporting. 05:27 RE1 reported to U3B/North Division that fire at 78 ‘Aipuni Street had been extinguished, and they were refilling at the post office. U3B/North Division advised RE1 to check the houses in that area again. 05:51 Command (BC4) advised U3B/North Division that E3A needed additional assistance at the Bypass above Keawe Street. E3A advised they had three (3) tankers in the area, and the next area of concern is Kai Hele Kū Street. 05:54 Command (BC4) directed U3 to report back to FS3 to load the pumpkin and scout a location for set up in anticipation of helicopters being able to respond. Command (BC4) advised U3 to take caution, as heavy equipment was

Date/Time	Resource Assignment: Utility 3B (U3B)
04:00–06:00	operating in the area. Command (BC4) asked if U3B/North Division copied. 05:57 Command (BC4) asked if U3B/North Division was sending any units to assist E3A with fire near Kai Hele Kū Street. U3B/North Division advised the brush fire was threatening the top portion of Hawaiian Homes. U3B/North Division confirmed they still had RE11, E3, and RE14. U3B/North Division advised they could release RE14 but they would need time to refill.
06:00–08:00	06:16 Airport Engine reported they had to refuel and would return. T3 reported they had half a tank of water but also needed to refuel. U3B/North Division reported it was looking good, and T3 should refuel. 06:25 E3A requested additional resources (an engine or wildland) by Kai Hele Kū Street. U3B/North Division reported the Hawaiian Homes area looked good, and E1/Mini1 crew) and T3 could respond. Command (BC4) affirmed and advised to keep one (1) unit at that location on fire watch. 06:30 Utility 5 (U5) reported that they had gone through the backyards of Hawaiian Homes with E1/Mini1, and the area looked good. U3B/North Division made U5 available. 07:03 Airport Engine reported they were staging at the post office. U3B/North Division told them to standby to see if they could be used elsewhere. 07:05 U3B/North Division advised the training field area above the Civic Center was looking good, and Airport Engine and RE1 could be available. Command (BC4) advised for the units to remain in staging and be used for contingencies. 07:47 U3B/North Division advised they were on the north flank accessed by Pukolii. U3 reported they were coming with relief personnel.
08:00–10:00	

Table 4.3.2.16 MFD Incident Management Assignments for Utility 5 (U5) on August 8, 2023, and August 9, 2023.

Date/Time	MFD Resource Assignment: Utility 5 (U5) F250 pick-up with skid pump, 300-gallon tank, no hose
August 8, 2023	
06:00–08:00	
08:00–10:00	
10:00–12:00	
12:00–14:00	
14:00–16:00	
16:00–18:00	
18:00–20:00	
20:00–22:00	Personnel reported to Fire Station 10 (FS10) on call back. The crew of five (5) was assigned to U5, which was a Ford 250 pickup truck that had a skid pump in the bed and a 300-gallon tank (no hoseline). 20:40 U5 reported they were on the Bypass with five (5) personnel ready for assignment in a utility vehicle with a pump but no hose. Command (BC5) assigned U5 and Ladder 3 (L3) to Structure Group under Engine 3 (E3). U5 officer recalled that they were positioned near Keawe Street and the Bypass. U5 crew recalled the wind was intense, but the smoke was not blowing towards them; it was blowing in the direction of Wahikuli (west/makai and north). 20:51 U5 reported they met with Medic 15 (M15). M15 relayed that Medic 3 (M3) had 32 patients and needed to know if they had egress access from Lahaina Station. Command (BC5) reported he believed the route from Hwy-30 through the Safeway parking lot to Keawe Street up to the Bypass was clear. U5 reported they were at the top of the Bypass, and the road was now impassable due to heavy smoke and fire. 20:51 Command (BC5) designated Relief Engine 14 (RE14) to be the Bypass Group with U5 and Engine 11 (E11) assigned to them. RE14 reported the fire was burning around the new construction site east (mauka) of Oil Road heading north.
20:00–22:00	RE14 reported that the head of the fire was advancing toward the Wahikuli neighborhood. RE14 assigned the private tanker to hit the fire and wet down the area between Oil Road and Crater Road. U5 was instructed to travel up Crater Road to meet with the tanker and run a line to mitigate the fire that was spotting in the grass. U5 followed a private tanker down Crater Road; they recalled they had difficulty with accessing some areas due to the topography. U5 assisted with brushwork and extinguishing fire by using a 1.5” handline working off the tanker. RE14 reported they were making good progress on the fire with U5 working off of the tanker already on scene. RE14 officer reported RE14 and E11 were staging at the top of Keawe Street to make sure the fire did not spread east (mauka). U5 crew described the brush in that area as continuous and approximately waist high, and a great deal of spotting was occurring due to large embers being blown by the wind. U5 crew recalled the fire front was coming from east (mauka) of Crater Road. The tanker tried to pre-treat the area before the fire reached them. U5 crew tried to make a stop, but the fire ran past them in seconds. U5 and the tanker had to pull back. 21:19 U5 reported the tanker had run out of water. When the tanker ran out of water, they had to reverse the tanker out so it could go refill. RE14 officer instructed U5 to check the status of Crater Road all the way to Wahikuli Road. 21:46 BC4 to Dispatch: BC4 was assuming Lahaina Command, and BC2 was 911. U5 crew recalled taking Crater Road to Wahikuli Road down toward Oil Road. U5 crew saw citizens in their POVs evacuating the area on Wahikuli, and they saw POVs and pedestrians leaving the area by heading north on Oil Road (approximately 21:49).
22:00–00:00	U5 saw two (2) tankers working in the area of Oil Road. One (1) tanker filled U5 tanks and then went back to spraying the area along Oil Road east (mauka) of Wahikuli Road. Some tankers would leave to refill while others worked on pre-treating the

TIMELINE OF EVENTS

Date/Time	MFD Resource Assignment: Utility 5 (U5) F250 pick-up with skid pump, 300-gallon tank, no hose
22:00–00:00	area. U5 officer recalled the fire was heading in that direction, and they decided they would try to make a stand near the intersection of Oil Road and Wahikuli Road. U5 crew recalled the fire appeared to be a couple of hundred yards away. They deployed handlines, but within seconds, the fire had reached them. Two (2) private tankers had to leave to refill, so U5 worked off Tanker 3 (T3) to try to mitigate the spotting and fire spread above the Wahikuli subdivision as best they could. U5 recalled they could see structures igniting and progressing north of Kapunakea. U5 crew reported it appeared to be sporadic fire spread at that point due to the large ember cast; it had not reached the level of structure-to-structure ignition. U5 was assigned to scout the dirt access roads along Oil Road up to and around Kā‘anapali Coffee Farms to identify access and egress routes. U5 crew recalled there were power lines down along portions of Oil/Old Stuart Road (prior to Pu‘ukoli‘i Road), but they were able to navigate around them in U5 pickup truck. U5 turned around and traveled down to Fleming Road and found the gate at Fleming Road open, which allowed for egress onto Hwy-30. As U5 traveled down Fleming Road they went house to house, knocking on doors and informing residents to immediately evacuate. As they were making the evacuation notifications, U5 crew recalled seeing the glow of the fire front traveling towards them. U5 officer recalled most residents complied, although residents of two (2) homes refused to evacuate despite being told of the immediate fire threat. U5 crew recalled that as they reached the bottom of Fleming Road, they could see houses at the top of Fleming Road starting to be impacted by the flames. U5 proceeded to Hwy-30 where they met and staged with RE14, T3, and two (2) private tankers. U5 officer recalled that E11 had remained at a lookout point at the top of Keawe Street, and they were now cut off on the other side of the Bypass with no way to get through. E11 remained in that location and became the Bypass Group leader. U5 officer recalled the next assignment was to move units north into Kā‘anapali (the next area expected to be impacted).
August 9, 2023 00:00–02:00	00:12 Command (BC4) directed U5 to remain with RE14 as they set up to make a stand in the Pinnacle neighborhood.

Date/Time	MFD Resource Assignment: Utility 5 (U5) F250 pick-up with skid pump, 300-gallon tank, no hose
00:00–02:00	00:33 U5 scouted the roads off Anapuni Loop for access and egress points. They found access to Old Stuart Road through a vacant lot. U5 found Old Stuart Road was clear to the Lahaina Civic Center. U5 returned to Anapuni Loop and reported their findings. U5 crew did not deploy handlines (other apparatus had) as they wanted to remain mobile. 01:24 Support Group assigned Mini1 to address a pole fire by the Chart House and pallet fire next to Safeway. U5 responded to assist at Safeway.
02:00–04:00	03:30 Battalion Chief 3 (BC3) reported that houses near Baby Beach could be saved. U5 officer recalled being assigned to determine if there were any salvageable structures along Front Street. U5 crew recalled they traveled down Front Street but could not make it past Ala Moana Road. Most of the houses had already burned and/or collapsed. One (1) house on a flag lot off Ala Moana was still burning, and they darkened down that fire and wet down the standing exposures. There was a hydrant with very low pressure in that area, but it was enough to allow the U5 operator to fill the tank. Mini1 came and assisted, dropping another tankful of water in this location.
04:00–06:00	04:18 U3B/Support Group requested U5 to return to the Leiali‘i Parkway area of Hawaiian Homes for assessment of conditions. U5 officer recalled when they arrived at Leiali‘i, they saw MFD apparatus already working in the area. U5 crew went across Hanohano Street and down to ‘Aipuni. U5 was able to retrieve hose from Mini11 (their pump was inoperable), and U5 crew stretched a 1.5” handline to the rear of the houses near the cul-de-sac of ‘Aipuni. Houses behind ‘Aipuni (addressed off Kaniau) had already or were still burning. U5 crew was joined by another engine and wildland unit using and repositioning the hoselines to extinguish fires and protect the standing structures. The crews continued to work down ‘Aipuni, to Aa Street, and then to Hooli. At this point, it was daylight, and the Hawaiian Homes area seemed to be managed.

Date/Time	MFD Resource Assignment: Utility 5 (U5) F250 pick-up with skid pump, 300-gallon tank, no hose
04:00–06:00	U5 Officer recalled he was asked to go down and check the conditions along Front Street. U5 had attempted multiple routes but was ultimately able to make access by traveling down the Bypass to Hōkiokio Place, past the Puamana community, to Front Street. U5 officer recalled that everything had burned out at this point. They were approached by a female civilian who reported there was another man in need of rescue with burns to his body and feet. U5 crew retrieved the victim and carried him back to U5. U5 crew took the civilians back to Hōkiokio Place and transferred them to medics. U5 checked the area for other survivors but did not find any. 05:51 U5 was assigned to assist Engine 3A (E3A) with a brush fire on the east (mauka) side of the bypass 100-150 yards from Kai Hele Kū Street. U5 responded and pulled a 1.5" line fed by a private tanker to help mitigate fire spread in the brush adjacent to the highway. U5 encountered three (3) citizens, one (1) requiring medical care for burns, so U5 transported them back to the medics at Hōkiokio Place.
06:00–08:00	U5 returned to the Launiupoko area and assisted with fire attack along Haniu Street. 06:09 U5 was asked for the status of their personnel. U5 was directed to swap crew (Ferreira moved to RE14) and return to Fire Station 3 (FS3) where the oncoming shift was waiting to relieve them. Remaining U5 crew returned to FS3 and took a lifeguard vehicle back to FS10 to retrieve their POVs.

Table 4.3.2.17 MFD Incident Management Assignments for Engine 3A (E3A) on August 8, 2023, and August 9, 2023.

Date/Time	MFD Resource Assignment: Engine 3A (E3A)
August 8, 2023	
06:00–08:00	
08:00–10:00	
10:00–12:00	
12:00–14:00	
14:00–16:00	
16:00–18:00	
18:00–20:00	
20:00–22:00	A relief crew in a lifeguard utility truck met Engine 3 (E3) crew at 'Ainakea Road and Kapunakea Street. E3 crew relocated into the Lifeguard utility truck, using designator E3A, and the relief crew went into service as E3. E3A returned to Fire Station 3 (FS3) for rehab. 21:46 BC4 to Dispatch: BC4 was assuming Lahaina Command, and BC2 was 911.
22:00–00:00	E3A assisted with relocating the Lahaina Civic Center Shelter to Maui Prep and assisted with loading people onto buses. E3A assisted with evacuating the Wahikuli area. E3A crew recalled people were actively in the process of leaving the neighborhood while others were walking into the neighborhood. E3A picked up at least four (4) individuals and brought them to where the buses were.
August 9, 2023	~00:08 E3A crew made multiple additional rescues but were unsure of how many.
00:00–02:00	00:27 E3A crew member utilized their personal minivan to collect evacuees from E3A and shuttle them to Maui Prep. The neighborhood appeared to be clear. E3A officer was concerned they may get trapped in the neighborhood due to deteriorating conditions.

TIMELINE OF EVENTS

Date/Time	MFD Resource Assignment: Engine 3A (E3A)
August 9, 2023	00:35 E3A was reassigned to the Support Group and relocated to Kā‘anapali to regroup with other FD units to coordinate.
00:00–02:00	01:21 E3A responds with Utility 3 (U3) to assist with evacuating civilians rescued from the water near the area of Waikiki Brewing and 900 Front Street (United States Coast Guard (USCG) requested assistance for evac of 50 people.).
02:00–04:00	03:42 E3A returned to Cannery Mall to ensure all civilians had been evacuated.
	E3A continued to assist with evacuation shuttles to Maui Prep.
04:00–06:00	04:18 E3A responded to Launiupoko Beach Park to check on residents and assess conditions. Battalion Chief 5 (BC5) responded and canceled E3A. At this time, both units noted a change in wind and reported, “Hard push north now, offshore and north” (04:20).
	05:36 Command (BC4) assigned E3A to scout the Bypass and check for fire extension and access points. E3A reported fire had remained on the west (makai) side, and most of the west (makai) side had burned out. E3A was assigned to stage at Keawe Street and the Bypass.
	05:51 MPD reported fire jumped to the east (mauka) side of the Bypass approximately 100–150 yards from Kai Hele Kū Street.
	E3A reported Engine 11 (E11) was responding, that there were three (3) private tankers in the area, and requested air support, if available.
	E3A reported additional assistance was needed for the east (mauka) fire near Kai Hele Kū Street. Relief Engine 14 (RE14) was sent to respond. An additional private tanker responded as well. E3A reported poor water pressure in the area. Tankers were taking turns attacking and refilling (two (2) at a time, rotating).
06:00–08:00	06:33 E3A reported to Command (BC4) that the fire near Kai Hele Kū Street should be a priority area once air support is available. E3A continued to assist with coordination of resources in that area.
08:00–10:00	[redacted]
10:00–12:00	

Table 4.3.2.18 MFD Incident Management Assignments for Relief Engine 14 (RE14) on August 8, 2023, and August 9, 2023.

Date/Time	Relief Engine 14 RE14 had minimal equipment - base radio only, 4 SCBAs and 3 Flashlights, No hose (had to use their own hose stored at FS10)
August 8, 2023	20:01 RE14 went into service from FS10 with a callback crew and was dispatched to Keawe Street and the Bypass.
20:00 – 22:00	RE14 crew recalled that, while en route, they could see the upcountry fire. Once they passed Olowalu, RE14 crew noticed a change in the wind – the wind was much stronger and was blowing in a N/NW direction.
	As they came up the Bypass they encountered heavy smoke and one (1) crew member recalled the area looked “real grim” like “a huge battle zone.” As they approached Lahainaluna Road, they were met with a “curtain of smoke.” RE14 recalled that they could not see actual structures through the smoke, they just saw “balls of fire.”
	20:06 Command (BC5) assigned RE14 and RE11 to respond to a brush fire that jumped the Bypass above the Wahikuli neighborhood and was headed north. E3 advised they would not be able to extinguish all of the fire but the priority was to keep it on the mauka side of Oil Road.
	20:11 RE14 confirmed the fire had jumped across Keawe Street from south to north. RE14 reported they were headed toward the construction site mauka of Oil Road where the new apartments were being built.
	RE14 officer recalled there were cars still trying to go down Keawe Street. RE14 officer tried to contact Central on FD2 but the radio traffic was congested. RE14 officer switched to FD1.
	20:17 RE14 asked Central if MPD units were available to respond to Lahaina.
	20:18 RE14 reported civilians were trying to evacuate down Keawe Street, but the area was being overrun by heavy fire and smoke. RE14 requested MPD units shutdown all traffic traveling into Lahaina.
	20:20 E11 requested any available tankers to proceed to the area and wet it down in an effort to contain the fire from spreading further north. Command (BC5) advised that private

TIMELINE OF EVENTS

Date/Time	Relief Engine 14 RE14 had minimal equipment - base radio only, 4 SCBAs and 3 Flashlights, No hose (had to use their own hose stored at FS10)
20:00 – 22:00	tankers may already be in that area but they had no radios. Command (BC5) advised E11 to flag them down. RE14 officer recalled encountering Mini11 coming up Keawe Street toward the Bypass. RE14 had a face-to-face with Mini11 crew and asked for a portable radio but they had none. Moments later E11 came up Keawe Street and RE14 officer had a face-to-face conversation with E11 officer. E11 officer advised they had just evacuated the area and E11 staged with RE14 on Keawe Street. 20:26 RE14 and RE1 had a radio exchange regarding the status of Keawe Street. They communicated the plan would be for an incoming tanker to try to keep the fire from jumping the Bypass mauka of the apartments. 20:49 RE14 reported they were staging with a private tanker on Keawe Street near the Church of Jesus Christ of Latter-Day Saints. 20:51 RE14 reported the fire was burning around the new construction site mauka of Oil Road heading north. RE14 reported that the head of the fire was advancing toward the Wahikuli neighborhood. Command (BC5) assigned RE14 to be Bypass Group with U5 and E11 reporting to RE14. RE14 officer (no portable radio) scouted the area on foot with E11 officer (had a portable radio) mauka of Oil Road. RE14 officer recalled seeing the fire “backing into the wind” where the north and south tradewinds met. RE14 assigned the private tanker to hit the fire and wet down the area between Oil Road and Crater Road. The tanker made it up Crater Road just northeast of the Bypass and Keawe Street. RE14 stated he had E11 officer contact U5. U5 was instructed to travel up Crater Road to meet with the tanker and run a line to mitigate the fire that was spotting in the grass. 21:14 RE14 (Bypass Group) requested command to send an additional tanker to that location. Command advised four (4) private tankers were en route with an estimated time of arrival of approximately 30 minutes. RE14 reported they were making good progress on the fire with U5 working off of the tanker already on scene. RE14 officer reported RE14 and E11 were staging at the top of Keawe Street to make sure the fire did not spread mauka.

Date/Time	Relief Engine 14 RE14 had minimal equipment - base radio only, 4 SCBAs and 3 Flashlights, No hose (had to use their own hose stored at FS10)
20:00 – 22:00	21:19 U5 operator advised RE14 that the tanker ran out of water and needed to refill. RE14 reversed the apparatus up Crater Road with the objective to attack the fire from that position. RE14 crew recalled they used an 1.5" handline from the rear of the engine as well as two (2) reels of wildland hose. RE14 recalled the fire continuing to slowly back into the wind. 21:46 BC4 to Dispatch: BC4 was assuming Lahaina Command, and BC2 was 911. 21:47 RE14 reported a wind shift and advised all units to be aware the fire spread may change. 21:49 U5 stated Crater Road was clear to Wahikuli and the gate to Wahikuli Road was open.
22:00 – 00:00	22:08 RE14 had an exchange with E11 asking if the road had been compromised. RE14 reported seeing new black smoke between their location on Crater Road and E11 (staging near Keawe and the Bypass). RE14 expressed concern that they may not be able to get back to E11’s location. E11 could not confirm. RE14 identified Wahikuli Road as their escape route. As a tanker arrived to their location, RE14 and the tanker traveled from Crater Road to Wahikuli Road. 22:11 RE14 had radio exchange with U5 and confirmed the tanker was able to exit off Crater Road to Wahikuli Road so the RE14 would be able to follow. E11 advised RE14 that fire is makai of their location. RE14 officer recalled seeing four to five (4-5) tankers operating off Oil Road (he could see their lights). As they were operating off Oil Road, RE14 could see fire starting near Keawe Street and Oil Road. RE14 officer could see the fire line moving north in the Wahikuli and Kahoma neighborhoods and he noted the structure fires were starting to outpace the brush fire between Crater Road and Oil Road. 22:12 RE14 transfers Bypass Group to E11 (who had a portable radio) due to the roads becoming impassable.

TIMELINE OF EVENTS

Date/Time	Relief Engine 14 RE14 had minimal equipment - base radio only, 4 SCBAs and 3 Flashlights, No hose (had to use their own hose stored at FS10)
22:00 – 00:00	As RE14 passed the intersection of Oil Road and Wahikuli Road they saw that multiple structures had already started to ignite. RE14 crew saw houses in the neighborhoods south were burning faster and faster. RE14, with the tanker following, took Wahikuli Road to the lower Hwy-30. 22:15 RE14 advised Command (BC4) they had come down from mauka of Oil Road. They traveled down the second road north of Fleming Road and advised that fire was impacting the top side of that road. RE14 officer recalled the structure fires were moving north. MFD apparatus passing by them were using hand signals to let them know there was no water in the area. RE14 officer met with a private tanker operator (who had no portable radio). The tanker driver indicated there was a good hydrant at Canoe Beach. 22:50 RE14 officer reported over the radio there was a good water supply confirmed at Canoe Beach (Hanakaʻōʻō Park). RE14 refilled tank there, encountering numerous roads that had been blocked by downed poles/wires along the way. RE14 had a face-to-face conversation with Command (BC4) and Command (BC4) made the decision to recall units to stage along the Highway. RE14 officer stated that a collective decision was made to have smaller trucks scout the area to assess the road conditions.
August 9, 2023 00:00 – 02:00	00:12 RE14 reported a civilian approached them at Coffee Farms and advised the gates were open but there were poles and wires down on that section of Oil Road. RE14 relocated to Puʻukoliʻi Road and Old Stuart Road to try to get a vantage point from that location. Command directed U5 to remain with RE14.
02:00 – 04:00	00:23 RE14 confirmed they saw a pole down on Oil Road. RE14 officer reported the fire seemed to be heading toward Kāʻanapali. RE14 officer confirmed the Kāʻanapali area had good water supply. RE14 officer suggested strategically staging units in the cul-de-sacs in the Pinnacle neighborhood to make a stand and stop fire progression.

Date/Time	Relief Engine 14 RE14 had minimal equipment - base radio only, 4 SCBAs and 3 Flashlights, No hose (had to use their own hose stored at FS10)
02:00 – 04:00	00:37 RE14 advised they traveled up Laiʻikae and were staging in a cul-de-sac near the Pinnacle entrance. RE14 officer recalled placement of units as follows: U5 and T3 staged in south Pinnacle RE14 and ARFF unit staged in the middle of Pinnacle RE1 and a ladder company set up in north Pinnacle Bypass Division remained E11 The units set up, pulled hose lines, and prepared for fire attack. 02:14 Command (BC4) requested an update location for RE14 and they advised they were in the Pinnacle cul-de-sac. RE14 officer recalled the units remained in that area until approximately 04:00.
04:00 – 06:00	RE14 officer recalled that at approximately 05:00, while the apparatus was staged in the Pinnacle neighborhood, the winds shifted. RE14 officer recalled the dominant wind now seemed to be tradewinds coming from the south. U5 went to scout Oil Road to reassess conditions and U5 officer reported the fires moving north had slowed and the field above the Civic Center had not been impacted. RE14 officer recalled that units were sent to do structural triage on ʻAipuni and other streets in the Hawaiian Homes area. Aa and ʻAinakea Roads had poles down, so large apparatus could not access. 05:02 U3 advised that hydrants around the Civic Center and fire station were dry. 05:02 Support Group assigned RE14 to travel from Leialiʻi Parkway to their first right, and where it tees off at ʻAipuni Street RE14 was assigned to pull to the back of house addressed at 108 05:05 RE14 responded to ʻAipuni Street. RE14 officer recalled seeing at least 3 engines along ʻAipuni Street putting out fires within and around ʻAipuni Street. RE14 operator recalled trying to access hydrants within the neighborhood but they were all dry. Canoe Beach was still being used as the main water supply and RE14 refilled there.

TIMELINE OF EVENTS

Date/Time	Relief Engine 14 RE14 had minimal equipment - base radio only, 4 SCBAs and 3 Flashlights, No hose (had to use their own hose stored at FS10)
04:00 – 06:00	05:26 RE14 requested an assignment from Support Group. Support Group responded that everything in that area was being addressed and RE14 should return to the Civic Center. RE14 officer was instructed to drop off L3 officer (so he could join L3 to be with his regular oncoming crew) and pick up another firefighter from U5. After crew swap, RE14 returned to assist with extinguishing hot spots in the Hawaiian Homes neighborhood. 05:57 RE14 was released from Hawaiian Homes and dispatched to assist E3A with a fire near Kai Hele Hu. RE14 reported they would need 10 minutes to refill. E3A reported that the water pressure was low and refill times were long in the Kai Hele Kū Street /Launiupoko area.
06:00 – 08:00	E3A instructed RE14 to come to Kai Hele Ku to the round-about and they would be guided in. 06:25 Support reports that the Hawaiian Homes area looks good and they could send units to assist with the fire near Launiupoko. 06:33 Command assigns RE14, E11, Mini11, Mini1, and T1 to be South Division (SD) under E3A. RE14 crew recalled there were 4 private tankers working in the area – 2 would work the fire while 2 left to refill. Private dozers (not coordinated with MFD) were cutting fire lines farther mauka. 06:43 RE14 crew recalled working spot fires between the Bypass and Launiupoko where a brush fire was burning mauka. RE14 crew pulled a handline to hit fire progressing mauka through a rockpile. 07:04 E3A/SD advised RE14 that they were in the location of the active flame front. RE14 advised the fire had reached up the road and they were knocking it down. RE14 advised they were stopping it at this location. 07:32 Command (BC4) advised the area was looking good – private dozers (coordinated by MFD) were able to cut lines. Air1 advised that with the dozer and T3 addressing a spot, it was “looking really good over here.” At shift change [time not provided] they checked in at Station 3 then they were released to return to Station 10 to switch out with oncoming crew.

Event Log Fire 2 and Fire 3

- **Fire 2 (F2): Deputy Chief Gavin Fujioka**
- **Fire 3 (F3): Assistant Chief of Operations Henry “Hanale” Lindo**

Fire Chief Ventura was in Colorado (in another time zone, four (4) hours ahead) on August 8, 2023, and F2 was the senior officer on duty. F2 received WhatsApp messages about the Olinda fire from chief officers . Chief Ventura called F2 at approximately 03:00 HST, which was around the time evacuations in the Olinda area started occurring. F2 responded to Fire Station 10 immediately after talking to Fire Chief Ventura. As the oncoming crew came on, F2 approved the backfilling of positions (including Lahaina).

F3 saw messages about the Olinda fire at approximately 04:00 and he reported to headquarters at approximately 06:00. F3 talked to the battalion chiefs on duty to see if they needed additional resources.

- Battalion Chief 6 (BC6) went to help with the Olinda fire voluntarily at approximately 04:00 on August 8, 2023 (they have authorization to do so for large incidents). BC6 assisted BC2, who was the IC. BC6 left the Olinda/Kula fire at approximately 06:00 on 8/9 and went to assist in Lahaina and also coordinated staffing (911 operations) for that evening and the next day.
- Battalion Chief 5 (BC5) worked August 7, 2023, and was held over on August 8, 2023, to cover the west side of the island. He assumed Command of the Lahaina AM Fire from E3 officer at 06:50. He returned Command to E3 at 09:27. BC5 assumed Command of the Lahaina PM Fire from E11 and retained Command until 21:46, when BC4 assumed Command.
- Battalion Chief 2 (BC2) was the IC of the Olinda fire (August 7, 2023–August 8, 2023).
- Battalion Chief 3 (BC3) arrived at headquarters at approximately 07:30 on callback. He was called in to assist with staffing (911 operations). BC3 passed staffing (911 operations) duties to BC4 after BC4 returned from the Olinda fire at approximately 16:02. BC3 responded with F2 and F3 to the Lahaina PM Fire.
- Battalion Chief 4 (BC4) came in to assist with the Olinda fire (initially) at approximately 07:30 on August 8, 2023. BC3 passed staffing duties (911 operations) to BC4 at 16:02 (BC4 returned to FS10 headquarters from the Olinda fire). BC4 passed staffing duties (911 ops) to BC2 at 21:46 when he assumed Command of the Lahaina PM Fire. BC4 retained Command until approximately 17:00 on August 9, 2023.
- Battalion Chief 1 (BC1) came in at approximately 07:30 on August 8, 2023 to relieve Olinda Command (BC2).

When F2, F3, and BC3 were monitoring the radio, they were initially focused on Olinda fire operations and the Kula fire, which started at 11:13. In the afternoon, when they heard the first structure had ignited in Lahaina, they talked to BC5,

and decided to redirect resources dedicated to Kula back to Lahaina. There was concern about coverage needed for other parts of the island, but they knew Lahaina was going to need support. F3 recalled that E11 was en route to Kula but was redirected back to Lahaina, as they only had three (3) engine companies staffed on the west side of the island.

F2 recalled that at approximately 15:45, F2, F3, and BC3 traveled together in BC3's reserve BC vehicle to Lahaina. F3 recalled listening to BC5 on the radio as he managed the incident and started building out command.

> *15:51 F2 advised Command that Alpha was sending two (2) tankers, [inaudible] was sending zone (1) tanker, and F2 advised Command that he, F3, and BC3 were heading his way.*

He did not recall all the radio traffic, but he knew there were structures involved.

> *16:05 Command from Fire 2: What is your location?*
>
> *Command: I am coming up Lahainaluna to the bypass, you can't get down, it's not safe to drive down past Kelawea (Street) from the top, it's complete blackout, I just coming up now to the Bypass from Lahainaluna.*
>
> *Fire 2: We are entering the bypass now and will meet you. Have we confirmed the area below Lahainaluna Road from the Bypass has been evacuated.*
>
> *Command: I can't confirm that.*
>
> *Command to Dispatch: I see a bunch of residents trying to drive out. Do you know if police are active below that …. trying to get all the residents below Kelawea (Street) out.*
>
> *Central: They are actively trying to get everyone out. They have some at Hale Mahaolu and the adjacent areas.*

F2 recalled arriving near the scene at approximately 16:15. F2, F3, and BC3 met with BC5 (IC) at Lahainaluna Road and the Bypass. They had a face-to-face discussion, and F3 transferred to BC5's vehicle. F3 recalled the front passenger door would not open so he sat in the back seat and started functioning in the role of deputy IC for BC5. F3 recalled calling private heavy equipment companies requesting deployment of resources to both Kula and Lahaina (approximately 15:50). F3 recalled being "in a wall of smoke" and he had no visual of where the fire apparatus was located. At this point they could see multiple structures fully involved down in the Lahainaluna neighborhood (Kelawea area) and the wind was "howling." F3 recalled seeing multiple structures on fire along the makai side of the park and noted how fast the fire was moving. F3 asked BC5 if F3 should take command, and BC5 responded that he could manage.

At 16:11 Command requested power to be shut off due to multiple downed utility poles and wires down. Central immediately responded that power was shut off.

> *16:11 Command: We need to shut power down.*
>
> *Central: MECO confirming power is shut off.*

After some time monitoring the situation, F2 told BC3 he wanted a view from Keawe Street. F2 and BC3 relocated down to Keawe Street so they could get a view looking back up towards the fire. F2 recalled communications on the radio were busy, but they could follow the traffic, despite that some transmissions were muffled. F2 recalled the column of smoke was pitch black and covered the entire neighborhood traveling towards the ocean. F2 talked face-to-face with F3 about repositioning. At some point, F2 recalled dispatch reporting the train station was on fire, which housed a 30,000 gallon propane tank.

> *16:22 Central: I know there are no units, we are getting reports of the sugar cane train off of the Mohana* on fire with propane tanks, they are trying to evacuate.*

(*Mohana–Unknown word in dispatch record. Most likely Limahana Place, where propane tanks and Sugar Cane Train are located.)

F2 had a radio exchange with Command about establishing a cut-off point for the rapidly progressing fire.

> *16:25 Command from Fire 2: Why don't you ... over on this side. We might have to write this whole subdi vision and industrial area off. I cannot see us stopping anything.*
>
> *Command: Where are you guys? You on the Bypass?*
>
> *Fire 2: We are coming down Keawe to the right of the church (85 Ulupono Street).*
>
> *Command: Yeah, you are talking about Kahoma Stream.*
>
> *Fire 2: Yeah, copy that, the fire will be on Kahoma Stream shortly, and I am not sure or confident that stream will hold this fire.*

Around that time, F2 took a left off Keawe Street onto Hwy-30. They saw apartment buildings near Kenui Street (possibly 10[redacted] Waine'e Street) completely engulfed by fire. F2 recalled it was at this point they realized the fire had spotted across Hwy-30. F3 and BC5 switched places so that F3 could drive and BC5 could track the incident. Normally BC5 would have an incident command board, but BC5 was in a reserve BC vehicle which was not equipped with a command board. F3 recalled a radio exchange between BC5 and Dispatch regarding evacuation of the Lahainaluna neighborhood (Kelawea area).

TIMELINE OF EVENTS

16:29 Dispatch from Command: We need to evacuate the whole Lahainaluna subdivision and also on the Lahaina side of Kahoma Stream, we are going to evacuate that whole area.

Command from Dispatch: They are working on it. They are currently at Lahaina Surf, Kahoma Village. They currently have one (1) fatality.

16:32 Command: All units, units, priority traffic, this is command. I want all units to evacuate the whole Lahainaluna subdivision. We are going to establish cutoff points on the Nāpili side of Kahoma Stream and south use the highway.

Command from South: We are going to anchor and shelter in place, we are going to find the best place to do that off Pauoa.

Next, F2 and BC3 went to survey the Emerald Plaza area. F2 recalled seeing E11 with Mini11 attacking a brush fire in an empty lot while people were evacuating down the riverbed. F2 ran out of the vehicle to help load civilians into an MPD vehicle. F2 recalled hearing radio traffic of E1 reporting they were stuck and would shelter-in-place and that Mini6 had to be abandoned.

F3 drove down Keawe Street, and he recalled the only units he could see were E3 and L3 making a stand on Kelawea Street (near Lu'i Street) and people were still running out of the neighborhood. F3 recalled they were trying to locate E1 and E6 but had been unable to do so. They heard other units in the Emerald Plaza area so they relocated there, but when they arrived, the visibility in the area was clear, and MFD units were working to extinguish a brush fire. They continued to drive down Keawe Street to Hwy-30, where they passed MPD. They could see fire impacting Kahoma Village and BC5 tried to reach E11 and other units to try to mitigate that area. F3 recalled that visibility would be very bad at times and then it would shift and be clear. F3 recalled that the fire had not impacted Komo Mai Street at this point. BC5 continued to retain command and was using a notepad for unit tracking but he could not locate E1 and E6. They were by Kahoma Stream when they heard the mayday come across the radio at 17:02 followed by the CPR in progress report.

17:11 E1 from Command: Shaw and the Highway, Shaw and the Highway, CPR in Progress

17:13 Dispatch from Command: Do you have the medics coming, you said they are on the Bypass?

Command from Fire 2: Medics just headed that way on the Bypass.

17:14 [Unit unknown]: Priority Traffic, Priority Traffic, We are at Honoapi'ilani and Shaw, we are rescue breathing.

Command: Medics should be there in a couple minutes.

F3 (with BC5) and F2 (with BC3) responded to Hwy-30 and Shaw Street. F2 had to travel Keawe Street to the Bypass, all the way down to Hōkiokio Place to the Hwy-30 in order to gain access to Shaw Street. F3 recalled Hwy-30 being heavily congested with traffic from Hōkiokio Place to Shaw Street and Hawaiian Electric crews working to clear downed utility poles.

At this point F2's focus shifted from the fire to the downed firefighter and the other firefighters that had been operating in the same area.

17:25 F2 asked Command if a personnel accountability report (PAR) had been received for RE1. Command responded that they had not heard from them in a while.

RE1 tried to respond multiple times but their transmissions were inaudible.

At 17:26 RE1 operator reported that all crew members were accounted for and they were in a dirt field off Dickenson in a safe position.

Prior to reaching Shaw Street, the relief BC vehicle occupied by F2 and BC3 broke down. At 17:28, F2 radioed BC5 and arranged for BC5 and F3 to pick up F2 and BC3 in BC5's vehicle. They would then transport them to the Cannery Mall Parking lot, where MFD personnel had left another BC vehicle (two (2) firefighters drove it to Safeway parking lot, where they added to E11 crew at 17:30). F2, F3 and BC3 designated this vehicle as F2 and drove to the hospital. BC5 remained with his vehicle and retained command.

F2 recalled there was no cell service, so he used the radio to instruct BC4, who was now handling 911 ops/staffing at FS10 headquarters, to inform the Fire Chief and the Fire Chief's secretary of the mayday so that family notifications could be made.

17:39 BC4 from Fire 2: Can you help me with some notifications? We don't have cell service down here. Can you call Chaz and Fire 1, let them know E6 A-Watch Captain is on his way to the hospital?

17:40 Fire 2 from BC4: Good copy, and I'll advise right now.

BC4 from Fire 2: We have to go switch out BC vehicles. Our BC vehicle won't shift, so we are going to switch it out and then go to the hospital.

The next day, F2 did a reconnaissance flight with Air 1 to survey the area of impact and help coordinate other incoming air assets.

06:02 Command from Fire 2: We are going to do a reconnaissance with Air 1 and then coordinate with them, air ops from the other helicopters that are going to be coming to Maui.

Command from Fire 2: We heard you are setting up a pumpkin so you have a little time until we recon.

Fire 2 from BC3: Bringing back the E6 personnel from yesterday, they don't have PPE. We did some recon and found E6 and E1, E1 is a total loss, E6 survived and some cosmetic damage, possible salvage.

BC3 from Fire2: Copy that. As soon as we get the road clear and we can move vehicles out of there, we will get mechanics there.

Fire2 from BC3: There is some equipment on E6, there is plenty of gear to salvage.

Aviation Resources

Aviation resources are critical to addressing the all-hazard environment of Maui County. Aircraft are needed to respond to vegetation fires, aerial rescues from mountainous areas, and personnel and equipment transport when roads are impassable. MFD contracts with Windward Aviation[95] for their helicopter operations. Windward provides the helicopters, pilots, and maintenance personnel. Since July 2022, the helicopter designation Air 1 has been a twin-engine Airbus/Eurocopter, BK 117-850G2, capable of delivering 300 gallons of water from a Bambi bucket, performing hoist operations, transporting personnel and equipment, and completing reconnaissance missions. A Hughes MD-500 capable of delivering 120 gallons of water is operational when the BK 117 is out of service for maintenance. The contract also allows for multiple aircraft to be operational when demand exists and if Windward Aviation has helicopters available. Requests for aircraft are made by the IC through a battalion chief.

Aircraft from the Hawai'i National Guard (HING) are also available for response to Maui and other Hawaiian counties. At the time of the Maui wildfires on August 8, 2023, and just prior, Army National Guard helicopter availability for emergency response was limited to a CH-47 Chinook (2,000 gallons using a Bambi bucket) and UH-60 (or HH-60) Black Hawk (500 gallons using a Bambi bucket) out of O'ahu. The reduced number of aircraft was due to many Black Hawks being located in Louisiana with the 29th Infantry Brigade Assigned to Fort Johnson for specialized training. The two (2) aircraft with crews were placed on standby on August 7, 2023, to ensure their ability to be "wheels up" in 30 minutes to two (2) hours.

Pōhakuloa Army Training Center on the Big Island also had a CH-47 Chinook and a UH-60 Black Hawk available for firefighting missions. As per Major General Hara, HI-EMA Director, these aircraft were available for Hawai'i County response on August 8, 2023, due to their proximity to the wildfires occurring on that island.

[95] *https://www.windwardaviation.com/about*

The following timeline includes communications (Table 4.3.2.19) with aviation assets assigned to the Lahaina AM and PM fires and communications referencing helicopter usage on the fire. Note: this record may not include all air-to-ground communications and other communications referencing the grounding of aircraft due to weather/ wind conditions.

Table 4.3.2.19 MFD Timeline of MFD aviation communications on August 8, 2023, and August 9, 2023.

Timeline of Aviation Communications
August 8, 2023 - August 9, 2023

DATE/TIME	AIR 1	AIR 2
August 8, 2023 06:00–08:00	07:24 Air 1 reported they were lifting off from the airport to assist Air 2 with the Lahaina fire.	06:48 Air 2 reported they were responding to the west side for the Lahaina fire.
	07:41 Air 1 reported that MFD resources and Air 2 would be able to have the Lahaina fire under control. Air 1 also noted that "this [was] sub conditions for flying." Air 1 returned to the airport.	07:05 Command (BC5) advised Air 2 there were strong winds and power lines surrounding the area they were operating in. Command (BC5) also advised they would not be able to provide a water source.
		07:12 Air 2 advised Command (BC5) that the winds were very strong, and they had a visual of the power lines. Air 2 advised there was a road above the Bypass, which may have been able to be utilized for fire attack (this was the dirt utility access road south of Ho'okahua Place). Air 2 advised he was going to try to land, but he would not be able to shut down due to the wind. Command (BC5) dispatched Tanker 3 (T3) to the road identified by Air 2.
		07:18 Air 2 confirmed T3 was in a good spot along that road, and if the fire progressed, T3 should have been able to make a good stand. Air 2 advised the bucket would be ineffective given the wind conditions so Air 2 could only provide observation support at this point.
		07:21 Air 2 advised they were looking for an area to land so they would not be in dry brush.
		07:41 Air 2 reported the fire appeared to be under control (Command (BC5) agrees). Air 2 expressed concern about the increasing wind and was going to discontinue air support. Command asked if Air 2 was able to locate a reservoir, and Air 2 confirmed the Kaua'ula reservoir was available but was a long haul. Air 2 left to return to base.

continued

TIMELINE OF EVENTS

Timeline of Aviation Communications
August 8, 2023 - August 9, 2023

DATE/TIME	AIR 1	AIR 2
August 8, 2023		08:04 Air 2 arrived at the hangar.
08:00–10:00		
10:00–12:00	10:44 Air 1 left the airport in an attempt to get a visual of the Kula fire and assess wind conditions. 11:26 Air 1 reported they finished recon of Olinda fire and had returned to base. Air 1 reported they would not be able to fly due to the high winds.	
12:00–14:00		
14:00–16:00		15:31 Air 2 contacted Command (BC5) and requested a condition update. Command (BC5) advised the winds were the same, if not worse. Air 2 reported they would try to respond. 15:51 Command (BC5) asked if Air 2 had launched. Air 2 reported that they wanted to help but conditions were too unsafe to launch.
16:00–18:00		
18:00–20:00		
20:00–22:00		
22:00–00:00		
August 9, 2023		
00:00–02:00		
02:00–04:00		
04:00–06:00	05:49 Battalion Chief 5 (BC5) reported he spoke with Don Sherer of Windward Aviation and was informed that helicopters would be able to fly today.	
06:00–08:00	06:02 Fire 2 (F2) advised Command he would be doing a recon with the air support to coordinate efforts, so Command (BC4) would have time to set up a pumpkin.	

continued

Timeline of Aviation Communications
August 8, 2023 - August 9, 2023

DATE/TIME	AIR 1	AIR 2
August 8, 2023	06:55 Air 1 advised they were just above the station and were looking for an assignment. Command advised that South Division (SD) is the most critical area at this point (where fire is near Kai Hele Kū Street and the Launiupoko community). Air 1 confirmed and reported they would head south. 06:59 Air 1 requested assignment from SD. SD advised they did not have a pumpkin available because they had no water pressure. SD advised east (mauka) of the Lahaina Bypass should be the priority area. 07:03 Engine 11 (E11) reported there was a pool located at 1[redacted] Haniu Street that Air 1 could possibly draw from. 07:32 Command (BC4) stated that the area was looking good, and the dozers had been able to cut lines. SD responded they should be able to release Air 1 in approximately 15–20 minutes. 07:36 E11 reported that there were flames burning back toward the Bypass on the north. SD reported they would have Air 1 make water drops. 07:41 Air 1 reported they saw a dozer line east (mauka) of it, but they would take care of it. 07:55 Air 1 reported to Command (BC4) that there were four (4) aircraft covering the south area now, so Air 1 was considering locating to the other side. Command (BC4) advised Air 1 to respond where they would be most effective. Command (BC4) advised there was a pumpkin set up on the north side. No further transmissions.	
06:00–08:00		

4.3.3 Maui Police Department (MPD) Response

Staffing

The wind conditions caused increased calls for service for MPD. There were reports of power outages around Lahaina, causing traffic signals to no longer work. There were also reports of large wind-borne debris, causing traffic hazards and damage to personal property. There were multiple reports of large tree limbs and metal roofing flying into the roadways, creating additional traffic hazards.

MPD had staffing levels that were consistent with normal day-to-day operations. No additional personnel were added to the patrol shifts on August 7, 2023. In the morning of August 8, 2023, high winds created the need to hold Bravo shift over to assist with increased calls for service. The Bravo (graveyard) shift Sergeant made the decision to hold over Bravo shift to assist with clearing calls for service. Bravo shift consists of six (6) officers. Alpha (daytime) shift came in for their normally assigned shift at 06:00. Alpha and Bravo shifts were normally scheduled to work 12-hour periods. Holding Bravo shift over increased the staffing level in Lahaina Town to a total of 13 officers.

Communication

Communications infrastructure is a vital component to managing a dynamic, complex operation that develops in natural or human-caused disaster incidents. High winds crippled the communications infrastructure, destroying cellular phone communication within the Lahaina region in the late morning of August 8, 2023.

Not having cellular communication significantly impacted first responders, residents, and tourists as they navigated the impacts of the incident. With no cellular communication, residents and tourists were not able to receive emergency alerts, communicate with loved ones, and/or to receive incoming or outgoing calls/texts. Cellular telephone technology has advanced over the years with cellular communication; most households no longer utilize traditional landline telephones. Studies have shown people more often transitioned to cellular communication as their primary telephone number and no longer use landline telephones[96]. Knowing both the number of residents in the Lahaina region who utilized landline telephone systems and whether those landlines were usable throughout the power outages is difficult, and it is unknown if landlines were operable when Lahaina suffered power outages.

The MPD no longer had cellular communication capabilities and had to rely solely on their portable and car radio systems while working in the Lahaina area. MPD personnel did state they did not have any cellular communication and were unable to let their family and friends know they were safe. MPD worked the entire fire incident without theability to communicate with their family or friends to see if they were safe from the fire. In one (1) incident, an officer indicated that his daughter was babysitting at a residence in the Kelawea neighborhood; without cellular communication, he was unable to determine if his daughter had escaped safely. The officer stated he was able to finally learn his daughter was safe two (2) days after the fire.

[96] Wireless Substitution: National Health Interview Survey Early Release Program

Dispatch

On August 7, 2023, Central was operating under “normal” staffing conditions until the early hours of August 8, 2023. At approximately 04:00 on August 8, 2023, an additional supervisor was contacted and requested to report to work on the island of Maui due to increased call volume. The supervisor reported to work at approximately 05:00. Upon arrival, the supervisor was informed that there was an active, large wildfire upcountry in the Olinda area. The Olinda wildfire, and associated wind-related events (e.g., wires/poles down, structural damage), were the primary focus throughout the morning. At approximately 10:00, an additional supervisor was called in to support staffing, and she was assigned to a dispatch terminal.

When a dispatcher answers an incoming call, they are responsible for the entirety of that call (i.e., dispatch of units and monitoring tactical radio operations until the resolution of an incident). The primary radio channel for fire operations is FD1. Multiple incidents may use FD1 as the primary communication channel between Central and field personnel. During shift change at 06:30 on the morning of August 8, 2023, one (1) tenured dispatcher noted that both FD1 and FD2 channels were in use, which was unusual.

Throughout the day on August 8, 2023, dispatchers were required to monitor multiple radio channels for the four (4) fires, in addition to weather-related events, and normal “day-to-day” calls. As the events continued to unfold, channels were assigned as follows:

- FD1–Primary Dispatch Channel
- FD2–Lahaina fire
- FD3–Upcountry fires (Olinda and Kula, which were merged on August 8, 2023, due to geographic co-location)
- FD4–Pūlehu fire
- FD5–Moloka‘i and Lāna‘i (Moloka‘i was receiving increasing calls from the island of Maui during the late afternoon and evening hours of August 8, 2023)
- FD6–Communication between field Battalion Chiefs (as needed)

Police channels were also in use and being monitored by dispatchers. Police channels operate separately from fire channels, and there is no interoperability for field personnel (police cannot hear fire/medic traffic, and fire/medics cannot hear police channels). During active incidents, the dispatchers must monitor radio traffic and track the location of field assets using computer-aided dispatch (CAD) and mapping software. Incidents are flagged on an incident map and prioritized by color (e.g., red is a high-priority call, orange is lower priority). Public safety vehicles equipped with automatic vehicle locating (AVL) or CAD global positioning system (GPS) systems can be seen on the map. While most police patrol vehicles had this capability, the majority of fire apparatuses did not, which presented challenges for maintaining accountability of assets. Due to staffing needs, previous Maui dispatchers, who were working for other County agencies, were requested to respond to assist at Central. A dispatcher on family leave offered to report to duty, and they were also brought in to assist. A new dispatcher (who had completed their training one (1) month prior), requested to be moved to a call-taking only station due to the overwhelming amount of radio traffic and the difficulty tracking first responder assets on scene. All five (5) call-taking/dispatch terminals were filled.

TIMELINE OF EVENTS

Throughout the day, dispatchers were assigned multiple radio channels to monitor. One (1) dispatcher, who had also worked the 2018 Lahaina fire, started her shift on August 8, 2023, with responsibility for three (3) radio channels (FD1, FD2, and Medic Comm), but during the height of activity, she was responsible for six (6) radio channels (FD1, FD2, FD3, FD4, FD 6, and Medic Comm). The dispatchers also supported field assets by tracking road closures (e.g., due to downed power lines, poles, or other debris); making calls for outside resources, including contacting Hawaiian Electric and private companies for heavy equipment assistance (e.g., bulldozers, tankers, etc.); and answering non-fire related calls.

Sometime after 14:30, the lone dispatcher on the island of Molokaʻi started to field an increasing number of emergency calls originating from the island of Maui. Citizens were calling asking for evacuation directions out of Lahaina to flee the worsening fire conditions. Many of the calls came into Molokaʻi with no geographical coordinates. The Molokaʻi dispatch terminal has the capability to see the same incident map as Central, and the dispatcher was able to see the volume and nature of calls occurring in Lahaina. They were monitoring channel FD5 and did not have further information about the events happening in Lahaina. To protect life safety, the dispatcher advised callers to seek shelter in the ocean. As calls "stacked" (i.e., placed on hold until a call-taker was available to answer), there was no time for the dispatchers to coordinate between the Molokaʻi and Central dispatch locations.

Despite upstaffing Central and receiving support from Molokaʻi, the "stacking of calls" meant that Central had to triage dispatch of units to the highest-priority events.

Brief Chronology of Significant Dispatch Events

Table 4.3.3.1 highlights a sample of the critical Lahaina fire event calls received by Central (limited to MFD resources). This is not a comprehensive list of calls received. It should be noted that Central was also receiving fire-related calls from the Olinda/Kula and Pūlehu areas, non-fire related emergency calls (e.g., medical emergencies, suicide, domestic violence, motor vehicle accidents, structural damage, wires/poles down, etc.), non-emergency calls (e.g., questions about power status, road closures, requests for unification with family members), and police administrative calls. All entries in the table refer to August 8, 2023. For the comprehensive list of these events, visit https://ag.hawaii.gov/maui-wildfire-investigation-resources-page/ or https://doi.org/10.54206/102376/VQKQ5427.

Table 4.3.3.1 Chronology of significant dispatch events on August 8, 2023, and August 9, 2023.

Chronology of Significant Dispatch Events
August 8, 2023 - August 9, 2023

TIME	EVENT
06:36	Central dispatched units to Kuʻialua Street near the Lahaina Intermediate School for a brush fire.
08:42	Central relayed to Battalion Chief 5 (BC5) that MECO* had a troubleshooter a few minutes away.
14:17	Engine 3 (E3) reported to Central that MECO* was working on power lines along Niheu Street and the Kuʻialua Street and Hoʻokahua Place/Street fire was extinguished.
14:56	Central dispatched MFD units for multiple calls reporting fire near Kuʻialua Street with flames seen.
15:06	Central received reports that evacuations were ordered for the area of Lahainaluna.
15:32	Central reported multiple calls for another fire at Kai Hele Kū Street and Hwy-30.
16:29	BC5 reported to Central that the entire neighborhood of Lahainaluna to Kahoma Stream must be evacuated. Central advised they were working on it and they currently had a report of one (1) fatality.
17:02	Central received an emergency alert activation from a firefighter's radio, known as a "1015" alert, signaling a firefighter mayday (i.e., immediate life threat). Once activated, the 1015 alert flashed across all dispatch terminals. It was this time that E1 and E6 crews were being overcome by fire and one (1) crew member had collapsed. Central was not able to contact the crew member initiating the 1015 or determine his location. Field personnel provided an update at 17:11 indicating CPR was in progress.
17:40	Central reported Front Street Apartments were fully engulfed.
17:48	Central reported Lahaina Pool and Aquatic Center were also catching fire.
18:38	Central reported parties trapped in a van at Territorial Savings.
18:43	Central reported there were parties trapped at The Coffee Bean.

**Now known as Hawaiian Electric.*

continued

TIMELINE OF EVENTS

Table 4.3.3.1 Chronology of significant dispatch events on August 8, 2023, and August 9, 2023.

Chronology of Significant Dispatch Events
August 8, 2023 - August 9, 2023

TIME	EVENT
19:25	Central reported people trapped in Aina Nalu apartments, surrounded by fire.
20:01	Central advised medics were reporting fire near Keawe Street and the Bypass moving quickly toward structures.
21:34	Central reported flames seen behind 1[redacted] Fleming Road.
22:05	Lahaina Civic Center was being abandoned as a shelter, and all parties needed to transfer to Maui Prep.
22:36	Central advises Command that two (2) buses were headed to help with transfer of parties to Maui Prep. Central also advised flames were moving fast toward the intersection from ‘Ainakea Road to Malanei.
23:44	Central advised high power lines had fallen on houses on Lau Niu Way with two (2) residents trapped.
00:53	Central advised MPD reporting embers flying near Leiali‘i Parkway.
01:21	Coast Guard Honolulu contacted Central to report 50 parties in need of rescue on Front Street by Waikiki Brewing Company.

Traffic Routes in Lahaina

Hwy-30 is the primary route to the Lahaina area from the Kahului airport. Hwy-340 is a secondary route but is significantly longer. Hwy-30 is the primary north/south route through Lahaina and the main route for tourists and residents to the Kā‘anapali area and north. Construction began on the Lahaina Bypass in 2010, and the 2.5-mile section in the center from Keawe to Hōkiokio Place was completed in 2013. The next section of the Lahaina Bypass, 2.7 miles south from Hōkiokio Place to a point between Launiupoko and Olowalu, was completed in 2018. The Bypass provides an alternative route around downtown Lahaina.

Front Street provides access from the north at Fleming Road and Hwy-30 to the far southern end of Lahaina where it connects with the Bypass. Travel from Front Street east has the following streets that provide access to Hwy-30 from north to south:

- Fleming Road
- Kapunakea Street
- Kenui Street

- Papalaua Street
- Lahainaluna Road
- Dickenson Street
- Prison Street
- Shaw Street
- ‘Aholo Road

Traffic conditions in this area on a normal day can be very challenging and slow moving from Lahaina residents and numerous tourists. Disruption of traffic signals and vehicular accidents further complicate traffic flows in this densely populated area.

From the Kelawea neighborhood, Lahainaluna Road and Komo Mai Street are the only two (2) ingress and egress routes. Streets in the neighborhood are known to be very congested due to the narrow roadway, population density, and many vehicles parked on the street. This caused significant challenges for vehicle movement into and out of the area, exacerbating the crisis.

Natural bodies of water also affected evacuations. For instance, the Kahoma Stream runs east to west and ends at the ocean, creating a barrier for traffic flows north and south. There are only four (4) routes over the stream:

- Lahaina Bypass
- Komo Mai Street
- Hwy-30
- Front Street

TIMELINE OF EVENTS

The following table (Table 4.3.3.2) represents a summary of traffic control points and evacuation challenges in west Maui.

Table 4.3.3.2 Traffic Control Challenges as Reported by MPD

Traffic Control Challenges
As reported by MPDe

Point	Date	Time	Location	Hazard	Traffic conditions	Impact	Evacuation Notes
1	August 8, 2023	05:40	Keawe Street at the northbound lanes of Hwy-30	Downed utility poles and power lines.	Impeded northbound traffic on Hwy-30.	Major intersection for northbound and southbound travel in Lahaina. Limited access to the Bypass.	Caused major traffic congestion. Limited evacuation from south to north.
2	August 8, 2023	05:40	Hwy-30 and Nāpilihau Street	Traffic signals out.	Congestion for northbound and southbound traffic on Hwy-30 in the Kāʻanapali area.	Major intersection for traffic flow in the Kāʻanapali area.	Caused traffic congestion. Limited and slowed evacuations traveling north out of Lahaina.
3	August 8, 2023	06:37	Lahainaluna Road and Kelawea Street	Police traffic control location. Initial fire at Lahainaluna Road and Kuʻialua Street area.	Stopped eastbound traffic from entering the fire area.	Allowed two (2) westbound lanes for evacuations.	Opened after fire control.
4	August 8, 2023	07:18	Lahainaluna Road and Hwy-30	Traffic signals out.	Congestion for northbound and southbound traffic on Hwy-30.	Major intersection for north, south, east and west travel in Lahaina.	Caused major traffic congestion. Limited evacuation from the middle of Lahaina.
5	August 8, 2023	07:18	Hwy-30, in the Olowalu area	Tree in the northbound lanes.	Congestion for travel in and out of Lahaina.	Primary road for entering and exiting Lahaina area.	Unknown.
6	August 8, 2023	Unavailable	Hwy-30, Front Street and Fleming Road	Traffic signal out.	Congestion for northbound and southbound traffic on Hwy-30.	Major three (3)-way intersection. Slowed travel and hindered traffic exiting via Front Street.	Caused major traffic congestion. Limited evacuations on Front Street from the middle of Lahaina.
7	August 8, 2023	Unavailable	Hwy-30 from Keawe Street to Leialiʻi Parkway	Traffic signals out. Power lines and utility poles down.	Congestion for northbound and southbound traffic on Hwy-30.	Primary road for northbound and southbound travel on the north side of Lahaina.	Caused major traffic congestion. Limited evacuations on Front Street from the middle of Lahaina.
8	August 8, 2023	08:04	Hwy-30 and Hōkiokio Place	Power lines down.	Congestion for northbound and southbound traffic on Hwy-30.	Primary road for northbound and southbound travel on the south side of Lahaina.	Caused major traffic congestion. Limited evacuations to the south of Lahaina.

continued

Traffic Control Challenges
As reported by MPDe

Point	Date	Time	Location	Hazard	Traffic conditions	Impact	Evacuation Notes
9	August 8, 2023	11:41	Kauhi Place and Kelawea Street	Power lines blocking roadway.	Congestion in neighborhood.	Created significant challenges to ingress and egress from the area.	Caused major traffic congestion. Limited evacuations from the Kelawea neighborhood.
10	August 8, 2023	13:25	Hwy-30 between Papalaua Street and Lahainaluna Road	Power lines down.	Complete closure for northbound and southbound traffic on Hwy-30.	Complete closure for northbound and southbound traffic on Hwy-30.	Road closed. Caused major traffic congestion. Limited evacuation routes.
11	August 8, 2023	Unavailable	Lahainaluna Road from Front Street to Waineʻe Street	Metal roofing material blocking the road.	Complete closure of Lahainaluna Road.	Primary exit off Front Street to the east to Hwy-30.	Road closed. Caused major traffic congestion. Limited evacuation routes.
12	August 8, 2023	14:40	1200 block of Hwy-30. Hwy-30 and Kenui Street	Abandoned vehicles.	Congestion for northbound and southbound traffic on Hwy-30.	Primary road for the Lahaina area.	Caused major traffic congestion. Limited evacuations from the neighborhood.
3a	August 8, 2023	14:55	Kuʻialua Street and Lahainaluna Road	Lahaina PM Fire.	Congested with responding Fire and Police units.	Primary evacuation route for the neighborhood east of the bypass.	Unknown.
13	August 8, 2023	Unavailable	Lahainaluna road westbound traffic from the Bypass to Hwy-30	Traffic signal out at Hwy-30 and Lahainaluna road.	Westbound traffic at a standstill.	Primary exit route for the Kelawea neighborhood.	Caused major traffic congestion. Limited evacuations from the Kelawea neighborhood.
14	August 8, 2023	15:26	Bypass between Keawe Street and Lahainaluna Road	Officers close the Bypass due to fire conditions.	Fire jumping the Bypass at Lahainaluna road.	Closed primary exit from Lahaina. Keawe Street and Hwy-30.	Public safety closure due to fire conditions. Reopened to allow traffic southbound on the Bypass after the fire passed.
15	August 8, 2023	Unavailable	Komo Mai Street and Keawe Street (Bypass)	Congestion from evacuating vehicles.	Congestion due to hazards at Hwy-30 and Keawe Street, and closure of Bypass due to fire conditions.	Traffic backing into the Kelawea neighborhood.	Caused major traffic congestion. Limited evacuations from the Kelawea neighborhood.
16	August 8, 2023	Unavailable	Komo Mai Street and Keawe Street at Oil Road	Gate opened to allow traffic onto Oil Road.	Not applicable.	Congestion relieved from Komo Mai Street and the Kelawea neighbor-hood.	Secondary exit route established.
6a	August 8, 2023	16:08	Hwy-30, Front Street, and Fleming Road	Traffic congestion from evacuating vehicles from the south. Gridlock.	Heavy traffic from the south. Traffic from the north (Kāʻanapali area) attempting to travel south.	Severe traffic congestion.	Caused major traffic congestion. Limited evacuation route to the north.

continued

TIMELINE OF EVENTS

Traffic Control Challenges
As reported by MPDe

Point	Date	Time	Location	Hazard	Traffic conditions	Impact	Evacuation Notes
17	August 8, 2023	16:36	Waine'e Street and Dickenson Street	Heavy fire conditions.	Eliminated ingress and egress from the neighborhood.	Primary exit off Front Street to the east to Hwy-30.	Eliminated evacuation exit route.
18	August 8, 2023	16:38	Kai Hele Kū Street used to access the Bypass	Exit route for south Lahaina area.	Traffic conditions allowed motorists to gain access to the Bypass.	Officers directed traffic south out of Lahaina.	Provided a secondary exit route to the south.
19	August 8, 2023	16:45	Eastern Kelawea neighborhood area	Gate opened to allow traffic out of the community.	Allowed motorists to egress the neighborhood.	Congestion relieved from the Kelawea neighborhood.	Provided a secondary exit route from the neighborhood.
6b	August 8, 2023	16:47	Hwy-30, Front Street, and Fleming Road	Traffic congestion from evacuating vehicles from the south.	Southbound traffic lanes opened for northbound travel.	Congestion relieved on northbound Front Street and Hwy-30.	Provided an additional lane to assist with exiting vehicles.
20	August 8, 2023	19:04	Shaw Street	Heavy fire conditions.	Eliminated ingress and egress from the area.	Primary exit off Front Street to the east to Hwy-30.	Eliminated evacuation exit route.
21	August 9, 2023	01:15	Wahikuli neighborhood	Heavy fire conditions.	Congested due to limited access and traffic on Hwy-30.	Eliminated ingress and egress from the area.	Slow evacuation due to traffic congestion.

Overnight wind conditions continued to increase, causing traffic hazards and delays. At approximately 05:40, officers reported downed poles and power lines in the northbound lanes of Hwy-30 and Keawe Street (Figure 4.3.3.1, #1). This caused extreme traffic congestion, as residents and tourists of Lahaina usually utilized Keawe Street and Hwy-30 to move to the north and south sides of Maui. Officers had to direct traffic at the intersection so they could assist motorists onto and off Keawe Street. Officers on traffic duty experienced high winds, airborne debris, loose dirt, and windborne objects. Officers also stated traffic signals were no longer operational due to the downed power lines in the northbound lanes of Hwy-30.

Around this same time, officers reported traffic signals were no longer functioning at Hwy-30 and Nāpilihau (Kā'anapali area) (Figure 4.3.3.1, #2). This created significant traffic congestion in both the northbound and southbound lanes of Hwy-30 in Kā'anapali. Officers attempted to alleviate the traffic congestion and responded to direct traffic at the impacted areas above. Officers remained in the area to help with traffic congestion until approximately 06:48, when additional resources were needed to assist with evacuations due to the fire above the Bypass.

Officers reported visible smoke at approximately 06:37 near the Ku'ialua Street and Lahainaluna Road area. As fire personnel began to fight the fire, officers evacuated the Ho'okahua Street and Ku'ialua Street areas. Officers continued to experience high winds, smoke-borne debris, loose dirt, and visible flames.

Officers evacuated the neighborhood north of Lahainaluna Road in the Ku'ialua Street area. The high winds caused the smoke and debris to blow west toward the Bypass. The only egress route out of this community was Lahainaluna Road, the only route to the Lahaina Bypass.

Officers made the decision to shut down traffic at Lahainaluna Road and Kelawea Street (Figure 4.3.3.1, #3). This decision prevented any traffic from moving eastbound toward the impacted fire area, allowing officers in the Ku'ialua Street area to evacuate residents out of the area without having to contend with any incoming traffic. Officers were creative while evacuating the residents, as they utilized both lanes of Lahainaluna Road to evacuate the residents toward the Bypass. These efforts now turned Lahainaluna Road into a two (2)-lane road west to the Bypass, which increased the number of evacuations from the area. Lahainaluna Road was reopened following fire control.

At approximately 07:18, officers provided an update that the traffic signals were no longer functioning at Lahainaluna Road and Hwy-30 (Figure 4.3.3.1, #4).

The Communications Center advised officers that a tree had fallen in the northbound lane of Hwy-30 (Lahaina bound lane of traffic) in the Olowalu area south of Lahaina (Figure 4.3.3.1, #5). This caused traffic congestion for residents and tourists traveling to and from Lahaina.

These initial traffic issues caused significant congestion along Hwy-30 on the morning of August 8, 2023. Each location required law enforcement officers to direct traffic and attempt to eliminate additional congestion. With the power outage and trees, power lines, and utility poles blocking the roadway, these were all long-term challenges with diminishing options.

Officers indicated that the traffic signals were no longer functioning at Hwy-30 where Front Street and Fleming Road converge on the north side of the shopping district in Lahaina Town (Figure 4.3.3.1, #6).

This additional traffic issue on Hwy-30 caused significant gridlock.

At approximately 07:23, residents of Aki Street in Lahaina (between Lahainaluna Road and Komo Mai Street areas) reported that a large piece of aluminum corrugated roof had blown off the residence at 4[redacted] Aki Street striking multiple vehicles parked on the road and was "wrapped up in electric and utility lines."

Due to increased high winds, officers indicated utility poles and power lines were down at Front Street and Hwy-30 (Figure 4.3.3.1, #6). Officers reported all traffic lights were out on Hwy-30 from the Keawe Street to Leiali'i Parkway by the Lahaina Police Station (Figure 4.3.3.1, #7).

At approximately 07:38, officers reported that they were completely overwhelmed with both traffic and pedestrian numbers. Alpha Team Sergeant reported there were high voltage lines on the roadway preventing any flow of traffic along Hwy-30. Officers reported they needed to create a traffic post at Front Street/Fleming Road and Hwy-30 to alleviate heavy traffic congestion in all directions (Figure 4.3.3.1, #6).

TIMELINE OF EVENTS

Demonstrating the previously described community cooperation between the authorities and the public, the Alpha Team Sergeant reported a resident at 4[redacted] Kauhi Place advised that the whole front portion of their residence blew off into the roadway exposing multiple wires and creating hazardous conditions.

At approximately 08:04, officers reported all roadways were shut down at Hwy-30 and Hōkiokio Place due to downed power lines (Figure 4.3.3.1, #8). This significantly impacted both ingress and egress south of Lahaina Town. Officers stated that getting needed resources into Lahaina Town and evacuating both motorists and pedestrians was difficult due to downed utility poles blocking the highway near Hōkiokio Place.

This was the fifth major intersection in the Lahaina area with traffic issues and significant congestion. Each location required law enforcement officers to direct traffic and attempt to eliminate additional congestion. There were now very limited options for traffic flow and diversions

At approximately 11:41, officers reported downed power lines blocking the roadway at Kauhi Place and Kelawea Street (Figure 4.3.3.2, #9). This created significant challenges to ingress and egress out of the area as Kelawea Street was a main access point to Lahainaluna Road for residents in the Kelawea neighborhood.

At approximately 13:25, Alpha Team Sergeant reported multiple downed power lines on the roadway at Hwy-30 between Papalaua Street and Lahainaluna Road (Figure 4.3.3.2, #10). This road closure cut off ingress and egress out of Lahaina Town. This road closure eliminated an eastbound exit route from Lahaina Town to Hwy-30, presenting a major closure of Hwy-30. This closure reduced the number of eastbound exit routes from eight (8) to seven (7) between Front Street and Hwy-30. Officers were forced to divert traffic to Front Street to exit Lahaina Town due to the roadway closure at the Bypass and Hwy-30.

At approximately 14:21, MPD Captain reported he was having the neighborhood evacuated at the Mill Street area between Lahainaluna Road and Dickenson Street due to downed power lines. This area contained a mix of residential and commercial properties.

Officers reported metal roofs had blown off properties in the Lahainaluna Road area, which blocked Lahainaluna Road traffic from Front Street to Waine'e Street (Figure 4.3.3.2, #11).

At approximately 14:40, the Communications Center received reports that motorists had stopped and abandoned their vehicles in the roadway at the 1200 block of Hwy-30 (Figure 4.3.3.2, #12). The 1200 block of Hwy-30 is just north of Kenui Street. This created additional traffic hazards, as motorists attempted to navigate the area. At this time, downed utility poles, blocked power lines, abandoned vehicles, and non-functioning traffic signals snarled Hwy-30 traffic in eight key locations.

Officers dealt with road closures, non-functional traffic lights, and heavy traffic congestion in the Lahaina area throughout the morning and into the afternoon. Officers dealt with uncooperative motorists and pedestrians as they worked to ease the traffic.

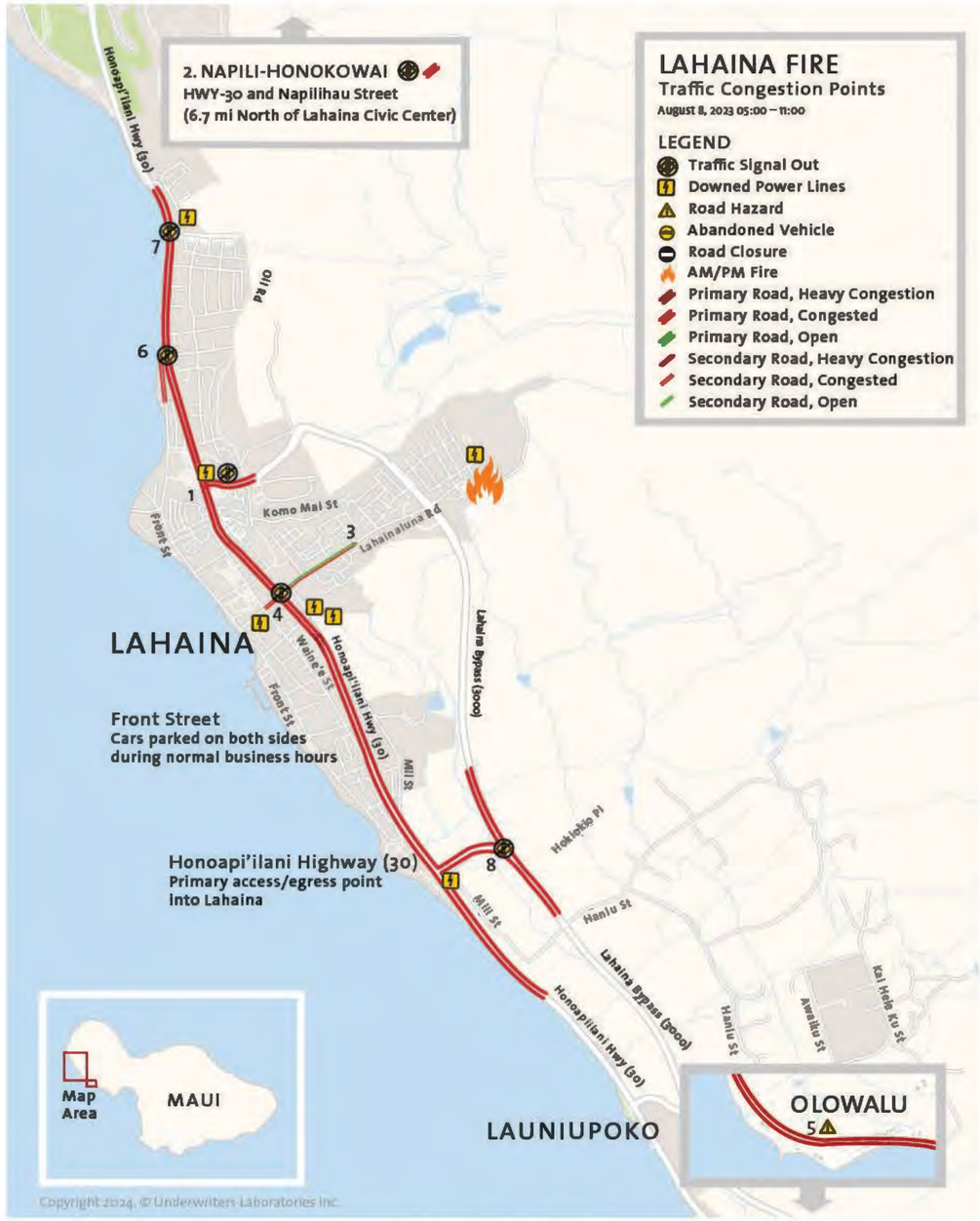


Figure 4.3.3.1 Traffic congestion points (August 8, 2023, 05:00–11:00).

TIMELINE OF EVENTS

At approximately 14:55, officers responded to Ku'ialua Street off Lahainaluna Road for a reported flare-up from the initial brush fire from the morning (Figure 4.3.3.2, #3a). Keawe Street to the Bypass was the only exit to the south of Lahaina, which was not blocked or impeded at this time. Officers voiced via the radio to stop all southbound traffic heading toward Lahaina on Hwy-30.

At approximately 15:06, officers responded to 7[redacted] Ho'okahua Street for a shed that was reported on fire. Officers were concerned about the fire being close to the propane tanks, so they used garden hoses to try to extinguish the fire.

A review of the CAD data indicated MPD staffing levels in Lahaina to be 19 officers at the time of the Lahaina PM fire, up from an initial 13 officers present during the first fire, which was already an increased number of on-duty officers. Additional officers responded from different locations in Maui. Two (2) officers who were on duty in Kīhei responded to Lahaina to assist with the traffic posts and evacuations. Two (2) officers who had just completed a homicide training class in Wailuku responded to assist with the evacuations. One (1) officer who was off-duty responded from the Wailuku area to assist with evacuations. One (1) officer who had just completed Emergency Vehicle Operations Course (EVOC) training responded to assist with evacuations.

At approximately 15:23, officers blocked ingress traffic access to the area on Lahainaluna Road from Hwy-30. Officers drove through the neighborhood using PA announcements and door-to-door notifications to warn residents to evacuate the area.

Lahainaluna Road (westbound) traffic was at a standstill from the Bypass to Hwy-30 due to the traffic lights being out (Figure 4.3.3.2, #13).

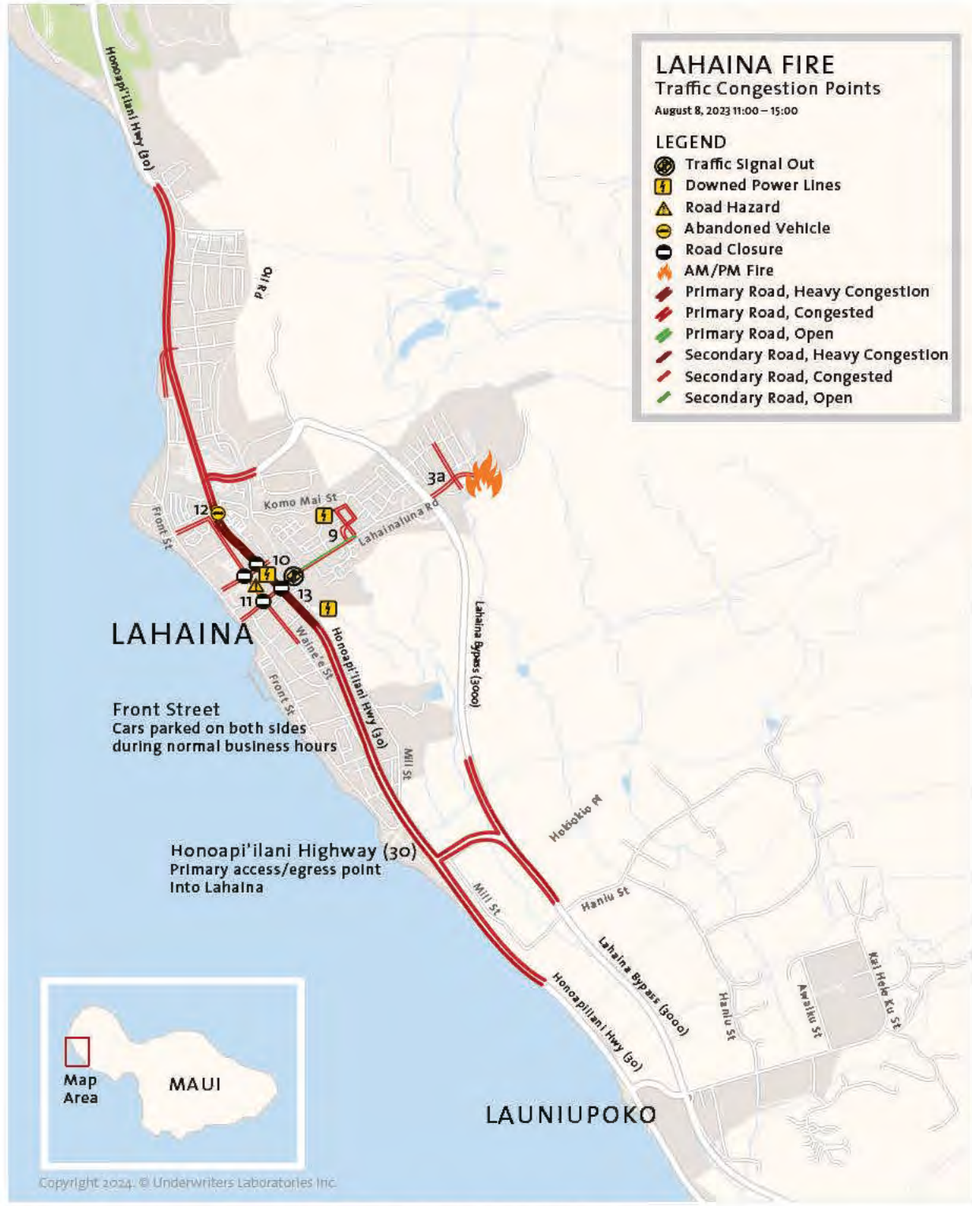


Figure 4.3.3.2 Traffic congestion points (August 8, 2023 11:00–15:00)

TIMELINE OF EVENTS

At approximately 15:26, the MFD dispatch stated that the fire jumped the Bypass and was heading westbound. MFD requested officers to evacuate the Kelawea residential community below the Bypass between Lahainaluna Road and Keawe Street. MFD personnel asked officers to shut down the Bypass, preventing any traffic to travel northbound or southbound (Figure 4.3.3.3, #14). Officers drove through the Kelawea neighborhood conducting PA announcements to evacuate the residents. Officers also stated they performed door-to-door notifications. Officers reported there were several residents already packing up to evacuate, while others refused to leave. Although complying with evacuation directions, residents leaving the area caused heavy traffic delays due to there only being two (2) ways out of the Kelawea community (i.e., Lahainaluna Road and Komo Mai Street). In the neighborhood, additional traffic congestion was caused by multiple parked vehicles, power lines down, and utility poles blocking the roadway. Officers could not evacuate residents eastbound Lahainaluna Road due to the fire moving westbound toward them.

There was heavy traffic congestion at the intersection of Hwy-30 and Lahainaluna Road due to traffic signal outages and downed utility poles on Hwy-30 between Papalaua Street and Lahainaluna Road. Komo Mai Street also experienced heavy congestion, as motorists could only turn westbound toward Hwy-30 due to the Bypass being closed to eastbound traffic (Figure 4.3.3.3, #15). Traffic congestion was compounded due to traffic signal outages at Hwy-30 and Keawe Street.

Traffic on Lahainaluna Road and Komo Mai Street was at a standstill. As another example of the authorities' and public's cooperation, officers were approached by a motorist who had keys to a gate for a dirt access road northbound off the Keawe Street (Bypass) at Oil Road. An officer opened the gate and escorted the heavy traffic off Komo Mai Street north out of the area (Figure 4.3.3.3, #16). Officers immediately recognized that they had to devise additional egress routes to help alleviate the traffic congestion on Komo Mai Street. Officers directed traffic into the Gateway shopping center, which later proved critical in getting the heavy traffic off Komo Mai Street and out of the path of the fire.

At approximately 15:56, due to increased hazardous conditions caused by fire, heavy smoke, high winds, and traffic conditions, officers began emergency transports of incapacitated residents. Officers transported residents to the Lahaina Civic Center, already a designated evacuation shelter for this incident. At approximately 16:04, officers responded and evacuated the senior citizens retirement home at 810 Kelawea Street. Officers faced challenges evacuating residents from the retirement home due to some disabled residents' inability to move quickly.

At approximately 16:08, officers advised that traffic at Hwy-30, Front Street, and Fleming Road was so impacted as to cause major delays due to the evacuation of residents from Front Street. Further delaying evacuation efforts, southbound traffic inflowed from the Kā'anapali area (Figure 4.3.3.3, #6a).

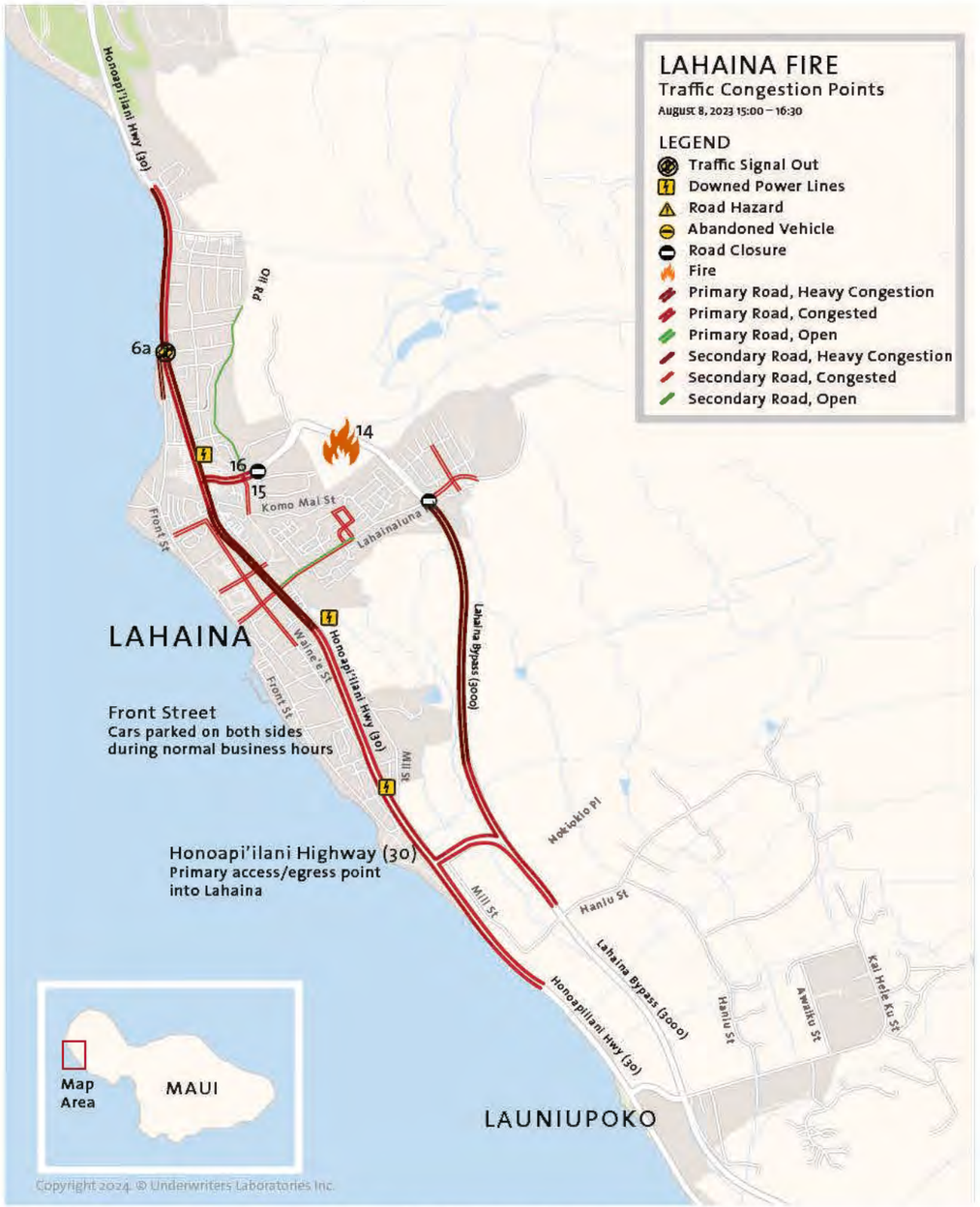


Figure 4.3.3.3 Traffic congestion points (August 8, 2023 15:00–16:30).

TIMELINE OF EVENTS

Officers evacuated residents on Mill Street as the fire encroached. Officers reported that propane tanks were exploding near the food truck area just east of Hwy-30 and south of Lahainaluna Road. Heavy smoke continued to saturate the area causing little to no visibility.

At approximately 16:26, officers reported that the fire was moving rapidly westbound through the Kelawea community. Officers described utility poles, houses, and center medians that were on fire around the area of Lahainaluna Road and Hwy-30. Officers reported that the smoke was so thick they had zero visibility when trying to evacuate area residents.

At approximately 16:29, an officer reported that Oil Road was passable, and all gates along the route were open to allow traffic to leave the Kelawea community area northbound from the fire. This now allowed officers to help alleviate some of the congestion by sending vehicles down Oil Road.

At approximately 16:32, officers evacuated the Weinberg Court Apartments at 615 Hwy-30. Officers rescued a 65-year-old male suffering from burns and drove him out of the area to medics, who provided medical attention.

At approximately 16:36, officers reported the neighborhood between Hwy-30, Waine‘e Street, and Dickenson Street was completely engulfed with fire, significantly hindering ingress and egress from the area (Figure 4.3.3.4, #17). The impacts in this area caused significant problems for ingress and egress. Dickenson Street, one (1) of eight (8) roads from Front Street that connects to Hwy-30, runs east and west and continues eastbound past Hwy-30. This route was no longer an option for residents and tourists to evacuate the area from Lahaina Town. The fire moved rapidly, and the heavy smoke made it difficult to evacuate the area due to zero visibility at times. Waine‘e Street parallels Hwy-30 and runs northbound from the curve at Kaua‘ula Road until the road dead ends into Kenui Street. During normal traffic conditions, Waine‘e Street is used to traverse through Lahaina Town to avoid traffic on Front Street. The fire and heavy smoke on Waine‘e Street created significant challenges to utilize Waine‘e Street to evacuate the area.

At approximately 16:38, a sergeant advised officers to direct egress traffic to the Bypass via Kai Hele Kū Street (southernmost street of Lahaina) (Figure 4.3.3.4, #18). This decision allowed officers to evacuate residents to the south and safely out of Lahaina Town. This traffic flow allowed motorists to gain access onto the Bypass.

At approximately 16:39, an officer transported two (2) adults to safety from the Weinberg Court Apartments off Waine‘e Street to the Lahaina Civic Center.

At approximately 16:45, an officer found an access dirt road that was blocked by a metal gate that was locked. The gate was located in the southeast section of the Kelawea residential community and adjacent to the southside of Kahoma Stream that ran westbound from the Bypass. The officer stated there were about 30–50 cars trapped by the gate and unable to flee the area. The officer got help from a resident who responded with a reciprocating saw to cut the lock. An officer opened a chain-link gate nearby by pulling it open with a tow strap to allow traffic to flee the area to safety. One side of the gate was opened, and a motorist stopped at the gate because he was not sure if

there was enough clearance to get through. The officer noticed the structures next to the line of cars were now fully engulfed, so he ran toward the gate and rammed his body into the cyclone gate to open the other side (Figure 4.3.3.4, #19). The officer’s actions allowed motorists to drive through the gate to get to safety. The officer indicated 30–50 fully loaded cars passed through the gate to safety.

At approximately 16:47, Alpha Team Sergeant opened southbound lanes of traffic at Hwy-30 and the southernmost point of Front Street, which allowed traffic to leave the area. This was critical in helping to alleviate the heavy traffic congestion and allowed a safe route for evacuations (Figure 4.3.3.4, #6b).

Officers rescued six (6) people from Weinberg Apartments and transported them to the Lahaina Civic Center.
At approximately 16:57, an officer rescued two (2) women who were involved in a traffic accident. One (1) woman indicated she was having chest pains and felt like she was having a heart attack. The other passenger of the vehicle indicated she had an injury to her ankle. Officers transported them to the Lahaina Civic Center from Keawe Street and Kuhua Street to medics for treatment.

At approximately 17:01, an officer was at a traffic post at Shaw Street and Hwy-30 when he heard firefighters radio a “mayday,” which indicated a fire crew was trapped by the fire. While directing traffic, a firefighter pulled up in a “Brush Truck” and stated he needed the officer’s vehicle to go rescue members of his fire crew. The officer stated the Brush Truck was no longer operable due to the severe damage it received when the firefighter drove through heavy smoke and fire to get help for his fire crew.[97] The officer gave his vehicle to the firefighter to help rescue his fire crew that was trapped by the fire. The firefighter later returned to the officer’s location with his fire crew. CPR was administered to the Fire Captain and he was later transported to the hospital for treatment. Shaw Street and Hwy-30 remained a traffic post until approximately 17:37 when the conditions deteriorated, and the officer responded to assist with evacuations at the Front Street Apartments.

At approximately 17:10, Alpha Team Sergeant informed the communications center the fire had now reached Front Street, and people appeared to be trapped.

Officers indicated the middle of Lahaina Town between Lahainaluna Road and Shaw Street was no longer accessible at times due to zero visibility from the heavy smoke, structure fires, and extreme heat. Officers began working from the north and south to enter Lahaina Town to conduct multiple evacuations and rescues.

At approximately 17:58, a detective rescued a female from Lahaina Town and escorted her to safety at the Lahaina Civic Center.

At approximately 18:01, officers advised the communications center that Kahoma Village started to catch fire. Officers drove through Kahoma Village and went door-to-door to evacuate residents. An officer contacted an elderly woman inside Kahoma Village who was watering her bushes with a garden hose. The officer encouraged the elderly woman to leave the area and assisted her with evacuating the location.

[97] Fire personnel later responded to the location of the Brush Truck and determined the vehicle was still operable after removing the debris from underneath the vehicle.

TIMELINE OF EVENTS

At approximately 18:15, officers indicated fire conditions, road conditions, and multiple traffic hazards made it difficult to conduct rescues in Lahaina Town. A radio announcement was made to request all available officers not assigned traffic posts to return to the station for additional assignments. To have a coordinated response, small teams of officers were assigned to four (4) sergeants. Lahaina Town was separated into four (4) quadrants. It was determined Lahainaluna Road would be the center of the officers' response grid, as it ran in an east-west direction from the ocean up toward the mountain range. Hwy-30 was the horizontal grid line, as it ran in a north-south direction from the southern point of Lahaina Town and northbound to the north side of Maui.

At approximately 18:42, officers were dispatched to The Coffee Bean at 878 Front Street where two (2) people were stuck inside a white van according to reported information. The responding officers drove through heavy smoke and structure fires to reach The Coffee Bean and located the white van. Upon arrival they noticed several cell phone flashlights shining from inside the café trying to get their attention. They opened the doors of the café and noticed approximately 15 people were stranded inside. The officers loaded as many people as they could into their vehicles receiving assistance from fire personnel to rescue the 15 people, driving them to safety at the Lahaina Civic Center. Body camera footage captured the rescue and fire conditions in the area. Heavy smoke made visibility difficult at times. One minute you could see the roadway and the next there was zero visibility. Officers and evacuees could be heard coughing and gasping for air as they escaped the area. The fire was burning on both sides of the roadway as they drove out of the area.

At approximately 18:43, officers were notified that the National Guard was activated and enroute to assist with traffic posts and evacuations.

At approximately 19:04, officers updated the communications center that Shaw Street was now impassable due to the fire (Figure 4.3.3.4, #20). This condition created another challenge for ingress and egress, since Shaw Street was no longer an escape route. This also cut off an additional exit route from Lahaina Town. With Papalaua Street already blocked off from the fire and now Shaw Street being blocked off from the fire, the potential evacuation exit routes from Front Street in Lahaina Town were reduced from eight (8) to six (6).

At approximately 19:11, officers reported they were trapped due to heavy smoke and fire at 505 Front Street (Shaw Street and Front Street). Officers indicated there was zero visibility from the smoke and that they had to leave the area. Officers later updated they were able to find their way out of the area impacted by the fire.

At approximately 19:16, officers advised they evacuated the Aulike Street area, which contained a homeless shelter near the aquatic center. Officers stated they made multiple rescue transports to the Lahaina Civic Center from the Aulike Street area.

At approximately 19:18, officers conducted numerous rescue transports of residents to the Civic Center shelter from fire impacted areas.

At approximately 20:07, officers began driving through the Wahikuli community and conducted evacuations via PA announcements and door-to-door notifications. Officers drove through the neighborhood between Kapunakea Street and Leiali'I Parkway to conduct evacuations. Officers indicated residents were packing up to leave the area but contacted some residents who were reluctant to leave.

At approximately 20:37, the fire crossed into the Aulike Street area located between Mill Street and Hwy-30. Officers evacuated the Safeway at Keawe Street and Hwy-30. Officers transported several stranded pedestrians from the Safeway and drove them to the Lahaina Civic Center.

At approximately 21:01, the fire was about 200 yards from Hōkiokio Place and Hwy-30. Officers moved onlookers and residents south, away from Hōkiokio Place, because the fire was now moving in their direction. Hōkiokio area was eventually cleared of vehicles and residents. Officers were then forced to move the pedestrians from Puamana Park toward Launiupoko. The downed power lines in the area caused significant delays in traffic movement out of the area.

The Assistant Police Chief contacted officers at approximately 21:46 and stated the fire department provided information that the fire was about two (2) miles from the Lahaina Civic Center. The Assistant Police Chief stated via the radio they were with the mayor, and a decision was made for the evacuation of the Lahaina Civic Center. At approximately 21:49, the Assistant Police Chief ordered the evacuation of the Lahaina Civic Center and moved the shelter location to Maui Prep Academy.

At approximately 22:10, patrol units evacuated the Lahaina Civic Center by using Maui public transit buses to transport people to Maui Prep Academy. Alpha Team Sergeant reported hundreds, if not thousands, of people were moved to Maui Prep Academy. The evacuations were conducted via buses and private vehicles.

At approximately 00:20, an Assistant Police Chief advised patrol units about unconfirmed reports of "bodies" in Lahaina and requested a unit to respond and confirm. Due to unsafe conditions, officers were not able to access certain areas of Lahaina to check for fire casualties.

At approximately 00:49, officers updated that the fire had now moved eastbound (mauka) of the Bypass. The fire was now headed toward the residential community east of the Bypass and south of Hōkiokio Place. Officers drove through the residential community making PA announcements to evacuate the area.

At approximately 01:00, officers transported stranded Lahaina citizens from Lahaina to the Maui Prep School.
At approximately 01:14, officers continued to respond to medical emergencies throughout the city and assisted citizens with various injuries.

TIMELINE OF EVENTS

At approximately 01:15, the fire was heading towards the Hawaiian Homes area just south of the Lahaina Civic Center. The fire was now in the residential community east of Hwy-30 and north of Kapunakea Street (Figure 4.3.3.4, #21). Evacuations were conducted in the area from Kapunakea Street to Leiali'i Parkway. Evacuations from this area were difficult due to the limited access points for ingress and egress. Oil Road was the eastern boundary and ran parallel to the residential community. Hwy-30 was the western boundary and ran parallel to the residential community. Residents were able to exit the community eastbound through the open gates by using Oil Road. There were five (5) roads that exited to Hwy-30 from the residential community. The five (5) access roads that allowed egress from the community were Kapunakea Street, Fleming Road, Wahikuli Road, Kaniau Road, and Leiali'i Parkway. The intersection at Hwy-30 and Kapunakea Street as well as the intersection at Fleming Road, Front Street, and Hwy-30 had heavy traffic congestion due to wires and poles down and the traffic signals not being functional. The intersections at Wahikuli Road and Hwy-30 and at Kaniau Road and Hwy-30 were controlled by a stop sign. There was heavy traffic congestion due to it being a "T" intersection and all traffic leaving Lahaina was headed northbound. The intersection at Leiali'i Parkway and Hwy-30 had heavy congestion due to wires and poles down and non-functional traffic signals. Officers assisted with traffic to head northbound from Leiali'I Parkway and Hwy-30. These conditions made evacuation of residents out of the residential community extremely difficult. Officers also stated they had difficulty evacuating residents who took refuge in the Wahikuli Wayside Park. The only evacuation route was northbound Hwy-30.

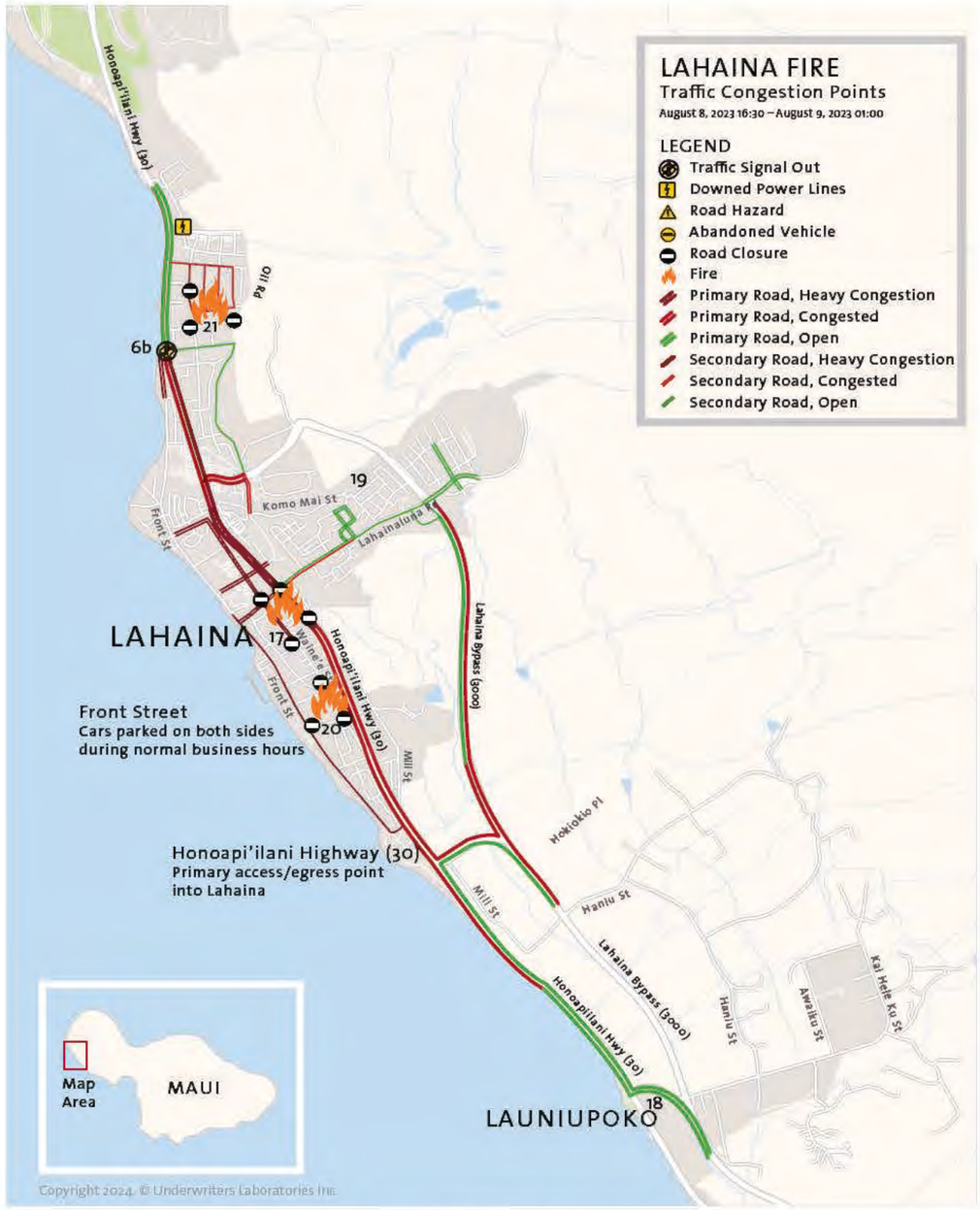


Figure 4.3.3.4 Traffic congestion points (August 8, 2023, 16:30–August 9, 2023, 01:00).

TIMELINE OF EVENTS

At approximately 01:19, Lahaina Fire personnel requested officers to evacuate the Kualapa Loop residents in Kāʻanapali, as the fire appeared to move in that direction. Officers responded to the Kualapa Loop on Kāʻanapali Parkway to evacuate residents from the vacation resorts.

At approximately 01:20, the Coast Guard asked for assistance from officers in attempting to locate and rescue approximately 50 people from the Waikiki Brewery Company area (900 Front Street and Papalaua Street). Due to unsafe conditions, officers were not able to access the area of Lahaina to check for fire casualties.

At approximately 03:25, officers located and transported a severe burn victim to medics to receive treatment.

At approximately 03:26, officers responded to the Honua Kai Resort (north of Lahaina) and evacuated their residents northbound.

From approximately 03:00 to 06:00, officers controlled several traffic posts north and south of Lahaina Town to assist with continued evacuations.

Evacuation efforts reduced until daylight as most of the traffic had already been diverted out of the area. These efforts continued until there was a transition to search the area for any remaining survivors and burn victims.

Throughout the fire, MPD personnel stated that they evacuated many residents in their patrol vehicles, filling the vehicles to capacity with each trip (Table 4.3.3.3). They also stated that they directed “thousands” of vehicles safely out of the fire’s path.

During interviews, officers advised they encountered residents and tourists who refused or had no sense of urgency to evacuate the area.

Officers stated they were verbally abused or ignored, and people drove around controlled traffic locations to enter Lahaina throughout the fire incident.

Table 4.3.3.3 Direct Rescues and Evacuations Discussed in Law Enforcement Technical Discussions (TDs).

Direct Rescues and Evacuations
As reported by MPD in Technical Discussions

Time	Location	Number Rescued	Evacuation Notes
06:37	Kuʻialua Street and Lahainaluna area	Unreported	Evacuations with PA and door-to-door notifications. Initial Fire area.
14:55	Kuʻialua Street and Lahainaluna area	Unreported	Evacuations with PA and door-to-door notifications. Lahaina PM Fire.
15:06	7[redacted] Hoʻokahua Street	Unreported	Shed fire with extension.
15:23	Lahainaluna road area	Unreported	Evacuations with PA and door-to-door notifications.
15:26	Kelawea community	Unreported	Evacuations with PA and door-to-door notifications.
n/a	Komo Mai Street area	Unreported	Opened gate to relieve traffic and provide a secondary means of egress. Evacuations with PA and door-to-door notifications.
15:56	Lahaina Area	Unreported	Evacuations with PA and door-to-door notifications. Officers began emergency transports of incapacitated residents.
16:04	8[redacted] Kelawea Street	Unreported	Evacuation of the Hale Mahaolu ‘Eono Senior Center.
n/a	Mill Street and Lahainaluna road	Unreported	Evacuations with PA and door-to-door notifications. Evacuation of residents.
16:32	Weinberg Court Apartments 615 Hwy-30	Unreported	Evacuation of apartments.
16:32	Weinberg Court Apartments 615 Hwy-30	65-year-old male	Evacuated with burns injuries.
16:39	Waineʻe Street area	Two (2) adults	Evacuated.
16:45	Kelawea Community	50+	Opened gate to provide secondary means of egress. Evacuations with PA and door-to-door notifications.
16:47	Weinberg Apartments	Six (6) citizens	Evacuated.
16:57	Keawe Street and Kuhua Street	Two (2) citizens	Involved in a traffic accident with significant injuries.
17:01	Shaw Street and Hwy30	Eight (8) firefighters	Assist with the mayday of eight (8) firefighters.
17:58	Lahaina	Unreported	Multiple fire related evacuations with PA and door-to-door notifications.
17:58	Lahaina	One (1) female	Rescued and evacuated from Lahaina Town.
18:01	Kahoma Village	Not available	Evacuations with PA and door-to-door notifications.
18:42	The Coffee Bean	15 citizens	Rescued and evacuated from Lahaina Town.

TIMELINE OF EVENTS

Search and Recovery of Deceased

At approximately 00:20, an Assistant Police Chief advised patrol units about unconfirmed reports of “bodies” in Lahaina and requested a unit to respond and confirm. Officers were not able to access certain areas of Lahaina to check for fire casualties.

Deceased body recoveries were conducted and supervised by Acting Lieutenant Matthew Brown and Detective Matthew Bigoss. The two (2) investigators relieved each other over the course of several days, beginning on August 9, 2023. Each worked a 12-hour shift and briefed the other as they transitioned onto their shift.

On August 9, 2023, after conducting evacuations and supervising efforts around Lahaina for almost 26 hours, Lieutenant Matthew Brown and his team began recovering bodies at 08:00.

The first human remains were located at approximately 08:00. As the day continued, officers from other MPD districts assisted with the body recovery process. On the first day, the team concentrated on body recoveries in the roadways. The bodies were photographed, noting time and location of recovery. The bodies were transported to the Lahaina Civic Center for the morgue technicians.

At 14:30, Detective Bigoss and his team relieved Lieutenant Brown. They continued with the recovery efforts until the evening hours and followed the same protocols for recoveries.

On August 10, 2023, at around 12:00, recovery search efforts continued and included mainly homes and vehicles. The supervisory team advised the bodies recovered in homes and on roadways were not recognizable as intact human remains. This created additional challenges in the recovery efforts. The human remains not being fully intact made it difficult to collect and transport to the Lahaina Civic Center.

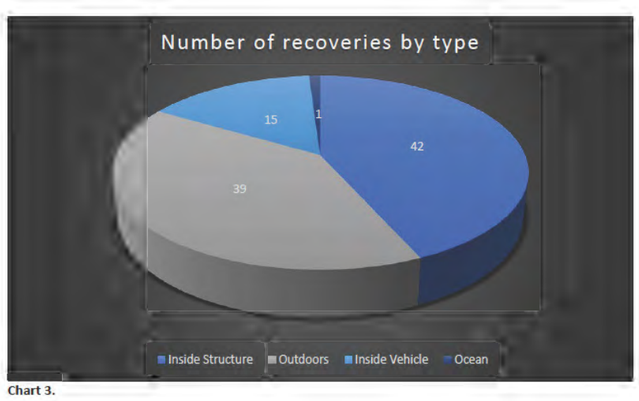


Figure 4.3.3.5 MPD Preliminary After-Action Recovery Report, page 65. Victims and recoveries by type.[98]

CHART 1

CHART 2

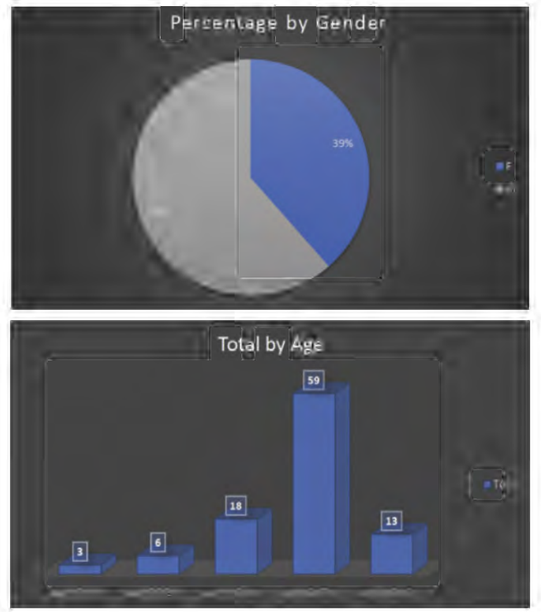


Figure 4.3.3.6 MPD Preliminary After-Action Recovery Report, page 54. Decedent data by gender and age type. Statistics/charts are based on total fire-related decedents identified.[99]

On August 11, 2023, MPD utilized the Urban Search and Rescue (USAR) team to assist with human remains recoveries. They were equipped with cadaver canines trained to locate human remains.

The next day, a large contingent of USAR teams arrived to assist with search efforts. They divided the teams up into groups with one (1) team being responsible for north of Lahainaluna Road and the other team being responsible for south of Lahainaluna Road. The USAR teams were given MPD radios and advised to alert the MPD recovery teams when they located human remains. The recovery teams responded and followed the same protocols about photographing, noting time and location, and transporting remains to the Lahaina Civic Center until the morgue technicians could take possession of the human remains.

Lieutenant Matthew Brown advised that all recoveries were logged noting the date, time, and location of each recovery. See Figures 4.3.3.7 through 4.3.3.13 for MPD’s detailed victim recovery locations.

[98, 99] *http://www.mauipolice.com/uploads/1/3/1/2/131209824/pre_aar_master_copy_final_draft_1.23.24.pdf*

TIMELINE OF EVENTS

C. Maps of Victim Recoveries

Map Legend 1

• = Location of recovery	
Number = Corresponding to number matching names to maps. *(The number does not represent a recovery sequence; instead, it denotes specific locations.)*	Example:
First Name, Middle name or initial, LAST NAME *(of decedent recovered)*	• 1, First, MI, LAST (99)
(Number) = Age of decedent at time of death.	
P = Parking Lot = Grocery Store	

Figure 4.3.3.7 MPD Preliminary After-Action Report, page 47. Maps of victim recoveries, map legend 1.[100]

[100] *http://www.mauipolice.com/uploads/1/3/1/2/131209824/pre_aar_master_copy_final_draft_1.23.24.pdf*

MAP 1



Figure 4.3.3.8 MPD Preliminary After-Action Report, page 48. Maps of victim recoveries, map 1.[101]

[101] *http://www.mauipolice.com/uploads/1/3/1/2/131209824/pre_aar_master_copy_final_draft_1.23.24.pdf*

TIMELINE OF EVENTS

MAP 2



Figure 4.3.3.9 MPD Preliminary After-Action Report, page 49. Maps of victim recoveries, map 2. [102]

[102] *http://www.mauipolice.com/uploads/1/3/1/2/131209824/pre_aar_master_copy_final_draft_1.23.24.pdf*

MAP 3



Figure 4.3.3.10 MPD Preliminary After-Action Report page 50. Maps of victim recoveries, map 3.[103] *Each red dot indicates the location of a recovery with a number that matches specific names to the mapped location (Figure 4.3.3.13).*

[103] *http://www.mauipolice.com/uploads/1/3/1/2/131209824/pre_aar_master_copy_final_draft_1.23.24.pdf*

TIMELINE OF EVENTS

MAP 4

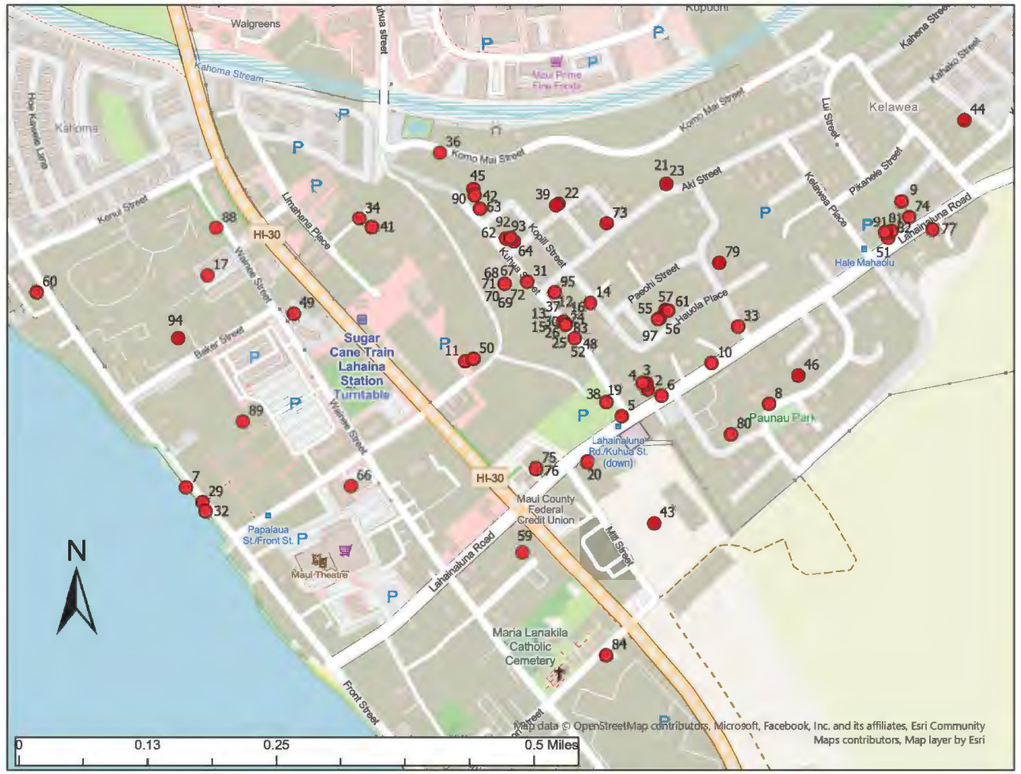


Figure 4.3.3.11 MPD Preliminary After-Action Report, Page 51. Maps of victim recoveries, map 4.* [104]
*Each red dot indicates the location of a recovery with a number that matches specific names to the mapped location (Figure 4.3.3.13). (*Note: Image rotated 90° clockwise from the original reference document).*

[104] *http://www.mauipolice.com/uploads/1/3/1/2/131209824/pre_aar_master_copy_final_draft_1.23.24.pdf*

MAP 5



Figure 4.3.3.12 MPD Preliminary After-Action Report, page 52. Maps of victim recoveries, map 5.[105]
Each red dot indicates the location of a recovery with a number that matches specific names to the mapped location (Figure 4.3.3.13).

[105] *http://www.mauipolice.com/uploads/1/3/1/2/131209824/pre_aar_master_copy_final_draft_1.23.24.pdf*

TIMELINE OF EVENTS

MAP LEGEND 2

1. Marilou Merquita DIAS (60)
2. Coleen Ann JONES (59)
3. Jonathan SOMAOANG (76)
4. Donna Lyn GOMES (71)
5. Lynn Misae MANIBOG (74)
6. Glenn Yoshio YOSHINO (75)
7. Freeman TAM LUNG (80)
8. Carolyn Hinae ONO (73)
9. Virginia Bernadette DOFA (90)
10. Rodolfo Sibucao ROCUTAN (76)
11. Douglas J. GLOEGE (59)
12. Dale Ann RICHTER (66)
13. Terri E. THOMAS (62)
14. Todd Mitsugi NAKAMURA (61)
15. Maluifonua TONE (73)
16. Faaoso TONE (70)
17. Maurice BUEN (79)
18. Tau PONALI (66)
19. Joseph Alexander SCHILLING (67)
20. Conchita Domagiay SAGUDANG (75)
21. Floyd Allen ST.CLAIR (75)
22. Melvamay Leimomi BENJAMIN (71)
23. Janet Kay ST. CLAIR (75)
24. Juan DELEON (45)
25. Revelina Baybayan TOMBOC (81)
26. Ediomede PAVIAN CASTILLO (35)
27. Theresa Elizabeth COOK (72)
28. David Jerry NUESCA Jr. (59)
29. Pablo Anteola PAGDILAO III (75)
30. Salote U. TONE (39)
31. Gwendolyn Kanani PUOU (83)
32. James Pillow SMITH (79)
33. Bernard Sulidad PORTABES (75)
34. Mark John KAMINSKY (S9)
35. Todd Eiji YAMAFUJI (68)
36. Alfredo Abanilla GALINATO (79)
37. Tony Manatu'ofa TAKAFUA (7)
38. Danilo Domagyay SAGUDANG (55)
39. Edward Katsumi SATO (76)
40. Clyde Takahashi WAKIDA (74)
41. Michael Steven MAHNENSMITH (80)
42. Glenda Quijano YABES (48)
43. Franklin Arturo TREJOS (68)
44. Keyiro Emmanuel FUENTES (14)
45. Joel Ibbay VILLEGAS (55)
46. Leroy WAGNER (69)
47. Rex Alfred COLE (64)
48. Bette Jo DYCKMAN (73)
49. Valerie Susan KAUFFMAN (78)
50. Rebecca Ann RANS (57)
51. Buddy Lorenzo JANTOC (79)
52. Robert P. DYCKMAN (74)
53. Michael Ray GORDON (68)
54. Carlo Vagay TOBIAS (54)
55. Luz Quijano BERNABE (64)
56. Salvador C. COLOMA (77)
57. Carole Gardner HARTLEY (60)
58. Leslie Eade SMITH (80)
59. Morris Sadao KAITA (74)
60. Buddy Joseph CARTER (85)
61. Michael Joseph MORINHO (61)
62. Rafael Arcega IMPERIAL (63)
63. Anthony Thomas SIMPSON (43)
64. Michael Mitsuru MISAKA (61)
65. Albert Hiroshi KITAGUCHI (62)
66. George Howard HALL III (67)
67. Eugene Lopez RECOLIZADO (50)
68. Maria Victoria Beza RECOLIZADO (51)
69. Justin Oliver Beza RECOLIZADO (11)
70. Angelica Quijano BACLIG (31)
71. Adela Quijano VILLEGAS (53)
72. Junmark Geovanie QUIJANO (30)
73. Tim Tetsuo NAKAMOTO (69)
74. Angelita VASQUEZ (88)
75. Vanessa BAYLOSIS (67)
76. Narciso BAYLOSIS Jr. (67)
77. Richard Sing Fong KAM (88)
78. Nicholas Stephen TURBIN (71)
79. Poomaikai Micah Kelikoaelakauaikekai Estores LOSANO (28)
80. Antonia Helen MOLINA (63)
81. Alfred Raymond RAWLINGS (84)
82. June Nobue ANBE (78)
83. Bibiana Tomboc LUTRANIA (58)
84. John Joseph MC CARTHY (74)
85. Douglas Warren MATSUDA-BOUCHER (65)
86. Rogelio Erice MABALOT (68)
87. Jeanne Marie ELIASON (57)
88. Roxanne Kinuyo IBARA-HINAU (68)
89. Joseph LARA (86)
90. Felimon Felipe QUIJANO (61)
91. Louise ABIHAI (97)
92. Leticia Padagas CONSTANTINO (56)
93. Allen John Padagas CONSTANTINO (25)
94. Linda Lee VAIKELI (69)
95. Matsuyuki OSATO (83)
96. Lee Fletcher ROGO (76)
97. Pending Identification (N/A)

Figure 4.3.3.13 MPD Preliminary After-Action Recovery Report, page 53. Maps of victim recoveries, map legend 2 [106]

[106] http://www.mauipolice.com/uploads/1/3/1/2/131209824/pre_aar_master_copy_final_draft_1.23.24.pdf

4.3.4 Hawaiian Electric

Hawaiian Electric had multiple crews working to address downed and unstable equipment from the early morning of August 8, 2023, and throughout the duration of the incident. However, the rate of the fire's growth would ultimately impede the crews' work in many areas of Lahaina.

In response to the early morning windstorm of August 8, 2023, the on-call field supervisor was notified of the need for early maintenance support at 03:40. The normal complement of maintenance personnel were available to respond. Maintenance crews in Lahaina were also supplemented by contractor support from Rokstad Power.

Dispatch was augmented starting in the morning of August 8, 2023 with four (4) dispatchers and one (1) supervisor working past their shifts into the evening. An operations engineer and several supervisors were also present to address the increased workload.

According to AVL records, beginning 04:17, Hawaiian Electric service vehicles were present in the Lahaina area. Twenty four unique Hawaiian Electric service vehicles would ultimately be present within the Lahaina Fire operational area throughout August 8, 2023.

Hawaiian Electric reported that they assigned a Liaison Officer to the Emergency Operations Center (EOC) at approximately 05:15 on August 8, 2023. This assignment was confirmed by the "Infrastructure" EOC sign-in log titled "2023-08-07 Severe Weather" and dated "08-07-2023" (see Appendix 6.5). Since the EOC was not staffed on August 7, 2023, at 05:15, it is believed that the date was documented in error, and the correct date for the sign-in log is August 8, 2023. The status report sent by Hawaiian Electric's EOC Liaison Officer via email to two (2) Hawaiian Electric personnel on August 8, 2023, at 05:58 (see Appendix Table 6.6) further verifies the presence of a Hawaiian Electric representative in the EOC on the morning of August 8, 2023. A second Hawaiian Electric representative signed in to the EOC on August 8, 2023, at 18:45. Hawaiian Electric states that this individual relieved the first representative.

Downed Equipment

Table 4.3.4.1 on the following page includes Hawaiian Electric's record of receiving reports of downed equipment as well as their response to these calls. Also included in the table are other reports for downed equipment found in the MPD dispatch record. A complete list of all downed utility equipment for the time period of this report is unknown. Knowing when equipment was compromised is impossible. Many factors could account for the lack of reporting, including people evacuating and equipment in remote areas or where people had already evacuated.

TIMELINE OF EVENTS

Table 4.3.4.1 Equipment Down Blocking Roadways as Reported by Hawaiian Electric.

Equipment Down Blocking Roadways as Reported by Hawaiian Electric*

Date	Time	Problem	General Area Description provided by Hawaiian Electric
August 8, 2023	05:42:00	Poles leaning onto Hwy-30.	Hawaiian Electric received a report from the MPD at approximately 05:42 of poles leaning at the corner of Honoapi'ilani Highway and Keawe Street. Hawaiian Electric crews responded by about 07:20 and were able to reinforce and stabilize the poles over the course of the morning. We do not believe that these poles fell on August 8th, but we understand that MPD shut down the right-hand turning lane at the intersection of Keawe Street and Honoapi'ilani Highway.
August 8, 2023	05:51:00	Pole leaning near 761 Waine'e Street.	Hawaiian Electric received a report from the MPD at approximately 05:51 of a pole leaning near 761 Waine'e Street. Crews stabilized the pole. We understand that MPD closed Waine'e Street between Lahainaluna Road and Dickenson Street on August 8.
August 8, 2023	05:51:00	Several poles on Hwy-30 near Hōkiokio Place. Hwy closed between Front Street and Hōkiokio Place.	Hawaiian Electric received a report from the MPD at approximately 05:51 that a stretch of poles fell onto Honoapi'ilani Highway south of Lahaina near Hōkiokio Place. MPD reported several more poles down in this location at approximately 06:13, and the County of Maui issued a tweet at 06:38 notifying the public that Honoapi'ilani Highway between Front Street and Hōkiokio Place was closed. Additional poles fell across Honoapi'ilani Highway at the intersection with 'Aholo Road at approximately 16:12. Hawaiian Electric crews and crews from a contractor, Rokstad, responded to the location of these downed poles in the morning and spent the remainder of the day addressing them. Once crews became aware of the need to clear the highway to facilitate the evacuation after the Lahaina PM broke out, their focus shifted to that work. By approximately 16:48, crews cleared the southbound lane of Honoapi'ilani Highway, allowing traffic to move. At 17:00, Maui County issued a press release announcing that southbound Honoapi'ilani Highway had been opened.
August 8, 2023	06:40:00	Broken pole at intersection of Lahainaluna Road and Ho'okahua Street.	Hawaiian Electric received a report from the MPD at approximately 06:40 that a pole had broken at the intersection of Lahainaluna Road and Ho'okahua Street. The MPD reported a line came down and there was a fire. Hawaiian Electric informed police the line was not energized at the time that MPD informed Hawaiian Electric of the broken pole, as by then, the last transmission line to West Maui had tripped offline. A troubleman responded to this location at approximately 07:00 to evaluate the damage. Additional crews responded later in the day to begin repairs to several broken poles in the area. We are not aware of any reports that this downed equipment impeded egress from Lahaina in the afternoon of August 8th.
August 8, 2023	08:43:00	Line down at 4[redacted] Kauhi Place.	Hawaiian Electric received a report around 08:43 of a line down at 4[redacted] Kauhi Place in Lahaina. Because the address is at the end of a dead-end road, it is not believed these lines blocked egress.
August 8, 2023	09:45:00	Eight (8) poles down near Hwy-30 south of Hōkiokio Place.	Hawaiian Electric personnel observed eight (8) poles down in the Puamana area by Honoapi'ilani Highway, south of Hōkiokio Place, around 09:45. These poles were located some distance away from the highway and were not blocking the highway.
August 8, 2023	10:14:00	Broken line at 3[redacted] Dickenson Street.	A Hawaiian Electric crew identified a broken line at 3[redacted] Dickenson Street in Lahaina at approximately 10:14. It is not believed this line blocked traffic.

continued

**Note: The information in the table is from Hawaiian Electric's February 16, 2024, production.*

Table 4.3.4.1 Equipment Down Blocking Roadways as Reported by Hawaiian Electric.

Equipment Down Blocking Roadways as Reported by Hawaiian Electric*

Date	Time	Problem	General Area Description provided by Hawaiian Electric
August 8, 2023	10:17:00	Service line down at 7[redacted] Mill Street.	A Hawaiian Electric crew identified a service line down at 7[redacted] Mill Street in Lahaina at approximately 10:17 AM. It is not believed this line blocked traffic.
August 8, 2023	11:45:00	Leaning and fallen poles on Mill Street (dirt road east of Hwy).	Hawaiian Electric became aware of leaning and fallen poles on Mill Street—a dirt road east of Honoapi'ilani Highway not actively traversed—around 11:45. These downed poles did not appear to block traffic. A troubleman was on scene at 12:44 PM.
August 8, 2023	14:19:00	Down poles blocking Hwy-30 near Papalaua Street.	At approximately 14:19, a Hawaiian Electric employee reported they were unable to pass the Subway in Lahaina by Papalaua Street because downed poles blocked Honoapi'ilani Highway. We understand from public social media that Honoapi'ilani Highway between Lahainaluna Road and Papalaua Street was closed around 14:20 on August 8th.
August 8, 2023	15:01:00	Five (5) poles down blocking Hwy-30 between Keawe Street and Kapunakea Street.	At approximately 15:01, Hawaiian Electric became aware of five (5) poles down on Honoapi'ilani Highway between Keawe Street and Kapunakea Street in front of a Shell gasoline station. Hawaiian Electric troublemen responded within 20 minutes. We understand that these poles were not cleared on August 8th. Although these poles blocked certain lanes of traffic, it was possible to drive around them through the adjacent Safeway parking lot.
August 8, 2023	16:50:00	Poles down blocking Hwy-30 near Lahaina Civic Center.	At approximately 16:50, Hawaiian Electric became aware, through the County of Maui and Red Cross, of poles down on Honoapi'ilani Highway near the Lahaina Civic Center, north of Lahaina. Hawaiian Electric dispatched crews to clear the downed equipment, although they were not able to access the area immediately due to difficulty getting across Lahaina. Crews were able to reach the area and worked to clear the downed equipment starting around 19:37. We understand that the road was not fully blocked and that traffic was able to proceed around these poles while they were down. Crews were able to clear them from the roadway by later in the evening.

Table 4.3.4.2 Additional Sources of Downed Hawaiian Electrical equipment impacting vehicle traffic or emergency responder efforts.

Additional Sources of Downed Hawaiian Electric Equipment

Date	Time	Report	Source
August 8, 2023	12:18:00	Four (4) utility poles down in the back of the homes located on Niheu Street.	Reported by MFD on scene of Lahaina PM fire at 12:18.
August 8, 2023	16:18:00	Hwy-30 near Leialii Parkway	Picture by motorist traveling southbound taken at 16:18.

TIMELINE OF EVENTS



Figure 4.3.4.1 Hawaiian Electric response to downed equipment.



TIMELINE OF EVENTS

Hawaiian Electric Communications Regarding Power Status

Hawaiian Electric dispatch communicated power status to Central Dispatch (MPD) upon their request. Table 4.3.4.3 only includes the time power status was communicated. Objective evidence that the power was off in the areas requested by Central will be addressed within the ATF cause and origin report.

Table 4.3.4.3 Hawaiian Electric record of communications with MPD and MFD regarding power status. Central is MPD's central dispatch.

Hawaiian Electric Record of Communications About Power Status
August 8, 2023

Date	Time	Hawaiian Electric Dispatch Communications with MPD/MFD Dispatch
August 8, 2023	5:51:00	**Central:** The Sergeant is on scene those poles at Honoapi'ilani and Keawe, poles 14 and 13, the pole's leaning, some broke at the base, but it's leaning at a 45-degree angle, but the foundation of how you put it in, is coming out. **Hawaiian Electric:** On the corner of Honoapi'ilani Hwy and Keawe Street, Poles E14 and E13, one (1) is down and one (1) is leaning with the pedestal coming out. Does he know if that is a metal pole or wooden pole? What's the event # for that one? **Central:** 8002610. **Hawaiian Electric:** 8002610. **Central:** Several poles are down at Honoapi'ilani and Hōkiokio, that's just coming in. **Central:** 7[redacted] Waine'e, there is a pole, it looks like a transformer was on this pole, it broke, and it was moving back and forth, the officer says it's leaning toward the cemetery. He did not give a pole number. We are closing Wiane'e from Dickenson to Lahainaluna. **Central:** Are we able to get an ETA for any of those that we just talked about, especially the Keawe Street one? **Hawaiian Electric:** No, not yet because we are working on the outage. We are running the lines from Lahaina to Lahainaluna to pick up the west side, then we can start hitting your list.
August 8, 2023	6:40:00	**Hawaiian Electric:** Hello Hawaiian Electric. **Central:** Hi Milea again, at 8[redacted] Lahainaluna Road right across from Lahaina Intermediate. Powerline came down and started a fire, so currently no one is on scene. They are headed up there now, but it's near a structure, so we need to de-engergize that as well. **Hawaiian Electric:** I think it just went out.
August 8, 2023	9:36:00	**Hawaiian Electric:** Hello Maui Electric. **Central:** Hi Maui Electric, Police Department. I know I called early for the pole #7A, but command is on scene asking someone to come regarding all the wires down. **Hawaiian Electric:** Ok. We have crews going in that direction. Do you need… **Central:** Let me ask them where they want you guys to go, can I put you on hold? **Hawaiian Electric:** Yeah. **Central:** It's where the poles snapped, that's where they want you to go. **Hawaiian Electric:** It is de-energized there. **Central:** OK. **Hawaiian Electric**: Everybody is de-energized in Lahaina at the moment, and we have crews going over there. Do they still need somebody to go over there? **Central:** Yes, to the pole right below Lahaina Intermediate because there are wires down across the road. Hawaiian Electric: OK, thank you.

Red text: Indicates that the power supply is cut off.

continued

**Now known as Hawaiian Electric.*

Hawaiian Electric Record of Communications About Power Status
August 8, 2023

Date	Time	Hawaiian Electric Dispatch Communications with MPD/MFD Dispatch
August 8, 2023	16:11:00	**Hawaiian Electric:** Maui Electric Trouble Department. **Central:** Hi MECO,* police department. Fire is asking if you can shut down all the electric off of Lahainaluna, above and below the bypass. **Hawaiian Electric:** It's off right now. **Central:** It's all off? **Hawaiian Electric:** Yea. **Central:** OK, thank you.
August 8, 2023	21:33:00	**Hawaiian Electric:** Hello, Maui Electric. **Central:** This is the police department. We are trying to confirm that the lines down in front of the Lahaina Station on Honoapi'ilani are all de-energized. **Hawaiian Electric:** Yes, it is, but it is not grounded, so you still cannot touch the lines, but the substation is burning. **Central:** OK, because they need to evacuate, so can they drive over it? **Hawaiian Electric:** Oh, what is the location? Where is it? Lahainaluna Road? **Central:** On Honoapi'ilani Highway, in front of the Lahaina Station. **Hawaiian Electric:** The Lahaina substation, right? **Central:** The Lahaina Police Station. **Hawaiian Electric:** Oh, Lahaina Police Station (talking in the background asking about running over lines). **Hawaiian Electric:** Yeah. You can have them run over the lines.

Red text: Indicates that the power supply is cut off.

**Now known as Hawaiian Electric.*

4.3.5 Department of Water Supply

The data recording system for the Maui County Department of Water Supply records the water level every half hour in each of the water storage tanks in both the Lahaina and Māhinahina storage and distribution systems.

Figure 4.3.5.1 shows the water volume stored versus time for the Lahaina, Māhinahina and the two (2) systems combined. Please note, the water level data ceases at approximately 15:30 on August 8, 2023.

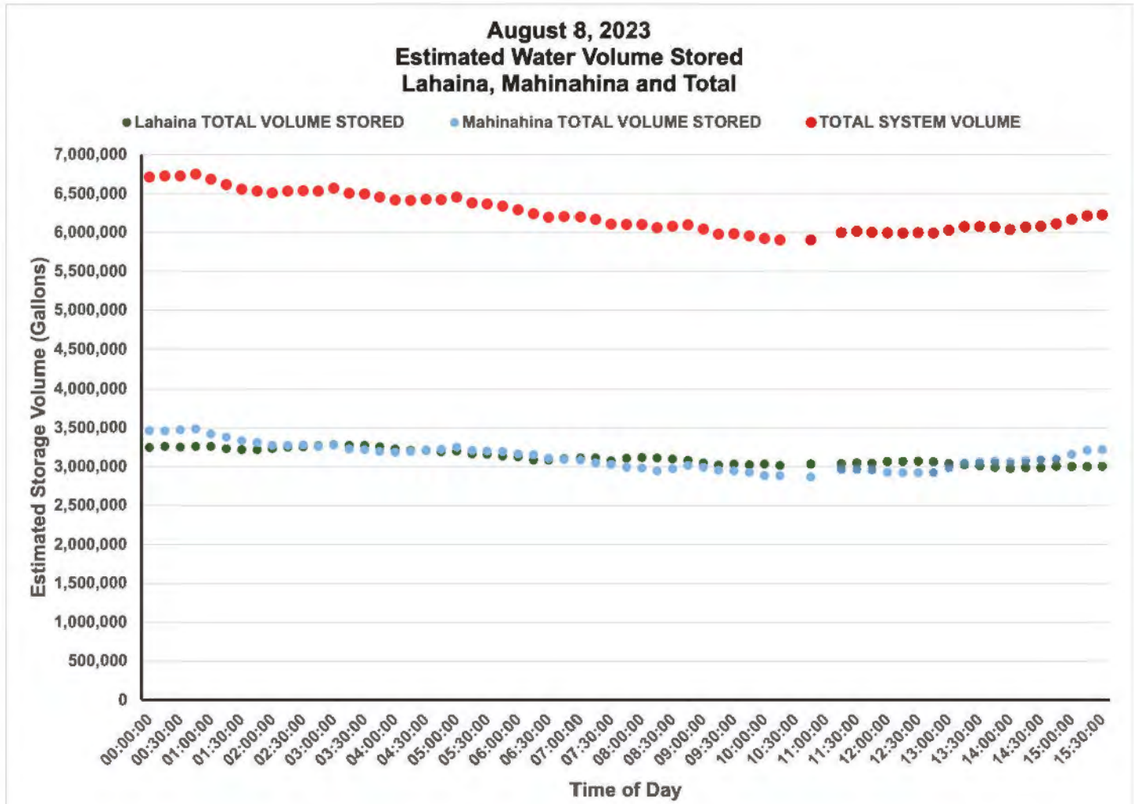


Figure 4.3.5.1 Estimated water volume stored by Maui County Department of Water Supply on August 8, 2023.[107]

[107] *The volumes calculated in this graph are preliminary estimates based upon the tank capacity and the tank level recorded by the system. The recording system stopped at 15:30 on August 8, 2023. This graph will be revised when additional information is provided by the County.*

During the fire event of August 8, 2023, water demand in parts of Lahaina exceeded the ability of the water storage and distribution system to deliver sufficient quantities of water at adequate pressure to support firefighting operations. As homes and other buildings burned, pipes melted/failed, and water ran freely. Pressure in water lines dropped, and very little water was available for use by firefighters in central and southern Lahaina.

It should be noted that the water supply did not fail in all of Lahaina. Parts of Lahaina had water service throughout the fire. Water shortages were most common in central and south Lahaina. However, the Maui County Department of Water Supply continued to produce water throughout the duration of the Lahaina PM fire. Both plants had electrical power and produced water throughout the fire. In addition, there are no pumps in the Lahaina water distribution system, as it is fed by gravity.

As listed below, there were several factors and facts related to the inability of the water storage and distribution system to deliver sufficient quantities of water at adequate pressure to desired locations within the system for firefighting during the fire event of August 8, 2023:

- As homes and other structures were damaged and destroyed by fire, household plumbing (e.g., plastic piping) inside—and in some cases outside—of the buildings melted or failed, allowing water to flow unrestricted from one (1) or more locations at many residences. As more homes and structures were damaged or destroyed by the fire, more pipes melted or failed, resulting in water freely flowing from more structures and diminishing the overall water pressure and supply in the fire area.
- Early on August 8, 2023, as the fire spread to buildings, a fire hydrant (Number 126, shown in Figure 4.3.5.2) near the intersection of Paunau Street and Pupu Place was struck and sheared off at the base. Maui utilizes wet barrel fire hydrants so a large amount of water flowed from the damaged fire hydrant base unrestricted.

Figure 4.3.5.2 Damaged Fire Hydrant 126 at the Intersection of Paunau Street and Pupu Place.



TIMELINE OF EVENTS

- Due to fire and traffic conditions, Maui County Department of Water Supply employees were unable to access the fire area and shut off water at the meters of affected residences and other buildings until August 9, 2023. Thus, the loss of water from multiple locations continued until that time and contributed to the lack of pressure within the water distribution system.
- Due to distance, water line size, and headloss (i.e., pressure loss as water travels through pipe), water from the Māhinahina water treatment plant (WTP) storage and distribution system did not substantially support the firefighting water demand in central and southern parts of Lahaina.
- Most reports of low pressure and water loss were in central and southern Lahaina. Firefighters were able to access water from fire hydrants in Hanakaʻōʻō Park (just north of the Maui Civic Center) late in the evening of August 8, 2023. This access to water is likely because water from the Māhinahina system supplied the hydrants in the park.
- Both the Lahaina and the Māhinahina WTPs had electric power and continued to produce water throughout the Lahaina PM fire. These facilities also had diesel backup power available that was not used during the Lahaina PM fire.
- Large-scale structural destruction from the fire resulted in reduced pressure within the storage and distribution system, even with continued production by the two (2) drinking WTPs. This reduced pressure is likely to have led to back siphonage, possibly drawing contaminants into the storage and distribution system.
- Although the water treatment, storage, and distribution systems are adequately sized for normal drinking water demands and the demands for a large structure fire event, they were not adequate to provide water at the required pressure for the urban conflagration of August 8, 2023.
- There is little to no plastic pipe in either the Lahaina or the Māhinahina drinking water treatment, storage, and distribution systems before the meters that provide water access at the customer's home or building. However, plastic pipe is likely widely used in homes and businesses for water piping after water passes through the meter into the individual occupancy.

4.3.6 Maui Emergency Management Agency (MEMA)

Table 4.3.6.1 MEMA Emergency Operations Center (EOC) staffing as of August 8, 2023.

MEMA Staff August 7, 2023–August 8, 2023		
Staff Member	**MEMA EOC Regular Staff Position (During Activation)**	**MEMA EOC Staffing on 8/8 (Individuals had to assume different roles due to Administrator Andaya's absence.)**
Herman Andaya	EOC Director	Off island (attending conference in Oʻahu)
Paul Coe	Operations Section Chief	EOC Director 8/7 21:00–8/8 14:24 Resumed EOC Director role at approximately 17:30 (per personal account)
Rocky Keohuhu-Bolor (Staff Specialist IV)	Planning Section Chief	Operations Section Chief EOC Director (relieved Paul Coe 8/8 14:24–8/8 17:30) Resumes Operations Section Chief^
Everett Balmores (Staff Specialist III)	Situational Awareness Chief*	Planning Section Chief Assigned this role under the guidance of Bolor This was the first time Balmores served in this capacity (per personal account)
Colleen Hauptman (Staff Specialist III^)	Recovery Section Chief*	On-Duty Officer, Staffed Partial activation of EOC withPaul Coe from 8/7 21:00–8/8 10:41
Gina Albanese (Staff Specialist III^)	No Role Designated	Assisted with Fire Management Assistance Grant (FMAG)^ Did not participate in Technical Discussions
Darryl Takeda	Logistics Section Chief*	Logistics Section Chief^ Did not participate in Technical Discussions
Gaye Gabaut	EOC Administrative Assistant MEMA Public Information Officer (PIO)	EOC Administrative Assistant MEMA PIO
Josh Aquinde (Staff Specialist III^)	Training Deployment with National Guard	Not present during the 8/8 wildfire incidents

**Information gathered from the pre-printed MEMA EOC Sign-in sheets*
^Information provided by MEMA staff during TDs

TIMELINE OF EVENTS

MEMA personnel are responsible for maintaining, staffing, and managing the Emergency Operations Center (EOC) operations. Access to the Maui EOC is restricted because of the confidential nature of the personal information (i.e., civilian names, addresses, etc.) used. Entry to the EOC requires an access code to open the door, and detailed sign-in logs are maintained. As an emergency event unfolds, the EOC staff on duty at the time requests representatives from the assisting and cooperating agencies to report to Maui EOC. The EOC sign-in sheets are grouped by organizational function and include pre-populated typewritten names of individuals representing specific organizations. The sign-in sheets also include spaces for signatures and time in and time out. All sign-in sheets provided to FSRI for August 7, 2023, through August 9, 2023, are in Appendix Table 6.5. The following information is taken from those entry logs.

Maui EOC was partially activated on August 7, 2023, at 21:00 with Paul Coe, Acting EOC Director in MEMA administrator's absence (according to technical discussions), and Colleen Hauptman (according to sign-in logs). As per the EOC sign-in sheets and WebEOC (the data management system used to manage EOC staffing and operations) records, many individuals confirmed their presence in the EOC from August 7, 2023, through September 30, 2023. Even though MEMA encourages strict compliance, it is apparent that people entered the EOC without following the sign-in/out process. As per the EOC Communications Test Log, the EOC was fully activated at 16:30 on August 8, 2023.

There is no data showing which MEMA personnel responded on August 8, 2023. The only missing EOC sign-in sheet is the one for MEMA personnel for August 8, 2023. Maui County has not produced this document after multiple requests.

MEMA Activity Logs (ICS 214 Form) are used to document individual tasks and events when assigned to an incident. This includes EOC assignments. These logs create an understanding of the event response minute-by-minute and hour-by-hour. They are typically used to recreate incidents and to prepare after action reports. As per information during TDs with MEMA personnel, completion of these forms is an expectation when assigned to the EOC. These forms were completed by some individuals representing assisting and cooperating agencies from August 7, 2023, through August 9, 2023, but not all.

The only ICS 214 Forms provided to support the incident analysis and report from August 7, 2023, through August 9, 2023, included representatives from MFD, MPD, Maui Corp Counsel, Agriculture, and Office of the Maui Mayor. There were no ICS 214 Forms received from MEMA personnel for these dates.

Because of missing data, it is difficult to make a complete and accurate accounting of activities within the EOC from August 7, 2023, through August 9, 2023.

EOC activities can also be documented within WebEOC. WebEOC is the data management system used to manage EOC staffing and operations. Individuals use the platform to complete requests for assistance (RFAs) and issue alerts for evacuations, road closures, or other types of emergencies. WebEOC can also be used by EOC members to log events, essentially taking the place of a paper 214.

For the period of August 7, 2023, through the early morning of August 9, 2023, the following event logs were completed by MEMA personnel within WebEOC (Table 4.3.6.2).

Table 4.3.6.2 Maui WebEOC Event Log Entries from August 7, 2023, through August 9, 2023.

Maui WebEOC Event Log Entries
August 7, 2023–August 9, 2023

Date	Time	Message Type	Message	Created By	Agency	EOC Position
August 7, 2023	21:33	Weather	Activated the EOC at 2100 hrs, 8/7/23 for the wind warning and to monitor any associated incidents.	Paul Coe	MEMA	Director
August 7, 2023	21:35	Weather	Advised State Warning Point of EOC partial activation.	Paul Coe	MEMA	Director
August 7, 2023	21:36	Weather	Created incident in WebEOC.	Paul Coe	MEMA	Director
August 7, 2023	22:29	Weather	Initiated Incident Action Plan.	Paul Coe	MEMA	Director
August 8, 2023	03:12	Fire	Fire burning between Olinda Road and Hwy-377. MFD on scene with multiple units.	Paul Coe	MEMA	Director
August 8, 2023	03:25	Info Update	Took call from (808) 281[redacted] requesting update on the Olinda Fire; advised that multiple MFD units were on scene and that at this point, no evacuations were requested. Advised caller to stay alert of fire conditions and that they could self-evac to family or friend if felt unsafe.	Paul Coe	MEMA	Director
August 8, 2023	04:51	Brushfire^	Shelter opened at Hannibal Tavares Community Center at 0445 on Makawao Road. At 0419 Evacuation Order Issued for Kula 200 subdivision off of 'Auli'i Drive due to brush fire. No word on shelters at this time.	Gina Albanese	MEMA	Unidentified
August 8, 2023	05:38	Power Outage	Power outage between Lahaina North to past Nāpili, Kapalua, approx. 7,000 customers.	Gina Albanese	MEMA	Unidentified
August 8, 2023	09:33	Bushfire	Maui Humane Society pet support trailer is on-station and operational at the Pukalani Shelter.	Andy Vliet	Red Cross	Emergency Shelters Group Leader
August 8, 2023	09:36	Info Update	Update to HI-EMA Mr. Chris Lupenui, Lahaina Fire 100% contained as of 830 hours Maui EOC Shift Change Brief.	Rocky Keohuhu-Bolor	MEMA	Operations Section Chief
August 8, 2023	10:23	Bushfire^	Generator on-site at Lahaina Civic Center shelter, and lights are on.	Andy Vliet	Red Cross	Emergency Shelters Group Leader
August 8, 2023	10:27	Utility Outage	Outage on Crater Road affecting 31 customers. Lines reported down by resident. Crews responding.	Kuhea Asiu	HECO*	Utilities Group Leader
August 8, 2023	10:36	Info Update	Received email from Director Public Works Jordan Molina at 910 hours. "Road closed at Olinda Road and lower Ehu Road in Makawao due to fallen trees. DPW crews on site working to clear. Will have another update at 11:00am."	Rocky Keohuhu-Bolor	MEMA	Operations Section Chief

continued

TIMELINE OF EVENTS

Maui WebEOC Event Log Entries
August 7, 2023–August 9, 2023

Date	Time	Message Type	Message	Created By	Agency	EOC Position
August 8, 2023	12:50	Tech Infrastructure	8 AM tech issues. Phone issues at Kahului Service Center–Rebooting Shoretel switch. Network issues Lahaina Locations: Senior Center, Fire Station.	David Duarte	Maui County	CMD Center Support
August 8, 2023	13:13	Bushfire	ARC Lahaina Recreation Center shelter manager reports that there are no clients there. Shelter population now zero.	Andy Vliet	Red Cross	Emergency Shelters Group Leader
August 8, 2023	14:00	Bushfire	Lahaina Civic Center shelter closed.	Andy Vliet	Red Cross	Emergency Shelters Group Leader
August 8, 2023	17:01	Utility Outage	Lahaina crews will be focusing on Hōkiokio Place to clear at least one (1) lane to allow traffic flow. Additional crew heading in to Lahaina to repair transmission lines.	Kuhea Asiu	HECO*	Utilities Group Leader
August 8, 2023	17:02	Utility Outage	A news release was issued to media and community leaders and stakeholders to advise them to prepare for an extended outage in Upcountry and West Maui. If power is not restored by 7 pm tonight, prepare for an overnight outage.	Kuhea Asiu	HECO*	Utilities Group Leader
August 8, 2023	23:49	Fire	FD3 requests diesel fuel to replenish engines responding to kula Fire. DPW to deliver fuel to Upcountry Fire crews in approximately 45 minutes following call.	Rocky Keohuhu-Bolor	MEMA	Operations Section Chief
August 9, 2023	01:39	Info Update	0515 hours 080923 0345 080823 observed and presumed deceased body is unconfirmed	Rocky Keohuhu-Bolor	MEMA	Operations Section Chief
August 9, 2023	02:27	Utility Outage	Lisa Paulson of Hotel and Lodging Association requests that if Kāʻanapali resorts face evacuation, she be contacted. She is liaison with Hawaiʻi Tourism Authority and the resort management personnel. Incl. Ph #.	Leedo Anderson	State	Emergency Shelters

During this same date range, MEMA sent the following public messages via their mass notification system, Active Alerts | Maui County, HI - Official Website.[108] These messages were distributed via Integrated Public Alert and Warning System[109] (IPAWS), Emergency Alert System[110] (EAS), and Wireless Emergency Alert[111] (WEA).

The following alerts are for all Maui wildfires during August 8, 2023, and August 9, 2023 (Table 4.3.6.3). Including the alerts for the Upcountry and Pūlehu fires provides context to the conditions personnel were performing under in the EOC.

Table 4.3.6.3 MEMA Public Alerts August 8, 2023–August 9, 2023.

MEMA Public Alerts
August 8, 2023–August 9, 2023

Date	Time	Event Type	Area	Message	Created By
August 8, 2023	04:09	Evacuation Immediate Warning	Kula	WEA long text message: Evacuation order on Maui for Kula 200 subdivision area off Aulii Dr due to a brushfire. Evacuate your family and pets now, do not delay. Will update with shelter info. Expect conditions that may make driving difficult, and watch for public safety personnel operating in the area. Maui Emergency Management Agency	Paul Coe
August 8, 2023	04:39	Fire Warning	Cmty Shelter Makawao	WEA long text message: Aulii Dr. evacuees, shelter will be established at Hannibal Tavares Community Center. Standby in lot until facility opened. MEMA	Paul Coe
August 8, 2023	05:00	Evacuation Immediate Warning	Kula	WEA long text message: Evacuation order on Maui for Hoopalua Dr. in Kula area due to a brushfire. Evacuate your family and pets now, do not delay. A shelter is open at Hannibal Tavres Community Center. Expect conditions that may make driving difficult, and watch for public safety personnel operating in the area. Maui Emergency Management Agency	Paul Coe
August 8, 2023	05:21	Evacuation Immediate Warning	Makawao	WEA long text message: Evacuation order on Maui for Hanamu Road and Kealaloa Avenue near Makawao for a brushfire. Evacuate your family and pets now, do not delay. A shelter is open at Hannibal Tavres Community Center. Expect conditions that may make driving difficult, and watch for public safety personnel operating in the area. Maui Emergency Management Agency	Paul Coe
August 8, 2023	16:04	Evacuation Immediate Warning	Kula	WEA message: Evacuation for Kulalani Subdivision Maui Emergency Management Agency has issued an evacuation order on Maui Island for Kulalani Subdivision in Kula due to a brushfire. Repeat, Maui Emergency Management Agency has issued an evacuation order on Maui Island for Kulalani Subdivision in Kula due to a brushfire. Evacuate your family and pets now, do not delay. Shelter is open at Hannibal Tavares Community Center. Expect conditions that may make driving difficult, and watch for public safety personnel operating in the area. Sent by the Maui Emergency Management Agency.	Everett Balmores

continued

TIMELINE OF EVENTS

MEMA Public Alerts
August 8, 2023–August 9, 2023

Date	Time	Event Type	Area	Message	Created By
August 8, 2023	16:16	Evacuation Immediate Warning	Kelawea Mauka Lahaina	WEA message: Evacuation for Kelawea Mauka Maui Emergency Management Agency has issued an evacuation order on Maui Island for Kelawea Mauka Subdivision due to a brushfire. Repeat, Maui Emergency Management Agency has issued an evacuation order on Maui Island for Kelawea Mauka Subdivision due to a brushfire. Evacuate your family and pets now, do not delay. Shelter is open at Lahaina Civic Center. Expect conditions that may make driving difficult, and watch for public safety personnel operating in the area. Sent by the Maui Emergency Management Agency.	Everett Balmores
August 8, 2023	20:46	Evacuation Immediate Warning	Wahikuli	WEA message: Evacuation for Wahikuli Evacuation order on Maui for Wahikuli Subdivision in Lahaina due to the Brushfire. Repeat, Evacuation order on Maui for Wahikuli Subdivision in Lahaina due to the Brushfire. Evacuate your family and pets now, do not delay. Evacuate North out of town toward Kapalua. Expect conditions that may make driving difficult, and watch for public safety personnel operating in the area. Sent by the Maui Emergency Management Agency.	Paul Coe
August 8, 2023	22:24	Evacuation Immediate Warning	Kula	WEA message: Evacuation for Pūlehu Road Area Evacuation order on Maui for Holopuni Road to Calasa Road due to Brushfire. Repeat, Evacuation order on Maui for Holopuni Road to Calasa Road due to Brushfire. Evacuate your family and pets now, do not delay. Shelter is open at Hannibal Tavares Community Center and Maui High School Gym. Expect conditions that may make driving difficult and watch for public safety personnel operating in the area. Sent by the Maui Emergency Management Agency.	Paul Coe
August 8, 2023	22:42	Evacuation Immediate Warning	Kīhei	WEA message: Evacuation for North Kīhei Evacuation order for North Kīhei area, north of Ohukai Road due to Brushfire. Repeat, Evacuation order for North Kīhei area, north of Ohukai Road due to Brushfire. Evacuate your family and pets now, do not delay. Recommended shelter is open at Maui High School Gym. Expect conditions that may make driving difficult, and watch for public safety personnel operating in the area. Sent by the Maui Emergency Management Agency.	Paul Coe

[108] *https://www.mauicounty.gov/983/MEMA-Alerts*
[109] *https://www.fema.gov/emergency-managers/practitioners/integrated-public-alert-warning-system*
[110] *https://www.fcc.gov/emergency-alert-system*
[111] *https://www.fcc.gov/consumers/guides/wireless-emergency-alerts-wea*

continued

MEMA Public Alerts
August 8, 2023–August 9, 2023

Date	Time	Event Type	Area	Message	Created By
August 8, 2023	23:28	Evacuation Immediate Warning	Kīhei	WEA message: Evacuation for Kīhei Mauka (east) of Piilani Hwy Evacuation order Kīhei Mauka (east) of Piilani Hwy, including all of Maui meadows, due to Brushfire. Repeat, Evacuation order Kīhei Mauka (east) of Piilani Hwy, including all of Maui meadows, due to Brushfire. Evacuate your family and pets now, do not delay. Recommended shelter is open at Maui High School Gym. Expect conditions that may make driving difficult and watch for public safety personnel operating in the area. Sent by the Maui Emergency Management Agency.	Paul Coe
August 9, 2023	00:37	Evacuation Immediate Warning	Upper Kimo	WEA message: Evacuation for Upper Kimo Road Evacuation order on Maui for Upper Kimo Road due to Brushfire. Repeat, Evacuation order on Maui for Upper Kimo Road due to Brushfire. Evacuate your family and pets now, do not delay. Shelter is open at Hannibal Tavares CC. Expect conditions that may make driving difficult, and watch for public safety personnel operating in the area. Sent by the Maui Emergency Management Agency.	Paul Coe
August 9, 2023	01:26	Evacuation Immediate Warning	Kā'anapali	WEA message: Evacuation for Kualapa Loop in Lahaina. Evacuation order on Maui for Kā'anapali Golf Estates area, including Kualapa Loop, Puu'Anoano Street, Hakui Loop, Wekiu Place due to Brushfire. Repeat, Evacuation order on Maui for Kā'anapali Golf Estates area, including Kualapa Loop, Puu'Anoano Street, Hakui Loop, Wekiu Place due to Brushfire. Evacuate your family and pets now, do not delay. Shelter is open at Maui Preparatory Academy. Expect conditions that may make driving difficult, and watch for public safety personnel operating in the area. Sent by the Maui Emergency Management Agency.	Paul Coe
August 9, 2023	05:50	Evacuation Immediate Warning	Launipoko	WEA message: Evacuation for Launiupoko Evacuation order on Maui for Launiupoko Estates area off Punakea Loop due to Brushfire. Repeat, Evacuation order on Maui for Launiupoko Estates area off Punakea Loop due to Brushfire. Evacuate your family and pets now, do not delay. Must evacuate toward Kahului, shelter at Maui High School or War Memorial. Expect conditions that may make driving difficult, and watch for public safety personnel operating in the area. Sent by the Maui Emergency Management Agency.	Paul Coe
August 9, 2023	06:17	Evacuation Immediate Warning	Kīhei Return	WEA long text message: Maui Fire and Maui PD have cleared Kīhei residents to return to the homes. Drive safely as there are public safety personnel operating in many areas. Maui Emergency Management Agency	Paul Coe

The EOC also submitted the following Requests for Assistance (RFA) during the same timeframe.

Table 4.3.6.4 EOC Requests for Assistance (RFAs) August 8, 2023–August 9, 2023.

EOC RFAs August 8, 2023–August 9, 2023				
Date	**Time**	**Task**	**Purpose**	**Requestor**
August 8, 2023	16:37	Requesting Hawai'i National Guard (HING) assets to immediately assist with MFD with fire suppression for the Kula fire. Immediate need through 81023.	MFD resources exceeded due to addressing two (2) fires in Kula and Lahaina (opposite sides of Maui Island).	Darryl Takeda
August 8, 2023	17:29	Requesting Civil Air Patrol (CAP) photo recon in Lahaina (West Maui) for fire intel. Along Lahaina Bypass from Hōkiokio Place to Fleming Road.	For intel for MFD.	Darryl Takeda
August 8, 2023	18:58	Request assistance transporting cots and other shelter supplies from Maui Humane Society in Kahului to Evacuation Shelter at Hannibal Tavares Community Center in Pukalani.	Preparing for overnight and extended evacuees in Pukalani Shelter due to ongoing fire in Kula.	Darryl Takeda
August 8, 2023	22:05	Requesting two (2) liaison officers to relieve Col Todd Curtright for Maui ECO HING rep	Request relief ASAP, but preferably before start of next operational period 89 @ 07:00.	Darryl Takeda
August 8, 2023	23:42	Request Search & Rescue Team to assist with searching for injured civilians in areas that were overrun by fire. Primarily Lahaina area and potentially other areas as the fires are still not contained.	Request Search & Rescue Team to assist with searching for injured civilians in areas that were overrun by fire.	Darryl Takeda
August 8, 2023	23:55	Requesting deployment of a Disaster Mortuary Team to assist with management of potential fatalities as a result of fire.	To assist Maui County with management of potential fatalities as a result of fire.	Darryl Takeda
August 9, 2023	01:31	Incident Management Team	None	Darryl Takeda

**Now known as Hawaiian Electric.*
^These records appear as they exist within WebEOC. Some records use the term "brushfire" and others use "bushfire."

MEMA Timeline of Significant Events

Individual accounts of the MEMA staff present during the August 8, 2023, Lahaina fire follows. This information was gathered through in-person technical discussions and document review produced by Maui County Corporate Counsel in response to requests for information by FSRI (Table 4.3.6.5 on the following page).

Table 4.3.6.5 MEMA Timeline of Significant Events on August 8, 2023, and August 9, 2023, based on Andaya Call/Text Records and technical discussions (TDs).

MEMA Timeline of Significant Events Based on Andaya Call/Text Records and Technical Discussion	
August 8, 2023	Andaya received a text notification regarding Olinda fire (the same that the public would receive). The text was an evacuation order for the Kula 200 subdivision of 'Auli'iDrive due to a brushfire. He recalls he texted Paul Coe and Gaye Gabuat (his administrative assistant) for an update, and he was told the situation was manageable.
04:19	According to phone records, Andaya was part of a group chat that consisted of Mayor Richard Bissen, Leo Caires, Mahina Martin, Tori Takeyesu, Keku Akana, and Josiah, and he recalled receiving intermittent texts about the event. During the TD with FSRI, he stated he felt confident that Paul Coe, who has extensive fire service and emergency management experience, could manage the situation.
05:35	ALERT was sent out regarding EOC status update advising personnel to be prepared for possible full activation.
06:21	ROAD CLOSURE Hwy-30 between Front Street and Hōkiokio Place due to down MECO* poles on the road.
06:52	Per Akana, the Lahaina Civic Center had opened for any residents needing shelter.
07:10	ROAD CLOSURE Lahainaluna Road from Kelawea Street to Ku'ialua Street due to brushfire.
07:18	Gabuat relayed to Andaya that Mayor Bissen arrived at the EOC.
08:18	ROAD CLOSURE UPDATE Hwy-30 between 'Aholo Road and Hōkiokio Place due to down MECO* poles.
08:59	Andaya relayed to Coe that Mayor Bissen did not think it was necessary at that point to issueemergency proclamation. Andaya recalled asking Mayor Bissen if Maui was going to do an emergency proclamation because he was aware the Big Island was issuing one. Andaya stated the Mayor did not think it was necessary at that point.
09:22	Col Udani (Hawai'i National Guard (HING)) texted Andaya requesting an update on the current brushfire. Udani advised they were working on an RFA for Hawai'i County's ongoing brushfire.
09:30	Andaya provided an update to Udani. Andaya advised there were two (2) fires on Maui–Lahaina and Kula. Andaya advised MFD had a handle on Lahaina, but Kula was greater concern. Andaya relayed MG Hara asked if Maui needed state assistance, but the Mayor and Chief indicated they could manage with current assets. In the TD, Andaya recalled he was sitting next to Major General (MG) Hara, and Hara asked if Maui needed resources. Andaya recalled that MG Hara advised the Big Island was requesting resources, and he inquired if Maui would need assistance. He advised MG Hara that Paul would request resources, if needed.
09:55	Andaya asked Gabuat how many homes have been destroyed. Gabuat responded at 10:06 that two (2) were destroyed.
10:41	Hauptman leaves EOC (she was with Paul Coe when partial activation started at 21:00 on August 7, 2023).
10:42	Andaya relayed to Gabuat that he did not see anything on WebEOC.
10:47	Maui EOC produced Situation Report (SitRep) No. 1. See Appendix 6.7
11:03	Bolor advised Andaya via text that once logged into WebEOC, there was a SitRep and shelter info. Andaya recalled that at approximately 11:00, there was a video teleconference with Maui and Big Island–and the wildfires on the Big Island were the primary concern. At 11:32, Andaya texted Hiro Toiya (Honolulu County Emergency Management Agency) that he was in a state video teleconference.
12:38	ROAD CLOSURE UPDATE: Lahainaluna Road open.
12:51	Andaya advised group text, per General Hara, the state may declare an emergency declaration, even if Maui County did not. Tori Takayesu advised they have a draft that Paul Coe was reviewing just in case.

continued

TIMELINE OF EVENTS

MEMA Timeline of Significant Events
Based on Andaya Call/Text Records and Technical Discussion

13:44	Toiya (Honolulu County Emergency Management Agency) advised Andaya that Big Island announced full activation over Hawai'i Warning System (HAWAS) and expected to be operating 24/7 for the next few days. He asked if Andaya would be staying in O'ahu. Andaya advised that MEMA staff, the mayor, and the Fire Chief are not requesting additional assets like Big Island.
14:03	ROAD CLOSURE Hwy-30 closed between Papalaua Street and Lahainaluna Road.
14:16 – 14:24	Text thread establishes that Paul Coe had been relieved by Rocky Keohuhu-Bolor. Bolor was now EOC Director. At 14:57, Bolor requested State Emergency Declaration status from Andaya.
15:15 – 15:27	Gabuat advised Andaya that there was a new fire in Lahaina near the Intermediate School, and it was approaching houses. At 15:25, she advised the fire jumped the roadway, and they were closing the Bypass. Andaya asked if the Mayor was in the room; Gabuat responded no. She advised that MFD was going to do another evacuation.
15:24	Caires advised via text that Lt. Governor Luke signed the State Declaration. At 15:25, Andaya sent an update to the group chat and advised he would forward a copy.
15:28	Andaya advised James Barros that Olinda, and a portion of Lahaina had to be evacuated.
15:37	ROAD CLOSURE Lahainaluna Road closed between Hwy-30 and the Lahaina Bypass due to fire.
15:29	Andaya reported to group text that there was a new fire in Lahaina near the Intermediate School, approaching houses per Chief Giesea. The fire had jumped over the roadway. They were closing Lahaina Bypass, and MFD was doing another evacuation.
15:50	Andaya advised Bolor that the State Declaration had been signed.
16:02	Andaya relayed to Gabuat that he was texting the Mayor when he received updates from her or Chief Giesea.
16:03 – 16:10	Gabuat commented that multiple people look overwhelmed. Andaya asked if he should come home. Gabuat responds that it may look okay. Andaya asked when Paul Coe was scheduled to return, and Gabuat responded that Coe was returning at 19:00.
16:16	Bolor responded to Andaya that Wireless Emergency Alerts (WEA) were being issued for the evacuations.
16:30	Maui EOC was at Level 1 Full Activation. State Warning Point (SWP) was apprised. HI-EMA was at normal operations. The State of Hawai'i had published an Emergency Declaration covering Hawai'i County and Maui County.
16:55	During the briefing Gabuat texted Andaya. Rocky Bolor relayed Chief Giesea working with Gina Albanese on the Fire Management Assistance Grant (FMAG), and it was two (2) incidents. Now waiting on National Guard.
17:31	Andaya had an eight (8)-minute conversation with Paul Coe. Andaya relayed to Gabuat that two (2) separate FMAGs need to be submitted, and Paul sounded panicked.
17:43	Andaya asked Gabuat if any homes on the west side had been lost, but she responded she did not know.
18:18 – 18:28	Andaya and Gabuat texted about the shelter situation. Andaya advised they should activate the Community Emergency Response Team (CERT) to assist with shelter staffing and Red Cross.
19:00 – 20:31	Text communications between Andaya, Barros, and Bissen focused on request for assistance (RFA), including deployment of Air National Guard and possible aviation support on 8/9, if weather conditions permitted.
19:19 – 19:52	Luke Meyers (HI State Disaster Mgt. Adv.) requested status of Lahaina from Andaya. Meyers relayed there were social media reports of apartments and structures being affected. Andaya responded that Lahaina flared up again, Kelawea Mauka subdivision was evacuated, and Lahaina Bypass was closed. Meyers asked if any businesses had been lost, and Andaya said he believed one (1) had.
19:47	ROAD CLOSURE Hwy-30, Lahaina bound closed at Ma'alaea.
20:06	Gabuat relayed there was a bad fire on Front Street. Andaya responded that he better come home tomorrow.
20:06	ROAD CLOSURE Hwy-30 to Lahaina bound traffic at Leiali'i Parkway, Kā'anapali bound open.

**Now known as Hawaiian Electric.*

continued

^These records appear as they exist within WebEOC. Some records use the term "brushfire" and others use "bushfire."

MEMA Timeline of Significant Events
Based on Andaya Call/Text Records and Technical Discussion

20:07	ROAD CLOSURES Multiple road closures in Lahaina Town. Do NOT go to Lahaina Town.
20:08	Gabuat advised there were reports that about 100 people were going into the ocean to escape the smoke.
20:38	ROAD CLOSURE Keawe Street closed Hwy-30 to Lahaina Bypass.
21:01 – 21:14	Text conversation about loss of use of Lahaina and Kīhei shelters due to staffing. Andaya recommended having county workers operate shelters like Honolulu and Kaua'i do, but Gabuat relayed Bolor raised liability issues.
21:31	Maui EOC produced SitRep No. 2 (see Appendix 6.8).
21:38	Gabuat advised there was now a fire in Kīhei near Pūlehu Road.
21:57	Gabuat advised the Maui High School gym was now open with county workers.
22:39	Gabuat advised Kā'anapali hotels may have to be evacuated. Andaya asked if the Red Cross was in the room and to have them call his cell.
23:04	Andaya informed Barros he would be flying back to Maui tomorrow morning (8/9).

August 9, 2023

01:11	Gabuat advised another evacuation in Lahaina and that it looks like the area from Lahaina to Kā'anapali had been destroyed.
03:16	National Weather Service (NWS) event canceled. High wind warning from 8/9/2023 03:15 to 18:00 HST for Maui County. Event extended wind advisory from 8/9/2023 03:15 to 18:00 HST for Maui County.
03:44	ROAD CLOSURE Kahekili Hwy closed to Lahaina bound traffic (evac. from Lahaina only).
03:59	ROAD CLOSURE UPDATE All roads in Lahaina Town are closed. Emergency personnel only.
07:03	Andaya requested to speak with Kuhea (HECO*) or an alternate contact number for HECO*. Balmores advised they were in their 07:00 shift change briefing.

4.3.7 Crisis Communications

Maui Mayor Richard T. Bissen, Jr.
With the approach of Hurricane Dora, Mayor Richard T. Bissen, Jr. was kept aware of weather forecasts by MEMA via email.

Given concerns about high winds and the NWS fire danger warnings, two (2) MEMA staff members were assigned to the EOC on the night of August 7, 2023.

When Mayor Bissen visited the EOC that evening (August 7, 2023) at approximately 19:30, it was empty, and he realized the night shift coverage was scheduled to start at 21:00.

On the morning of August 8, 2023, Mayor Bissen recalled receiving a text alert on his phone, around 05:00, that emergency evacuations were happening in Kula and a shelter was being opened. While he was already scheduled to be at a meeting in Kula that morning, he went directly to the EOC and arrived at approximately 06:00/06:30. At that point, he only knew about one (1) active fire—in Kula.

Arriving at the EOC, Mayor Bissen noted it was the most people he had seen in that facility since taking office in January 2023. Individuals present included the managing director, chief of communications, assistant fire and police chiefs, and MEMA personnel. He did not believe that all the available positions (approximately 60) were filled at that point but reported that later in the event, there were more than 100 people in the EOC.

At approximately 06:30, Mayor Bissen recalled that Lahaina reported a fire as well. While that fire was being monitored, "everything was about Kula," given the larger size of the Kula fire and adjacent evacuation area at that time.

Mayor Bissen attended the HI-EMA statewide coordination meeting via Zoom that morning at 11:00 and recalls seeing Major General (MG) Hara, MEMA Administrator Herman Andaya, FEMA Regional Administrator Bob Fenton (who he didn't know then), and several others standing around a camera—since they were all at the Pacific Partnership 2023 Meeting on O'ahu. There was great concern about fires on the Big Island and in Kula at that time; the winds on Hawai'i and Maui were steadily increasing, and air assets could not be used.

Later that morning, Mayor Bissen was advised that the Lahaina fire was contained.

Throughout the day on August 8, 2023, until approximately 02:30 the next morning (August 9, 2023), Mayor Bissen reported staying at the Maui County government complex in Kahului, moving between the EOC and his office.

"Nothing had let up in Kula" during this time; Mayor Bissen could still see the fire burning from the County Complex and thought Kīhei High School [Kūlanihāko'i High School] was going to be lost.

**Now known as Hawaiian Electric.*

Arriving at the EOC on the morning of August 9, 2023, Mayor Bissen was first made aware that lives were lost in Lahaina. Later that day, when weather conditions allowed the CAP to perform a reconnaissance flight over Lahaina Town, "then [he] saw what happened."

Mayoral Communication with MEMA

Mayor Bissen reported that his role in the EOC was to "ask layperson questions," "be supportive," "get needed resources," and "not take over" from the professional staff in the EOC.

Much of the communication that occurred in the EOC was verbal, and Mayor Bissen recalled that it "got very loud." Fire and police portable radios were the "main lifeline" for information from the field. At one point, Assistant Fire Chief Giesea gave a report about the Lahaina fire during an EOC briefing.

There was limited information coming in from other sources and "nothing in real time."

Mayor Bissen and his staff started seeing information "trickle in" via social media and also started getting calls from Lieutenant Governor Luke and others. He did not remember seeing any written flash reports or situation reports with "everything coming verbally."

There was "no reliable communication other than (public safety) radio," Mayor Bissen recalled. "Nobody knew how bad it was." At one point, the room in the EOC got quiet, and he could tell something serious had happened. Assistant Fire Chief Giesea reported that they had not received communication from one of the fire crews. Mayor Bissen does not remember how he found out about the water rescues along Front Street; his main concern was getting them out of the water.

In the EOC, Mayor Bissen spoke with the airport fire chief and obtained assistance with refilling SCBA cylinders for the MFD.

Mayor Bissen spoke to Lt. Colonel Curtright with Cto ask for help with traffic control, at the request of MPD. While he was initially reluctant to call MG Hara directly until advised that this was a past practice, he asked Administrator Andaya for MG Hara's number. Shortly thereafter, he received a call directly from MG Hara and got immediate assistance, "like WD-40."

Mayor Bissen "worked to get resources to people who needed them—not to decide what resources were needed."

Setting Up Shelters

Mayor Bissen reported that, over the course of August 8 and 9, 2023, "we were opening shelters left and right, 6 or 7." Due to changing conditions like fire impingement, loss of power, loss of water, etc., shelters were opened, closed, or relocated throughout the incident.

TIMELINE OF EVENTS

Maui County and Mayor's Office employees worked with many community volunteers and partners to open, staff, and provide resources for shelters across Maui in both Kula and, later, Lahaina.

The Maui Mayor's Office has one (1) satellite phone, and it was given to the Lahaina Civic Center shelter facility so evacuated families could reach their loved ones.

Mayor Bissen called the state Department of Education to have the principal come in and open Maui High School as a shelter.

Mayoral Press Briefings

On August 8, 2023, Mayor Bissen canceled all scheduled meetings and felt like he spent the day in the EOC doing radio and television interviews from his office or the EOC conference room.

At 10:00 on August 9, 2023, Lt. Governor (LG) Luke, MG Hara, and others held a press conference where Mayor Bissen made an initial report of six (6) fatalities on Maui.

Mayoral Emergency Proclamation

Around 20:00 on August 8, 2023, Mayor Bissen signed a local emergency proclamation. See Appendix 6.9 for full text of the mayoral emergency proclamation.

Governor Josh Green, M.D.

On July 30, 2023, Governor Josh Green flew from Honolulu to the continental United States for a family reunion.

From July 30, 2023 through August 7, 2023, Governor Green was in contact with his staff on O'ahu who were watching the approach of Hurricane Dora and assessing his potential return to Honolulu ahead of the storm. When it became apparent that Dora would pass far south without directly impacting the State of Hawai'i, Governor Green continued his planned two (2)-week visit with family.

On August 8, 2023, Governor Green became aware of a fire on the Big Island of Hawai'i, after receiving a call from his aunt and uncle in Waikoloa.

Around 21:00 EDT on August 8, 2023, (approximately 16:00 HST), Governor Green was notified about the Maui fires by his chief of staff. At that time, very little information was available about the extent of the fires on Maui, and he became increasingly concerned about the situation.

On August 9, 2023, in the morning, approximately 08:00 EDT/03:00 HST, Governor Green received an informal call relaying the information that multiple casualties were being treated on Maui, with patient transfers to hospitals on O'ahu. With that call, Governor Green decided to return home immediately and booked the soonest available flights from the East Coast: Logan International Airport in Boston, to Seattle-Tacoma, then back to Honolulu.

As Governor Green began his transit back home, he told his staff on O'ahu to begin preparing a major disaster declaration (MDD). Over the next couple hours, it became evident that the Lahaina fire was a terrible tragedy, although the ultimate scale was still unknown.

Gubernatorial Press Conferences

On the night of August 9, 2023, during a brief layover in Seattle, Governor Green did a television interview before boarding his final flight to Honolulu. At that point, the extent of the tragedy in Lahaina was still not clear.

Gubernatorial Emergency Proclamation

After landing in Honolulu, Governor Green signed the MDD, and it was transmitted to the White House just before midnight (HST) on August 9, 2023. See the Appendix 6.10 for the emergency proclamation.

On August 10, 2023, first thing in the morning, Governor Green flew to Maui and went directly to the Maui County Emergency Operations Center.

Lieutenant Governor Sylvia Luke

Prior to Governor Green's planned vacation, the state of Hawai'i had arranged for Lieutenant (Lt.) Governor Sylvia Luke to act in the capacity of the state's governor during the governor's absence.

With the impending passage of Hurricane Dora, Acting Governor Luke, HI-EMA, and the Governor's Office were briefed by the National Weather Service (NWS) on wind and weather conditions, with a Red Flag Warning issued on August 7, 2023.

In the early morning hours of August 8, 2023, Lt. Governor Luke awoke to windy conditions like she had never experienced during her many years in Honolulu. Although scheduled to attend a conference that day, Acting Governor Luke canceled her travel plans and began communicating regularly with various state officials, including Major General (MG) Hara.

> *080721AUG23: Text message from MG Hara to Governor, Lt Governor, Chief of Staff (CofS), Makana, Luis Salaveria, Mayor Roth, and Dawn Chang. Subj: HING Staffing a mission for CH-47 and crew support to Hawai'i County.*

At 09:00 that morning, Acting Governor Luke received the first situation report (SITREP) from HI-EMA.

> *080930AUG23: MG Hara directed administrator Barros to schedule a statewide coordination meeting at 11:00 with Acting Governor Lt. Gov. Sylvia Luke, Counties, FEMA, HING, and other Emergency Management stakeholders.*

Later that morning on August 8, 2023, at 11:00, Acting Governor Luke received her first briefing during a HI-EMA virtual coordination meeting that included all counties across the State of Hawai'i.

TIMELINE OF EVENTS

At that time, the primary concern expressed by participants was for wildfires on the Big Island of Hawai'i; she noted that Hawai'i County was actively "making requests for help" from HI-EMA for Hawai'i National Guard (HING) air support. It appeared the Maui County EOC was not fully activated, and she did not get the impression there was a significant concern on Maui.

At 14:00 on August 8, 2023, the next SITREP issued by HI-EMA indicated that the EOC in Hilo, Hawai'i (on the Big Island) was fully activated. Indications from Maui were that the Upcountry fire in Kula was their major concern, with only a partial EOC activation.

At about 21:00 on the evening of August 8, 2023, the Lt. Governor's Office began receiving numerous media inquiries about the situation on Maui. These outlets reported they could not get a response from Maui County and also stated that people were "jumping in the water." Acting Governor Luke conveyed these inquiries to staff in the Governor's Office, while her own staff monitored social media in an attempt to gain a picture of what was happening on Maui.

Approximately one (1) hour later, Lt. Governor Luke's staff began finding accounts of "Lahaina on fire" through social media and also their personal networks. Acting Governor Luke remembers calling MG Hara and confirming that both of them were not getting accurate information from Maui. They discussed the differences between the information contained in the SITREPs and what they were now learning from social media and other sources.

Around 23:00, Acting Governor Luke recalls telling HI-EMA Administrator Colonel Barros that he needed to be "more proactive" in getting information from Maui, and he advised that HI-EMA was preparing another SITREP.

Lt. Governor Luke and her staff worked through the overnight hours from August 8, 2023, into August 9, 2023, trying to develop a sense of the situation in Maui.

090415AUG23: Acting Governor Sylvia Luke called MG Hara on work phone twice within the hour.

Only after daylight on August 9, 2023, did the magnitude of the tragedy start to become apparent.

At 10:00 on August 9, 2023, Acting Governor Luke, MG Hara, and others held a press conference where Mayor Bissen reported six (6) fatalities on Maui.

091000AUG23: Acting Governor Sylvia Luke Maui Fires & Hurricane Dora Press Conference. I [MG Hara] briefed NGCS support efforts. Mayor Bissen made initial notification of 6 fatalities during his brief.

Another press conference was held at 21:00 on August 9, 2023, with Lt. Governor Luke presiding in her role as Acting Governor.

092100AUG23: Acting Governor Luke Press Conference at Hawai'i Convention Center, attendees/speakers:

- Lieutenant Governor Sylvia Luke (serving as Acting Governor)
- Major General Kenneth S. Hara, Adjutant General, Hawai'i State Department of Defense
- Bob Fenton, Region Administrator, Federal Emergency Management Agency
- Senator Mazie Hirono
- Senator Brian Schatz
- James Tokioka, Director, Department of Business, Economic Development & Tourism

Governor Green arrived back on O'ahu the night of August 9, 2023, and resumed his responsibilities.

Lt. Governor Emergency Proclamations

Lt. Governor Luke signed a state-level emergency proclamation at 15:21 on August 8, 2023, allowing the HING to provide counties with assistance and giving access to state emergency funds.[112]

081521AUG23: Acting Governor issued Emergency Proclamation for Hurricane Dora and Wildfires.

Also on August 8, 2023, Lt. Governor Luke spoke with representatives from the White House about the Presidential Disaster Declaration process.

A second emergency proclamation was issued at 07:54 the morning of August 9, 2023, in an attempt to divert people from flying into Maui unless they were part of the emergency response.

090754AUG23: Second Proclamation Relating to Wildfires (discouraging nonessential travel to the Island of Maui).

A third emergency proclamation for the wildfires was issued at 13:57 on August 9, 2023.[113]

091357AUG23: Third Proclamation Relating to Wildfires

Hawai'i Emergency Management Agency (HI-EMA)

With the approach of Hurricane Dora, HI-EMA conducted a virtual statewide coordination meeting for state agencies, county officials, and federal partners on August 4, 2023, at 13:00. This meeting includeda briefing from the NWS HFO on the impending high winds, surf, and potential fire danger arising from Dora's passage.

041300AUG23: Tropical Cyclone Dora Statewide Coordination Meeting (Virtual) NWS brief on high winds, possible red flag warning, and high surf.

Note: Italicized text is quoted directly from the "HI-EMA Administrator Timeline" document provided to FSRI. See Appendix 6.11.

[112] *Emergency Declaration https://dod.Hawaii.gov/hiema/governor-issues-emergency-proclamation-relating-to-wildfires/*
[113] *Emergence Declaration https://dod.Hawaii.gov/hiema/governor-issues-third-proclamation-relating-to-wildfires/*

TIMELINE OF EVENTS

The NWS HFO subsequently issued a statewide Red Flag Warning on August 7, 2023, at 03:15.

> *070315AUG23: National Weather Service (NWS) issues Red Flag Warning.*

At 09:00 on August 7, 2023, MG Hara convened a division meeting with HING and HI-EMA leadership, the state homeland security administrator, and all key staff.

> *070900AUG23: The Adjutant General (TAG) Division Meeting–TAG initial guidance to Hawai'i National Guard (HING): be prepared to (BPT) execute National Guard Civil Support (NGCS) operations due to possible impacts from Hurricane Dora and the High-pressure system north of the state (Pressure gradient). Anticipated missions: Aerial Fire Suppression, Security, Incident Awareness and Assessment, Emergency Evacuation.*

In the morning hours of August 8, 2023, at approximately 04:00 and 04:20, the HI-EMA State Warning Point (SWP) received two (2) "flash reports" from the Hawai'i County EOC in Hilo, with information about two (2) fires of concern.

Later that morning, at 06:38, Hawai'i County Mayor Roth notified state officials about two (2) fires on the Big Island.

> *080638AUG23: Mayor Roth notifies Governor, MG Hara, etc. that 2 major fires active. (Hawai'i County) Emergency Operations Center (EOC) is activated. Kohala Ranch is evacuated and may need helicopters.*

Shortly thereafter, the Hawai'i County EOC made a formal RFA with aerial firefighting assets to the HING's joint operations center (JOC) through HI-EMA's WebEOC system.

In response to this request, at 07:15 on August 8, 2023, MG Hara directed that HING helicopters be placed on alert to support Hawai'i County, and mission planning was started by the appropriate personnel.

At 07:48, the Hawai'i Army National Guard (HIARNG) state aviation action officer (SAAO) advised the HING joint staff that "helicopters [were] unable to launch due to wind speeds."

Also around this time, HI-EMA became aware that fires were being reported on Maui and, at the direction of MG Hara, the HING joint operations chief (J3) emailed HI-EMA Operations at 08:50 and then followed up directly with MEMA to get more information.

> *080852WAUG23: HING/J3 responded to TAG's text RFI on 080831WAUG2023. "HI-EMA is calling Hawai'i County for an update and they haven't received anything from Maui. I'll call MEMA direct"*

HI-EMA released its first situation report (SITREP) at 09:00 on August 8, 2023. This report included information about two (2) "brush fires" on Maui; "Upper Kula," and "Lahaina: in the area of Lahainaluna Road."

At 09:09, the HING/J3 sent a direct email to MEMA Administrator Herman Andaya:

> *"Good Morning Herman, We are currently working an RFA for Hawai'i County regarding their ongoing fire(s) and I'm just reaching out to you for any update with your ongoing brush fire(s)."*

No response to this email was received.

At 09:22 and 09:27, the HING/J3 texted MEMA Administrator Andaya directly:

> *"Aloha Herman, This is COL Udani with the Hawai'i National Guard. Checking in with you for any updates on the current brush fire. We are working an RFA for Hawai'i County's ongoing brush fire."*
>
> *"Sorry, just found out you're at the Pacific Partnership Meeting."*

And received a (text) response at 09:30:

> *"No worries. There are two fires on Maui, Kula and Lahaina. Seems that Maui Fire Department (MFD) has a handle on Lahaina. Kula is a different story. Spoke to Gen Hara and he mentioned that Big Island is requesting assistance and if Maui needed State assistance. Spoke to Mayor and Chief, and they indicated that they are able to fight this fire with the assets they have … for now. Thank you for asking. I'll keep you posted."*

Also at 09:30 on August 8, 2023, MG Hara directed HI-EMA Administrator Barros to schedule a statewide (virtual) coordination meeting at 11:00 that day. In advance of this meeting, MG Hara recalls speaking with the state's acting attorney general to confirm the RFA process, as well as Acting Governor Luke to request an emergency declaration (issued August 8, 2023, at 15:21) allowing access to the state's major disaster fund (MDF) to deploy HING and other state resources.

A virtual statewide coordination meeting was held at 11:00 on August 8, 2023. Several of the principals participating in this event were already attending the Pacific Partnership Meeting on O'ahu and joined together via Microsoft Teams from that location.

> *081100AUG23: Statewide coordination meeting held virtually. Present at the 'Alohilani Resort were MG Hara, Administrator Barros, HI-EMA Executive Officer (XO) Don Aweau, FEMA Rep, MEMA Herman Andaya, KEMA Elton Ushio, American Red Cross (ARC) Diane Peters-Nguyen, and Defense Coordinating Officer (DCO) COL Brian Watkins.*

MG Hara left the Pacific Partnership Meeting at 13:00 on August 8, 2023, and returned to HING Headquarters (HQ) at Fort Ruger, where he met with key staff and then "spent an hour" with HI-EMA leadership.

At 13:45, in response to Hawai'i County's RFAs, the HING tasked Hawai'i Army National Guard (HIARNG) and Hawai'i Air National Guard (HIANG) personnel with providing support to the Hawai'i County Civil Defense Agency.

TIMELINE OF EVENTS

HI-EMA's second SITREP was disseminated at 14:00 on August 8, 2023, and reflected that both Hawai'i and Maui Counties were dealing with brushfires. This SITREP contained the following information regarding Maui County:

Maui County

- Maui EOC is partially activated.
- Maui Fire department reports two brush fires:
  - Upper Kula: near Haleakala Highway and Kula Highway.
    - Evacuations underway for Haleakala 377 area of MM2, Kula 200 subdivision: Aulii Drive, Hanamu Road, Hoopalua Drive, and Kealaloa and Meha to the Y.
    - Open shelters at Hannibal Tavares Community Center and King Kekaulike High School. Oskie Rice Arena opened for evacuation, staging, and large animal evacuation.
    - Approximately 675 acres.
    - Containment unknown.
    - Impacts: 2 residential structures lost. No injuries or loss of life.
  - Lahaina: in the area of Lahainaluna Road.
    - Open shelter at the Lahaina Civic Center
    - Approximate 3 acres burned.
    - 100% Contained.
    - Impacts: No structures lost. No injuries or loss of life.

Figure 4.3.7.1 Source: Excerpt from HI-EMA Situation Update Number 2 document from August 8, 2023 at 14:00.

HI-EMA sent a staffing email to five personnel at 14:47 on August 8, 2023, advising that, "HI-EMA will be activating the SEOC tomorrow [8/9/23] morning in support of the counties' brushfires response."

At 15:30, HI-EMA/HING became aware that the situation on Maui was changing.

> *081530AUG23: A Lahaina fire flareup prompts evacuations, a road closure, and Shelter-In-Place (SIP) advisory on W. Maui.*

On August 8, 2023, at 16:00, MG Hara convened a meeting with senior HING leadership to provide an update that the "situation [was] dynamic" and to reorient HIARNG aviation support toward Maui County (by this time, Hawai'i

County was working directly with the Pōhakuloa Training Area to obtain support from active army helicopters available at that location on the Big Island).

At 16:28 on August 8, 2023, HING Lieutenant Colonel (LTC) Curtright—located on Maui—received a call from MEMA requesting a HING representative in the Maui EOC; he immediately responded to that location and arrived approximately 17:00–17:20.

The first formal RFA from Maui County was received by HING via WebEOC at 17:45 on August 8, 2023.

> *081745AUG23: MEMA Maui County Support RFA #102259 to HING for immediate assistance with the Maui Fire Department and Maui Police Department for the Kula fire.*

At 18:25, MG Hara held a meeting in his office and approved the HING's initial plan to support Maui County's RFA. By 20:00 that night, the HING had staffed the aviation and traffic control point missions requested by Maui County, starting the morning of August 9, 2023—weather permitting (for the helicopters slated to perform aerial firefighting).

HI-EMA Administrator Barros recalled speaking with MEMA Administrator Andaya "several times" on August 8, 2023, and hearing from him about the fire in Lahaina. Barros stated, "We have it contained," and indicated they were "worried about Kula and damaged structures."

During a meeting at HING headquarters, between 20:00 and 20:45 that night, MG Hara was notified by MEMA Administrator Andaya that Maui Mayor Bissen wanted to talk with him directly; MG Hara called Mayor Bissen at 20:48 and gave LTC Curtright immediate authority to deploy 16 HING members on Maui to help support the MPD with traffic control. During this call, MG Hara did not receive "any further details as to the severity of the fires in Lahaina" and recollected that the "focus was on the Kula fire threatening homes and property."

During the late evening hours of August 8, 2023, HI-EMA Administrator Barros got a call from the USCG in Honolulu advising, "They were launching cutters from O'ahu because of reports of people in the water on Maui." Administrator Barros reached out to MEMA for confirmation and received no additional information. Shortly thereafter, he received a call from the Hawai'i Tourism Authority "asking what they are supposed to do on Maui." At that point, Administrator Barros "started trying to bring in HI-EMA people as soon as they could get [to the SEOC]."

At 00:41 on August 9, 2023, another RFA was received from Maui County for SAR support.

On August 9, 2023, at 00:56, MG Hara approved the launch of up to two (2) HING helicopters for Maui County at 07:00 that day.

TIMELINE OF EVENTS

The HI-EMA SWP alerted multiple state agencies at 01:17 that the SEOC would be activating at 06:00 on August 9, 2023, with state emergency support functions (SESFs) for:

- Transportation (SESF1)
- Communications (SESF2)
- Firefighting (SESF4)
- Mass Care, Housing, and Human Services (SESF6)
- Energy (SESF12)
- Military Support (SESF20)

At 01:20 on August 9, 2023, MG Hara approved HING personnel to provide SAR support for Maui County effective immediately, using a 12-person team already on Maui, with additional personnel from O'ahu deploying at 07:00 via military aircraft.

MG Hara received two (2) calls from Acting Governor Luke at 04:00 and 04:15 the morning of August 9, 2023. He recalled, "That was the first time I knew Lahaina [Town] burned; we still didn't know how many died."

At 06:00 on August 9, 2023, the HI-EMA SEOC began moving into a full activation status, including staffing a "Maui desk" to provide direct/continual communication with MEMA and the Maui County EOC.

At 06:28, HI-EMA sent an invitation for a state-county (virtual) coordination meeting about the fires in Hawai'i and Maui Counties; this meeting occurred at 08:00 on August 9, 2023.

MG Hara departed HING HQ for the Hawai'i state capitol at 09:00.

During a 10:00 press conference with Acting Governor Luke at the state capitol, "Mayor Bissen made initial notification of 6 fatalities during his [virtual] brief."

At 11:00 on August 9, 2023, a HIARNG CH-47 Chinook helicopter made its first aerial firefighting water drop on Maui at the Kula fire.

During the balance of the day on August 9, 2023, HI-EMA continued to bring additional personnel into the SEOC, and the HING sent additional resources to Maui, including a KC-135 aircraft with 30 personnel at 18:23.

On August 9, 2023, at 18:28, HIARNG helicopters Imua 833 and Imua 835 (both CH-47 Chinooks) completed 13 flight hours and 58 total water drops over Maui.

Another press conference was held at 21:00 that night at the Hawai'i Convention Center in Honolulu.

At 7:05 on August 10, 2023, MG Hara departed for an initial aerial survey of Lahaina with Governor Green and FEMA Regional Administrator Fenton.

4.3.8 American Medical Response (AMR)

On a typical day, American Medical Response (AMR) staffs nine (9) Advanced Life Support transport units (ALS) and one (1) ALS Special Response Vehicle (SRV). Usually, three (3) ALS units are based on West Maui (one (1) in Lahaina and two (2) in Nāpili). In response to the most acute phase of the incident (from the time EMS was activated around 15:40 on August 8 through first light on August 9), AMR deployed one (1) SRV paramedic unit to establish Medical Command and three (3) additional ALS units for a total of six (6) line ambulances in West Maui. One (1) of the ambulances established triage, treatment, and transport areas for Command. A mini-clinic/triage was set up in a MFD truck bay at Medic Station 5 in Nāpili, and ambulances responded to calls from this site.

Additionally, three (3) back-up ambulances and additional on- and off-duty personnel who responded to the scene were placed into varying functional roles. AMR worked closely with MFD and MPD and activated Coast Guard assets who played a valuable role from the water. During those first few hours, the EMS system triaged and treated over 60 patients and transported over 30 patients by ambulance.

Communication was difficult, especially in the early hours of the event. Many people came directly to the Nāpili Fire Station because there was no phone (911) service. Cell phone and pager service was also interrupted. Medical communications were maintained with Central Dispatch via the ultra high frequency (UHF) and 800 megahertz (MHz) radios.

AMR Transport Data as provided by Hawai'i State Department of Health:

- 31 responses for patient care
- 27 patient transports
- Three (3) patients refused transport
- One (1) patient has no record of transport
- Nine (9) patients (three (3) females and six (6) males) were transported shortly after 15:40 on August 8, 2023 from Lahaina Bypass and Lahainaluna Road. These patients did not have their ages recorded.
- Eight (8) additional patients were transported on August 8, 2023
- 13 patients were transported on August 9, 2023
- 17 males
- 13 females
- One (1) gender not reported
- Ages ranged from 30–92
- Ten (10) smoke inhalations
- Six (6) burns
- Two (2) burns with smoke inhalation

4.3.9 U.S. Coast Guard Operations (USCG)

The following information was provided by the USCG Sector Honolulu (USA) via three (3) emails to FSRI personnel on January 23, 24, and 26, 2024.

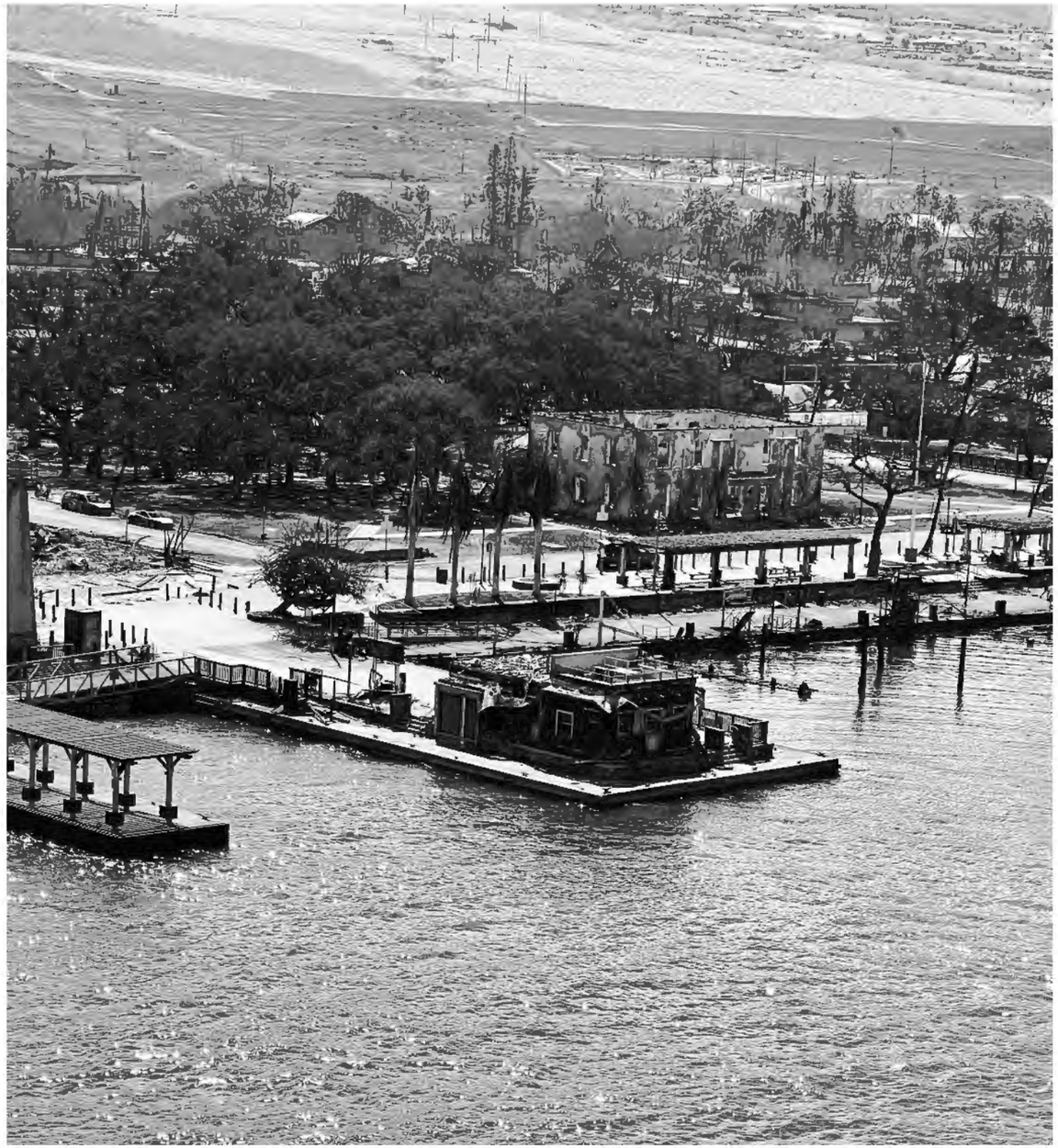
At 17:53 on August 8, 2023, USCG received a request from MPD dispatch for USCG assistance for an EMS transfer in response to a report of people in the water at Lahaina break-wall. O‘ahu USCG headquarters coordinated the SAR effort, treating the incident as a mass rescue. One (1) Response Boat–Medium (RBM) from Ma‘alaea Harbor responded. The RBM arrived at Lahaina harbor at approximately 19:00. The RBM vessel reported sustained winds of 35 knots (40 mph), with gusts up to 50 kts (57 mph) and initial visibility of eight (8) nautical miles (NM); this visibility was reduced to less than ten (10) feet as they entered the dense plume of black smoke emanating from Lahaina. In addition, airborne embers were landing on and around the crew members. A still image shows the fire and smoke, while the RBM moved toward the Lahaina shoreline (shown in Figures 7 through 9).

A USCG helicopter rescue swimmer was transported by ground to the harbor, but helicopters were grounded due to high winds. The rescue swimmer assisted with shore-based rescues. A USCG C-130 plane was requested for SAR, but aircraft were ineffective due to poor visibility from smoke. Although precise rescue longitude and latitude coordinates are not available, rescue operations were performed in the vicinity of the Lahaina Harbor break-wall. USCG recovered one (1) deceased female, approximately 40 years of age. The saved/rescued individuals were transported via the RBM to Ma‘alaea Harbor where they were then transported via ground ambulance to the hospital.

Seventeen people, ranging from five (5) to 60 years of age, were rescued from the water, and 40 were assisted from ashore. Patients suffered various burns and cuts. Most of the patients were suffering from the side effects of smoke inhalation. One (1) individual suffered fractures to both ankles. A certified emergency medical technician (EMT) was on board and completed assessments of all patients. Patient care information was then passed to the Emergency Medical Services (EMS) while patients were being offloaded. The patients who were taken ashore were received by local EMS. The Emergency Operations Center (EOC), part of the Emergency Management Center (EMC), tasked the National Park Service’s EMTs with assessing and treating all patients prior to boarding a city bus, which transported victims to shelters for additional care.

An O‘ahu-based USCG Cutter and U.S. Navy resources were requested to provide assistance. The USCG Cutter positioned itself within ten (10) miles of the Lahaina coastline. The USCG served as a maritime SAR coordinator, coordinating search efforts with those of Good Samaritan vessels and other partner agencies. A cutter small boat spotted a body on the Lahaina shoreline (time could not be confirmed). The Hawai‘i Department of Land and Natural Resources (DLNR) was advised for body recovery.

USCG SAR operations in Lahaina were conducted from August 8, 2023, through August 11, 2023.



4.3.10 Aircraft Rescue and Firefighting (ARFF) Units

Fire 4 (F4) reported he had a face-to-face conversation with Chief Colby Handly (Airport Fire), who came to the EOC at one point on the evening of August 8, 2023 (does not recall the time). Chief Handly asked how the airport could assist. The airport has specific protocols in place regarding what apparatus, if any, can leave the airport. Those protocols were unknown to F4.

Per dispatch, F4 relayed to command that two (2) ARFF units would be responding to assist (i.e., designator Airport Fire and Kapalua ARFF or K-ARFF). Airport Fire was assigned to Structure Group and K-ARFF was assigned to Support Group.

At 21:26, Command assigned Airport Fire to Structure Group.

At 22:07, Command from Kapalua ARFF: “We have one (1) utility vehicle if you need support moving the abandoned at the Civic Center. We also have 60 at the airport seeking refuge.”

Command disbanded Support Group at 23:54 as all units relocated from the Highway and Hawaiian Homes to Kā‘anapali.

At 00:35, Command re-established Support Group. Command assigns Kapalua ARFF to Support Group, reporting to U3B. Command advised Support Group is to provide support function and prepare for evacuation for the next neighborhood north.

Table 4.3.10.1 Aircraft Rescue and Firefighting (ARFF) Units on August 8, 2023, and August 9, 2023.

Date / Time	ARFF UNITS
August 8, 2023	
06:00 – 08:00	
08:00 – 10:00	
10:00 – 12:00	
12:00 – 14:00	
14:00 – 16:00	
16:00 – 18:00	
18:00 – 20:00	20:16 Fire 4 (F4) advised the EOC that they were arranging for an ARFF truck (three (3)-person crew) to respond from Kahului. Command acknowledged and said they were looking forward to the help.
20:00 – 22:00	21:18 Airport Fire reported that they were at Lahainaluna and the Bypass waiting for assignment. 21:26 Command asked Structure Group if they needed additional resources and that two (2) engines were available. Structure Group advised there were no viable hydrants, but the engines could still be used. Command assigned Airport Fire to report to Structure Group. 21:37 Airport Fire advised they were at Wialee (unreadable–likely Leialiʻi) Parkway ready for assignment. Structure Group assigned Airport Fire to stage at the top of Hawaiian Homes and monitor. 22:07 Kapalua ARFF (K-ARFF) reported they had one (1) utility vehicle to support evacuation of the Civic Center to Maui Prep if needed and advised that there were 60 civilians seeking refuge at the airport. Command advised K-ARFF to report to Support Group for assignment. 22:09 All Support Group units were assigned to report to Fire Station 3 (FS3) to help shuttle from Civic Center to Maui Prep. 22:18 Structure Group assigned Airport Fire to extinguish spot fires between Wahikuli neighborhood and Front Street. Airport Fire acknowledged. 22:23 Structure Group advised Airport Fire that the fire had already reached Front Street and they could abandon that assignment.
22:00 – 00:00	23:46 ARFF reports staging on Highway north of Canoe Beach with other Structure Group units.
August 9, 2023	
00:00 – 02:00	00:35 Command advised there were two (2) ARFF units working: K-ARFF was assigned to Support Group, and Airport Fire was assigned to Structure Group.
02:00 – 04:00	03:16 Facebook post stated close to 100 firefighters had been on duty, including 11 from state airport rescue personnel.
04:00 – 06:00	05:09 Airport Fire reported they were pulling up to FS3 and ready for assignment. Support Group advised them to stage at the post office off Leialiʻi Parkway, and if water supply was sufficient, they would be called. 05:13 Support assigned Airport Fire to attack fire … the railroad tracks west (makai) of Hawaiian Homes and assist the engine with its main line off Leialiʻi Parkway. 05:22 Airport Fire advised they were heading to Canoe Beach to refill. Upon refilling, Support Group assigned Airport Fire to extinguish telephone poles along the Highway to maintain ingress and egress access. 05:32 Airport Fire advised they had finished refilling and were staging at the post office off Leialiʻi Parkway. Support advised Airport Fire to extinguish burning power poles. 05:52 Airport Fire advised they were ready for reassignment. Support Group assigned them to respond to the top of Leialiʻi Parkway to provide structure protection and prevent the grass fire from wrapping around the homes and vehicles.
06:00 – 08:00	06:16 Airport Fire advised they needed to refuel. Airport Fire was instructed by Support Group to refuel at fire station [number unknown] where a generator was still operating the fuel pumps. 07:03 Airport Fire reported they had refueled and were ready for reassignment. Support advised Airport Fire that the current conditions looked good and they should remain in staging to see if they were needed elsewhere. 07:07 Command advised AirportFire to remain available in staging with Relief Engine 1 (RE1) and that both assets would be used for contingencies.

continued

4.3.11 Hawai'i Division of Forestry and Wildlife (DOFAW) Fire Response Units

On August 8, 2023, DOFAW units responded to the Maui wildfires upon request of MFD. Due to the Olinda Fire igniting after normal working hours, DOFAW personnel were paged to report to headquarters to prepare for response. Information provided by DOFAW Maui Unit Leader. DOFAW's response includes their own equipment (Table 4.3.11.1) and private contractors' equipment (Table 4.3.11.2).

Table 4.3.11.1 Hawai'i Division of Forestry and Wildlife (DOFAW) Units Staffing and Equipment on August 8, 2023, and August 9, 2023.

Hawai'i Division of Forestry and Wildlife (DOFAW) Units Staffing and Equipment August 8, 2023 and August 9, 2023

Department	Date	Staffing	Equipment
Olinda Fire (24-hour shift coverage)	August 8, 2023	27 (25 online/2 overhead personnel + logistical support staff)	• Type 1 (4,000 gallons; 6x6) • Three (3) Type VI (F450/F550) • Two (2) Type IV M62s • Two (2) Type VI w/ 300-gallon slip-on units
Olinda Fire (24-hour shift coverage)	August 9, 2023	28 (26 online/2 overhead personnel + logistical support staff)	• Type 1 (4,000 gallons; 6x6) • Three (3) Type VI (F450/F550) • Two (2) Type IV M62s • Two (2) Type VI w/ 300-gallon slip-on units
Kula Fire (Provided assistance to MFD upon request)	August 8, 2023	Four (4) fire personnel with one (1) M62 reassigned to Kula fire to assist with initial attack	
Lahaina Fire	DOFAW resources not requested		

Table 4.3.11.2 Private Heavy Equipment Contractors and Equipment Utilized on August 8, 2023, and August 9, 2023.

Private Heavy Equipment Contractors working with DOFAW August 8, 2023 and August 9, 2023

Department	Date	Contractor	Equipment
Olinda Fire (24-hour shift coverage)	August 8, 2023 (*too windy for helicopter resources)	Akau Construction LLC	1 x D6 dozer 1 x 4,000-gallon water tender
Olinda Fire (24-hour shift coverage)	August 9, 2023	Kiawe Express LLC	1 x excavator + chainsaw operator
		Akau Construction LLC	1 x D6 dozer 1 x 4,000-gallon water tender
		Hawaiian Dredging Construction Company, Inc.	1 x 4,000-gallon water tender
Olinda Fire (24-hour shift coverage)	August 10, 2023	Paradise Helicopters	1 x Type II helicopter
		Windward Aviation Inc.	1 x Type III helicopter
		Akau Construction LLC	1 x D6 dozer 1 x 4,000-gallon water tender
		Hawaiian Dredging Construction Company, Inc.	1 x 4,000-gallon water tender
Kula Fire (Provided assistance to MFD upon request)	August 8, 2023	Akau Construction LLC	1 x 4,000-gallon water tender reassigned to assist DOFAW engine crew with initial attack
Lahaina Fire	DOFAW resources not requested		

SUMMARY

5.0 Summary

The Lahaina Fire Comprehensive Timeline Report (Phase 1) describes the events and timing of August 8-9, 2023, in the Lahaina region. FSRI conducted an extensive data collection effort to establish a comprehensive timeline and fact base around the Lahaina fire. This report pieces together a detailed timeline of preparedness efforts, fire progression, evacuation activities, emergency response, and fire suppression actions based on a comprehensive array of data sources including radio communications, and radio transcripts, video, images (still images or image capture from digital videos), emergency logs, technical discussions (TDs) with authorities and residents, witness statements, text and phone logs, email records, automatic vehicle location applications, social media posts, witness accounts, and corroborated personal experiences. Mapping and analysis illustrate how the fires moved from the wildland into Lahaina's neighborhoods, rapidly transforming from a grassland fire into a catastrophic urban conflagration.

An Incident Analysis Report (Phase 2), outlining FSRI's independent analysis of these events, will follow to provide detail on conditions influencing preparedness efforts and the original fire situation, attempts to stop its rapid progression through Lahaina Town, and evacuation efforts. The analysis will include a review of county and state emergency response management policies and procedures to determine where changes are necessary to make them more effective in responding to future events. Incident analysis will incorporate science and evidence-based analyses with information from FSRI's fire dynamics research, local subject matter experts, industry standards and best practices, and the collective experiences of FSRI's team.

The Forward-Looking Report (Phase 3) of this comprehensive independent analysis will help answer critical questions about, "How do we prevent this from happening again?" The final report will have several discrete and interrelated components including a standards of cover analysis to assess the capabilities of the Maui County Fire Department, a community risk assessment to analyze natural and human caused risks to Maui, community risk reduction planning to help mitigate risk, and a review of fire and building codes.



6.0 Appendix

6.1 Subpoena Requests and Statuses

Subpoena Requests and Status

Subpoena No.	Service Date	Description (Summary)	Response Deadline	*Email Requests	Actual Response Date
2023-084 Maui Emergency Management Agency	November 27, 2023	(1) Current editions, as of August 2023, for all emergency management-related plans for Maui County. Including, but not limited to: (a) the Maui County Emergency Operations Plan (EOP); (b) the West Maui Emergency Plan; and (c) any operational and/or tactical plans addressing wildfire, wind, tsunami, evacuation, emergency notification, alert/warning, and other related planning documents. (Note: We have the May 2021 EOP, and the May 2018 West Maui Emergency Plan. We are mostly interested in specific operational and/or tactical plans addressing specific emergencies, and more specifically wildland or WUI fires.);	December 11, 2023	September 24, 2023	October 13, 2023 & November 21, 2023
		(2) All drafts, updates, and/or revisions to the West Maui Emergency Plan draft document dated May 14, 2018;		October 20, 2023	October 13, 2023 & November 21, 2023
		(3) All drafts, updates, and/or revisions to the Maui County Emergency Operations Plan, May 2021 edition ("Basic Plan");		October 20, 2023	October 13, 2023 & November 21, 2023
		(4) All "Functional and Hazard Annexes" included/referenced in Sections III and IV of the Basic Plan, May 2021 edition;		October 20, 2023	October 13, 2023 & November 21, 2023
		(5) All draft and completed "Functional and Hazard Annexes," to the Basic Plan, for wildfire-related activities and/or WUI fires;		October 20, 2023	November 14, 2023, Maui Dept. of Corp Counsel stated none exist
		(6) All after-action reviews (AARs) and records of any Maui County exercises (table-top, functional, full-scale) conducted for wildfire and/or WUI fires from 2013–2023;		October 20, 2023	November 14, 2023, Maui Dept. of Corp Counsel stated none exist
		(7) All Maui County departmental strategic plans, policies, or procedures that support the Maui County Emergency Operations Plan;		October 20, 2023	November 27, 2023
		(8) Records of daily Maui County Emergency Operations Center (EOC) activation status for the period 1–15 August 2023;		October 20, 2023	December 13, 2023
		(9) Identification and contact information for the Maui County officials listed in Figure 5 "Lines of Succession" of the Maui County EOP, May 2021 edition, from 7–10 August 2023;		October 20, 2023	December 13, 2023

continued

Subpoena Requests and Status

Subpoena No.	Service Date	Description (Summary)	Response Deadline	*Email Requests	Actual Response Date
		(10) Daily EOC organizational chart(s), by National Incident Management System Incident Command System (NIMS-ICS) role(s) and/or emergency support function(s) (ESF) for the period August 7-10, 2023;		October 20, 2023	As of December 13, 2023, Maui Dept. of Corp Counsel confirmed no further responsive record exists
		(11) Rosters, sign-in sheets, logs, and documents, physical or electronic, listing all personnel that staffed the EOC from 8:00 p.m. on August 7, 2023, through 8:00 p.m. on August 10, 2023, as well as an accounting of the time(s) that each person was present in the EOC;		August 31, 2023, September 24, 2023, October 20, 2023	November 27, 2023 partial production. December 6, 2023 additional production. As of December 13, 2023, Maui Dept. of Corp Counsel confirmed no further responsive record exists
		(12) All documents, physical or electronic, that were developed in the EOC during the time period from 8:00 p.m. on August 7, 2023, through 8:00 p.m. on August 10, 2023;		October 20, 2023	December 12, 2023. As of February 12, 2024, letter from Jordan Inafuku (Maui outside counsel) states that additional responsive documents will be produced.
		(13) Records of all communications made to or by the MEMA Administrator from 8:00 p.m. on August 7, 2023, through 8:00 p.m. on August 10, 2023. These records may include but are not limited to: texts, phone calls, and emails;		October 20, 2023	December 13, 2023.
		(14) Transcripts and records maintained by any electronic emergency management system, such as WebEOC, from 8:00 p.m. on August 7, 2023, through 8:00 p.m. on August 10, 2023;		October 20, 2023	December 13, 2023 partial production. March 1, 2024 HI-EMA extracted additional data from WebEOC responsive to this request
		(15) Copies of all incident action plans (IAPs) for the fire events that occurred in Maui County on August 7–10, 2023 (Maui Fires"") that were developed from 8:00 p.m. on August 7, 2023, through 8:00 p.m. on August 10, 2023;		October 20, 2023	December 6, 2023. As of December 13, 2023, Maui Dept. of Corp Counsel confirmed no further responsive record exists
		(16) Recordings of all EOC operations and of images from cameras located in the community that were viewed in the EOC from 8:00 p.m. on August 7, 2023, through 8:00 p.m. on August 10, 2023;		October 20, 2023	December 6, 2023

continued

APPENDIX

Subpoena Requests and Status

Subpoena No.	Service Date	Description (Summary)	Response Deadline	*Email Requests	Actual Response Date
		(17) Training/certification and exercise records for MEMA and MEMA employees for the past two (2) years (NIMS and other), including individual qualifications, local exercises, statewide exercises, and coordinated exercises with Federal and NGO partners;		October 20, 2023	December 13, 2023
		(18) Information on all preparedness messaging addressing the August 2023 wind event that may have been distributed by MEMA and/or Maui County prior to the Maui Fires. This includes, by way of illustration and not limitation, media releases, outreach campaigns, social media, Integrated Public Alert and Warning System (IPAWS), Wireless Emergency Alerts (WEA), and/or directives;		October 20, 2023	November 30, 2023
		(19) All maintenance and testing logs for the statewide alert and warning siren system in Maui County.		October 20, 2023	December 13, 2023
2023-084 Maui Emergency Management Agency	November 27, 2023	(1) Maui County DPW or Hawai'i Department of Transportation Brush Clearance Standard Operating Guidelines (SOG);	December 11, 2023	September 24, 2023t	October 23, 2023. As of December 13, 2023, Maio Dept. of Corp Counsel confirmed no further responsive record exists
		(2) Maui County DPW Brush Clearance Records in Lahaina are from January 1, 2020 to August 8, 2023.		September 24, 2023t	November 24, 2023
2023-086 Maui Department of Water Supply	November 27, 2023	(1) All records describing (size, location, permitted and operating capacity, etc.) the drinking water production facilities feeding the storage and distribution	December 11, 2023	October 25, 2023	December 13, 2023
		(2) The typical operating methodology for the drinking water treatment, storage, and distribution system in Maui County;		October 25, 2023	December 13, 2023
		(3) Documentation giving a general description of the water storage and distribution system components;		October 25, 2023	Discussed during site visit January 22–23, 2023
		(4) All records showing the water levels in the storage tanks under normal operating conditions, just before the fire event and during the fire event;		October 25, 2023	December 13, 2023
		(5) Design and operating information for the storage system including locations of the storage tanks and distribution system pumps;		October 25, 2023	Discussed during site visit January 22–23, 2023
		(6) Available fire storage capacity in the system under normal operating conditions;		October 25, 2023	Discussed during site visit January 22–23, 2023

continued

Subpoena Requests and Status

Subpoena No.	Service Date	Description (Summary)	Response Deadline	*Email Requests	Actual Response Date
		(7) All documentation showing distribution system connections between the East and West sides of Maui;		October 25, 2023	Discussed during site visit January 22–23, 2023
		(8) Documentation showing the size of the distribution system pipes connected to the fire hydrants in the primary area of the Lahaina fire; system;		October 25, 2023	Discussed during site visit January 22–23, 2023
		(9) Documentation showing the types of pipe materials used in the distribution		October 25, 2023	December 13, 2023
		(10) Documentation showing the typical depth of the pipes in the distribution system;		October 25, 2023	December 13, 2023.
		(11) The emergency operating plan, if any, for a major water usage event;		October 25, 2023	Discussed during site visit January 22–23, 2023
		(12) All records of how the storage and distribution system was brought back online assuming a loss of pressure during the fire event;		October 25, 2023	As of December 13, 2023, Maui Dept. of Corp Counsel confirmed no further responsive record exists
		*Unless stated otherwise, all requests pertaining to regularly updated plans, procedures, or other documents, are for the version that was in use on August 7–9, 2023.		October 25, 2023	N/A
2023-101 Maui Police Department	December 29, 2023	(1) Automated Vehicle Location data for August 8, 2023;	January 4, 2024	September 24, 2023	All items: January 18, 2024
		(2) Computer Aided Dispatch record for August 8–10, 2023.		August 31, 2023 & October 24, 2023	
		(2) Computer Aided Dispatch record for August 8–10, 2023.		August 31, 2023 & October 24, 2023	(2) January 18, 2024
2023-103 Maui Police Department	December 29, 2023	(1) Definitions of MPD dispatch codes and identifiers, including abbreviations found in MPD Event Chronologies and Dispatch Reports for August 8–10;	January 12, 2024	November 16, 2023	(1) January 14, 2024

continued

APPENDIX

Subpoena Requests and Status

Subpoena No.	Service Date	Description (Summary)	Response Deadline	*Email Requests	Actual Response Date
		(2) Documents describing unit codes;		November 16, 2023	(2) January 18, 2024
		(3) Policies for assigning “UDTH” event types;		(3) January 18, 2024	(3) January 18, 2024
		(4) Documents defining UDTH event types;		November 16, 2023	(4) January 18, 2024
		(5) All recorded MPD radio comms for August 8, 2023–August 10, 2023		August 31, 2023	(5) January 17, 2024
		(6) Staffing rosters for August 7–9, 2023		August 31, 2023	(6) January 24, 2024
		(7) Training records for MPD personnel from date of hire to August 8, 2023		Subpoena only	(7) January 24, 2024 (not in proper format)
		(8) Records of mandatory/recommended educational and training requirements for each MPD position;		Subpoena only	(8) January 24, 2024
		(9) Personnel deployment assignments, 2018–2023;		Subpoena only	(9) January 24, 2024 (produced general travel records only)
		(10) Policies and procedures for responding to wildfire or WUI events;		Subpoena only	(10) January 18, 2024 (partial, and records are not responsive)
		(11) Evacuation plans and analyses;		Subpoena only	(11) None to date
		(12) After Action Reports related to any and all wildfire incidents, WUI incidents, or mass evacuations;		Subpoena only	(12) None to date. As of January 30, 2024, Maui Dept. Corp Counsel confirmed no responsive documents.
		(13) Powerpoint presentation shared by Sgt. Chase Bell during Maui Police Commission meeting, September 20, 2023.		Subpoena only	(13) January 24, 2023
2023-104 Maui Fire Department	December 29, 2023	(1a) Current Fire and Rescue Operations Division personnel training/certification records for wildland firefighting, WUI firefighting, structural firefighting, incident management/command/organization, emergency medical care and/or first aid, and radio operations;		Subpoena only	(1a) January 24, 2024 (training completion records produced in .pdf) January 30, 2024, (XML and CSV provided)

continued

Subpoena Requests and Status

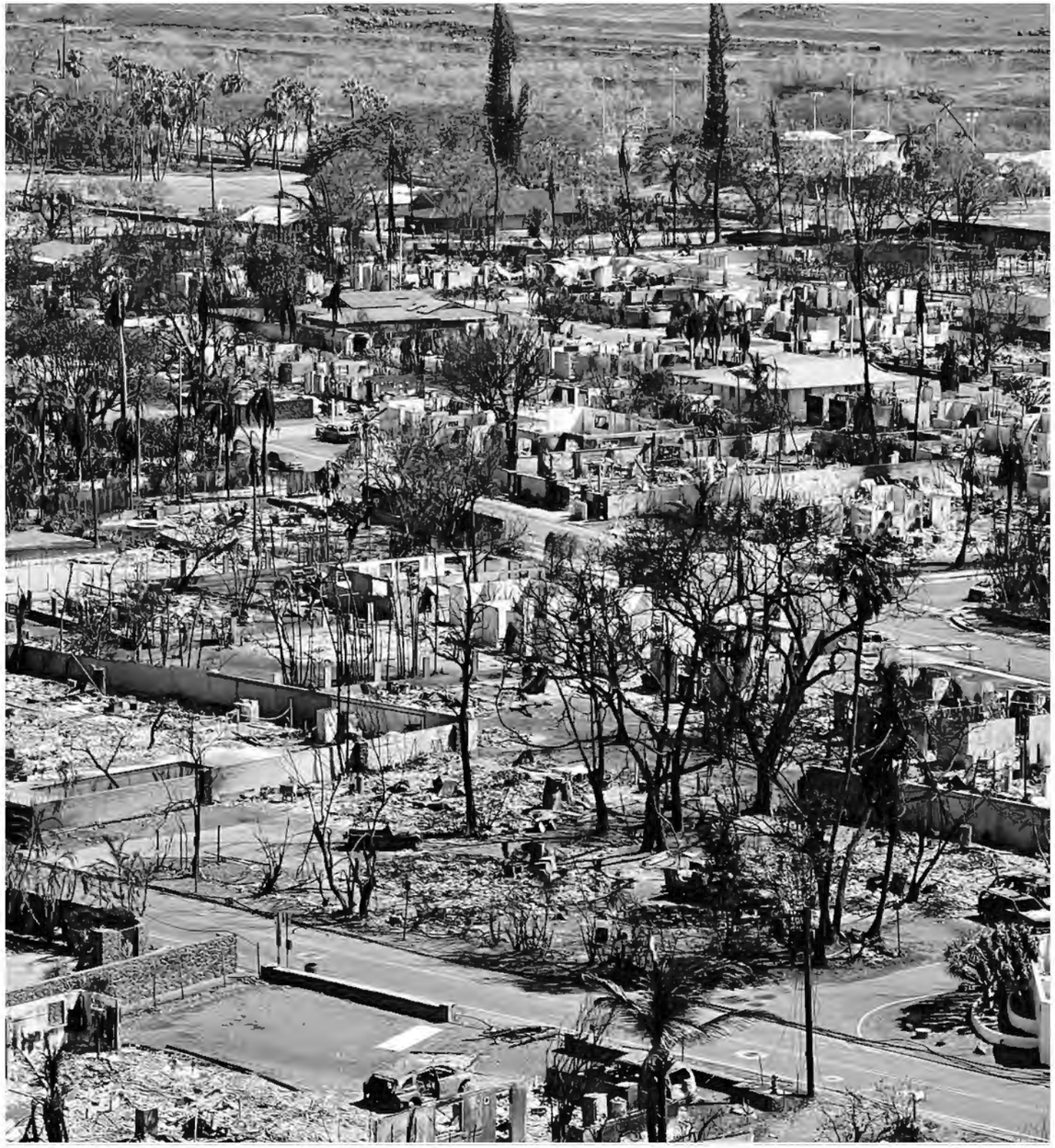
Subpoena No.	Service Date	Description (Summary)	Response Deadline	*Email Requests	Actual Response Date
		(1b) Current Fire and Rescue Operations Division personnel qualifications pertaining to wildfire, WUI, and All Hazard incidents;		Subpoena only	(1b) January 24, 2024, (partial– training records provided; unclear what qualifications achieved by personnel)
		(2) Mandatory and/or recommended educational and training requirements for each position within Fire and Rescue Operations Division;		Subpoena only	(2) January 17, 2024 (partial- course sign in sheets provided). As of February 12, 2024, per Jordan Inafuku (outside counsel), there is no required training for each position within MFD’s fire rescue operations division beyond the minimum qualifications of each position.
		(3) Records of personnel deployment for all Fire and Rescue Operations Division personnel from 2018–2023;		Subpoena only	(3) January 17, 2024
		(4) Evacuation plans and analyses;		Subpoena only	(4) None to date
		(5) After Action Reports related to any and all wildfire incidents, WUI incidents, or mass evacuations;		Subpoena only	(5) January 17, 2024
		(6) Draft or completed fire incident reports for the Lahaina, Kula, Kihei, and Olinda fires.		Subpoena only	(6) January 17, 2024
2023-105 County of Maui	December 29, 2023	(1) Information regarding the wildfire damage assessment map posted on the County of Maui website on August 12, 2023;		Subpoena only	(1) January 24, 2024. Confirmed via email January 30, 2024, from Maui Dept. of Corp Counsel, no responsive documents.
		(2) Documents regarding multi-agency training exercises, drills, and other multi-agency training		Subpoena only	(2) None to date
2023-106 County of Maui Department of Finance	December 29, 2023	(1) As of August 8, 2023, the most current and highest definition aerial imagery of all areas impacted by the Lahaina fire;		Subpoena only	(1) January 30, 2024 (provided access to EagleView)

continued

APPENDIX

Subpoena Requests and Status

Subpoena No.	Service Date	Description (Summary)	Response Deadline	*Email Requests	Actual Response Date
		(2) Documents regarding multi-agency training exercises, drills, and other multi-agency training		Subpoena only	(2) None to date
2023-106 County of Maui Department of Finance	December 29, 2023	(1) As of August 8, 2023, the most current and highest definition aerial imagery of all areas impacted by the Lahaina fire;		Subpoena only	(1) January 30, 2024 (provided access to EagleView)
		(2) All information on improved properties within the areas of Olinda, Kula, Kihei, and Lahaina that were destroyed or damaged by the Maui fires on August 8, 2023, including date each structure built and modified.		Subpoena only	(2) February 9, 2024
2023-107 County of Maui Department of Water Supply	December 29, 2023	(1) Operational records for water supply and distribution systems for the island of Maui from August 7–10, 2023;		Subpoena only	(1) January 17, 2024
		(2) Records of water production rates for all treatment plans within the water supply and distribution systems for the island of Maui from August 7–10, 2023;		Subpoena only	(2) February 9, 2024
		(3) System information obtained during the wildfires, including but not limited to t(a) loss of system pressure;		Subpoena only	(3a) None to date. Confirmed via email January 26, 2024, from Maui Dept. of Corp Counsel, no responsive documents.
		3(b) empty water storage tanks;		Subpoena only	(3b) None to date. Confirmed via email January 26, 2024, from Maui Dept. of Corp Counsel, no responsive documents.
		3(c) lack of power at the treatment plant resulting in loss of water production.		Subpoena only	(3c) None to date. Confirmed via email January 26, 2024, from Maui Dept. of Corp Counsel, no responsive documents.



APPENDIX

6.2 National Weather Service (NWS) Products Released (Communications)

NWS Products Released*
Prior to the August 8, 2023 Lahaina PM Fire

Date	NWS Communication or Product Type	Time	Product Content	Source
8/1/2023	Area Forecast Discussion	8:22PM	Latest forecast from the National Hurricane Center in Miami, Florida indicates that Hurricane Dora will cross 140W in the central Pacific late this weekend. Thereafter, Dora is expected to move on a path that would generally keep it well south of the islands early next week. This scenario would bring an increase in trade wind speeds Monday and Tuesday. As a deep-layer high to the northeast builds westward, winds could become strong as the trade wind flow becomes quite dry. With Keetch-Byram Drought Index (KBDI) values potentially exceeding 600 for the first time this summer by that time, Red Flag conditions could be met.	NWS–Area Forecast
8/2/2023	Area Forecast Discussion	3:43AM	Hurricane Dora located about 2,800 miles away.	NWS–Area Forecast
8/2/2023	Fire Weather Planning	4:21AM	DISCUSSION KBDI values are likely to exceed 600 in about a week, bringing increased potential for Red Flag conditions as the trade wind flow becomes strong and dry.	NWS–Fire Weather Planning Forecast
8/2/2023	Area Forecast Discussion	10:00AM	DISCUSSION Hurricane Dora is located about 2,600 miles away and is also tracking west at near 15 mph. The latest forecast from the National Hurricane Center in Miami, Florida indicates that Hurricane Dora will cross 140W and into the Central Pacific Basin late this weekend. Thereafter, Dora is expected to move on a path that would generally keep it well south of the islands early next week. This scenario will strengthen trade winds Monday and Tuesday. As a deep layer high north of Dora moves in from the northeast, winds could become strong and trade flow could dry out. With KBDI values potentially exceeding 600 for the first time this summer, Red Flag fire weather conditions could be met.	NWS–Area Forecast
8/2/2023	Area Forecast Discussion	3:57PM	DISCUSSION Hurricane Dora is located about 2,600 miles away and is also tracking west at near 15 mph. The latest forecast from the National Hurricane Center in Miami, Florida indicates that Hurricane Dora will cross 140W and into the Central Pacific Basin on Sunday. Thereafter, Dora is expected to move on a path that would generally keep it well south of the islands early next week. This scenario will strengthen trade winds Monday and Tuesday. As a deep layer high north of Dora moves in from the northeast, winds could become strong and trade flow could dry out. With KBDI values potentially exceeding 600 for the first time this summer, Red Flag fire weather conditions could be met.	NWS–Area Forecast
8/3/2023	Fire Weather Planning Forecast	4:25AM	DISCUSSION A return of very dry conditions and strong easterly trade winds is expected early next week.	NWS–Fire Weather Planning Forecast
8/3/2023	Fire Weather Planning Forecast	3:17PM	DISCUSSION Trades will ramp up early next week, and windy, very gusty, and dry weather with critical fire conditions are possible late Monday into Wednesday.	NWS–Fire Weather Planning Forecast

** Does not include products unrelated to Hurricane Dora.*

continued

NWS Products Released
Prior to the August 8, 2023 Lahaina PM Fire

Date	NWS Communication or Product Type	Time	Product Content	Source
8/3/2023	Area Forecast Discussion	9:01PM	DISCUSSION Expect windy and very gusty trade winds early next week, along with a period of stable and rather dry conditions. While it should continue to be monitored, guidance shows Dora passing south of the islands with deep high pressure moving in tandem to the north of Hawaii. Confidence is rising that we will experience a strong and rather dry trade wind flow with an unusually low inversion. This points toward limited showers with trade winds becoming strong and very gusty over and downwind of terrain. At the very least, a Wind Advisory will be needed for Tuesday and possibly as early as late Monday. FIRE WEATHER Breezy and rather dry weather produced near critical fire weather conditions today and a couple of fires have started on Oahu. Trade winds will ease this evening and hold at moderate strength Friday through the weekend. The potential is rising for critical fire weather conditions early next week. Dry, stable, and breezy to locally windy trades are looking increasingly likely as deep high pressure to the north moves in tandem with Hurricane Dora, which is forecast to pass south of the islands. The KBDI is expected to reach the critical 600 mark by Tuesday, and models show leeward relative humidity may fall below 45 percent on Tuesday and Wednesday. We will also have to monitor conditions for Monday as drier conditions move in with building trades.	NWS–Area Forecast
8/4/2023	Area Forecast Discussion	3:45AM	SYNOPSIS Trades will increase early next week, with very gusty and dry conditions possible late Monday into Wednesday. DISCUSSION Expect windy and very gusty trade winds early next week, along with a period of stable and rather dry conditions. While it should continue to be monitored, guidance shows Dora passing south of the islands with deep high pressure moving in tandem to the north of Hawaii. Confidence is rising that we will experience a strong and rather dry trade wind flow with an unusually low inversion. This points toward limited showers with trade winds becoming strong and very gusty over and downwind of terrain. At the very least, a Wind Advisory will be needed for Tuesday and possibly as early as late Monday. FIRE WEATHER The potential is rising for critical fire weather conditions early next week. Dry, stable, and breezy to locally windy trades are looking increasingly likely as deep high pressure to the north moves in tandem with Hurricane Dora, which is forecast to pass south of the islands. The KBDI is expected to reach the critical 600 mark by Tuesday, and models show leeward relative humidity may fall below 45 percent on Tuesday and Wednesday. We will also have to monitor conditions for Monday as drier conditions move in with building trades.	NWS–Area Forecast
8/4/2023	Fire Weather Planning Forecast	3:45AM	DISCUSSION Trades will increase early next week, with very gusty and dry conditions possible late Monday into Wednesday.	NWS–Fire Weather Planning Forecast

continued

APPENDIX

NWS Products Released Prior to the August 8, 2023 Lahaina PM Fire

Date	NWS Communication or Product Type	Time	Product Content	Source
8/3/2023	NWS-Honolulu Forecaster Email to Hawaii fire contacts	12:40PM	NWS Honolulu expects Hurricane Dora to pass south of Hawaii early next week. There is higher than normal confidence in the forecast track, and although no direct impacts are anticipated, there is significant concern that strong trade winds will develop sometime on Monday and peak Tuesday. These strong and gusty winds will be accompanied by a very stable and rather dry atmosphere that will likely produce critical fire weather conditions on Tuesday, and possibly as early as late Monday. NWS Honolulu will likely issue a Fire Weather Watch Saturday or Sunday. Confidence in the development of critical fire weather conditions this many days away is quite rare, and we believe that this warrants a heads up to you. If you have any questions about the forecast, please contact the NWS Honolulu operations floor at 808-973-5280. Also, the latest information brief from NWS Honolulu is attached for your reference.	NWS–Honolulu Forecaster email
8/4/2023	TC Dora State-County Coordination Meeting	1:00PM	HI-EMA will be hosting a TC Dora State-County Coordination Meeting tomorrow, August 4, at 1:00 PM HST. Your attendance and participation are appreciated. NWS-Honolulu Forecaster explains Hurricane Dora's impact on weather using PPT.	
8/4/2023	Fire Weather Planning Forecast	3:30PM	Trades will ramp up early next week, and windy, very gusty, and dry weather with critical fire conditions are expected late Monday into Wednesday.	NWS–Fire Weather Planning Forecast
8/4/2023	Area Forecast Discussion	8:40PM	SYNOPSIS Expect windy, very gusty, and dry conditions late Monday into Wednesday. DISCUSSION Expect windy and very gusty trade winds early next week, along with a period of stable and dry conditions. While it should continue to be monitored, guidance continues to show Dora passing south of the islands with deep high pressure moving in tandem to the north of Hawaii. This will result in a strong and rather dry trade wind flow with scant showers. Models show a very low and strong subsidence inversion developing as early as late Monday, along with winds of 40 to 50 kt around the inversion level. Under this stable and strong flow, winds over and downwind of terrain should exceed the Wind Advisory threshold, and localized damaging wind gusts to High Wind Warning levels are a real possibility. Trade winds will gradually decline on Wednesday. FIRE WEATHER There are no significant fire weather concerns through the weekend, but critical fire weather conditions are looking highly likely early next week. Dry, stable, and breezy to windy trades are expected as deep high pressure to the north moves in tandem with Hurricane Dora, which is forecast to pass south of the islands. Conditions could develop as early as late Monday, but Tuesday has the greatest potential as the KBDI is expected to reach the critical 600 mark and models show leeward relative humidity falling below 45 percent. A Fire Weather Watch will be issued sometime this weekend to highlight this threat.	NWS–Area Forecast

continued

NWS Products Released Prior to the August 8, 2023 Lahaina PM Fire

Date	NWS Communication or Product Type	Time	Product Content	Source
8/5/2023	Area Forecast Discussion	3:35AM	SYNOPSIS Expect windy, very gusty, and dry conditions late Monday into Wednesday. DISCUSSION Expect windy and very gusty trade winds early next week, along with a period of stable and dry conditions. While it should continue to be monitored, models show Dora passing south of the islands with deep high pressure moving in tandem to the north of Hawaii. This will result in a strong and rather dry trade wind flow with scant showers. Models show a very low and strong subsidence inversion developing as early as late Monday, along with winds of 40 to 50 kt around the inversion level. Under this stable and strong flow, winds over and downwind of terrain should exceed the Wind Advisory threshold, and localized damaging wind gusts to High Wind Warning levels are a real possibility. Trade winds will gradually decline on Wednesday. FIRE WEATHER There are no significant fire weather concerns through the weekend, but critical fire weather conditions are looking highly likely early next week. Dry, stable, and breezy to windy trades are expected as deep high pressure to the north moves in tandem with Hurricane Dora, which is forecast to pass south of the islands. Conditions could develop as early as late Monday, but Tuesday has the greatest potential as the KBDI is expected to reach the critical 600 mark and models show leeward relative humidity falling below 45 percent. A Fire Weather Watch will be issued sometime later this weekend to highlight this threat.	NWS–Area Forecast
8/5/2023	Fire Weather Planning Forecast	3:36AM	DISCUSSION Moderate trade winds will prevail through Sunday. An upper trough moving near the islands may trigger a modest increase in shower activity, with the highest rainfall chances remaining over windward areas. Expect windy, very gusty, and dry conditions late Monday into Wednesday.	NWS–Fire Weather Planning Forecast
8/5/2023	NWS Social Media	8:00AM	#HurricaneDora tracking south of #Hawaii & is forecast to stay well south, indirect impacts are possible especially Mon into Wed: Higher surf along east-facing shores Strong and gusty trade winds Dry weather & high fire danger We'll continue to monitor #HurricaneDora	NWS–Social Media
8/5/2023	Area Forecast Discussion	9:46AM	SYNOPSIS Expect windy, very gusty, and dry conditions late Monday into Wednesday. DISCUSSION The main decision today will be whether or not to issue the Fire Weather Watch on this shift. We are expecting a significant change in our winds Monday through Wednesday. The fronts to the north will weaken, allowing the high to build to our north. At the same time, Hurricane Dora, currently about 1500 miles southeast of Hilo, will have moved to be about 500 miles south of the islands.	NWS–Area Forecast

continued

APPENDIX

NWS Products Released Prior to the August 8, 2023 Lahaina PM Fire

Date	NWS Communication or Product Type	Time	Product Content	Source
			The resultant tightening of the pressure gradient over the islands, combined with a drier air mass over the islands, strongly suggests a strong and gusty wind pattern setting up. Models show a very low and strong subsidence inversion developing as early as late Monday, along with winds of 40 to 50 kt around the inversion level. Under this stable and strong flow, winds over and downwind of terrain should exceed the Wind Advisory threshold, and localized damaging wind gusts to High Wind Warning levels are a real possibility. Trade winds will gradually decline on Wednesday. FIRE WEATHER There are no significant fire weather concerns through the remainder of the weekend, but critical fire weather conditions are looking highly likely early next week. Dry, stable, and breezy to windy trades are expected as deep high pressure to the north moves in tandem with Hurricane Dora, which is forecast to pass south of the islands. Conditions could develop as early as late Monday, but Tuesday has the greatest potential as the KBDI is expected to reach the critical 600 mark and models show leeward relative humidity falling below 45 percent. A Fire Weather Watch will be issued sometime later this weekend to highlight this threat.	
8/5/2023	Area Forecast Discussion	3:40PM	SYNOPSIS Expect windy, very gusty, and dry conditions late Monday into Wednesday. DISCUSSION That would bring winds to advisory levels on the summits Monday morning, and possibly to some adjacent lower elevations. Warning level winds would be possible by Monday afternoon for the summits, with additional lower elevation areas reaching advisory levels. While no watches or advisories have been issued yet, they are likely to be issued overnight or tomorrow morning. We are expecting a significant change in our winds Monday through Wednesday. The fronts to the north will weaken, allowing the high to build to our north. At the same time, Hurricane Dora, currently about 1,400 miles southeast of Hilo, will have moved to be about 500 miles south of the islands. The resultant tightening of the pressure gradient over the islands, combined with a drier air mass over the islands, strongly suggests a strong and gusty wind pattern setting up. Models show a very low and strong subsidence inversion developing as early as late Monday, along with winds of 40 to 50 kt around the inversion level. Under this stable and strong flow, winds over and downwind of terrain should exceed the Wind Advisory threshold, and localized damaging wind gusts to High Wind Warning levels are a real possibility. Trade winds will gradually decline on Wednesday. FIRE WEATHER There are no significant fire weather concerns through the remainder of the weekend, but critical fire weather conditions are looking highly likely early next week. Dry, stable, and breezy to windy trades are expected as deep high pressure to the north moves in tandem with Hurricane Dora, which is forecast to pass south of the islands.	NWS–Fire Weather Planning Forecast

continued

NWS Products Released Prior to the August 8, 2023 Lahaina PM Fire

Date	NWS Communication or Product Type	Time	Product Content	Source
			Conditions could develop as early as late Monday, but Tuesday has the greatest potential as the KBDI is expected to reach the critical 600 mark and models show leeward relative humidity falling below 45 percent. A Fire Weather Watch will be issued sometime later this weekend to highlight this threat. HFO WATCHES/WARNINGS/ADVISORIES Gale Watch from Monday evening through late Tuesday night for Maalaea Bay-Pailolo Channel-Alenuihaha Channel-Big Island Leeward Waters-Big Island Southeast Waters.	
8/5/2023	Area Forecast Discussion	6:56PM	SYNOPSIS Expect windy, very gusty, and dry conditions late Monday into Wednesday. DISCUSSION Expect a significant change in our winds Monday through Wednesday. High pressure will build to our north as Hurricane Dora, currently about 1,400 miles southeast of Hilo, passes westward about 500 miles south of the islands. The resultant tightening of the pressure gradient over the islands, combined with a drier air mass over the islands, strongly suggests a strong and gusty wind pattern setting up. Models show a very low and strong subsidence inversion developing as early as late Monday, along with winds of 40 to 50 kt around the inversion level. Under this stable and strong flow, winds over and downwind of terrain should exceed the Wind Advisory threshold, and localized damaging wind gusts to High Wind Warning levels are a real possibility. Expect advisory level winds on the summits of Maui and the Big Island Monday morning, and possibly across adjacent lower elevations. Warning level winds would be possible by Monday afternoon for the summits, with additional lower elevation areas reaching advisory levels. While no watches or advisories have been issued yet, they are likely to be issued overnight or tomorrow morning. Trade winds will gradually decline on Wednesday. FIRE WEATHER There are no significant fire weather concerns through the remainder of the weekend, but critical fire weather conditions are looking highly likely early next week. Dry, stable, and breezy to windy trades are expected as deep high pressure to the north moves in tandem with Hurricane Dora, which is forecast to pass south of the islands. Conditions could develop as early as late Monday, but Tuesday has the greatest potential, as the KBDI is expected to reach the critical 600 mark and models show leeward relative humidity falling below 45 percent. A Fire Weather Watch will be issued sometime later this weekend to highlight this threat. HFO WATCHES/WARNINGS/ADVISORIES Gale Watch from Monday evening through late Tuesday night for Maalaea Bay-Pailolo Channel-Alenuihaha Channel-Big Island Leeward Waters-Big Island Southeast Waters.	NWS–Fire Weather Planning Forecast

continued

APPENDIX

NWS Products Released Prior to the August 8, 2023 Lahaina PM Fire

Date	NWS Communication or Product Type	Time	Product Content	Source
8/5/2023	NWS Social Media		Moderate trade winds through Sunday, but then expect very gusty conditions Mon-Wed. Now would be a good time to secure loose items for the workweek! #HIwx	NWS–Social Media
8/6/2023	Area Forecast Discussion	3:33AM	SYNOPSIS Expect windy, very gusty, and dry conditions Monday into Wednesday. DISCUSSION Expect a significant change in our winds Monday through Wednesday. High pressure will build to our north as Hurricane Dora, currently about 1,150 miles southeast of Hilo, passes westward about 500 miles south of the islands. The resultant tightening of the pressure gradient over the islands, combined with a drier airmass, will drive a strong and gusty wind pattern. Models show a very low and strong subsidence inversion developing as early as Monday, along with winds of 40 to 50 kt around the inversion level. Under this stable and strong flow, winds over and downwind of terrain should exceed the Wind Advisory threshold, and localized damaging wind gusts to High Wind Warning levels are a real possibility. Expect advisory level winds on the summits of Maui and the Big Island Monday morning, and possibly across adjacent lower elevations. Warning level winds would be possible by Monday afternoon for the summits, with additional lower elevation areas reaching advisory levels. A High Wind Watch is in effect from Monday morning through late Tuesday night. FIRE WEATHER There are no significant fire weather concerns today and tonight, but critical fire weather conditions are looking highly likely beginning Monday. Dry, stable, and breezy to windy trades are expected as deep high pressure to the north moves in tandem with Hurricane Dora, which is forecast to pass south of the islands. Conditions could develop as early as Monday, but Tuesday has the greatest potential, as the KBDI is expected to reach the critical 600 mark and models show leeward relative humidity falling below 45 percent. A Fire Weather Watch is now in effect from Monday morning through late Tuesday night for leeward portions of the islands, where critical fire conditions are most likely to develop. HFO WATCHES/WARNINGS/ADVISORIES Fire Weather Watch from Monday morning through late Tuesday night for Kauai Leeward - Oahu South Shore - Wai'anae Coast - Oahu North Shore - Olomana - Central Oahu - Waianae Mountains - Molokai Leeward - Lanai Makai - Lanai Mauka - Maui Leeward West - Maui Central Valley - Leeward Haleakala - Kona - South Big Island - Kohala. High Wind Watch from Monday morning through late Tuesday night for i Mauka - Haleakala Summit - Big Island Interior - Big Island Summits - Maui Central Valley North - Maui Central Valley South - South Maui/Upcountry. Gale Watch from Monday morning through late Tuesday night for Maalaea Bay - Pailolo Channel - Alenuihaha Channel - Big Island Leeward Waters - Big Island Southeast Waters.	NWS–Area Forecast

continued

NWS Products Released Prior to the August 8, 2023 Lahaina PM Fire

Date	NWS Communication or Product Type	Time	Product Content	Source
8/6/2023	High Wind Watches	3:33AM	STRONG AND GUSTY WINDS POSSIBLE MONDAY MORNING THROUGH LATE TUESDAY NIGHT The gradient between high pressure north of the main Hawaiian Islands and Hurricane Dora passing safely south of the islands may drive very strong and gusty easterly winds across the area in the coming days. A stable air mass and low inversion will amplify this effect, especially over and lee of terrain across the eastern islands. This watch may be extended or modified later today or tonight. HIGH WIND WATCH IN EFFECT FROM MONDAY MORNING THROUGH LATE TUESDAY NIGHT ● WHAT: East winds 20 to 50 mph with localized gusts over 60 mph possible. ● WHERE: Portions of Lanai, Maui and the Big Island. ● WHEN: From Monday morning through late Tuesday night. ● IMPACTS: Damaging winds could blow down trees and power lines. Widespread power outages are possible. Travel could be difficult, especially for high profile vehicles. PRECAUTIONARY/PREPAREDNESS ACTIONS Take precautions now to protect property. Tie down loose objects or move them to a sheltered location.	NWS–High Wind Watches
8/6/2023	Red Flag Warnings	3:33AM	CRITICAL FIRE WEATHER CONDITIONS POSSIBLE MONDAY MORNING THROUGH LATE TUESDAY NIGHT ACROSS LEEWARD AREAS. Strong and gusty winds, combined with low humidities and KBDI values possibly exceeding 600, may lead to critical fire conditions across leeward areas over the coming days. This watch may be extended or modified later today or tonight. FIRE WEATHER WATCH IN EFFECT FROM MONDAY MORNING THROUGH LATE TUESDAY NIGHT FOR LEEWARD AREAS DUE TO STRONG AND GUSTY WINDS WITH LOW HUMIDITY... The National Weather Service in Honolulu has issued a Fire Weather Watch, which is in effect from Monday morning through late Tuesday night. * AFFECTED AREA: Leeward portions of all Hawaiian Islands. * WIND: East winds 20 to 30 kt with higher gusts. * HUMIDITY: 40 to 45 percent during afternoon and evening. * IMPACTS: Any fires that develop will likely spread rapidly. Outdoor burning is not recommended. PRECAUTIONARY/PREPAREDNESS ACTIONS A Fire Weather Watch means that critical fire weather conditions are forecast to occur. Listen for later forecasts and possible Red Flag Warnings.	NWS–Red Flag Warnings

continued

APPENDIX

NWS Products Released Prior to the August 8, 2023 Lahaina PM Fire

Date	NWS Communication or Product Type	Time	Product Content	Source
8/6/2023	Fire Weather Planning Forecast	3:34AM	FIRE WEATHER WATCH IN EFFECT FROM MONDAY MORNING THROUGH LATE TUESDAY NIGHT. DISCUSSION Moderate trade winds will prevail through today. Showers may increase later today, with the highest rainfall chances remaining over windward areas. Expect windy, very gusty, and dry conditions Monday into Wednesday. HIZ218-070300- Maui Leeward West - Including Lahaina, Kaanapali 3:34 AM HST Sunday, August 6, 2023 FIRE WEATHER WATCH IN EFFECT FROM MONDAY MORNING THROUGH LATE TUESDAY NIGHT.	NWS–Fire Weather Planning Forecast
8/6/2023	Red Flag Warnings	4:01AM	CRITICAL FIRE WEATHER CONDITIONS POSSIBLE MONDAY MORNING THROUGH LATE TUESDAY NIGHT ACROSS LEEWARD AREAS. Strong and gusty winds, combined with low humidities and KBDI values possibly exceeding 600, may lead to critical fire conditions across leeward areas over the coming days. This watch may be extended or modified later today or tonight. Updated to state winds in mph versus knots. FIRE WEATHER WATCH REMAINS IN EFFECT FROM MONDAY MORNING THROUGH LATE TUESDAY NIGHT FOR LEEWARD AREAS DUE TO STRONG AND GUSTY WINDS WITH LOW HUMIDITY * AFFECTED AREA: Leeward portions of all Hawaiian Islands. * WIND :East winds 20 to 30 mph with higher gusts. * HUMIDITY: 40 to 45 percent during afternoon and evening. * IMPACTS: Any fires that develop will likely spread rapidly. Outdoor burning is not recommended. PRECAUTIONARY/PREPAREDNESS ACTIONS A Fire Weather Watch means that critical fire weather conditions are forecast to occur. Listen for later forecasts and possible Red Flag Warnings.	NWS–Red Flag Warnings
8/6/2023	Area Forecast Discussion	10:02AM	SYNOPSIS Moderate trade winds will prevail through today. However, significant changes are expected Monday through Wednesday as dry air and strong winds with potentially damaging wind gusts move into the region. During the latter half of the week, a return to more seasonable trade wind weather is expected. DISCUSSION Expect a significant change in our winds Monday through Wednesday. High pressure will build to our north as Hurricane Dora, currently just over 1,000 miles southeast of Hilo, passes westward about 500 miles south of the islands. The resultant tightening of the pressure gradient over the islands, combined with a drier air mass, will drive a strong and gusty wind pattern.	NWS–Red Flag Warnings

continued

NWS Products Released Prior to the August 8, 2023 Lahaina PM Fire

Date	NWS Communication or Product Type	Time	Product Content	Source
			Models show a very low and strong subsidence inversion developing as early as Monday, along with winds of 40 to 50 kt around the inversion level. Under this stable and strong flow, winds over and downwind of terrain should easily exceed the Wind Advisory threshold, and localized damaging wind gusts to High Wind Warning levels are possible. For timing, winds will begin to increase significantly on Monday, peak on Tuesday, and gradually decline on Wednesday. The High Wind Watch has been expanded to include the Kohala and North Big Island zones as well as Kahoʻolawe with this morning's updates, and further changes to the High Wind Watch are possible later today. Very dry air will also accompany the strong winds, creating significant fire weather concerns as well. See the Fire Weather section below for additional details. SYNOPSIS Expect windy, very gusty, and dry conditions Monday into Wednesday. HFO WATCHES/WARNINGS/ADVISORIES Fire Weather Watch from Monday morning through late Tuesday night for Kauai Leeward - Oahu South Shore - Waianae Coast-Oahu North Shore - Olomana - Central Oahu - Waianae Mountains - Molokai Leeward - Lanai Makai - Lanai Mauka - Maui Leeward West - Maui Central Valley - Leeward Haleakala - Kona-South Big Island - Kohala. High Wind Watch from Monday morning through late Tuesday night for Lanai Mauka - Kahoolawe - Haleakala Summit - Kohala - Big Island Interior - Big Island Summits - Maui Central Valley North - Maui Central Valley South - South Maui/Upcountry - Big Island North. Gale Watch from Monday morning through late Tuesday night for Maalaea Bay - Pailolo Channel - Alenuihaha Channel - Big Island Leeward Waters - Big Island Southeast Waters.	
8/6/2023	High Wind Watches	10:05AM	STRONG AND GUSTY WINDS POSSIBLE MONDAY MORNING THROUGH LATE TUESDAY NIGHT. The gradient between high pressure north of the main Hawaiian Islands and Hurricane Dora passing safely south of the islands may drive very strong and gusty easterly winds across the area in the coming days. A stable air mass and low inversion will amplify this effect, especially over and lee of terrain across the eastern islands. This watch may be extended or modified later today or tonight.	NWS–Red Flag Warnings

continued

APPENDIX

NWS Products Released Prior to the August 8, 2023 Lahaina PM Fire

Date	NWS Communication or Product Type	Time	Product Content	Source
			HIGH WIND WATCH REMAINS IN EFFECT FROM MONDAY MORNING THROUGH LATE TUESDAY NIGHT. * WHAT: East winds 25 to 45 mph with localized gusts over 65 mph possible. * WHERE: Portions of Lanai, the central valley of Maui, and lower elevations of the Big Island interior. * WHEN: From Monday morning through late Tuesday night. * IMPACTS: Damaging winds could blow down trees and power lines. Widespread power outages are possible. Travel could be difficult, especially for high profile vehicles. PRECAUTIONARY/PREPAREDNESS ACTIONS Take precautions now to protect property. Tie down loose objects or move them to a sheltered location.	
8/6/2023	High Wind Watches	3:24PM	STRONG AND GUSTY WINDS POSSIBLE MONDAY MORNING THROUGH LATE TUESDAY NIGHT. The gradient between high pressure north of the main Hawaiian Islands and Hurricane Dora passing safely south of the islands will drive very strong and gusty easterly winds across the area from Monday through Wednesday. A stable air mass and low inversion will amplify this effect, especially over island terrain and across leeward areas. This watch may be modified or upgraded later tonight or early Monday. HIGH WIND WATCH IN EFFECT FROM MONDAY MORNING THROUGH LATE TUESDAY NIGHT. * WHAT: Northeast winds 25 to 45 mph with localized gusts over 60mph possible. * WHERE: Portions of Kauai, Lanai, Maui, Molokai, Oahu and the Big Island. * WHEN: From Monday morning through late Tuesday night. * IMPACTS: Damaging winds could blow down trees and power lines. Widespread power outages are possible. Travel could be difficult, especially for high profile vehicles. PRECAUTIONARY/PREPAREDNESS ACTIONS Take precautions now to protect property. Tie down loose objects or move them to a sheltered location.	NWS–High Wind Watches

continued

NWS Products Released Prior to the August 8, 2023 Lahaina PM Fire

Date	NWS Communication or Product Type	Time	Product Content	Source
8/6/2023	Red Flag Warnings	3:33PM	CRITICAL FIRE WEATHER CONDITIONS POSSIBLE MONDAY MORNING THROUGH LATE TUESDAY NIGHT ACROSS LEEWARD AREAS Strong and gusty winds, combined with low humidities and KBDI values nearing or exceeding 600, may lead to critical fire conditions across leeward areas Monday through late Tuesday night. This watch may be modified or upgraded later tonight or early Monday. FIRE WEATHER WATCH REMAINS IN EFFECT FROM MONDAY MORNING THROUGH LATE TUESDAY NIGHT FOR LEEWARD AREAS DUE TO... * AFFECTED AREA: Leeward portions of all Hawaiian Islands. * WIND: East winds 20 to 30 mph with higher gusts. * HUMIDITY: 40 to 45 percent during afternoon and evening. * IMPACTS: Any fires that develop will likely spread rapidly. Outdoor burning is not recommended. PRECAUTIONARY/PREPAREDNESS ACTIONS. A Fire Weather Watch means that critical fire weather conditions are forecast to occur. Listen for later forecasts and possible Red Flag Warnings.	NWS–Red Flag Warnings
8/6/2023	Area Forecast Discussion	3:48PM	SYNOPSIS Moderate trade winds will prevail through today. However, significant changes are expected Monday through Wednesday as dry air with strong winds with potentially damaging wind gusts move into the region. During the latter half of the week, a return to more seasonable trade wind weather is expected. DISCUSSION Expect a significant change in our winds on Monday. High pressure will build to our north as Hurricane Dora, currently about 925 miles southeast of Hilo, passes westward about 500 miles south of the Big Island. The resultant tightening of the pressure gradient over the islands, combined with a much drier air mass, will drive strong, gusty winds into the region. Models show a very low and strong subsidence inversion developing during the day on Monday, with speeds of 40 to 50 kt around the inversion level. Under this stable and strong flow, winds will begin to increase significantly on Monday, peak on Tuesday, and gradually decline on Wednesday. Winds over and downwind of terrain should easily exceed the Wind Advisory threshold (sustained speeds of 30-39 mph for an hour or more and/or gusts of 50-57 mph). In some places, damaging wind gusts to High Wind Warning levels (sustained speeds of 40 mph or greater for an hour or more and/or guests of 66 mph or higher) will be possible. With this afternoon's forecast updates, some changes have been made to the wind forecast to increase speeds across the western islands as well. The High Wind Watch has also been expanded to include additional zones and islands with this afternoon's updates. This watch may need to be converted to warnings and/or advisories tonight or early tomorrow morning, so continue to monitor for changes.	NWS–Area Forecast

continued

APPENDIX

NWS Products Released Prior to the August 8, 2023 Lahaina PM Fire

Date	NWS Communication or Product Type	Time	Product Content	Source
			Along with the strong winds, very dry air will also be moving into the region, creating significant fire weather concerns as well. See the Fire Weather section below for additional details. FIRE WEATHER Critical fire weather conditions are highly likely beginning Monday. Dry, stable, and breezy to windy trades are expected as deep high pressure to the north moves in tandem with Hurricane Dora, which is forecast to pass well south of the islands. Conditions could develop as early as Monday, but Tuesday has the greatest potential, as the KBDI is expected to reach near or just above the 600 mark. Additionally, models show leeward relative humidity falling below 45 percent. A Fire Weather Watch is now in effect from Monday morning through late Tuesday night for leeward portions of the islands, where critical fire conditions are most likely to develop. HFO WATCHES/WARNINGS/ADVISORIES Fire Weather Watch from Monday morning through late Tuesday night for Kauai Leeward - Oahu South Shore - Waianae Coast - Oahu North Shore - Olomana - Central Oahu - Waianae Mountains - Molokai Leeward - Lanai Makai - Lanai Mauka - Maui Leeward West - Maui Central Valley - Leeward Haleakala - Kona - South Big Island - Kohala. High Wind Watch from Monday morning through late Tuesday night for Kauai Leeward - Kauai Mountains - Waianae Coast - Oahu North Shore - Olomana - Central Oahu - Waianae Mountains - Lanai Mauka - Kahoolawe - Maui Windward West - Maui Leeward West - Haleakala Summit - Kohala - Big Island Interior - Big Island Summits - Kauai North - Kauai South - East Honolulu - Honolulu Metro - Ewa Plain - Koolau Leeward-Molokai - Lanai Windward - Lanai Leeward - Lanai South - Maui Central Valley North - Maui Central Valley South - South Maui/Upcountry - South Haleakala - Big Island South - Big Island Southeast - Big Island North. Gale Warning from 6 AM Monday to 6 AM HST Wednesday for Ma‘alaea Bay - Pailolo Channel - Alenuihaha Channel - Big Island Leeward Waters - Big Island Southeast Waters. Small Craft Advisory from 6:00 AM Monday to 6:00 AM HST Wednesday for all remaining Hawaiian waters.	
8/6/2023	Area Forecast Discussion	9:13PM	FIRE WEATHER Critical fire weather conditions are highly likely beginning Monday. Dry, stable, and strong and gusty trades are expected as deep high pressure to the north moves in tandem with Hurricane Dora, which is forecast to pass well south of the islands. Conditions could develop as early as Monday, but Tuesday has the greatest potential, as the KBDI is expected to reach near or just above the 600 mark. Additionally, models show leeward relative humidity falling below 45 percent. A Fire Weather Watch is now in effect from Monday morning through late Tuesday night for leeward portions of the islands, where critical fire conditions are most likely to develop.	NWS–Area Forecast

continued

NWS Products Released Prior to the August 8, 2023 Lahaina PM Fire

Date	NWS Communication or Product Type	Time	Product Content	Source
			HFO WATCHES/WARNINGS/ADVISORIES Fire Weather Watch from Monday morning through late Tuesday night for Kauai Leeward - Oahu South Shore - Waianae Coast - Oahu North Shore - Olomana - Central Oahu - Waianae Mountains - Molokai Leeward - Lanai Makai - Lanai Mauka - Maui Leeward West - Maui Central Valley - Leeward Haleakala - Kona - South Big Island - Kohala. High Wind Watch from Monday morning through late Tuesday night for Kauai Leeward - Kauai Mountains - Waianae Coast - Oahu North Shore - Olomana - Central Oahu - Waianae Mountains - Lanai Mauka - Kahoolawe - Maui Windward West - Maui Leeward West - Haleakala Summit - Kohala - Big Island Interior - Big Island Summits - Kauai North - Kauai South - East Honolulu - Honolulu Metro - Ewa Plain - Koolau Leeward - Molokai - Lanai Windward - Lanai Leeward - Lanai South - Maui Central Valley North - Maui Central Valley South - South Maui/Upcountry - South Haleakala - Big Island South - Big Island Southeast - Big Island North. Gale Warning from 6:00 AM Monday to 6:00 AM HST Wednesday for Maalaea Bay - Pailolo Channel - Alenuihaha Channel - Big Island Leeward Waters - Big Island Southeast Waters. Small Craft Advisory from 6:00 AM Monday to 6:00 AM HST Wednesday for all remaining Hawaiian waters.	
8/6/2023	NWS Social Media		While Hurricane Dora passes well south with no direct impacts here, the strong pressure gradient between it & the high pressure to the north creates a threat of damaging winds & fire weather(due to ongoing dry conditions) from early Mon to Wed. Strong winds in yellows & oranges on map result from significant pressure differences between high '7 low-pressures. Combined w/ dry conditions, thes winds pose a serious fire & damaging wind threat. Stay Alert!	NWS–Social Media
8/7/2023	High Wind Watches	3:15AM	Almost the same as 8/8/2023 at 3:18	NWS–High Wind Watches
8/7/2023	Red Flag Warnings	3:15AM	RED FLAG WARNING FOR LEEWARD AREAS DUE TO GUSTY WINDS AND LOW HUMIDITY. Very dry fuels combined with strong and gusty easterly winds and low humidities below 45 percent will produce critical fire weather conditions through Tuesday night. RED FLAG WARNING IN EFFECT FROM 6 AM THIS MORNING TO 6 AM HST WEDNESDAY FOR GUSTY WINDS AND LOW HUMIDITY... The National Weather Service in Honolulu has issued a Red Flag Warning, which is in effect through 6:00 AM HST Wednesday.	NWS–Red Flag Warnings

continued

APPENDIX

NWS Products Released Prior to the August 8, 2023 Lahaina PM Fire

Date	NWS Communication or Product Type	Time	Product Content	Source
			* AFFECTED AREA: Leeward portions of all Hawaiian Islands. * WIND: East winds 30 to 45 mph with gusts over 65 mph expected. * HUMIDITY: 40 to 45 percent during afternoons and evenings. * IMPACTS: Any fires that develop will likely spread rapidly. Outdoor burning is not recommended. PRECAUTIONARY/PREPAREDNESS ACTIONS A Red Flag Warning means that critical fire weather conditions are either occurring now or will shortly. A combination of strong winds, low relative humidity, and warm temperatures can contribute to extreme fire behavior. A Red Flag Warning does not predict new fire starts.	
8/7/2023	Fire Weather Planning Forecast	3:30AM	RED FLAG WARNING IN EFFECT UNTIL 6 AM HST WEDNESDAY DISCUSSION Very dry fuels (KDBI around 600) combined with strong and gusty easterly winds and low humidities below 45 percent will produce critical fire weather conditions this afternoon through Tuesday night. See the Red Flag Warning for more information. A return of a more typical trade wind pattern is anticipated later in the week through the weekend. HIZ218-080215- Maui Leeward West- Including Lahaina, Kaanapali 3:30 AM HST Monday, August 7, 2023 RED FLAG WARNING IN EFFECT UNTIL 6 AM HST WEDNESDAY TODAY Sky/weather.....Mostly sunny. Isolated showers until noon. LAL.....1. Max temperature.....82 to 88. Min humidity.....45 percent. 20-foot winds.....Windy. East 15 to 30 mph until noon, then 25 to 35 mph. Mixing height.....3,000 ft. AGL. Transport winds.....East 15 to 20 mph. TONIGHT Sky/weather.....Partly cloudy. LAL.....1. Min temperature.....Around 70. Max humidity.....85 percent. 20-foot winds.....Very windy. Northeast 30 to 45 mph. Mixing height.....3,000 ft. AGL. Transport winds.....East around 25 mph.	NWS–Fire Weather Planning Forecast

continued

NWS Products Released Prior to the August 8, 2023 Lahaina PM Fire

Date	NWS Communication or Product Type	Time	Product Content	Source
			TUESDAY Sky/weather.....Mostly sunny. LAL.....1. Max temperature.....82 to 88. Min humidity.....40 percent. 20-foot winds.....Very windy. Northeast 35 to 45 mph. Mixing height.....4,500 ft. AGL. Transport winds.....East around 30 mph. HIZ219-080215- Maui Central Valley- Including Kahului 3:30 AM HST Monday, August, 7 2023 RED FLAG WARNING IN EFFECT UNTIL 6:00 AM HST WEDNESDAY TODAY Sky/weather.....Mostly sunny. Isolated showers until noon. LAL.....1. Max temperature.....86 to 91. Min humidity.....45 percent. 20-foot winds.....Windy. Northeast 10 to 15 mph until 9 AM. 25 to 30 mph after 3 PM. Mixing height.....3,500 ft. AGL. Transport winds.....East 10 to 15 mph. TONIGHT Sky/weather.....Partly cloudy. LAL.....1. Min temperature.....67 to 72. Max humidity.....90 percent. 20-foot winds.....Windy. Northeast 25 to 35 mph. Mixing height.....3,000 ft. AGL. Transport winds.....East around 20 mph. TUESDAY Sky/weather.....Mostly sunny. LAL.....1. Max temperature.....86 to 91. Min humidity.....20 percent. 20-foot winds.....Very windy. Northeast 25 to 40 mph. Mixing height.....5,000 ft. AGL. Transport winds.....East around 25 mph.	

continued

APPENDIX

NWS Products Released Prior to the August 8, 2023 Lahaina PM Fire

Date	NWS Communication or Product Type	Time	Product Content	Source
8/7/2023	Area Forecast Discussion	3:30AM	SYNOPSIS Breezy easterly trade winds are forecast to become strong and gusty later today through midweek as Hurricane Dora passes far to the south. Outside of a few windward showers this morning, very dry air arriving from the east will limit rainfall chances through Wednesday. A return of a more typical trade wind pattern is anticipated later in the week through the weekend. DISCUSSION An upper low nearby to the northwest combined with a mid-level trough and a sufficient amount of low-level moisture will support a few light showers favoring windward and mountain locations this morning. Satellite imagery showed the leading edge of a very suppressed and dry air mass approaching from the east, which also marks the leading edge of the easterly wind surge. This drier air (PWs dipping well below normal) combined with a strong pressure gradient between Dora passing to the south and high pressure to the north will support strong and gusty winds later today through midweek. The subsidence inversion is forecast to dip to around 3,000 ft., which is well below normal. This stable/dry air and low inversion combined with the strong pressure gradient (50 kt winds shown around the inversion to 850 mb) will generate advisory to warning-level wind speeds this afternoon through Wednesday. For the second half of the week through the weekend, expect a return of a more typical trade wind pattern, with windward and mountain shower coverage increasing. FIRE WEATHER Very dry fuels (KDBI around 600) combined with strong and gusty easterly winds and low humidities below 45 percent will produce critical fire weather conditions this afternoon through Tuesday night. See the Red Flag Warning for more information. HFO WATCHES/WARNINGS/ADVISORIES Wind Advisory from 6:00 AM this morning to 6:00 AM HST Wednesday for Niihau - Olomana - Kauai East - Ko'olau Windward - Windward Haleakala - Kipahulu - Big Island East. Red Flag Warning from 6:00 AM this morning to 6:00 AM HST Wednesday for Kauai Leeward - Oahu South Shore - Waianae Coast - Oahu North Shore - Olomana - Central Oahu - Waianae Mountains - Molokai Leeward - Lanai Makai - Lanai Mauka - Maui Leeward West - Maui Central Valley - Leeward Haleakala - Kona - South Big Island - Kohala - Big Island Interior.	NWS–Fire Weather Planning Forecast

continued

NWS Products Released Prior to the August 8, 2023 Lahaina PM Fire

Date	NWS Communication or Product Type	Time	Product Content	Source
			High Wind Warning from 6:00 AM this morning to 6:00 AM HST Wednesday for Kauai Leeward - Kauai Mountains - Waianae Coast - Oahu North Shore - Central Oahu - Waianae Mountains - Lanai Mauka - Kaho'olawe - Maui Windward West - Maui Leeward West - Haleakala Summit - Kohala - Big Island Interior - Big Island Summits - Kauai North - Kauai South - East Honolulu - Honolulu Metro - Ewa Plain - Koolau Leeward - Molokai - Lanai Windward - Lanai Leeward - Lanai South - Maui Central Valley North - Maui Central Valley South - South Maui/Upcountry - South Haleakala - Big Island South - Big Island Southeast - Big Island North. Gale Warning from 6:00 AM this morning to 6:00 AM HST Wednesday for Maalaea Bay - Pailolo Channel - Alenuihaha Channel - Big Island Leeward Waters - Big Island Southeast Waters.	
8/7/2023	Red Flag Warnings	4:42AM	RED FLAG WARNING FOR LEEWARD AREAS DUE TO STRONG WINDS AND LOW HUMIDITY Very dry fuels combined with strong and gusty easterly winds and low humidities below 45 percent will produce critical fire weather conditions through Tuesday night. RED FLAG WARNING REMAINS IN EFFECT UNTIL 6:00 AM HST WEDNESDAY FOR STRONG WINDS AND LOW HUMIDITY. * AFFECTED AREA: Leeward portions of all Hawaiian Islands. * WIND: East winds 30 to 45 mph with gusts over 60 mph expected. * HUMIDITY: 35 to 45 percent during afternoons and evenings. * IMPACTS: Any fires that develop will likely spread rapidly. Outdoor burning is not recommended. PRECAUTIONARY/PREPAREDNESS ACTIONS A Red Flag Warning means that critical fire weather conditions are either occurring now or will shortly. A combination of strong winds, low relative humidity, and warm temperatures can contribute to extreme fire behavior. A Red Flag Warning does not predict new fire starts. SYNOPSIS Breezy easterly trade winds will strengthen and become strong and potentially damaging this evening and continue through Tuesday as Hurricane Dora passes far south of the state. Outside of lingering showers over Kauai and O'ahu today, very dry air arriving from the east will limit rainfall chances through Wednesday. A return of a more typical trade wind pattern is anticipated later in the week through the weekend.	NWS–Red Flag Warnings

continued

APPENDIX

NWS Products Released Prior to the August 8, 2023 Lahaina PM Fire

Date	NWS Communication or Product Type	Time	Product Content	Source
			DISCUSSION The combination of strong winds (40-50 kt near inversion height) and strengthening/lowering inversion to compress/accelerate the winds between inversion and terrain will lead to the potential for damaging trade winds tonight into Tuesday. The strongest winds are expected over mountain terrain and downslope into leeward areas, where a High Wind Warning is in effect. Elsewhere, exposed windward areas will also see strong winds and are covered by a Wind Advisory. Wind speeds are expected to ramp up this afternoon/evening from east to west across the state, with the window for strongest winds after midnight tonight through the day on Tuesday. FIRE WEATHER Critical fire weather conditions are expected for the next few days as strong winds and a very dry air mass affects the state. The KBDI is expected to break 600 tomorrow, with afternoon relative humidities dropping below 45 percent. Combined with strong winds over 20 mph, the potential for extreme fire behavior is possible with any wildfires that develop and a Red Flag Warning is currently in effect. HFO WATCHES/WARNINGS/ADVISORIES Wind Advisory until 6:00 AM HST Wednesday for Niihau - Olomana - Kauai East - Koolau Windward - Windward Haleakala - Kipahulu - Big Island East. Red Flag Warning until 6:00 AM HST Wednesday for Kauai Leeward - Oahu South Shore - Waianae Coast - Oahu North Shore - Olomana - Central Oahu - Waianae Mountains - Molokai Leeward - Lanai Makai - Lanai Mauka - Maui Leeward West - Maui Central Valley - Leeward Haleakala - Kona - South Big Island - Kohala - Big Island Interior. High Wind Warning until 6:00 AM HST Wednesday for Kauai Leeward - Kauai Mountains - Waianae Coast - Oahu North Shore - Central Oahu - Waianae Mountains - Lanai Mauka - Kahoʻolawe - Maui Windward West - Maui Leeward West - Haleakala Summit - Kohala - Big Island Interior - Big Island Summits - Kauai North - Kauai South - East Honolulu - Honolulu Metro - Ewa Plain - Koolau Leeward - Molokai - Lanai Windward - Lanai Leeward - Lanai South - Maui Central Valley North - Maui Central Valley South - South Maui/Upcountry - South Haleakala - Big Island South - Big Island Southeast - Big Island North. Gale Warning until 6 AM HST Wednesday for Maalaea Bay - Pailolo Channel - Alenuihaha Channel - Big Island Leeward Waters - Big Island Southeast Waters.	
8/7/2023	High Wind Watches	3:40PM	STRONG AND GUSTY WINDS THROUGH TUESDAY NIGHT	NWS–High Wind Watches

continued

NWS Products Released Prior to the August 8, 2023 Lahaina PM Fire

Date	NWS Communication or Product Type	Time	Product Content	Source
8/7/2023	Area Forecast Discussion	3:53PM	SYNOPSIS Building trade winds will become strong and potentially damaging this evening and continue through Tuesday as Hurricane Dora passes far south of the state. Dry air arriving from the east will limit rainfall chances through Wednesday. A return of a more typical trade wind pattern is anticipated later in the week through the weekend. DISCUSSION Water vapor imagery shows an upper level low northwest of the state, with heights building over the islands associated with an upper high far to the northeast. Surface analysis shows high pressure northeast of the state, with a strengthening gradient over the islands between it and Dora far to our south. The change in air mass was particularly notable with the 00 z sounding from Hilo, which now shows a strong inversion near 4 kft. Precipitable water also dropped from 1.9 to 1.2 inches over the past 12 hours.The subsidence inversion is also starting to lower in Lihue, which is closer to the band of moisture that is just shifting west of the state. Late afternoon visible satellite imagery shows a much more stable cloud field just upstream of the state, with the previous showery clouds now west of Kauai. Wind speeds have picked up through the day and have generally been in the wind advisory range across multiple islands. Model forecast soundings/cross sections show the inversion even lower, down below 3 kft. The combination of strong winds (40-50 kt near inversion height) and strengthening/lowering inversion to compress/accelerate the winds between inversion and terrain will lead to the potential for damaging trade winds tonight into Tuesday. The strongest winds are expected over mountain terrain and downslope into leeward areas, where a High Wind Warning is in effect. Elsewhere, exposed windward areas will also see strong winds and are covered by a Wind Advisory. Wind speeds are expected to ramp up from east to west across the state, with the window for strongest winds after midnight tonight through the day on Tuesday. In addition to the winds, precipitable waters are expected to drop to less than one (1) inch (or more than a standard deviation below normal for this time of year). This will lead to little if any rainfall over the next few days. For the second half of the week, more seasonable breezy trade winds will return to the state as pressure gradient relaxes. More typical moisture levels will return to the state as well, with showers mainly focusing along windward and mauka areas, particularly during the overnight through morning hours each day. FIRE WEATHER Critical fire weather conditions are expected for Tuesday and a Red Flag Warning remains in effect. Fuels are dry, as indicated by the KBDI expected to break 600 tomorrow. Despite the drying air mass, surface dew points have lingered near 70 F today, which have kept relative humidity from dropping below 50%. RH is expected to drop below the 45% threshold red flag conditions tomorrow. Combined with winds that will be stronger than today, the potential exists for extreme fire behavior with any wildfires that ignite.	NWS–Area Forecast

continued

APPENDIX

NWS Products Released Prior to the August 8, 2023 Lahaina PM Fire

Date	NWS Communication or Product Type	Time	Product Content	Source
			HFO WATCHES/WARNINGS/ADVISORIES Wind Advisory until 6:00 AM HST Wednesday for Niihau - Olomana - Kauai East - Koolau Windward - Windward Haleakala - Kipahulu - Big Island East. Red Flag Warning until 6:00 AM HST Wednesday for Kauai Leeward - Oahu South Shore - Waianae Coast -Oahu North Shore - Olomana - Central Oahu - Waianae Mountains - Molokai Leeward - Lanai Makai - Lanai Mauka - Maui Leeward West - Maui Central Valley - Leeward Haleakala - Kona - South Big Island - Kohala - Big Island Interior. High Wind Warning until 6:00 AM HST Wednesday for Kauai Leeward - Kauai Mountains - Waianae Coast - Oahu North Shore - Central Oahu - Waianae Mountains - Lanai Mauka - Kahoʻolawe - Maui Windward West - Maui Leeward West - Haleakala Summit - Kohala - Big Island Interior - Big Island Summits - Kauai North - Kauai South - East Honolulu - Honolulu Metro - Ewa Plain - Koolau Leeward - Molokai - Lanai Windward - Lanai Leeward - Lanai South - Maui Central Valley North - Maui Central Valley South - South Maui/Upcountry - South Haleakala - Big Island South - Big Island Southeast - Big Island North. High Surf Advisory until 6:00 PM HST Tuesday for Olomana - Kauai East - East Honolulu - Koolau Windward. High Surf Warning until 6:00 PM HST Tuesday for Maui Windward West - Molokai Windward - Molokai Southeast - Windward Haleakala - Kipahulu - Big Island Southeast -Big Island East - Big Island North. Small Craft Advisory until 6:00 AM HST Wednesday for Kauai Northwest Waters - Kauai Windward Waters - Kauai Leeward Waters - Kauai Channel - Oahu Windward Waters - Oahu Leeward Waters - Kaiwi Channel - Maui County Windward Waters - Maui County Leeward Waters - Big Island Windward Waters. Gale Warning until 6:00 AM HST Wednesday for Maalaea Bay - Pailolo Channel - Alenuihaha Channel - Big Island Leeward Waters - Big Island Southeast Waters.	
8/7/2023	Red Flag Warnings	3:55PM	RED FLAG WARNING FOR LEEWARD AREAS DUE TO STRONG WINDS AND LOW HUMIDITY Very dry fuels combined with strong and gusty easterly winds and low humidities will produce critical fire weather conditions through Tuesday night. RED FLAG WARNING REMAINS IN EFFECT UNTIL 6 AM HST WEDNESDAY FOR STRONG WINDS AND LOW HUMIDITY * AFFECTED AREA: Leeward portions of all Hawaiian Islands. * WIND: East winds 30 to 45 mph with gusts over 60 mph.	NWS–Red Flag Warnings

continued

NWS Products Released Prior to the August 8, 2023 Lahaina PM Fire

Date	NWS Communication or Product Type	Time	Product Content	Source
			* HUMIDITY: 35 to 45 percent through the afternoon hours. * IMPACTS: Any fires that develop will likely spread rapidly. Outdoor burning is not recommended. PRECAUTIONARY/PREPAREDNESS ACTIONS A Red Flag Warning means that critical fire weather conditions are either occurring now or will shortly. A combination of strong winds, low relative humidity, and warm temperatures can contribute to extreme fire behavior. A Red Flag Warning does not predict new fire starts.	
8/7/2023	Area Forecast Discussion	8:55PM	DISCUSSION Deep layer ridging combined with an anomalously strong pressure gradient over the area between Hurricane Dora passing well to the south and the surface ridge to the north will support very strong easterly winds and dry conditions into midweek. Guidance depicts the winds steadily trending up overnight, with a peak expected through the day Tuesday. Peak wind gust observations through this evening have already surged into the 45 to 55 MPH range across the state in the windier locations. Humidities dipped into the mid 40s this afternoon, which is well below normal. The upper air sounding at Hilo and Lihue supported this with very dry profiles along with a lowering inversion height (<5,000 ft). The inversion height may dip toward the 3,000 ft mark Tuesday, which will only drive stronger accelerations after accounting for the island terrain and peak mixing hours. For potential impacts regarding the dry conditions and strong/potentially damaging winds, see the latest High Wind and Red Flag Warnings.	NWS–Area Forecast
8/7/2023	NWS Social Media	9:20PM	Breezy easterly trade winds will strengthen and become strong and potentially damaging this evening, and will continue through Tuesday. Dry Air from the east will limit rainfall through Wednesday. Hurricane Dora will continue moving westward far south of the Hawaiian Islands.	NWS–Social Media
8/8/2023	Red Flag Warnings	3:17AM	RED FLAG WARNING FOR LEEWARD AREAS DUE TO STRONG WINDS AND LOW HUMIDITY Very dry fuels combined with strong and gusty easterly winds and low humidities will produce critical fire weather conditions through tonight. RED FLAG WARNING REMAINS IN EFFECT UNTIL 6 AM HST WEDNESDAY FOR STRONG WINDS AND LOW HUMIDITY * AFFECTED AREA: Leeward portions of all Hawaiian Islands. * WIND: East winds 30 to 45 mph with gusts to around 60 mph. * HUMIDITY: 35 to 45 percent through the afternoon hours. * IMPACTS: Any fires that develop will likely spread rapidly. Outdoor burning is not recommended.	NWS–Red Flag Warnings

continued

APPENDIX

NWS Products Released Prior to the August 8, 2023 Lahaina PM Fire

Date	NWS Communication or Product Type	Time	Product Content	Source
			PRECAUTIONARY/PREPAREDNESS ACTIONS... A Red Flag Warning means that critical fire weather conditions are either occurring now or will shortly. A combination of strong winds, low relative humidity, and warm temperatures can contribute to extreme fire behavior. A Red Flag Warning does not predict new fire starts.	
8/8/2023	High Wind Watches	3:18AM	STRONG AND GUSTY WINDS THROUGH EARLY WEDNESDAY HIGH WIND WARNING REMAINS IN EFFECT UNTIL 6:00 AM HST WEDNESDAY * WHAT: East winds 30 to 45 mph with localized gusts to around 60 mph. * WHERE: Across mountain terrain and downslope into leeward sections of Kauai, Oahu, Molokai, Lanai, Kaho'olawe, Maui, and the Big Island. * WHEN: Through 6:00 AM HST Wednesday. * IMPACTS: Damaging winds may blow down trees and power lines and damage roofs. Power outages are possible. Travel will be difficult, especially for high profile vehicles. PRECAUTIONARY/PREPAREDNESS ACTIONS Strong winds may lead to property damage. Hazardous driving conditions due to powerful cross winds will pose a serious risk for drivers, especially for light weight and high profile vehicles. Loose outdoor items should be brought inside or secured properly.	NWS–High Wind Watches
8/8/2023	Fire Weather Planning Forecast	4:00AM	RED FLAG WARNING IN EFFECT UNTIL 6 AM HST WEDNESDAY DISCUSSION Very dry fuels (KDBI around 600) combined with strong and gusty easterly winds and low humidities below 45 percent will produce critical fire weather conditions through tonight. See the Red Flag Warning for more information. A return of a more typical trade wind pattern is anticipated later in the week through the weekend. HIZ218-090215- Maui Leeward West- Including Lahaina, Kaanapali 4:00 AM HST Tuesday, August 8, 2023 ...RED FLAG WARNING IN EFFECT UNTIL 6:00 AM HST WEDNESDAY... TODAY Sky/weather.....Sunny. LAL.....1. Max temperature.....81 to 90. Min humidity.....40 percent. 20-foot winds.....Very windy. Northeast 35 to 45 mph. Mixing height.....4,500 ft. AGL. Transport winds.....East around 30 mph.	NWS–Fire Weather Planning Forecast

continued

NWS Products Released Prior to the August 8, 2023 Lahaina PM Fire

Date	NWS Communication or Product Type	Time	Product Content	Source
			TONIGHT Sky/weather.....Partly cloudy. LAL.....1. Min temperature.....69 to 74. Max humidity.....85 percent. 20-foot winds.....Very windy. Northeast 35 to 45 mph. Mixing height.....4,000 ft. AGL. Transport winds.....East around 30 mph. WEDNESDAY Sky/weather.....Mostly sunny. LAL.....1. Max temperature.....81 to 89. Min humidity.....40 percent. 20-foot winds.....Windy. Northeast 25 to 30 mph until noon, then 15 to 30 mph. Mixing height.....4,500 ft. AGL. Transport winds.....East around 25 mph. HIZ219-090215- Maui Central Valley- Including Kahului 4:00 AM HST Tuesday, August 8, 2023 ...RED FLAG WARNING IN EFFECT UNTIL 6:00 AM HST WEDNESDAY... TODAY Sky/weather.....Sunny. LAL.....1. Max temperature.....86 to 92. Min humidity.....25 percent. 20-foot winds.....Very windy. Northeast 25 to 40 mph. Mixing height.....5000 ft AGL. Transport winds.....East around 25 mph. TONIGHT Sky/weather.....Mostly clear. LAL.....1. Min temperature.....68 to 73. Max humidity.....80 percent. 20-foot winds.....Windy. Northeast 25 to 35 mph. Mixing height.....4,000 ft. AGL. Transport winds.....East around 25 mph. WEDNESDAY Sky/weather.....Sunny. LAL.....1. Max temperature.....Around 88. Min humidity.....35 percent. 20-foot winds.....Windy. Northeast 15 to 30 mph. Mixing height.....5,000 ft. AGL. Transport winds.....East around 20 mph	

continued

APPENDIX

NWS Products Released
Prior to the August 8, 2023 Lahaina PM Fire

Date	NWS Communication or Product Type	Time	Product Content	Source
8/8/2023	NWS Social Media	9:26AM	UPDATE: High Wind & Fire Weather Alerts High Wind: 30-45 mph winds, gusts up to 60 mph. Secure property, expect outages & difficult travel.	NWS–Social Media
8/8/2023	NWS Social Media	9:27AM	UPDATE: High Wind & Fire Weather Alerts High Wind: 30-45 mph winds, gusts up to 60 mph. Secure property, expect outages & difficult travel. Red Flag: High fire danger with rapid spread. NO outdoor burning. Stay safe & cautious #HawaiiWeather	NWS–Social Media
8/8/2023	Area Forecast Discussion	9:40AM	HFO WATCHES/WARNINGS/ADVISORIES Wind Advisory until 6:00 AM HST Wednesday for Niihau - Olomana - Kauai East - Koolau Windward - Windward Haleakala - Kipahulu - Big Island East. Red Flag Warning until 6:00 AM HST Wednesday for Kauai Leeward - Oahu South Shore - Waianae Coast - Oahu North Shore - Olomana - Central Oahu - Waianae Mountains - Molokai Leeward - Lanai Makai - Lanai Mauka - Maui Leeward West - Maui Central Valley - Leeward Haleakala - Kona - South Big Island - Kohala - Big Island Interior. High Wind Warning until 6:00 AM HST Wednesday for Kauai Leeward - Kauai Mountains - Waianae Coast - Oahu North Shore - Central Oahu - Waianae Mountains - Lanai Mauka - Kahoʻolawe - Maui Windward West - Maui Leeward West - Haleakala Summit - Kohala - Big Island Interior - Big Island Summits - Kauai North - Kauai South - East Honolulu - Honolulu Metro - Ewa Plain - Koolau Leeward - Molokai - Lanai Windward - Lanai Leeward - Lanai South - Maui Central Valley North - Maui Central Valley South - South Maui/Upcountry - South Haleakala - Big Island South - Big Island Southeast - Big Island North. Gale Warning until 6:00 PM HST Wednesday for Maʻalaea Bay - Pailolo Channel - Alenuihaha Channel - Big Island Leeward Waters - Big Island Southeast Waters.	NWS–Area Forecast
8/8/2023	Area Forecast Discussion	3:38PM	SYNOPSIS Strong and potentially damaging easterly winds along with very dry conditions will persist tonight and Wednesday as Hurricane Dora passes far to the south. Dangerous fire weather conditions will persist through Wednesday afternoon. A return of a more typical trade wind pattern is anticipated later in the week through the weekend. DISCUSSION The overall weather picture and afternoon forecast philosophy have changed very little since this morning.	NWS–Area Forecast

continued

NWS Products Released
Prior to the August 8, 2023 Lahaina PM Fire

Date	NWS Communication or Product Type	Time	Product Content	Source
			The strong pressure gradient between Hurricane Dora passing well to our south and a surface ridge to our north will drive damaging easterly winds and dry conditions across the main Hawaiian Islands through Wednesday afternoon. While models show winds peaking into this evening, they will remain strong tonight, then slowly ease tomorrow. Peak wind gusts in the 50 to 60 mph range are not uncommon this afternoon across the state in the windier locations. In addition, very dry conditions will continue, triggering a dangerous fire weather scenario. Afternoon soundings support this, with very dry profiles noted along with low inversion heights of less than 5,000 ft. This will continue to drive stronger wind speed accelerations due to a combination of island terrain and the peak mixing hours. For potential impacts regarding the dry conditions and winds, see the latest High Wind and Red Flag Warnings. The Red Flag Warning has been extended through Wednesday afternoon. Existing Wind Advisories have been extended through Wednesday afternoon as well. High Wind Warnings will continue through tonight, then be downgraded to Wind Advisories through Wednesday afternoon. FIRE WEATHER Very dry fuels (KDBI around 600) combined with strong and gusty easterly winds and low humidities below 45 percent will produce critical fire weather conditions through Wednesday afternoon. See the extended Red Flag Warning for more information. HFO WATCHES/WARNINGS/ADVISORIES Wind Advisory until 6:00 PM HST Wednesday for Niihau - Olomana - Kauai East - Koolau Windward - Windward Haleakala - Kipahulu - Big Island East. Red Flag Warning until 6:00 PM HST Wednesday for Kauai Leeward - Oahu South Shore - Waianae Coast - Oahu North Shore - Olomana - Central Oahu Waianae Mountains - Molokai Leeward - Lanai Makai - Lanai Mauka - Maui Leeward West - Maui Central Valley - Leeward Haleakala - Kona - South Big Island - Kohala - Big Island Interior. High Wind Warning until 6:00 AM HST Wednesday for Kauai Leeward - Kauai Mountains - Waianae Coast - Oahu North Shore - Central Oahu - Waianae Mountains - Lanai Mauka - Kahoʻolawe - Maui Windward West - Maui Leeward West - Haleakala Summit - Kohala-Big Island Interior - Big Island Summits - Kauai North - Kauai South - East Honolulu - Honolulu Metro - Ewa Plain - Koolau Leeward - Molokai - Lanai Windward - Lanai Leeward - Lanai South - Maui Central Valley North - Maui Central Valley South - South Maui/Upcountry - South Haleakala - Big Island South - Big Island Southeast - Big Island North. High Surf Advisory until 6:00 AM HST Wednesday for Olomana - Kauai East - East Honolulu - Koolau Windward. High Surf Warning until 6:00 AM HST Wednesday for Maui Windward West - Molokai Windward - Molokai Southeast - Windward Haleakala - Kipahulu - Big Island Southeast - Big Island East - Big Island North.	

continued

APPENDIX

NWS Products Released Prior to the August 8, 2023 Lahaina PM Fire

Date	NWS Communication or Product Type	Time	Product Content	Source
			Wind Advisory from 6:00 AM to 6:00 PM HST Wednesday for . Small Craft Advisory until 6:00 PM HST Wednesday for Kauai Northwest Waters - Kauai Windward Waters - Kauai Leeward Waters - Kauai Channel - Oahu Windward Waters - Oahu Leeward Waters - Kaiwi Channel - Maui County Windward Waters - Maui County Leeward Waters - Big Island Windward Waters. Gale Warning until 6:00 PM HST Wednesday for Maalaea Bay - Pailolo Channel - Alenuihaha Channel - Big Island Leeward Waters - Big Island Southeast Waters.	
8/8/2023	High Wind Watches	3:39PM`	STRONG AND GUSTY WINDS THROUGH WEDNESDAY AFTERNOON Wind Advisories are extended through Wednesday afternoon while High Wind Warnings will be downgraded to Wind Advisories after 6:00 AM HST Wednesday morning. HIGH WIND WARNING REMAINS IN EFFECT UNTIL 6:00 AM HST WEDNESDAY * WHAT: East winds 30 to 45 mph with localized gusts to around 60 mph. * WHERE: Across mountain terrain and downslope into leeward sections of Kauai, Oahu, Molokai, Lanai, Kaho'olawe, Maui, and the Big Island. * WHEN: Through 6:00 AM HST Wednesday. * IMPACTS: Damaging winds may blow down trees and power lines and damage roofs. Power outages are possible. Travel will be difficult, especially for high profile vehicles. PRECAUTIONARY/PREPAREDNESS ACTIONS Strong winds may lead to property damage. Hazardous driving conditions due to powerful cross winds will pose a serious risk for drivers, especially for light weight and high profile vehicles. Loose outdoor items should be brought inside or secured properly.	NWS–High Wind Watches
8/8/2023	Red Flag Warnings	3:39PM`	RED FLAG WARNING FOR LEEWARD AREAS DUE TO STRONG WINDS AND LOW HUMIDITY Very dry fuels combined with strong and gusty easterly winds and low humidities will produce critical fire weather conditions through Wednesday afternoon. RED FLAG WARNING NOW IN EFFECT UNTIL 6:00 PM HST WEDNESDAY FOR STRONG WINDS AND LOW HUMIDITY * AFFECTED AREA: Leeward portions of all Hawaiian Islands. * WIND: East winds 30 to 45 mph with gusts to around 60 mph. * HUMIDITY: 35 to 45 percent through the afternoon hours.	NWS–Red Flag Warnings

continued

NWS Products Released Prior to the August 8, 2023 Lahaina PM Fire

Date	NWS Communication or Product Type	Time	Product Content	Source
			* IMPACTS: Any fires that develop will likely spread rapidly. Outdoor burning is not recommended. PRECAUTIONARY/PREPAREDNESS ACTIONS... A Red Flag Warning means that critical fire weather conditions are either occurring now or will shortly. A combination of strong winds, low relative humidity, and warm temperatures can contribute to extreme fire behavior. A Red Flag Warning does not predict new fire starts.	
8/8/2023	Fire Weather Planning Forecast	3:41PM	RED FLAG WARNING IN EFFECT UNTIL 6 PM HST WEDNESDAY DISCUSSION Strong and potentially damaging easterly winds along with very dry conditions will persist tonight and Wednesday as Hurricane Dora passes far to the south. Dangerous fire weather conditions will persist through Wednesday afternoon. A return of a more typical trade wind pattern is anticipated later in the week through the weekend. HIZ218-091415- Maui Leeward West- Including Lahaina, Kaanapali 3:41 PM HST Tuesday, August 8, 2023 ...RED FLAG WARNING IN EFFECT UNTIL 6:00 PM HST WEDNESDAY... TONIGHT Sky/weather.....Partly cloudy. LAL.....1. Min temperature.....69 to 74. Max humidity.....85 percent. 20-foot winds.....Very windy. Northeast 35 to 45 mph. Mixing height.....4,000 ft. AGL. Transport winds.....East around 30 mph. WEDNESDAY Sky/weather.....Mostly sunny. LAL.....1. Max temperature.....81 to 89. Min humidity.....40 percent. 20-foot winds.....Windy. Northeast 25 to 30 mph until noon, then 15 to 30 mph. Mixing height.....4,500 ft. AGL. Transport winds.....East around 25 mph. WEDNESDAY NIGHT Sky/weather.....Partly cloudy. LAL.....1. Min temperature.....68 to 74. Max humidity.....85 percent. 20-foot winds.....Breezy. Northeast 10 to 25 mph. Mixing height.....4,500 ft. AGL. Transport winds.....East around 20 mph.	NWS–Social Media

APPENDIX

6.3 PreFire Social Media Posts

Pre-Fire Social Media Posts
August 4, 2023 through August 8, 2023

Date	Agency/ Organization	Time	Platform	Message
August 4, 2023	Maui Emergency Management Agency	17:00	Instagram	Hurricane Dora is continuing to track well South of the Hawaiian Islands. MEMA will continue to monitor this system as it passes Hawai'i.
August 6, 2023	Maui County	03:33	Twitter/X	High Wind Watch until August 9, 2023 at 06:00.
August 6, 2023	Maui Emergency Management Agency	03:33	Facebook	High wind warning. Event extended (area): Kaho'olawe and northern portions of the Big Island. East winds 25 to 45 mph with localized gusts over 65 mph possible. NWS issued on August 6, 2023 at 10:05. Remains in effect from Monday morning through late Tuesday night.
August 6, 2023	Maui Emergency Management Agency	03:33	Instagram	High Wind Watch portions of Lāna'i, Maui and the Big Island. Remains in effect: From Monday morning through late Tuesday night. What: East winds 20 to 50 mph with localized gusts over 60 mph possible. Impacts: Damaging winds could blow down trees and power lines. Widespread power outages are possible. Travel could be difficult, especially for high profile vehicles. Event extended (area): Kaho'olawe and northern portions of the Big Island. East winds 25 to 45 mph with localized gusts over 65 mph possible. NWS issued on 08/06/23 at 10:05 AM HST
August 6, 2023	Maui Emergency Management Agency	06:35	Twitter/X	High Wind Watch issued August 6 at 3:33AM HST until August 9 at 6:00 AM HST by NWS Honolulu, HI * WHAT: East winds 20 to 50 mph with localized gusts over 60 mph possible. * WHERE: Portions of Lāna'i, Maui and the Big Island. * WHEN: From Monday morning through late Tuesday night.
August 6, 2023	Maui Emergency Management Agency	15:24	Facebook	High wind watch in effect from Monday Morning through late Tuesday night. Northeast winds 25 to 45 mph with localized gusts over 60 mph possible. Portions of Kauai, Lanai, Maui, Molokai, Oahu and the Big Island. Damaging winds could blow down trees and power lines. Widespread power outages are possible. Travel could be difficult, especially for high profile vehicles. Take precautions to protect property. Tie down loose objects or move them to a sheltered location.
August 6, 2023	Maui Emergency Management Agency	15:24	Instagram	High Wind Watch in effect from Monday morning through late Tuesday night... • What: Northeast winds 25 to 45 mph with localized gusts over 60 mph possible. • Where: Portions of Kauai, i, Maui, Molokai, Oahu, and the Big Island. • When: From Monday morning through late Tuesday night. • Impacts: Damaging winds could blow down trees and power lines. Widespread power outages are possible. Travel could be difficult, especially for high profile vehicles. NWS issued an extended area on August 6, 2023 at 15:24 HST.

continued

Pre-Fire Social Media Posts
August 4, 2023 through August 8, 2023

Date	Agency/ Organization	Time	Platform	Message
August 6, 2023	Maui 24/7	None	Facebook	HIGH WIND WATCH: STRONG AND GUSTY WINDS POSSIBLE MONDAY MORNING THROUGH LATE TUESDAY NIGHT: The gradient between high pressure north of the main Hawaiian Islands and Hurricane Dora passing safely south of the islands may drive very strong and gusty easterly winds across the area in the coming days. A stable air mass and low inversion will amplify this effect, especially over and lee of terrain across the eastern islands. This watch may be extended or modified later today or tonight. Lāna'i Mauka - Haleakala Summit - Big Island Interior - Big Island Summits - Maui Central Valley North - Maui Central Valley South - South Maui/Upcountry - 03:33 HST Sunday August 6, 2023 ...HIGH WIND WATCH IN EFFECT FROM MONDAY MORNING THROUGH LATE TUESDAY NIGHT... * WHAT: East winds 20 to 50 mph with localized gusts over 60 mph possible. * WHERE: Portions of Lāna'i, Maui and the Big Island. * WHEN: From Monday morning through late Tuesday night. * IMPACTS: Damaging winds could blow down trees and power lines. Widespread power outages are possible. Travel could be difficult, especially for high profile vehicles. PRECAUTIONARY/PREPAREDNESS ACTIONS... Take precautions now to protect property. Tie down loose objects or move them to a sheltered location.
August 6, 2023	Maui 24/7	None	Facebook	FIRE WEATHER WATCH: ...CRITICAL FIRE WEATHER CONDITIONS POSSIBLE MONDAY MORNING THROUGH LATE TUESDAY NIGHT ACROSS LEEWARD AREAS... Strong and gusty winds, combined with low humidities and KBDI values possibly exceeding 600, may lead to critical fire conditions across leeward areas over the coming days. This watch may be extended or modified later today or tonight. Updated to state winds in mph versus kts. Kauai Leeward - Oahu South Shore - Waianae Coast - Oahu North Shore - Olomana - Central Oahu - Waianae Mountains - Molokai Leeward - Lāna'i Makai - Lāna'i Mauka - Maui Leeward West - Maui Central Valley - Leeward Haleakala - Kona - South Big Island - Kohala ...FIRE WEATHER WATCH REMAINS IN EFFECT FROM MONDAY MORNING THROUGH LATE TUESDAY NIGHT FOR LEEWARD AREAS DUE TO STRONG AND GUSTY WINDS WITH LOW HUMIDITY... * AFFECTED AREA: Leeward portions of all Hawaiian Islands. * WIND: East winds 20 to 30 mph with higher gusts. * HUMIDITY: 40 to 45 percent during afternoon and evening. * IMPACTS: Any fires that develop will likely spread rapidly. Outdoor burning is not recommended.

continued

APPENDIX

Pre-Fire Social Media Posts
August 4, 2023 through August 8, 2023

Date	Agency/ Organization	Time	Platform	Message
				PRECAUTIONARY/PREPAREDNESS ACTIONS... A Fire Weather Watch means that critical fire weather conditions are forecast to occur. Listen for later forecasts and possible Red Flag Warnings.
August 6, 2023	Maui Emergency Management Agency	None	Facebook	U.S. National Weather Service Honolulu & Central Pacific Hurricane Center: While Hurricane Dora passes well south with no direct impacts here, the strong pressure gradient between it & the high pressure to the north creates a threat of damaging winds & fire weather (due to ongoing dry conditions) from early Mon to Wed. Strongest winds in yellow & oranges on map result from significant pressure differences between high & low pressures. Combined w/dry conditions, these winds pose a serious fire & damaging wind threat. Stay Alert!
August 6, 2023	Maui Emergency Management Agency	None	Facebook	Wind Advisory
August 6, 2023	Maui Fire Department	None	Facebook	U.S. National Weather Service Honolulu & Central Pacific Hurricane Center: Moderate winds through Sunday, but then expect very gusty conditions Mon-Wed. Now would be a good time to secure loose items for the workweek!
August 7, 2023	Maui Emergency Management Agency	03:36	Instagram	Wind Advisory portions of the Niʻihau, Kauaʻi, Oahu, Maui and the Big Island. When: Through 6:00 AM HST Wednesday What: Northeast winds 20 to 35 mph with gusts over 50 mph Impacts: Winds this strong can tear off shingles, knock down tree branches, blow away tents and awnings and make it difficult to steer, especially for drivers of high profile vehicles.
August 7, 2023	Maui County	None	Twitter/X	Red flag warning issued August 7, 2023 at 15:55 until August 9 at 06:00 by NWS Honolulu, HI
August 7, 2023	Maui County	None	Facebook	National Weather service issued a high wind warning for portions of Maui County that extends from 06:00 August 7, 2023 until 06:00 August 8, 2023 (Wednesday).
August 7, 2023	Maui 24/7	None	Facebook	YOUR MAUI WEATHER FORECAST FOR TODAY: Isolated showers before noon. Mostly sunny, with a high near 90 degrees. Heat index values as high as 96. Very windy, with an east northeast wind 17 to 22 mph increasing to 27 to 32 mph in the morning. Winds could gust as high as 47 mph. . TONIGHT: Partly cloudy, with a low around 72 degrees. Very windy, with an east northeast wind 30 to 32 mph, with gusts as high as 47 mph.
August 7, 2023	Maui 24/7	None	Facebook	RED FLAG WARNING: RED FLAG WARNING FOR LEEWARD AREAS DUE TO STRONG WINDS AND LOW HUMIDITY: Very dry fuels combined with strong and gusty easterly winds and low humidities below 45 percent will produce critical fire weather conditions through Tuesday night.

continued

Pre-Fire Social Media Posts
August 4, 2023 through August 8, 2023

Date	Agency/ Organization	Time	Platform	Message
				Kauaʻi Leeward - Oahu South Shore - Waianae Coast - Oahu North Shore - Olomana - Central Oahu - Waianae Mountains - Molokai Leeward - Lānaʻi Makai - Lānaʻi Mauka - Maui Leeward West - Maui Central Valley - Leeward Haleakala - Kona - South Big Island - Kohala - Big Island Interior- 4:42 AM HST Monday, August 7, 2023 ...RED FLAG WARNING REMAINS IN EFFECT UNTIL 6:00 AM HST WEDNESDAY FOR STRONG WINDS AND LOW HUMIDITY... * AFFECTED AREA: Leeward portions of all Hawaiian Islands. * WIND: East winds 30 to 45 mph with gusts over 60 mph expected. * HUMIDITY: 35 to 45 percent during afternoons and evenings. * IMPACTS: Any fires that develop will likely spread rapidly. Outdoor burning is not recommended. PRECAUTIONARY/PREPAREDNESS ACTIONS... A Red Flag Warning means that critical fire weather conditions are either occurring now or will shortly. A combination of strong winds, low relative humidity, and warm temperatures can contribute to extreme fire behavior. A Red Flag Warning does not predict a new fire starts.
August 7, 2023	Maui 24/7	None	Facebook	HIGH WIND WARNING: ...STRONG AND GUSTY WINDS THROUGH TUESDAY NIGHT... Kauaʻi Southwest - Kauai Mountains - Waianae Coast - Oahu North Shore - Central Oahu - Waianae Mountains - Lānaʻi Mauka - Kahoʻolawe - Maui Windward West - Maui Leeward West - Kohala - Big Island Interior- Kauai North - Kauaʻi South - East Honolulu - Honolulu Metro - Ewa Plain - Koolau Leeward - Molokai Windward - Molokai Southeast - Molokai North - Molokai West - Molokai Leeward South - Lanai Windward - Leeward - Lanai South - Maui Central Valley North - Maui Central Valley South - South Maui/Upcountry - South Haleakala - Big Island South - Big Island Southeast - Big Island North 3:15 AM HST Monday, August 7, 2023 ...HIGH WIND WARNING IN EFFECT FROM 6 AM THIS MORNING TO 6:00 AM HST WEDNESDAY... * WHAT: East winds 30 to 45 mph with gusts over 65 mph expected. * WHERE: Portions of Kauai, Oahu, Molokai,, Kahoʻolawe, Maui, and the Big Island.

continued

APPENDIX

Pre-Fire Social Media Posts
August 4, 2023 through August 8, 2023

Date	Agency/ Organization	Time	Platform	Message
August 7, 2023	Maui 24/7	None	Facebook	* WHEN: Through 6:00 AM HST Wednesday. * IMPACTS: Damaging winds may blow down trees and power lines and damage roofs. Power outages are possible. Travel will be difficult, especially for high profile vehicles. PRECAUTIONARY/PREPAREDNESS ACTIONS... Strong winds may lead to property damage. Hazardous driving conditions due to powerful cross winds will pose a serious risk for drivers, especially for light weight and high profile vehicles. Loose outdoor items should be brought inside or secured properly.
August 7, 2023	Maui 24/7	None	Facebook	WINDY FORECAST: The National Weather Service in Honolulu said based on the current forecasts, Hurricane Dora is expected to move on a path about 500 miles south of Hawai'i, which will increase trade wind speeds starting Monday, with very strong and gusty winds Tuesday. A high wind warning has been issued for most of the state Monday morning through Wednesday morning for the expected strong winds. A short-lived southeast swell is expected to fill in Tuesday through midweek as Dora passes far to the south, with rough and dangerous waves. A high surf warning has been issued for the east shores of Hawai'i, Maui and Molokai for waves of 10 to 15 feet.
August 7, 2023	Maui Emergency Management Agency	None	Twitter/X	Red Flag Warning issued August 7 at 3:15AM HST until August 9 at 6:00AM HST by NWS Honolulu, HI The National Weather Service in Honolulu has issued a Red Flag Warning, which is in effect through 6:00 AM HST Wednesday. * AFFECTED AREA: Leeward portions of all Hawaiian Islands.
August 7, 2023	Maui Emergency Management Agency	None	Twitter/X	High Wind Warning issued August 7 at 3:40 PM HST until August 9 at 6:00 AM HST by NWS Honolulu, HI. * WHAT: East winds 45 to 60 mph with gusts in excess of 80 mph. * WHERE: Summits of Haleakala, Mauna Kea, and Mauna Loa. * WHEN: Through 6:00 AM HST Wednesday.
August 7, 2023	Maui Fire Department	None	Facebook	A number of weather threats affecting Maui County to begin the week: Large surf on east facing shores. Strong winds, with especially high wind speeds at higher elevations. A red flag fire weather watch in leeward areas as dry conditions are impacted by gusty winds.
August 8, 2023	Maui County	05:32	Twitter/X	ROAD CLOSURE UPDATE: Kamehameha V Hwy (Molokai) is now OPEN.
August 8, 2023	Maui County	06:27	Twitter/X	ROAD CLOSURE:Haleakala Hwy 377 between Kula Hwy and L. Kimo Drive / Kealaloa Road closed from Hanamu to 37.

continued

Pre-Fire Social Media Posts
August 4, 2023 through August 8, 2023

Date	Agency/ Organization	Time	Platform	Message
August 8, 2023	Maui Emergency Management Agency	07:19	Twitter/X	MEMA Alert: EVACUATION ORDER on Maui for Kula 200 subdivision off Aulii Dr due to a Brushfire. Grab your "go kits" and evacuate your family and pets now!
August 8, 2023	Maui County	07:41	Twitter/X	MEMA Alert: Evacuation Notification
August 8, 2023	Maui Emergency Management Agency	08:32	Twitter/X	MEMA Alert: EVACUATION ORDER for multiple streets in area of King Kekaulike High School evacuated due to dangerous brushfire; evacuate from Aulii Drive, Hoʻopalua Drive, Hanamu Road, and Kealaloa Avenue. Grab your "go kits" and evacuate your family and pets now! Shelter open at Hannibal Tavares Center.
August 8, 2023	Maui County	09:38	Twitter/X	ROAD CLOSURE: Honoapiʻilani Highway between Front Street and Hōkiokio Road due to down Meco* poles on the road.
August 8, 2023	Maui County	09:55	Facebook	Lahaina Fire update #2 at 9:55 AM: Maui Fire Department declared the Lahaina brush fire 100% contained shortly before 9:00 AM today. Power outages are impacting the ability to pump water, and the public is asked to conserve water in West Maui. Lahainaluna Road remains closed while Hawaiian Electric responds to downed power lines

**Now known as Hawaiian Electric.*

6.4 Wind Conditions Reported by Remote Automatic Weather Stations (RAWS)

#STATION: KHRH1

#STATION NAME: KOHALA RANCH

#LATITUDE: 20.089900

#LONGITUDE: -155.826290

#ELEVATION [ft]: 1326

STATE: HI	DATE / TIME	Wind Speed	Wind Direction	Wind Cardinal Direction	Wind Gust	Peak Wind Direction
		Miles / Hour	Degrees	Code	Miles / Hour	Degrees
KHRH1	08/07/2023 20:35 HST	4	102	ESE	9	144
KHRH1	08/07/2023 21:31 HST	12	129	SE	31	147
KHRH1	08/07/2023 22:35 HST	13	128	SE	31	99
KHRH1	08/07/2023 23:35 HST	13	111	ESE	32	96
KHRH1	08/08/2023 00:35 HST	13	114	ESE	44	66
KHRH1	08/08/2023 01:35 HST	19	68	ENE	47	69
KHRH1	08/08/2023 02:35 HST	24	45	NE	47	66
KHRH1	08/08/2023 03:35 HST	16	104	ESE	55	135
KHRH1	08/08/2023 04:35 HST	28	54	NE	56	70
KHRH1	08/08/2023 05:35 HST	32	49	NE	62	60
KHRH1	08/08/2023 06:35 HST	34	47	NE	62	51
KHRH1	08/08/2023 07:35 HST	37	54	NE	60	65
KHRH1	08/08/2023 08:35 HST	34	52	NE	67	53
KHRH1	08/08/2023 09:35 HST	35	56	NE	74	48
KHRH1	08/08/2023 10:35 HST	36	52	NE	63	67
KHRH1	08/08/2023 11:35 HST	41	49	NE	64	58
KHRH1	08/08/2023 12:35 HST	39	51	NE	64	54
KHRH1	08/08/2023 13:35 HST	42	52	NE	64	65
KHRH1	08/08/2023 14:35 HST	42	55	NE	66	59
KHRH1	08/08/2023 15:35 HST	38	55	NE	81	51
KHRH1	08/08/2023 16:35 HST	36	53	NE	82	38
KHRH1	08/08/2023 17:35 HST	31	60	ENE	69	54
KHRH1	08/08/2023 18:35 HST	34	53	NE	69	66
KHRH1	08/08/2023 19:35 HST	35	59	ENE	66	61
KHRH1	08/08/2023 20:35 HST	29	56	NE	61	55
KHRH1	08/08/2023 21:35 HST	29	64	ENE	61	70
KHRH1	08/08/2023 22:35 HST	31	61	ENE	64	64
KHRH1	08/08/2023 23:35 HST	33	56	NE	61	55
KHRH1	08/08/2023 23:35 HST	27	70	ENE	61	45
KHRH1	08/09/2023 01:35 HST	20	82	E	57	52
KHRH1	08/09/2023 02:35 HST	16	99	E	46	50
KHRH1	08/09/2023 03:35 HST	11	125	SE	42	144
KHRH1	08/09/2023 04:35 HST	11	75	ENE	47	128
KHRH1	08/09/2023 05:35 HST	11	90	E	40	116
KHRH1	08/09/2023 06:35 HST	12	72	ENE	35	26
KHRH1	08/09/2023 07:35 HST	16	183	S	37	246
KHRH1	08/09/2023 08:35 HST	16	168	SSE	42	122
KHRH1	08/09/2023 09:35 HST	11	233	SW	41	180
KHRH1	08/09/2023 10:35 HST	18	187	S	44	181
KHRH1	08/09/2023 11:35 HST	10	246	WSW	32	230
KHRH1	08/09/2023 12:35 HST	21	66	ENE	33	39

continued

APPENDIX

6.5 Maui Emergency Management Agency (MEMA) Emergency Operations Center (EOC) Sign-Ins
August 7, 2023 to August 9, 2023

2023-08-07 Severe Weather — 08-07-2023
Event Name — Date

MEMA Staff

Print Name	Signature	Organization	Time In	Time Out
Paul Coe		OPS Section Chief		
Gaye Gabuat		EOC Administrative Assistant	0630	2300
Rocky Keohuhu-Bolor		Planning Section Chief	0715	0001
Colleen Hauptman		Recovery Section Chief	8:20pm	10:00pm 8/8
Everett Balmores		Situational Awareness Chief	0620	
Gina Albanese				
Darryl Takeda		Logistics Section Chief	~~0640~~ 0540	0313
Joshua Aquinde				

S:\Emergency Management\ADMINISTRATION\1. Tracking\MISC\Sign in & Out.xlsx

2023-08-07 Severe Weather — 08-07-23
Event Name — Date

Infrastructure

Print Name	Signature	Organization	Time In	Time Out
Shayne Agawa		DEM - Director		
Robert Schmidt		DEM - Deputy Director		
		DEM		
		DEM		
Jordan Molina		DPW - Director		
Wendy Taomoto		DPW - Deputy Director	6:55 pm	
		DPW		
		DPW		
John Stufflebean		Dept. of Water - Director		
James Landgraf		Dept. of Water - Deputy Director	8:20	
		Dept. of Water		
		Dept. of Water		
Kuhea Asiu		HECO	5:15 AM	
Matthew Nielsen		HHEM	1200	2100

S:\Emergency Management\ADMINISTRATION\1. Tracking\MISC\Sign in & Out.xlsx

2023-08-09 SEVERE WEATHER EVENT
Event Name — Date

Command

Print Name	Signature	Organization	Time In	Time Out
Richard Bissen Jr.		Mayor	6:40	
Herman Andaya		EOC Director		
Leo Caires		Chief of Staff	8:00 A	
Kekuhaupio Akana		Managing Director	0620 dmm	
Josiah Nishita		Deputy Managing Director		
Scott Teruya		Finance Director		
Steve Tesoro		Finance Deputy Director		
Mark Middleton		Safety Officer - Risk Management	0650	
David Duarte		ITSD	3 pm	
Jon Gushiken		ITSD		
		ITSD		
Victoria Takayesu			0730	1600
Mia A.		PIO	6:15pm	
Kathleen Wade		DOT A	4:30 Pm	0730 Pm
ZEKE KALUA		OFFICE OF THE MAYOR	6:59 AM	

S:\Emergency Management\ADMINISTRATION\1. Tracking\MISC\Sign in & Out.xlsx

APPENDIX

2023-08-07 [illegible] — 230808

Event Name — Date

Human Services

Print Name	Signature	Organization	Time In	Time Out
Lori Tsuhako	[illegible]	DHHC - Director	540p	
Saumalu Mataafa		DHHC - Deputy Director		
Douce Moore	[illegible]	~~DHHC~~ DOE	8:00 AM	
		DHHC		
Pat McCall		DPR - Director		
Shane Dudoit		DPR - Deputy Director		
		DPR		
		DPR		
Kevin Drake		DOE		
Desiree Sides	Desiree Sides	DOE	4:30	
Rebecca Winkie	Rebecca Winkie	DOE	8/9 9:00 AM / 8/9 6:30 PM	3:30 PM
		DOE		
[redacted]		American Red Cross		
[redacted]		American Red Cross	0541	
[redacted]		American Red Cross	1800	

S:\Emergency Management\ADMINISTRATION\1. Tracking\MISC\Sign In & Out.xlsx

52

FIRE-MAUICOUNTY-00016282

8 Aug 23

Event Name — Date

Public Safety

Print Name	Signature	Organization	Time In	Time Out
Bradford Ventura	—	MFD - Fire Chief		
Gavin Fujioka	—	MFD - Deputy Chief		
Jeff Giesea	[illegible]	MFD - Chief	0445	
Rylan Yatsushiro	[illegible]	MFD - Fire Services Officer	0730	
Ryan Otsuka	[illegible]	MFD - Battalion Chief	8/8 1616	8/9 2130
Colby Hayley	[illegible]	~~MFD~~ ARFF	1845	0700
John Pelletier		MPD - Chief of Police		
Wade Maeda		MPD - Deputy Chief		
Reid Pursley		MPD		
~~Nick Angeli~~ Gregory Okamoto	[illegible]	MPD	1720	
GORDON SAGUN	[illegible]	MPD	0448	0630
Nic Krau		MPD - Hana		
Kim Massey		MPD - Lana'i		
Nathaniel Hubbard		MPD - Moloka'i		
Ari Wong	[illegible]	National State Park	1853	

S:\Emergency Management\ADMINISTRATION\1. Tracking\MISC\Sign In & Out.xlsx

Todd Cartright [illegible] — HI National Guard — 1720 — 08

FIRE-MAUICOUNTY-00016283

8 AUG 2023

Event Name — Date

Public Safety

Print Name	Signature	Organization	Time In	Time Out
		National State Park		
		National State Park		
		National State Park		
Howard Rodrigues		DLNR		
Ronald Cahill		DLNR		
JOHN YAMAMOTO	[illegible]	DLNR	2230	
		DLNR		
Andrew Martin		Prosecuting Attorney		
Shelly DeMattos		Prosecuting Attorney 1st Deputy		
		Prosecuting Attorney		
		Prosecuting Attorney		
CHO ANDREW WALL	[illegible]	US Coast Guard	8:30 am	
		US Coast Guard		
		US Coast Guard		
		US Coast Guard		

S:\Emergency Management\ADMINISTRATION\1. Tracking\MISC\Sign In & Out.xlsx

Kiethy

FIRE-MAUICOUNTY-00016284

8/8/23

Event Name — Date

Infrastructure

Print Name	Signature	Organization	Time In	Time Out
Sayble Bissen	[illegible]	HECO	6:45p	
		HECO		
Ty Fukuroku		DOT Highways		
		DOT Highways		
		DOT Highways		
Kathy Wade		State DOT Airports		
Marvin Moniz		State DOT Airports		
		State DOT Airports		
Duane Kim		DOT Harbors		
		DOT Harbors		
Walter Pacheco		MPD - Communications		
Jason Takayama		MPD - Communications		
		MPD - Communications		

CLIFFORD BAGUIO [illegible] — MPD - CIU — 2800 am

S:\Emergency Management\ADMINISTRATION\1. Tracking\MISC\Sign In & Out.xlsx

FIRE-MAUICOUNTY-00016286

APPENDIX

Level 1 Activation Fire — 8/8 8/9

Event Name — Date

Human Services

Print Name	Signature	Organization	Time In	Time Out
[redacted]		VOAD		
[redacted]		VOAD	3:28pm	5:20pm
Dr. Pang		DOH	23:47	
Bridget Velaso		DOH	7 AM	2000
		DOH		
		DOH		
Rogerene "Kali" Arce		Dept of Ag - Director	8/9/23 8:20AM	8/9/23 11:00PM
Koa Hewahewa		Dept of Ag - Deputy Director	7:00pm 8:13am	9:15am
		Dept of Ag		
		Dept of Ag		
Layne Silva		Dept of Liquor - Director		
Jarrett Kahoohanahano		Dept of Liquor - Deputy Director		
		Dept of Liquor		
		Dept of Liquor		
Pat McCall		Parks & Recreation - Director	8:32am	?

S:\Emergency Management\ADMINISTRATION\1. Tracking\MISC\Sign In & Out.xlsx

FIRE-MAUICOUNTY-00016277

8/9

Event Name — Date

MEMA Staff

Print Name	Signature	Organization	Time In	Time Out
Paul Coe		OPS Section Chief	0700	
Gaye Gabuat		EOC Administrative Assistant	0045	2300
Rocky Keohuhu-Bolor		Planning Section Chief	0001	0001
Colleen Hauptman		Recovery Section Chief		
Everett Balmores		Situational Awareness Chief		
Gina Albanese				
Darryl Takeda		Logistics Section Chief	0650	2152
Joshua Aquinde				
Liana Nahi		OED / Call Support	4:46pm	8:05pm
[redacted]		AMR	0800	2000
Priya Landgraf		Office of the Mayor	230P	10P

S:\Emergency Management\ADMINISTRATION\1. Tracking\MISC\Sign In & Out.xlsx

FIRE-MAUICOUNTY-00016310

8/9

Event Name — Date

MEMA Staff

Print Name	Signature	Organization	Time In	Time Out
Paul Coe		OPS Section Chief	0700	
Gaye Gabuat		EOC Administrative Assistant	0045	2300
Rocky Keohuhu-Bolor		Planning Section Chief	0001	0001
Colleen Hauptman		Recovery Section Chief		
Everett Balmores		Situational Awareness Chief		
Gina Albanese				
Darryl Takeda		Logistics Section Chief	0650	2152
Joshua Aquinde				
Liana Nahi		OED / Call Support	4:46pm	8:05pm
[redacted]		AMR	0800	2000
Priya Landgraf		Office of the Mayor	230P	10P

S:\Emergency Management\ADMINISTRATION\1. Tracking\MISC\Sign In & Out.xlsx

FIRE-MAUICOUNTY-00016300

Brushfire — 8/9/23 ~~8/10/2023~~

Event Name — Date

Command

Print Name	Signature	Organization	Time In	Time Out
Richard Bissen Jr.		Mayor		
Herman Andaya		EOC Director		
Leo Caires		Chief of Staff	6:00AM	
Kekuhaupio Akana		Managing Director	0640am	
Josiah Nishita		Deputy Managing Director		
Scott Teruya		Finance Director	7:00	
Steve Tesoro		Finance Deputy Director		
Mark Middleton		Safety Officer - Risk Management	0630	
David Duarte		ITSD	[illegible]	
Jon Gushiken		ITSD		
		ITSD		
Cynthia Lallo		Senior EA		
Victoria Takayesu		Corp Counsel	7:00	

S:\Emergency Management\ADMINISTRATION\1. Tracking\MISC\Sign In & Out.xlsx

FIRE-MAUICOUNTY-00016270

APPENDIX

MAUI FIRES — 8/9

Event Name — Date

Public Safety

Print Name	Signature	Organization	Time In	Time Out
Bradford Ventura		MFD - Fire Chief		
Gavin Fujioka		MFD - Deputy Chief		
Jeff Giesea		MFD - Chief		
Rylan Yatsushiro		MFD - Fire Services Officer		
		MFD		
		MFD		
John Pelletier		MPD - Chief of Police		
Wade Maeda		MPD - Deputy Chief		
Reid Pursley		MPD		
Nick Angell		MPD		
		MPD		
Nic Krau		MPD - Hana		
Kim Massey		MPD - Lana'i		
Nathaniel Hubbard		MPD - Moloka'i		
Ari Wong	[signature]	National State Park	0630	

S:\Emergency Management\ADMINISTRATION\1. Tracking\MISC\Sign In & Out.xlsx

32

FIRE-MAUICOUNTY-00016271

Maui Fires — 8/9

Event Name — Date

Public Safety

Print Name	Signature	Organization	Time In	Time Out
		National State Park		
		National State Park		
		National State Park		
Howard Rodrigues		DLNR		
Ronald Cahill		DLNR		
JOHN YAMAMOTO	[signature]	DLNR	1800	
		DLNR		
Andrew Martin		Prosecuting Attorney		
Shelly DeMattos		Prosecuting Attorney 1st Deputy		
		Prosecuting Attorney		
		Prosecuting Attorney		
Jesse Harris	[signature]	US Coast Guard	1400	2200
MARK THAYER	[signature]	US Coast Guard	2000	2400
CLIO DREW WALL	[signature]	US Coast Guard	[illegible]	0800
CLIO DREW WALL	[signature]	US Coast Guard	2400	

S:\Emergency Management\ADMINISTRATION\1. Tracking\MISC\Sign In & Out.xlsx

32

FIRE-MAUICOUNTY-00016272

8/9

Event Name — Date

Infrastructure

Print Name	Signature	Organization	Time In	Time Out
Shayne Agawa		DEM - Director		
Robert Schmidt	[signature]	DEM - Deputy Director	7:05 12:20 5:40	8:10 2:50 8:05
		DEM		
		DEM		
Jordan Molina		DPW - Director		
Wendy Taomoto	[signature]	DPW - Deputy Director	7:00 pm	2pm 8/10
		DPW		
		DPW		
John Stufflebean		Dept. of Water - Director		
James Landgraf		Dept. of Water - Deputy Director		
		Dept. of Water		
		Dept. of Water		
[redacted]		HECO	4:00AM	8:30PM
[redacted]	808-260-[redacted]	HAWAIIAN TELCOM		
TY FUKUROKU	808-281-[redacted]	DOT HWYS		

S:\Emergency Management\ADMINISTRATION\1. Tracking\MISC\Sign In & Out.xlsx

32

FIRE-MAUICOUNTY-00016273

8/9

Event Name — Date

Infrastructure

Print Name	Signature	Organization	Time In	Time Out
[redacted]		HECO	5:00 pm	3:00 am
		HECO		
Ty Fukuroku		DOT Highways		
Derek Takahashi	[signature]	DOT Highways	7:10	
		DOT Highways		
Kathy Wade	[signature]	State DOT Airports	1650	2130
Marvin Moniz		State DOT Airports		
		State DOT Airports		
Duane Kim		DOT Harbors		
		DOT Harbors		
Walter Pacheco	[signature]	MPD - Communications	0630	2200
Jason Takayama		MPD - Communications		
		MPD - Communications		

S:\Emergency Management\ADMINISTRATION\1. Tracking\MISC\Sign In & Out.xlsx

32

FIRE-MAUICOUNTY-00016274

APPENDIX

Event Name _____ Date 8/9 Wednesday

Human Services

Print Name	Signature	Organization	Time In	Time Out
Lori Tsuhako		DHHC - Director		
Saumalu Mataafa		DHHC - Deputy Director		
Christopher Kish	[signature]	DHHC	7:15pm	8:00 am
[redacted]		DHHC		
Pat McCall	[signature]	DPR - Director	8:44pm	10:45am
Shane Dudoit		DPR - Deputy Director		
		DPR		
		DPR		
X Kevin Drake		DOE		
Desiree Sides	[signature]	DOE	5:20pm	8:15pm
Rebecca Winkie		DOE		
		DOE		
[redacted]		American Red Cross		
✓ [redacted]		American Red Cross		
		American Red Cross		

S:\Emergency Management\ADMINISTRATION\L. Tracking\MISC\Sign in & Out.xlsx

FIRE-MAUICOUNTY-00016275

Event Name _____ Date 8/9/23

Human Services

Print Name	Signature	Organization	Time In	Time Out
Shane Dudoit	[signature]	Parks & Recreation - Deputy Director	6:30	
		Parks & Recreation		
		Parks & Recreation		
~~David Underwood~~	retired	~~Personnel - Director~~		
Cynthia Razo-Porter	CMR	Personnel - ~~Deputy~~ Director	720	820
		Personnel		
		Personnel		
LEETO ANDERSON	[signature]	SHERIFF	1800	
X Marc Takamori	[signature]	Transportation	830pm	830am
X [redacted]		Maui Health System		-
Saumalu Mataafa	[signature]	DHHC	6:40am	8:05
Kawanoe Bataygan	[signature]	Transportation	6:55am	6:57pm
Marc Takamori	[signature]	Transportation	6:30pm	

S:\Emergency Management\ADMINISTRATION\L. Tracking\MISC\Sign in & Out.xlsx

FIRE-MAUICOUNTY-00016276

Event Name _____ Date 8/9

Human Services

Print Name	Signature	Organization	Time In	Time Out
X [redacted]		VOAD		
[redacted]		VOAD / The Salvation Army	7:10a	
X Dr. Pang		DOH		
Bridget Velaso		DOH		
Marc Nishimoto	[signature]	DOH	640pm	1040pm
		DOH		
Rogerene "Kali" Arce	[signature]	Dept of Ag - Director	8/9 8:00 am	8/9 11:00pm
Koa Hewahewa	[signature]	Dept of Ag - Deputy Director	8am	
		Dept of Ag		
		Dept of Ag		
Layne Silva		Dept of Liquor - Director		
Jarrett Kahoohanahano		Dept of Liquor - Deputy Director		
		Dept of Liquor		
		Dept of Liquor		
X Pat McCall		Parks & Recreation - Director		

S:\Emergency Management\ADMINISTRATION\L. Tracking\MISC\Sign in & Out.xlsx

FIRE-MAUICOUNTY-00016278

Event Name _____ Date 8/9

Human Services

Print Name	Signature	Organization	Time In	Time Out
Shane Dudoit		Parks & Recreation - Deputy Director		
		Parks & Recreation		
		Parks & Recreation		
~~David Underwood~~		Personnel - Director		
Cynthia Razo-Porter	[signature]	Personnel - ~~Deputy~~ Director	10:00	
		Personnel		
		Personnel		
X [redacted]		MHLA	1:30pm	9:00pm
[redacted]		MHLA	8am	5:30pm
[redacted]		MVCB	7pm	8:30AM
[redacted]		HHEM	1300	2100

S:\Emergency Management\ADMINISTRATION\L. Tracking\MISC\Sign in & Out.xlsx

FIRE-MAUICOUNTY-00016279

8/9

Event Name | Date

Planning

Print Name	Signature	Organization	Time In	Time Out
Kathleen Aoki		Dept. of Planning - Director		
Garrett Smith		Dept. of Planning - Deputy Director		
James Bulka	James A. Ryalon rep for Planning Dept.	Dept. of Planning	8:45	
		Dept of Planning		
Lila Lawrence		Communications Officer	6:30	
Rogerene Kali Arce	Rogerene Kali Arce	Dir. of Ag. County	8:00 AM	

S:\Emergency Management\ADMINISTRATION\1. Tracking\MISC\Sign in & Out.doc

32

FIRE-MAUICOUNTY-00016280

This page intentionally left blank.

APPENDIX

6.6 Hawaiian Electric Emergency Operations Center (EOC) Update August 8, 2023

EXEMPT FROM DISCLOSURE UNDER FOIA, UIPA, AND RELATED LAWS

From: [redacted]

Sent: 8/8/2023 5:58:27 AM
To: [redacted]
Subject: EOC Update #1 - Wind Event and Upcountry Fire

Good morning, [redacted]–

Sending you two a more detailed update, a general one will be sent to the LNO team and [redacted] to follow.

MEMA has partially activated the Emergency Operating Center (EOC) due to a large brush fire happening Upcountry that started at 12:22 a.m. I reported to the EOC at 5:15 a.m.
At this time an evacuation order is in place for multiple streets near King Kekaulike High School, but the fire is not a threat to the school at this time.

- The evacuation covers those from Auli'i Drive, Ho'opalua Drive, Hanamu Road and Kealaloa Avenue.
- An admin day has been called, so no school for Upcountry students today. A shelter has been opened at Pukalani Community Center/Hannibal Tavares Community Center. Awaiting an approximate count of people currently there.
- One house was burned down, but no one was inside.
- MFD has warned me that it looks like the brush fire may have started near our downed power lines. This is pending an investigation, of course. I have asked MFD and MPD to please refrain from saying this publicly and also not to refer to this on their radios, as there are community folks who listen in to police scanners and such and then report on social media. They have both acknowledged and agreed. Nothing has been mentioned on the police/fire radio so far.
- Proactively asking MPD/MFD where their crews are and to be sure that they assume all downed lines are energized. MPD is checking to see if they need to request lines to be de-energized.

Will keep you posted.

Thanks,

[redacted]

CONFIDENTIAL TREATMENT REQUESTED
SUBJECT TO CONFIDENTIALITY AND NON-DISCLOSURE AGREEMENT

MECO-FSRI-0000001480

6.7 Maui Emergency Management Agency (MEMA) Emergency Operations Center (EOC) Situation Report No. 1: August 8, 2023

Incident Name: 230807 Severe Weather

EOC Partial Activation 8/7 @ 2100

2 FIRES as of 8/8 @ 1047

KULA FIRE (reported 8/8 @ 1222 AM)
- 1100 Acres (rough estimate)/Containment: 0%
- South DIVS (Devin): E10, WL10, WL10a, E14, DOFAW engine-keep fire E/Makua of Kula Hwy
- East DIVS (Vanderpoel): E13, Mn13, DOFAW tankers-working backside to contain gulch East of Kul 200 neighborhood.
- Structure GP (Gaddis, Teroka): RE2 at Kananoe, E5 at 1330s Haleakala-protect structures from further exposures
- HE Goup (BC6): Honolulu Tanker, Kaupo Ranch Tanker (D6), GF Tankers x2 (d6,d9) - keep fire east of Kula Hwy, working Mauka
- Air-1 completed morning reconnaissance then return to base due to winds (30 mph gusts)
- 2 residential structures lost. No injuries or loss of life
- Shift change. Change Incident Commander
- Investigators deployed

LAHAINA(LUNA FIRE (near Lahaina Intermediate) (reported at 8/8 @ 0637)
- MFD dispatched (Lahaina, Napili). 3 acres (rough estimate)
- Air-2 return to base due to winds. Investigators deployed
- **Reported at 100% contained at 0904**

Infrastructure as of 8/8 @ 819

- Power Outages: West Maui and Upcountry (Crews working on restoration)
- Pole down Honoapiilani Road between Front Street and Hokiokio (Crews responding)
- West Maui 2628 HECO customers affected
- Water impacted: Residential Upcountry. Request for conservation. Water for MFD not impacted
- Closed: Pukalani DMV (due to smoke), Lahaina DMV (due to power)

EVACUATIONS as of 8/8 @ 0819

- **Evacuated Haleakala 377 area of MM2**
- **Kula 200: Auli and Hoopalua and Hanamu as well as all side streets**
- Kealaloa and Meha to the Y

SHELTERS as of 8/8 @ 0640

- Open: Hannibal Taveres Community Center Pukalani
  - Some evacuees staying in cars (approx. 20) in parking lot
  - 54 people, 17 dogs, 7 cats
  - Humane Society on scene for small animals
- Kaomulu Ranch (Kula) opened up Oskie Rice Arena for evacuation, staging and (large) animal evacuation
- Open: Lahaina Civic Center Downstairs (Power Out)
  - 7 people

SCHOOL CLOSURES as of 8/8@ 0640

- Closed: Kamehameha Schools
- Closed King Kekaulike High
- Makawao Intermediate Only 6th grade scheduled
- Closed: Lahainaluna Intermediate, High School and Princess Nāhi'ena'ena Elementary School (due to power outage)

ROAD CLOSURES as of 8/8 @ 0819

- Road closed on Honoapiilani from Front Street to Hokioko
- Road closed on Wainee from Dickenson to Lahainaluna
- Road partially closed and blocked off from Honoapiilani / Keawe. Right hand turn lane from Honoapiilani to Keawe blocked with cones
- Road closed on Lahainaluna from Kelawea to Kuialua

This information is for Emergency Management use only and can not be distributed without permission from Maui Emergency Management Agency

FIRE-MAUICOUNTY-00020163

APPENDIX

6.8 Maui Emergency Management Agency (MEMA) Emergency Operations Center (EOC) Situation Report: No. 2: August 8, 2023

Incident Name: 230807 Severe Weather — **EOC Full Activation 8/8 @ 1630**

3 FIRES as of 8/8 @ 2131

KULA FIRE (reported 8/8 @ 1222 AM)
- 1100 Acres (rough estimate)/Containment: 0%
- South DIVS (Devin): E10, WL10, WL10a, E14, DOFAW engine keep fire E/Makua of Kula Hwy
- East DIVS (Vanderpool): E13, Mn13, DOFAW tankers working backside to contain gulch East of Kula 200 neighborhood.
- Structure GP (Geddis, Teroka): RE2 at Kanaroa, E5 at 1330s Haleakala protect structures from further exposures
- RE Group (BC6): Honolulu Tanker, Kaupo Ranch Tanker (D6), GF Tankers x2 (d6,d9) - keep fire east of Kula Hwy, working Mauka
- Air: 1 completed morning reconnaissance then return to base due to winds (80 mph gusts)
- 2 residential structures and 1 greenhouse lost. No injuries or loss of life

LAHAINALUNA FIRE (near Lahaina Intermediate): (reported at 8/8 @ 0617)
- MFD dispatched (Lahaina, Napili).
- Lahaina Fleet up. Hoohaiwa Place @ 1500
- Fire within 2 miles of Civic Center shelter @ 2135

KIHEI FIRE (near Pulehu Road): 8/8 @ 2131

Infrastructure as of 8/8 @ 1505

- Power Outages: West Maui and Upcountry (Crews working on restoration)
- Pole down Honoapiilani Road between Front Street and Holokiko (Crews responding)
- West Maui 2628 HECO customers affected
- Water impacted: Residential Upcountry. Request for conservation. Water for MFD not impacted
- Closed: Pukalani DMV (due to smoke), Lahaina DMV (due to power)
- 30 Poles down (29 in Lahaina). Strong wind restricts climbing poles

EVACUATIONS as of 8/8 @ 2322

- Evacuated Haleakala 377 area of MM2
- Kula 200: Auli and Hoopaiua and Hanamu as well as all side streets
- Kealaloa and Meha to the Y
- Area above Makanoe Place being recommended for evacuation @ 1410
- Kulalani subdivision @ 1533. EAS/WEA sent @ 1608
- Lahaina Kelawea Mauka Subdivision near bypass @ 1533. EAS/WEA sent @1615
- Wahikuli subdivision (Lahaina) emergency evacuation @ 2035
- Kihei - North of Ohukai Road emergency evacuation @ 2245
- Pulehu Area (Kula)- Holopuni Road to Calesa Road @ 2229
- Kihei – Mauka of Piilani Hwy up to and including Maui Meadows @ 2334
- Kula – Upper Kimo Road area emergency evacuation @ 8/9 0040
- Lahaina – Kaanapali Golf Estates area including Kaulapa Loop, PuuAnoano St, Hakui Loop, Wekio Pl @ 8/9 0129

SHELTERS as of 8/9 @ 0142

- Open: Hannibal Tavares Community Center, Pukalani
  - 250 people, 17 dogs, 7 cats
  - Humane Society on scene for small animals
- Kaonoulu Ranch (Kula): opened up Oskie Rice Arena for evacuation, staging and (large) animal evacuation
- Maui Prep (transfer from civic center): 600 people (more on the way)
- Maui High School open with DOE and Parks emps. 1200 people
- War Memorial Auditorium open 8/9 @ 65 people
- Transferring people from Maui High to War Memorial

ROAD CLOSURES as of 8/8 @ 1930

- Honoapiilani Hwy-Lahaina
- Front Street
- Honoapiilani S-Bound
- Keawe/Fleming
- Hokiokioi/Launiopoko
- Lahaina bypass
- Leialii Hwy-Southbound
- Aholo-Liholiho
- Honoapiilani/Fleming
- Kaheki Hwy/Waihee school
- Kufumanu Circle
- Haleakala Hwy/Kulalani
- Kekauilike
- Lower Kimo/Haleakala Hwy
- Haleakala Hwy/Kealaloa
- Haleakala Hwy/Crater Road

SCHOOL CLOSURES as of 8/8@ 1500

- Closed: Kamehameha Schools
- Closed King Kekaulike High
- Makawao Intermediate: Only 8th grade scheduled
- Closed: Lahainaluna Intermediate, High School and Princess Nahi'ena'ena Elementary School (due to power outage)
- Schools listed above will also be closed on 8/9
- Closed: Seabury Hall
- Closed: Haleakala Waldorf Middle & High School

This information is for Emergency Management use only and can not be distributed without permission from Maui Emergency Management Agency

FIRE-MAUICOUNTY-00045827

6.9 Emergency Proclamation: Mayor of Maui

RICHARD T. BISSEN, JR.
Mayor

KEKUHAUPIO R. AKANA
Managing Director

OFFICE OF THE MAYOR
COUNTY OF MAUI
200 SOUTH HIGH STREET
WAILUKU, MAUI, HAWAI'I 96793
www.mauicounty.gov

EMERGENCY PROCLAMATION

By the authority vested in me as Mayor of the County of Maui, by the Revised Charter of the County of Maui (1983), as amended, and the Constitution and laws of the State of Hawaii, I, RICHARD T. BISSEN, JR., Mayor of the County of Maui of the State of Hawaii, hereby determine, designate, and proclaim as follows:

WHEREAS, Chapter 127A Hawai'i Revised Statutes, provides for the establishment of County Organizations for emergency management and disaster relief with the Mayor having direct responsibility and authority over emergency management within the County; and

WHEREAS, as of August 8, 2023 several large wildfires are burning in the County of Maui, including in the Kula and Lahaina areas;

WHEREAS, these fires have burned homes, burned hundreds of acres and forced closure of roads and schools, and evacuations in the Kula and Lahaina areas;

WHEREAS, very dry conditions and strong and potentially damaging easterly winds caused by the passage of Hurricane Dora to the south of the State are contributing to the wildfire danger;

WHEREAS, these fires threaten to cause damages, losses, and suffering of such character and magnitude to affect the health, welfare, and living conditions of a substantial number of persons, and to affect the economy of the County, and has the potential to be of such a nature as to warrant rehabilitative assistance from the County;

WHEREAS, due to the possibility of imminent disaster due to property damage and/or bodily injury to residents of Maui County, and the need for government agencies and representatives from the

APPENDIX

6.9 Emergency Proclamation: Mayor of Maui *(continued)*

private sector to mobilize and provide immediate services to outer island residents, a Civil Defense state of emergency is authorized pursuant to Chapters 127A, Hawai'i Revised Statues, as amended.

WHEREAS, the anticipated occurrence of a severe, sudden, and extraordinary event of damaging high winds and very dry conditions threatens to cause damage, loss, and suffering of such character and magnitude to affect the health, welfare, and living conditions of a substantial number of persons, and to affect the economy of Maui County, and is expected to be of such a nature as to warrant rehabilitative assistance from the County and the State; and

WHEREAS, there is need for government agencies and representatives from the private sector to mobilize and provide immediate services to County residents and to mitigate hazardous situations in advance of the weather effects from Hurricane Dora; and

WHEREAS, pursuant to sections 127A-14(b), Hawaii Revised Statutes ("Haw. Rev. Stat.") the Mayor is authorized to declare by proclamation whether an emergency or disaster has occurred, or there is an imminent danger or threat of an emergency or disaster and authorize actions under chapter 127A, Haw. Rev. Stat., and the expenditure of funds thereunder; and

WHEREAS, pursuant to §127A 13(b)(2), Haw. Rev Stat., the Mayor may suspend any County law that impedes or tends to impede, or that may be detrimental to, the expeditious and efficient execution of, or conflict with, emergency functions; and

WHEREAS, Haw. Rev. Stat. §127A-13(b)(4) further provides that the Mayor may direct and control mandatory evacuation of the civilian population; and

WHEREAS, Haw. Rev. Stat. §127A-13(b)(5) further provides that the Mayor may exercise any additional emergency functions to the extent necessary to prevent hoarding, waste, destruction of materials, supplies, commodities, accommodations, facilities, and services to effectuate equitable distributions as the public welfare may require; and

WHEREAS, Haw. Rev. Stat. §127A-12(a)(5), the Mayor may direct or control, as may be necessary for emergency management, alerts, warnings, notifications, and activations; warnings and signals for alerts and any type of warning device, system, or method to be used

in connection therewith; partial or full mobilization of personnel in advance of or in response to an actual emergency or disaster; the conduct of civilians and the movement and cessation of movement of pedestrians and vehicular traffic during, before, and after alerts, emergencies, or disasters; and

WHEREAS, pursuant to Haw. Rev. Stat. §127A-12(c)(17), the Mayor may take any and all steps necessary or appropriate to carry out the purposes of chapter 127A, Haw. Rev. Stat., notwithstanding that powers in Haw. Rev. Stat. §127A 13(b) may only be exercised during an emergency period; and

NOW, THEREFORE, I, RICHARD T. BISSEN, JR., Mayor of the County of Maui, pursuant to the authority vested in me as the Mayor of the County of Maui as set forth above, in order to promote and protect the public health, safety, and welfare of the residents and visitors of the County of Maui, do hereby proclaim, determine, declare, and find that:

1. There is imminent danger of a state of emergency in all or any portion of the County of Maui, as of the date and time of this Proclamation; and

2. Any public property of the County, real or personal, may be possessed, used, managed, controlled, or reallocated as I require for the purposes of emergency management functions under Haw. Rev. Stat. Chapter 127A, including parks, playgrounds, and other public or private buildings; and

3. The provisions, in whole or in part, of Haw. Rev. Stat. Chapter 103D and Haw. Rev. Stat. §§ 103-50, 103-53, 103-55, 105-1 to 105-10, and 464-4 that impede or tend to impede the expeditious discharge of the functions of emergency management, or that compliance therewith is impracticable due to existing conditions and, therefore, such provisions shall not apply to any such emergency management functions; and

4. Without regard to Haw. Rev. Stat. Chapters 76, 78, and 88, agencies, officials, officers, employees of the County and other persons may be ordered and directed as I deem necessary to carry out emergency management functions under Haw. Rev. Stat. Chapter 127A; and

5. The provisions of the Maui County Code, in whole or in part, shall be suspended including, but not limited to, Chapter 2.20 (intergovernmental agreements), §§3.12.060 and 3.12.070

APPENDIX

6.9 Emergency Proclamation: Mayor of Maui *(continued)*

(purchasing procedures), Chapter 3.56 (gifts and donations), to the extent that they impede the expeditious discharge of the functions of emergency management or the compliance therewith is impracticable due to existing conditions; and

6. All County officers and employees shall be required to take all steps requested by the State of Hawaii Director of Department of Health to qualify the County of Maui for reimbursement from the Federal Emergency Management Agency and for other state and federal relief as may be available to reimburse the County of Maui for the expenses it incurs in addressing this emergency.

7. Sections 127A-12(a)(5), 127A-13(b)(3), and 127A 13(b)(4), Haw. Rev. Stat., and the Director of the Maui Emergency Management Agency is directed to take appropriate actions to direct or control, as may be necessary for emergency management:

   a. Alerts, warnings, notifications, and activations;
   b. Warnings and signals for alerts and any type or warning device, system, or method to be used in connection therewith;
   c. Partial or full mobilization of personnel in advance of or in response to an actual emergency or disaster;
   d. The conduct of civilians and the movement and cessation of movement of pedestrians and vehicular traffic during, before, and after alerts, emergencies, or disasters;
   e. Shut off water mains, gas mains, electric power connections, or suspension of other services; and
   f. Mandatory evacuation of the civilian population.

8. Section 127A-12(c), Haw. Rev. Stat., in order to provide emergency disaster relief, I hereby direct all County agencies and officers to cooperate with and extend their services, materials, and facilities as may be required to assist in all efforts to eliminate the danger.

This Proclamation of Emergency is effective August 8, 2023, and shall terminate on the first to occur of (1) sixty (60) days after the date of this Proclamation, or (2) issuance of a Declaration of Termination of Emergency issued by the undersigned, whichever occurs first. Pursuant to this Proclamation, I hereby exercise any and all powers listed in Haw. Rev. Stat. Chapter 127A.

RICHARD T. BISSEN, JR.; Mayor
County of Maui
August 8, 2023

APPROVED AS TO FORM AND LEGALITY:

VICTORIA J. TAKAYESU, Corporation Counsel
Department of the Corporation Counsel

APPENDIX

6.10 Emergency Proclamation: Office of the Governor State of Hawai'i

OFFICE OF THE GOVERNOR
STATE OF HAWAI'I

PROCLAMATION
RELATING TO WILDFIRES

By the authority vested in me by the Constitution and laws of the State of Hawai'i, in order to provide relief for disaster damages, losses, and suffering, and to protect the health, safety, and welfare of the people, I, SYLVIA LUKE, Acting Governor of the State of Hawai'i, hereby determine, designate and proclaim as follows:

WHEREAS, as of August 8, 2023 several large wildfires are burning in the counties of Hawaii and Maui, including in the North Kohala, South Kohala, Kula, and Lahaina areas;

WHEREAS, these fires have burned hundreds of acres and forced closure of roads and schools, and evacuations in the Kohala Ranch, Kula, and Lahaina areas;

WHEREAS, very dry conditions and strong and potentially damaging easterly winds caused by the passage of Hurricane Dora to the south of the State are contributing to the wildfire danger;

WHEREAS, these fires threaten to cause damages, losses, and suffering of such character and magnitude to affect the health, welfare, and living conditions of a substantial number of persons, and to affect the economy of the State, and has the potential to be of such a nature as to warrant rehabilitative assistance from the State;

WHEREAS, the Legislature of the State of Hawai'i has appropriated from the general revenues of the State monies as may be necessary for expenditure by or under the direction of the Governor for the immediate relief of the conditions created by the emergency;

WHEREAS, in expending such monies, the Governor may allot any portion to any agency, office, or employee of the state or to any county for the most expeditious and efficient relief of the conditions created by the emergency.

WHEREAS, pursuant to sections 127A-14 and 127A-16, Hawaii Revised Statutes, the Governor may determine whether an emergency or disaster has occurred, or whether there is an imminent danger or threat of an emergency or disaster and authorize actions under chapter 127A, Hawaii Revised Statutes, and the expenditure of

FIRE-MAUICOUNTY-00020172

funds thereunder;

WHEREAS, pursuant to section 127A-13(a)(3), Hawaii Revised Statutes, the Governor may suspend any law that impedes or tends to impede or is detrimental to the expeditious and efficient execution of, or that conflicts with, emergency functions, including laws specifically made applicable to emergency personnel;

WHEREAS, pursuant to section 127A-13(a)(2), Hawaii Revised Statutes, the Governor may relieve hardships and inequities, or obstructions to the public health, safety, and welfare found by the Governor to exist in the laws and to result from the operation of federal programs or measures taken under chapter 127A, Hawaii Revised Statutes, by suspending laws, in whole or in part, or by alleviating the provisions of laws on such terms and conditions as the Governor may impose; and

NOW, THEREFORE, I, Sylvia Luke, Acting Governor of the State of Hawai'i, hereby determine that an emergency or disaster contemplated by section 127A-14, HRS, is occurring in the Counties of Maui and Hawai'i, State of Hawai'i, and do hereby authorize and invoke the following emergency provisions which are expressly invoked, if not already in effect upon this declaration of an emergency:

I. **Invocation of Laws**

Section 121-30, HRS, and I hereby authorize the Adjutant General to activate such units of the Hawai'i National Guard as may be necessary to assist and aid civilian authorities in disaster relief and in averting any imminent public danger and threat and to ensure the compliance with the civil laws of the State of Hawai'i.

Sections 127A-12 and 127A-13, HRS, in order for county and state agencies to provide emergency relief and engage in emergency management functions as defined in section 127A-2, HRS, as a result of and in response to this event.

Sections 127A-3, 127A-12(a)(5), 127A-13(a)(5), and 127A-13(a)(6), HRS, and the Director of Hawai'i Emergency Management and the Administrator of Emergency Management are directed to take appropriate actions to direct or control, as may be necessary for emergency management:

a. Alerts, warnings, notifications, and activations;
b. Warnings and signals for alerts and any type or warning device, system, or method to be used in connection therewith;

2

FIRE-MAUICOUNTY-00020173

c. Partial or full mobilization of state personnel in advance of or in response to an actual emergency or disaster;

d. The conduct of civilians and the movement and cessation of movement of pedestrians and vehicular traffic during, before, and after alerts, emergencies, or disasters;

e. Shut off water mains, gas mains, electric power connections, or suspension of other services; and

f. Mandatory evacuation of the civilian population.

Section 127A-12(b)(13), HRS, requiring each public utility, or any person owning, controlling, or operating a critical infrastructure, to protect and safeguard its or the person's property, or to provide for the protection and safeguarding thereof, and provide for the protection and safeguarding of all critical infrastructure and key resources; provided that without prejudice to the generality of the foregoing two clauses, the protecting or safeguarding may include the regulation or prohibition of public entry thereon, or the permission of the entry upon terms and conditions as I may prescribe.

Section 127A-12(b)(16), HRS, directing all state agencies and officers to cooperate and extend their services, materials, and facilities as may be required to assist in emergency response efforts.

Section 127A-16, HRS, by activating the Major Disaster Fund.

II. Suspension of Laws

The following specific provisions of law are suspended, as allowed by federal law, pursuant to sections 127A-12(b)(8) and 127A-13(a)(3), HRS, to the extent that the law impedes or tends to impede or be detrimental to the expeditious and efficient execution of, or to conflict with, emergency functions, including laws which by this chapter specifically are made applicable to emergency personnel:

Section 37-41, HRS, **appropriations to revert to state treasury; exceptions**, to the extent that appropriations lapse at the end of the fiscal year prior to completion of the emergency actions.

Section 37-74(d), HRS, **program execution**, except for sub-sections 37-74(d)(2) and 37-74(d)(3), HRS, and any such transfers or changes considered to be authorized transfers or changes for purposes of section 34-74(d)(1) for legislative reporting

requirements, to the extent that legislative authorization would likely delay appropriation transfers or changes between programs to provide necessary funding to complete the emergency actions.

Section 40-66, HRS, **lapsing of appropriations**, to the extent that the timing of the procurement of the construction of the emergency permanent repairs may occur the fiscal year following the original emergency proclamation.

Chapter 89, HRS, **collective bargaining in public employment,** to the extent that compliance with this chapter requires additional time detrimental to the expeditious and efficient execution of emergency actions.

Chapter 89C, HRS, **public officers and employees excluded from collective bargaining,** to the extent that compliance with this chapter requires additional time detrimental to the expeditious and efficient execution of emergency actions.

Section 103-2, HRS, **general fund**, to the extent that compliance results in any additional delays.

Section 103-53, HRS, **contracts with the State or counties; tax clearances, assignments**, only to the extent necessary to waive the Internal Revenue Service (IRS) tax clearance requirement

Section 103-55, HRS, **wages, hours, and working conditions of employees of contractors performing services**, to the extent that compliance results in any additional delays.

Chapter 103D, HRS, **Hawaii public procurement code**, to the extent that compliance results in any additional delays involved in meeting procurement requirements for selecting contractors in a timely manner to respond to emergency situations.

Chapter 104, HRS, **wages and hours of employees on public works**, to the extent that compliance with this chapter requires additional time detrimental to the expeditious and efficient execution of emergency actions.

Sections 105-1 to 105-10, HRS, **use of government vehicles, limitations,** to the extent that compliance with this chapter requires additional time detrimental to the expeditious and efficient execution of emergency actions.

Section 127A-30, HRS, **rental or sale of essential commodities during a state**

APPENDIX

6.10 Emergency Proclamation: Office of the Governor State of Hawai'i *(continued)*

of emergency; prohibition against price increases, because the automatic invocation of this provision is not needed for this emergency.

III. Severability

If any provision of this Proclamation is rendered or declared illegal for any reason, or shall be invalid or unenforceable, such provision shall be modified or deleted, and the remainder of this Proclamation and the application of such provision to other persons or circumstances shall not be affected thereby but shall be enforced to the greatest extent permitted by applicable law.

IV. Enforcement

No provision of this Proclamation, or any rule or regulation hereunder, shall be construed as authorizing any private right of action to enforce any requirement of this Proclamation, or of any rule or regulation. Unless the Governor, Director of Emergency Management, or their designee issues an express order to a non-judicial public officer, no provision of this Proclamation, or any rule or regulation hereunder, shall be construed as imposing any ministerial duty upon any non-judicial public officer and shall not bind the officer to any specific course of action or planning in response to the emergency or interfere with the officer's authority to utilize his or her discretion.

I FURTHER DECLARE that the disaster emergency relief period shall commence immediately and continue through August 15, 2023 unless terminated or superseded by seperate proclamation, whichever shall occur first.

Done at the State Capitol, this
8th day of August 2023

SYLVIA LUKE,
Acting Governor of the State of Hawai'i

APPROVED:

Matthew S. Dvonch
Acting Attorney General, State of Hawai'i

5

FIRE-MAUICOUNTY-00020176

This page intentionally left blank.

APPENDIX

6.11 HI-EMA Administrator Timeline of Events

HI-EMA Administrator Timeline of Events August 4, 2023 through August 12, 2023	
August 4, 2023 13:00 041300AUG23	Tropical Cyclone Dora Statewide Coordination Meeting (Virtual) – NWS brief on high winds, possible red flag warning, and high surf.
August 7, 2023 03:15	National Weather Service (NWS) issues Red Flag Warning
August 7, 2023 09:00	The Adjutant General (TAG) Division Meeting – TAG initial guidance to Hawaii National Guard (HING): be prepared to (BPT) execute National Guard Civil Support (NGCS) operations due to possible impacts from Hurricane Dora and the High-pressure system north of the state (Pressure gradient). Anticipated missions: Aerial Fire Suppression, Security, Incident Awareness and Assessment, Emergency Evacuation. NWS forecasts high winds, fire weather, Red Flag Warning, and high surf, etc.). a. NWS issues Red Flag Warning b. MEMA issues warnings
August 8, 2023 06:38	Mayor Roth notifies Governor, MG Hara, etc. that 2 major fires are active. (Hawai'i County) Emergency Operations Center (EOC) is activated. Kohala Ranch is evacuated and may need helicopters.
	First notification of fire on Hawai'i Island
August 8, 2023 06:55	HING/J3 (Operations) texted TAG and Deputy Adjutant General (DAG) about Joint Operations Center (JOC) receiving a Request for Assistance (RFA) via WEBEOC for a fire bucket mission on the Big Island. Also informed TAG and DAG that Hawai'i Army National Guard (HIARNG) and State Army Aviation Officer (SAAO) were notified and prepared to respond as needed.
August 8, 2023 07:15	TAG called HING/J3 (COL Udani) about the 080655AUG23 text message. TAG directed placement of CH-47s on alert and discussed Commanders Critical Information Requirements. Planning priority for aerial suppression support to the Island of Hawai'i.
August 8, 2023 07:17	Texted info from Mayor Roth to J3 and DAG, ref: 080638AUG23 notification from Mayor Roth
August 8, 2023 07:20	HING/J3 confirmed TAG's text message above (080717AUG23) while informing TAG and DAG that aviation support would come from O'ahu (CH-47) and depending on the wind, it might not be able to fly. SAAO will have a better answer by 08:00. Provided a quick cost estimate of $13,000 just to deploy the aircraft (A/C) there and back.
August 8, 2023 07:21	Text Message from MG Hara to Governor, Lt. Governor, Chief of Staff (CofS), Makana, Luis Salaveria, Mayor Roth, and Dawn Chang. Subj: HING Staffing a mission for CH-47 and crew support to Hawaii County Maui Wildfire Timeline of Events 041300AUG23 to 121120AUG23
August 8, 2023 07:30	MG Hara departed Fort Ruger for 'Alohilani Resort Waikiki for Pacific Partnership Meeting Day 1; arrived at 07:45.
August 8, 2023 07:33	TAG inquired to HING DOJS and J3 about his previous guidance via text to HING/J3. "I gave guidance yesterday to anticipate RFA for wildfire support (water bucket, traffic control points [TCPs]). Was any staffing done prior to the Request for Assistance (RFA) received this morning?"
August 8, 2023 07:48	HING J3 sends the HING JOC the Initial Hawaii Water Bucket Support Concept of Operation (CONOP). HING JOC prepares cost estimates and monitors WebEOC for potential RFAs. HIARNG SAAO informs J Staff that helicopters are unable to launch due to wind speeds
August 8, 2023 07:51	HING J3 responded to TAG's text Request for Information (RFI) on 080733WAUG23 with: "Sir, Byron and I discussed possible response to brush fires and availability of resources but not TCPs."
August 8, 2023 08:00	HING JOC begins working on TCP CONOP and cost estimates for Hawaii County support. Submits Tasking T23080801 to HING J3 for review.
August 8, 2023 08:25	HING J3 issues verbal Warning Order to HIARNG G3 and HIANG DOS of potential TCP mission. Component commands begin contacting service members for availability.

continued

HI-EMA Administrator Timeline of Events August 4, 2023 through August 12, 2023	
August 8, 2023 08:31	TAG provided guidance via text with DAG and HING J3. "Check with HIEMA for current status of the fire and if Hawaii County needs the CH47. Need to know if Fire 1 can fly. We need to determine if we should stage on Hawaii Island. Also, need update for Maui fires. I think if only one fire on Hawaii needs support then we keep the second crew on standby."
August 8, 2023 08:50	HING JOC emailed HI-EMA Operations requesting current status of fires on Hawai'i and Maui. CSM Brandon Kumalae followed up with a phone call to HI-EMA Operations Branch Chief Matthew Wall.
August 8, 2023 08:52	HING/J3 responded to TAG's text RFI on 080831WAUG2023. "HIEMA is calling Hawai'i County for an update and they haven't received anything from Maui. I'll call MEMA direct"
August 8, 2023 09:00	Situation Update #1 received from HI-EMA Hurricane Dora is passing south of the state, bringing high winds, fire weather, and high surf to the state. The incident "2023-21 Counties Brushfires" is active in WebEOC

Hawai'i County

- Hawai'i Fire department reports two (2) brush fires:
- Maui Wildfire Timeline of Events 041300AUG23 to 121120AUG23
  - North Kohala: Off Akoni Pule Highway (Highway 270) near Kohala Ranch
    - All of Kohala Ranch being evacuated.
    - Open shelters at Hisaoka Gym and Waimea Community Center.
    - Approximate acreage burned unknown.
    - Containment unknown.
  - South Kohala: Near Lalamilo
    - No evacuations ordered at this time.
    - Open shelters at Hisaoka Gym and Waimea Community Center.
    - Approximate acreage burned unknown.
    - Containment unknown.

Maui County

- Maui Fire department reports two (2) brush fires:
  - Upper Kula: near Haleakalā Highway and Kula Highway
    - Evacuation orders issued for Kula 200 subdivision area off 'Auli'i Drive, Hanamu Road, Hoopalua Drive, 'Auli'iDrive.
    - Open shelters at Hannibal Tavares Community Center and King Kekaulike High School.
    - Approximately 675 acres burned.
    - Containment unknown.
  - Lahaina: in the area of Lahainaluna Road.
    - Evacuation order issued for the area surrounding Lahaina Intermediate School.
    - Open shelter at the Lahaina Civic Center
    - Approximate acreage burned unknown.
    - Containment unknown.

August 8, 2023 09:09	HING/J3 sent an email to Mr. Herman Andaya and cc'd HING JOC: "Good Morning Herman, We are currently working an RFA for Hawaii County regarding their ongoing fire(s) and I'm just reaching out to you for any update with your ongoing brush fire(s)." - No response was received at HING JOC.
August 8, 2023 09:10	H-IEMA Situation Update #1 sent out to Administrator Barros, Don Aweau, Matthew Hall, State Warning Point, and Jeff Wong – shared to me later by Administrator Barros at Pacific Partnership Meeting (PPM), received by JS at 081008AUG23.
August 8, 2023 09:16	Texted DAG and HING/J3 asking for any updates. J3 responded with "Sir, from Asst Fire Chief Okinaka: Their Hawai'i Fire Department (HFD) aircraft can't fly due to winds. Fire is at north boundary of Kohala ranch and may threaten homes on the south side. Their ground assets are there now. They have contacted Pōhakuloa Training Area (PTA) to see if their birds can fly yet."
August 8, 2023 09:22	THING J3 texted Herman Andaya. "Aloha Herman, This is COL Udani with the Hawai'i National Guard. Checking in with you for any updates on the current brush fire. We are working an RFA for Hawaii County's ongoing brush fire." Maui Wildfire Timeline of Events 041300AUG23 to 121120AUG23

continued

APPENDIX

HI-EMA Administrator Timeline of Events
August 4, 2023 through August 12, 2023

August 8, 2023 09:25	HING J3 texted TAG and DAG re: 080916AUG23 text "MG Hara – tracking going through HI-EMA first...we did Sir, and we are still waiting from them too...so we went direct
August 8, 2023 09:27	HING/J3 texted Herman Andaya. "Sorry, just found out you're at the Pacific Partnership Meeting." (J3)
August 8, 2023 09:30	Herman Andaya replied to HING/J3's text messages. "No worries. There are two (2) fires on Maui, Kula and Lahaina. Seems that Maui Fire Department (MFD) has a handle on Lahaina. Kula is a different story. Spoke to Gen Hara and he mentioned that Big Island is requesting assistance and if Maui needed State assistance. Spoke to Mayor and Chief and they indicated that they are able to fight this fire with the assets they have...for now. Thank you for asking. I'll keep you posted." J3 replied with "Mahalo Herman." [No other text messages between J3 and Andaya]
August 8, 2023 09:30	MG Hara directed administrator Barros to schedule a statewide coordination meeting at 11:00 with Acting Governor Lt. Gov. Sylvia Luke, Counties, FEMA, HING, and other Emergency Management stakeholders.
August 8, 2023 10:49	TAG informed Chief, National Guard Bureau (CNGB) via email: *"There are four fires, two on Hawaii Island and two on Maui. High winds from indirect impacts of Hurricane Dora, a high-pressure system north of the state, and dry conditions has the state in a Red Flag warning for the next few days.* *The fire in Kohala (north Hawaii) is threatening homes. The winds are prohibiting rotary wing startup and shut down - excess of 45 knots and poor visibility.* *Hawaii County requested Immediate Response Authority support from active duty Blackhawks at Pōhakuloa Training Area. Still not sure on the status of this request. I scheduled a coordination meeting at 11:00 HST and will have better situational awareness following.* *I also have a CH47 and crew (O'ahu) on standby for support."*
August 8, 2023 11:00	Statewide coordination meeting held virtually. Present at the 'Alohilani Resort were MG Hara, Administrator Barros, HI-EMA Executive Officer (XO) Don Aweau, FEMA Rep, MEMA Herman Andaya, KEMA Elton Ushio, American Red Cross (ARC) Diane Peters-Nguyen, and Defense Coordinating Officer (DCO) COL Brian Watkins.
August 8, 2023 12:00	The Maui News via AP reports a brush fire emitting heavy smoke in Maui's Upcountry region and at least 50 people sheltering at an emergency center. https://www.cnn.com/interactive/2023/08/hawaii-wildfires-timeline-maui-lahaina-dg/index.html Maui Wildfire Timeline of Events 041300AUG23 to 121120AUG23
August 8, 2023 13:00	MG Hara departed Pacific Partnership Meeting for Fort Ruger, Bldg. 306; arrived at 13:15 (ref: vehicle log).
August 8, 2023 13:00	Liaison Officer (LNO) established at Hawai'i County Civil Defense – MSgt Alexander Chai (291 CBCS). An email from Col Wrazien at 12:34 stated SM was "en-route to HCDA". Purpose: Coordinate HING response to wildfires in Hawaii County (helo fire bucket, pax for traffic control/security), daylight hours only, initiated in Technician status with State Active Duty (SAD) Request for Orders (RFO) following.
August 8, 2023 13:20	DJS, CoJS & J3 recalled to TAG Conference Room
August 8, 2023 13:45	HING Tasking T23080801 Brush Fire Support to Hawai'i County

WHO: HIARNG / HIANG
WHAT: Provide Support to Hawaii County Civil Defense Agency
WHERE: Hawai'i County, Kohala / Waimea
WHEN: 08 - 11 August 2023
WHY: to provide HING NGCS to Hawaii County's efforts in controlling ongoing brush fires.
COORDINATING INSTRUCTIONS:
1. Please acknowledge the JOC at jochi@hawaii.gov upon receipt of this message
2. DIRLAUTH WITH POC only when mobilized to support: Mr. Thomas Olson, 808-935-0031 or at thomas.oldson@hawaiicounty.gov
3. ADDITIONAL INSTRUCTIONS:

continued

HI-EMA Administrator Timeline of Events
August 4, 2023 through August 12, 2023

a. Current Situation
(1) Strong easterly gusts and low humidity have set the conditions for wild brush fires in dry areas of the state. Hawai'i County is currently experiencing two uncontrolled wildfires in the Kohala and Waimea areas.
(2) Hawaii County has entered an RFA for Aviation Support and could possibly request additional HING support as the situation develops.
b. HIARNG provide the following:
(1) Aviation support: On Order, provide Aircraft, Water Bucket(s), Aircrew (RFA 102239)
(2) Query personnel available on Hawai'i island to provide Law Enforcement Support (TCP) (RFA 102252).
(3) Query personnel available to augment the Joint Operations Center for Night Shift
(4) Populate and return Attachment 1 Wildfire Cost estimate to HING JOC, NLT COB 08 August 2023
c. HIANG Provide the following:
(1) Query personnel available on Hawaii island to provide Law Enforcement Support (TCP) (RFA 102252).
(2) Provide LNO to HCCDA
(3) Populate and return Attachment 1 Wildfire Cost estimate to HING JOC, NLT COB 08 August 2023

continued

APPENDIX

6.12 Lahaina Fire Staffing Matrix

Lahaina Fire Staffing Matrix

Assignment	Time in Service (Approximate)	Name(s)	Notes
Engine 1 (E1)	August 8, 2023 08:00 - August 8, 2023 17:00	Capt. Jay Fujita FFIII Christian "Kawika" Casco FFI Nathanael Ham FFI Rhys Buen	• E1 burned over at approximately 16:30 • E1 crew evacuates with E6 crew in PD SUV driven by Mosher (used Mini1 to get it)
Engine 1 (E1) in Mini1 (M1)	August 8, 2023 17:02 - August 9, 2023 09:00	Captain Jay Fujita FFIII Christian "Kawika" Casco FFI Nathanael Ham FFI Rhys Buen FFIII Tyler Pascual FFI Bryan Pali FFI Tanner Mosher	• E1 was destroyed and E6 broke down during LL burn over • Remaining E6 crew members Pascual, Pali, and Mosher move to recovered Mini1 with E1 members (crew of 7) • Pascual, Pali, and Mosher (E6 crew) move to a BC SUV at approximately 20:10 and resume the designator E6 • E1 crew remains in Mini1 using the designator E1 for the remainder of the incident
Relief Engine 1 (RE1)	August 8, 2023 14:30 - August 9, 2023 09:00	FFIII Matthew Mann* FFIII Bronson Pocock FFI Alakai Akana FFI Kainalu Cadman	
Wildland 3 (WL3)	August 8, 2023 06:30 - August 8, 2023 16:30	FFIII Dana Anderson (AM) FFI Matthew Wilburn (PM)	• WL3 Dana Anderson (B-Watch T3 operator) took WL3 in response to the AM Lahaina fire and staffed Relief Engine 3 (RE3) which responded to the Kula fire on 8/8. • WL3 was used to run district calls staffed by A-Watch personnel. • Matt Wilburn (E3 crew) drove WL3 to the second Lahaina fire. • 16:29 E3 crew abandons WL due to pole blocking egress near Ka'akolu Street. • WL3 was later found in the same location destroyed by fire.
Engine 3 (E3)	August 8, 2023 07:30 - August 8, 2023 20:00	Capt. Peter Gand FFI Aina Kohler FFI Matthew Wilburn (driving WL3) FFI Kapa Palakiko	• Crew swap after 20:00 at 'Ainakea and Kapunakea. Gand, Kohler, Wilburn, and Palakiko relieved by Azman's crew • They swap into a lifeguard utility and use designator E3A
Engine 3 (E3)	August 8, 2023 20:00 - August 9, 2023 07:30	Capt. Reza Azman FFIII Michah Palmerton FFI Richard Sato Capt. Chad Sambrano FFI Travis Texiera	• Azman (B-Watch) was on 1st Lahainaluna fire • At 20:00, Azman, Palmerton, Sato, and Sambrano report on callback and relieve E3 crew. Gand's crew transfers to lifeguard vehicle using designator E3A • Sambrano returns after leaving RE11 earlier for family matter • Sato returns after working assigned shift on August 7 - August 8 on L3B Watch
Engine 3 (E3)	August 8, 2023 20:00 - August 9, 2023 18:30	Capt. Peter Gand FFI Aina Kohler FFI Matthew Wilburn (WL3 Driver) FFI Kapa Palakiko	• 20:00 Azman's crew staffs E3 to give Gand's crew a break. Gand, Kohler, Wilburn, and Palakiko utilize a lifeguard vehicle and use designator E3A • E3A is assigned South division on August 9 06:33 • Assisted with evacs in E3A and Kohler's POV • Kohler leaves at shift change • Palakiko ends assists T3 on August 9 • Gand and Wilburn remain in lifeguard vehicle until August 9 18:00

A-Watch | ***B-Watch*** | ***C-Watch***
**Not Interviewed*

continued

Lahaina Fire Staffing Matrix

Assignment	Time in Service (Approximate)	Name(s)	Notes
Ladder 3 (L3)	August 7, 2023 07:30 - August 8, 2023 08:00	FFIII Aaron Kahaloa FFI Richard Sato FFI Kenny Puaa Capt. George Dagan*	• L3 B-Watch crew responded to first morning Lahainaluna fire. They were relieved on scene by oncoming A-Watch • Sato returns to staff E3 on August 8 20:00; Kahaloa and Puaa return to staff U3B on August 8 18:00; Puaa moves to U3 on August 8 18:40
Ladder 3 (L3)	August 8, 2023 07:30 - August 9, 2023 08:00	**FFIII Keahi Ho - Acting Officer (AO)** FFI Koa Bonnell FFI Chayce Tancayo FFI Justin Aubrey	• Captain Herrick (L3 A Watch Capt.) was on annual leave. He reported for duty at 14:00 and was assigned to U3B • Ho was AO of L3 • L3 A-Watch relieved L3 B-Watch on scene of first Lahainaluna fire • Early AM on August 9, L3 driver shuttled water to L3 firefighters attacking fire above Civic Center
Ladder 3 (L3)	August 9, 2023 07:30 - August 10, 2023 07:30	Capt. Matthew Akiona FFIII Jonathon Duncan FFI Ryan Dickson FFI Aaron Griffith FFI Jonathan Varona	• Akiona staffed RE14 at approximately 17:00 on August 8 • Griffith staffed U3B/U3 on August 8 • Jonathan Varona went to FS3 with his children on August 8 but was not involved in the incident until August 9. His wife (Aina Kohler E3/E3A) was already working the incident as E3 driver. • August 9: All were on regular duty day
Tanker 3 (T3)	August 8, 2023 07:00 - August 9, 2023 17:30	**FFIII Cody Cordeiro** FFIII Dana Anderson*	• Cordeiro is part of a Wildland Cadre and received texts about Olinda Fire and reported to work early • He is A-Watch T3 driver • He relieved B-Watch driver Dana Anderson on scene at approximately 07:00 • Cordeiro responded to both Lahainaluna fires on T3
Tanker 3 (T3)	August 9, 2023 17:30 - August 10, 2023 19:30	**FFIII Cody Cordeiro** FFI Chad Tokunaga	• Tokunaga moved to T3 on August 9 to relieve Cordeiro
Utility 3 (U3)	August 8, 2023 18:00 - August 9, 2023 09:00	**Capt. Mike Howe** FFI Aaron Griffith (moves from U3B) FFI Kenneth Puaa (moves from U3B)	• Capt. Howe was delivering SCBA bottles and water to field personnel, riding alone initially • At approximately 18:40 on August 8, U3 meets up with U3B and Griffith and Puaa transfer to U3
Utility 3B (U3B)	August 8, 2023 18:00 - August 9, 2023 09:00	**Capt. Tim Herrick** FFIII Aaron Kahaloa FFI Aaron Griffith (moves to U3) FFI Kaikane Beam FFI Kenneth Puaa (moves to U3) FFI Peter Kaina	• Herrick calls crew members and they respond at approximately 18:30 on August 8 • Griffith and Puaa move over to U3 at approximately 18:40 to assist Capt. Howe, who was riding alone • **U3B was assigned Support Group on August 8 at 20:56; reinstated as Support Group on August 9 at 00:35; and assigned North Division on August 9 at 05:35**
Utility 5 (U5)	August 8, 2023 18:00 - August 9, 2023 07:00	**Capt. Alma Aiwohi** FFIII Dane Pacheco FFI Ross Bisera FFI Connor Kihune FFII Eli Ferreira (moves to RE14)	• August 8: Aiwohi worked on E14 at the Olinda Fire. Went home. Returned to duty at approximately 17:30 • **On August 8 at 20:43, U5 was assigned Structure Group**

A-Watch | ***B-Watch*** | ***C-Watch***
**Not Interviewed*

continued

APPENDIX

Lahaina Fire Staffing Matrix

Assignment	Time in Service (Approximate)	Name(s)	Notes
Utility 5 (U5)	August 9, 2023 07:00 - August 9, 2023 17:00	Capt. George Dagan* FFIII Nikolai Reuss FFI Shaun Walsh FFI Wangdu Hovey FFI Keoki Nakoa (moves to Mini 1 on August 9)	• Worked on E10 at the Olina Fire on August 8 • Released from duty on August 9 at 08:00 but stayed to staff U5 • At 17:00 (approaching 36 hours), relieved by Aiwohi and crew
Engine 6 (E6)	August 8, 2023 06:35 - August 8, 2023 07:45	Capt. Garren Oura FFIII Ian Pascua FFI Rocky Keawekane FFI James Case Capt. Mike Mullalley	• E6 was dispatched to first Lahainaluna fire. Capt. Mike Mullalley jumps on E6 early with on duty B-Watch crew (5-member engine). Crew was relieved on scene by oncoming A-Watch shift • After a break, B-Watch Oura, Pascua, and Keawekane return on August 8 at 18:00 to staff RE11
Engine 6 (E6)	August 8, 2023 07:00 - August 8, 2023 16:30	Capt. Mike Mullalley FFIII Tyler Pascual FFI Bryan Pali FFI Tanner Mosher (driving WL6)	• E6 is assigned South Division on August 8 15:56 • E6 experiences burn over with Engine 1 at approximately 16:30. Mayday called at 17:02 for Mullalley. Mosher rescues Engine 1 and Engine 6 crew using Mini 1 and an MPD SUV • WL6 was abandoned when a pole came down on it at 16:29 in Lahainaluna neighborhood • E1 and E6 crew remain in Mini 1 using the designator E1 until 19:00 • E6 crew separate from E1 crew at 19:00 and resume E6 designator in BC SUV. Mini 1 remains E1.
Engine 6 (E6) in BC Vehicle	August 8, 2023 19:00 - August 9, 2023 07:30	FFIII Tyler Pascual FFI Bryan Pali FFI Tanner Mosher	• Remaining E6 crew are reassigned to the BC vehicle driven to, and left at Safeway, by Pagdilao and Lawson. They separate from E1/Mini 1 and designate the SUV as E6 with a crew of 3 around 19:00
Wildland 6 (WL6)	August 8, 2023 06:50 - August 8 12:30	FFI Tanner Mosher (Driving WL6)	• WL6 was abandoned when a pole came down on it at 16:29 in Lahainaluna neighborhood
Engine 11 (E11)	August 8, 2023 07:00 - August 9, 2023 07:00	Capt. Joseph "Ikaika" Blackburn FFIII Tyler Perdido FFI Jordan Dunn FFI Kainalu Kealoha FFI Kaaukai Rowland (moves to RE11) FFI Tashsa Pagdilao FFI Nicholas Lawson	• A-Watch crew coming on duty saw E11 responding to fire. Crew takes RE11 and Mini 11 and swaps with crew on scene. Off-going B-Watch returns RE11 to the station • Rowland moves to RE11 at 14:30 to relieve Sambrano • Pagdilao and Lawson drive BC vehicle to Safeway and add to E11 crew at approximately 17:30
Relief Engine 11 (RE11)	August 8, 2023 08:00 - August 8, 2023 18:00	Capt. Chad Sambrano (leaves at 14:30) FFIII Steven Graver (AO) FFI Robert "Bubba" Kukahiko FFI Dane Rogers FFT Ka'aukai Rowland (moves from E11)	• E11 crew was coming on duty, went to relieve B-Watch in RE11 on scene crews swap apparatus • Sambrano, Graver, Kukahiko, and Rowland (A-Shift detail) take RE11 • At around 14:30 Sambrano leaves for family matter and Graver becomes AO • Graver, Kukahiko, and Rogers are relieved at 18:00 at Emerald Plaza because they were at 36 hours
Relief Engine 11 (RE11)	August 8, 2023 18:00 - August 9, 2023 07:00	Capt. Garren Oura FFIII Ian Pascua FFI Rocky Keawekane FFT Ka'aukai Rowland FFI Cory Palmeira	

A-Watch | *B-Watch* | *C-Watch*
**Not Interviewed*

continued

Lahaina Fire Staffing Matrix

Assignment	Time in Service (Approximate)	Name(s)	Notes
Relief Engine 14 (RE14)	August 8, 2023 17:00 - August 9, 2023 17:00	Capt. Kanoa Shannon FFIII Ryan Watanabe FFIII Dennis Swain Capt. Matthew Akiona	• Akiona moves to L3 at 07:00 on August 9 to be with own crew • Ferreira moved from upstaffed U5

APPENDIX

6.13 Fire Progression Map Data

Fire Progression Map Data

Lat/Long	Date	Time	Unit	Description	Source
20.883860364738297, -156.66401638910472	8/8/23	14:55		Numerous callers. At the end of the cul-de-sac of Ku'ialua. Caller said the fire was spreading fast.	Event Chronology Report
20.884342048197535, -156.66255405110235	8/8/23	14:58		Driver approaches the area of fire origin from the east on Lahainaluna Road. Smoke seen traveling from the ravine, west, behind 5[redacted] Ho'okahua Street.	Civilian Video
20.884018250679546, -156.6641491651476	8/8/23	15:00	E11	E11: E11 on scene, right now we have approximately 20 by 100 on the north flank near the houses. We will be pulling an attack line and extinguishing this flank heading west down toward the bypass.	Dispatch Audio FD1
20.883570, -156.665079	8/8/23	15:05		Fire next to shed at 7[redacted] Ho'okahua Street	MPD Body Cam
20.884764726305747, -156.66303488332733	8/8/23	15:06		Smoke moving from east of 8[redacted] Ho'okahua Street toward the west	Civilian Video
20.883570, -156.665079	8/8/23	15:06	4B30	Shed on fire at 7[redacted] Ho'okahua Street	MPD Audio
20.883653670823666, -156.66518042894995	8/8/23	15:12	RE11	Command to RE11: The plan is you guys come up Lahainalua and go to 7[redacted] Ho'okahua, there is a shed that some police have some water city lines on it now, I need you to address that as soon as you get here.	Dispatch Audio FD2
20.88171683655705, -156.6655354659209	8/8/23	15:20	RE11	Civilian video from a distance (1[redacted] Shaw Street) showing grass fire in the area of the bypass, south of Lahainaluna Rd.	Civilian Video
20.88482811612651, -156.66213942050342	8/8/23	15:20	T3	T3: We are on the top and it is backing up kind of like where you are passing right now. It's in this ravine and the fire is on the other side, the redline can't get to that side of it but it's backing slowly up that hill.	Dispatch Audio FD2
20.882754073783563, -156.66598470756716	8/8/23	15:21	E11	E11 to Command: E11 to Dispatch: Have PD shut down the overpass, to Lahainaluna Road, it's jumped the road and headed toward the cars. E11 to Dispatch: The fires hit the road. E11 to Command: The fire has jumped the road, it is now over to the bypass, heading toward Lahainaluna Road, heading west, west toward the shore	Dispatch Audio FD2
20.883042271353748, -156.6681083363771	8/8/23	15:23	L3	Command to L3: Can you come back to mauka Park, the fire has jumped over Lahainaluna and burned right up to the cars in this park area, I need you to address this grassy area ASAP.	Dispatch Audio FD2
20.882709, -156.669819	8/8/23	15:24	4B30	We're at Ka'akolu making checks and the back of the house is burning	MPD Audio
20.883498, -156.666688	8/8/23	15:25	418	Visibility right at the overpass of the bypass is about 5 feet at this point.	MPD Audio
20.88155139708477, -156.67035060362676	8/8/23	15:28	L3	L3 to Command: We got a structure involved at the bottom of that fire at the top of Dickenson Street of the side of Lahainaluna here.	Dispatch Audio FD2
20.881678870182043, -156.6702497609155	8/8/23	15:29	RE11	RE11 to Command: Priority traffic, we've got a structure with the roof involved, on the corner of the top houses and another structure that is potentially involved, we have a hydrant and are right behind L3, we're stretching lines.	Dispatch Audio FD2

continued

Fire Progression Map Data

Lat/Long	Date	Time	Unit	Description	Source
20.882476960173356, -156.66991757317015	8/8/23	15:31	RE11	RE11 to Command: We have possible involvement up Ka'akolu Street. on the back side of Lahainaluna Road.	Dispatch Audio FD2
20.881400723861002, -156.67075433899385	8/8/23	15:34	E11, L3	Dispatch to Command: We've got someone trapped at 5[redacted] Lahainaluna Road, an 88 year old male that is handicapped. Command to E11: Can you address that? E11: Copy 5[redacted] Lahainaluna, L3 pull up a little so we can get past you.	Dispatch Audio FD2
20.881645292831827, -156.67048778906138	8/8/23	15:35	L3, E11	L3: We can use another unit here, we have E11 behind us, we are trying to secure a water supply, we have one structure to the left of us that's gone and we have another one to the right with suspected 2 people inside.	Dispatch Audio FD2
20.881894335216835, -156.67062984261847	8/8/23	15:35	L3, E3	L3 to Command: 5[redacted] Lahainaluna Road, the 2-story house in front of E3, E3 will be alpha side accountability.	Dispatch Audio FD2
20.882650867032638, -156.66967775726312	8/8/23	15:37	RE11, E3	Command: There is one house on Lahainaluna that is fully going now. We need to stop it where you are, that has to be the cutoff there, that road back there RE11: Copy that Chief, I did move positions, we took that road Ka'akolu and took a right into a cul-de-sac and we have some houses threatened on the backside, we are stretching attack lines. Command to Dispatch: I am going to need medics up here. E3 to Command: We got a structure fire at 5[redacted] Ka'akolu, we are going to need an engine company over here, all we have is our wildland. Command: Copy, is that on the corner there. E3: It's up from the corner, just behind the park, it might be multiple structures, right now we have 5[redacted] Ka'akolu that we are going to lose. Command: Yea, there are multiple structures going.	Dispatch Audio FD2
20.879885, -156.671546	8/8/23	15:38		4[redacted] Pā'ū'ū Place, Fire right by their house	MPD Event Chronology
20.879483, -156.671673	8/8/23	15:39		44[redacted] Pā'ū'ū Place, Shed on fire	MPD Event Chronology
20.877437912029897, -156.6773923954953	8/8/23	15:39		Video shot from the corner of Lahainaluna Road and Honopiilani Hwy showing the smoke moving past the Smokestack and makai.	Civilian Video
20.881787, -156.673198	8/8/23	15:40	419	Fire in the brush at the end of Kauhi St, near 4[redacted] Kauhi St near the residence	MPD Audio
20.883596, -156.668297	8/8/23	15:41	419	Palm tree on fire next to 6[redacted] Kaalo Pl and behind Kelawea Mauka Makai Park	Civilian Photo
20.8812484952052, -156.67113127094348	8/8/23	15:41	L3	Command to L3: You have to move further down Lahainaluna, there are houses 3-4 down from you that are lighting up.	Dispatch Audio FD2
20.878215574859116, -156.67334282927422	8/8/23	15:48		4[redacted] Pauwala, her yard is on fire	Dispatch Audio FD2
20.881318, -156.670632	8/8/23	15:50	4B10	That address at 5[redacted] the visibility is zero and fire is blocking the way there.	MPD Audio
20.874887, -156.678253	8/8/23	15:56		Fire approaching north of harbor, edge of smoke plume	Civilian Video

continued

APPENDIX

Fire Progression Map Data

Lat/Long	Date	Time	Unit	Description	Source
20.878769, -156.675142	8/8/23	15:56	S40	Right by the transformer place, fire starting	MPD Audio
20.878777799855573, -156.67535938852657	8/8/23	15:57		Another caller saying fire is starting up on Lahainaluna near Kuhua	MPD Event Chronology
20.883598274605774, -156.67219304807804	8/8/23	15:58		8[redacted] Lu'i Street fully engulfed--doesn't believe anyone is there	MPD Event Chronology
20.877777, -156.675987	8/8/23	16:02	T22	The fires jumped right here at Robertsons, bypass side of Mill	MPD Audio
20.883489501444217, -156.6685644596109	8/8/23	16:04	None	County Water Works truck on fire	Event Chronology Report
20.88127417467844, -156.67163558891232	8/8/23	16:04		Central to Command: They are evacuating Hale Mahaolu now, we have a vehicle fire, one of the county water trucks by Kelawea and an elderly female trapped at 3[redacted] Pauwala Place.	Dispatch Audio FD2
20.8831648274424, -156.67410474872977	8/8/23	16:06		Edge of smoke plume traveling over this location, 3[redacted] Komo Mai Street.	Civilian Video
20.883443, -156.667992	8/8/23	16:07		Video shot from Lahainaluna Rd, over 7[redacted] Ku'ialua St and toward the smokestack, showing thick black smoke moving west/northwest toward the ocean	Civilian Video
20.882609, -156.676047	8/8/23	16:07	VOP8	We need to push traffic out Komo Mai, the flames are coming out.	MPD Audio
20.881130, -156.671808	8/8/23	16:08	419	Most Hale Mahaolu has been evacuated, fires right there.	MPD Audio
20.8785895818247, -156.67435628711166	8/8/23	16:08	E6, RE1	E6 from RE1: Your location, we are coming up Lahainaluna, heavy smoke. E6: On Pauoa, were protection the structures impacting the electrical transformer station, if you can get around us you can effect the structures that are in front of us, if you can't you will have to work off our engine, let me know.	Dispatch Audio FD2
20.876199, -156.674978	8/8/23	16:09	401	It looks like the fire is reaching Mill St.	MPD Audio
20.876465196357778, -156.67526833101027	8/8/23	16:09		Smoke plume along ground running just to the north of the Aloha Gas Station property	Civilian Video
20.877996, -156.675716	8/8/23	16:13	T22	The fire is in the the food truck area, Real Mexican Grindz	MPD Audio
20.877062, -156.676570	8/8/23	16:14	4SA2	Fire in the median on the highway between Lahainaluna and Dickenson.	MPD Audio
20.877427, -156.677015	8/8/23	16:15	4SA2	I'm about to leave Lahainaluna and the highway, I can't do it anymore.	MPD Audio
20.877511, -156.676929	8/8/23	16:17	415	The fire jumped the highway at Lahainaluna	MPD Audio
20.877217, -156.677294	8/8/23	16:19	4SA2	We got another fire right by the 76	MPD Audio
20.881869118763078, -156.68142530551302	8/8/23	16:21	None	Behind the apartment complex. Grass in the backyard on fire.	Event Chronology Report
20.877045, -156.677325	8/8/23	16:22	T22	The fire is on the town side of Lahainaluna that grass field makai side of 76.	MPD Audio

continued

Fire Progression Map Data

Lat/Long	Date	Time	Unit	Description	Source
20.878221636177663, -156.67408569410333	8/8/23	16:22	E3, E11, WL6	Command from SD: We are stuck on Pauoa off of Lahainaluna and can't get out, and there are residents right in the path of the fire.	Dispatch Audio FD2
20.880248956493183, -156.67937504261303	8/8/23	16:22		Command from Central: I know there are no units, we are getting reports of the sugar cane train off of the Mohana on fire with propane tanks, they are trying to evacuate.	Dispatch Audio FD2
20.871886342672596, -156.67767068800987	8/8/23	16:24		By the big banyan tree is on fire	MPD Event Chronology
20.877065, -156.675570	8/8/23	16:24	401	We might have 1 fatality, homes rear of Mill St.	MPD Audio
20.881000968310072, -156.67592328701204	8/8/23	16:25		Behind 3[redacted] house on Aki St on fire	MPD Event Chronology
20.876558, -156.678114	8/8/23	16:26	415	We've got poles on fire, houses catching all of Waine'e	MPD Audio
20.87515102776966, -156.67953659746044	8/8/23	16:31		Parking lot behind the Lahaina inn -- off Lahainaluna Road near Front Street, brush on fire near the building	MPD Event Chronology
20.882944605010696, -156.67025994990962	8/8/23	16:32		Multiple houses on fire on Kaakepa Street, from the vantage point of 8[redacted] Kanua Street.	Civilian Video
20.88179091952925, -156.6813416518505	8/8/23	16:34		Another caller..saying fire in backyard of Kenui	MPD Event Chronology
20.88179091952925, -156.6813416518505	8/8/23	16:35		This caller saying 1[redacted] Kenui ...backyard on fire at 1[redacted] Kenui	MPD Event Chronology
20.874891, -156.676765	8/8/23	16:36	415	Wainee's on fire, engulfed next to [Maria] kila Church	MPD Audio
20.88015135530013, -156.68022940747042	8/8/23	16:36		10[redacted] Wainee Street / pavillion in the middle of property on fire	MPD Event Chronology
20.873289, -156.673983	8/8/23	16:37	4SA2	I need help at Weinberg Apartments for female with burns to her body	MPD Audio
20.881866267738683, -156.68151727364162	8/8/23	16:42	None	Trees of fire. Building is on fire. Evacuating the building. Fully engulfed. Hale Ohana Apartments and Kenui, fully engulfed. Hale Ohana Apartments and Kenui, fully engaged.	Event Chronology Report
20.884329665692302, -156.68006087218765	8/8/23	16:42	RE11	Command from RE11: We fell out and we are at Foodland Farms, the new Komo Mai Hokohoma subdivision, that I think is unpassable, multiple structure fires involved, that subdivision is lost for the most part.	Dispatch Audio FD2
20.883883598224852, -156.67504514135229	8/8/23	16:42	E11	E11 from Command: Come up to Tamuras, there is a vacant lot that is on fire, I need you to hit that before it gets into some of these warehouses.	Dispatch Audio FD2
20.881590529049777, -156.67860794538817	8/8/23	16:43	E11	Showing to the water flow 2 activations. 9[redacted] Honoapi'ilani	Event Chronology Report
20.881897, -156.681800	8/8/23	16:44	499	Hale Ohana Apartments, below the highway and Kenui Street is fully engulfed.	MPD Audio
20.87994265941814, -156.6818481895669	8/8/23	16:46		16:46 House fully engulfed. 1[redacted] Baker Street at Hale Mahaolu	Event Chronology Report

continued

APPENDIX

Fire Progression Map Data

Lat/Long	Date	Time	Unit	Description	Source
20.88327632706056, -156.66857850184186	8/8/23	16:46		6[redacted] Kaalo Place on fire	MPD Body Cam
20.882966860425213, -156.68038546073106	8/8/23	16:49	RE11	RE11 from Command: Are you by Opukea? That's a good spot. RE11: Negative, I'm at...across from Kahoma Stream, I've got a view of Opukea. It's being impacted on the cars on the outside extending to the building, it needs to get evacuated.	Dispatch Audio FD2
20.882079, -156.681481	8/8/23	16:52	4Z20	Fire looks like it jumped riverside, and it's headed toward the apartment building behind Taco Bell	MPD Audio
20.874551203877946, -156.67554834908873	8/8/23	16:53		Advised large fire, 6[redacted] Waine'e @ Aina Nalu	Event Chronology Report
20.881223, -156.681126	8/8/23	16:53	S40	The Hale Ohana Apartments right off the highway is engulfed in flames, it's about to jump over to the Lahaina Apartments across the street.	MPD Audio
20.869371, -156.668955	8/8/23	16:58	UKN	The fire's coming by the homeless shelter, I'm trying to clear this out.	MPD Audio
20.87818151046653, -156.682016193533	8/8/23	16:59		9[redacted] Front Street on fire--elderly female within	MPD Event Chronology
20.883383204572592, -156.66907340516693	8/8/23	17:09		Multiple houses and cars on fire in the area of Kanua Street and Kaalo Place spreading west.	Civilian Video
20.885489, -156.684347	8/8/23	17:10	4A30	It's getting close to the Cannery Mall, the fire.	MPD Audio
20.87812113442809, -156.6819806453883	8/8/23	17:11	None	House on fire. Everyone is out of the house, 9[redacted] Front & 9[redacted] Front	Event Chronology Report
20.873751, -156.677617	8/8/23	17:11	415	Kobe's is on fire, all of this Waine'e	MPD Audio
20.88299376812532, -156.68605484515462	8/8/23	17:12	None	Palm trees on fire in the area, [redacted] Ala Moana (in the area)	Event Chronology Report
20.885200, -156.686909	8/8/23	17:15	4B31	Māla Wharf's on fire.	MPD Audio
20.884157, -156.678222	8/8/23	17:21	4SA2	The Island Grocery Depot, the very rear of it's starting to catch on fire and it's spreading toward Minit Stop gas station. And there's a 1[redacted] Kupuohi St. truck fully engulfed.	MPD Audio
20.885502, -156.684221	8/8/23	17:24	4A30	It's starting to spread through Cannery Mall.	MPD Audio
20.8762289149416, -156.68071977404833	8/8/23	17:25	None	Sprinkler water flow RP pending, 8[redacted] Front St Unit[redacted]	Event Chronology Report
20.885100, -156.662253	8/8/23	17:26	VOP8	Flare up, 10x10 right across from the middle school, If fire can contain this, it won't jump over. If not it's just gonna take down the whole school.	MPD Audio
20.883498, -156.677386	8/8/23	17:30	4K14	I'm evacuating people out of Emerald Plaza. We have a couple structures on fire and vehicles up here as well.	MPD Audio
20.882405762598335, -156.68199129090485	8/8/23	17:31	E11, T3	E11: Copy, we have a structure fire in Kahoma Village, 1 single structure, roof is involved. Command: Copy is that the apartments in there, are they sprinklered? E11: It's a residence on the Kenui Street side, T3 has to go get water, we just need somebody to put some water on it.	Dispatch Audio FD2

continued

Fire Progression Map Data

Lat/Long	Date	Time	Unit	Description	Source
20.884298, -156.668485	8/8/23	17:34		Homes on fire in the area of 6[redacted] Ka'akolu Street. Water Tender flowing water to save 6[redacted] Ka'akolu and surrounding structures	Civilian Video
20.875791, -156.675379	8/8/23	17:34	418	The fire looks like it is jumping right at Dickenson and the highway. It is headed Southbound. We need to bleed traffic out.	MPD Audio
20.881128, -156.682236	8/8/23	17:35	4A30	The Front Street Apartments starting to catch fire. I am trying to evacuate everyone nearby.	MPD Audio
20.881356531686055, -156.68671603222438	8/8/23	17:38		Fire at Pu'unoa Baby beach	MPD Event Chronology
20.881094, -156.682343	8/8/23	17:39	T34	Multiple Units in Front St Apartments are fully engulfed.	MPD Audio
20.882607, -156.682403	8/8/23	17:39	T34	Kahoma Village has a couple homes on fire too. I'll go there.	MPD Audio
20.881346, -156.686688	8/8/23	17:40	Central	A fire's starting at Baby Beach	MPD Audio
20.881449428696296, -156.68200152398117t	8/8/23	17:40		Dispatch to Command: Front Street apartment fully engulfed, Kahoma Village, I know they are working on that and a fire starting at Baby Beach.	Dispatch Audio FD2
20.882057184786756, -156.6874853268697	8/8/23	17:40		Dispatch to Command: Front Street apartment fully engulfed, Kahoma Village, I know they are working on that and a fire starting at Baby Beach.	Dispatch Audio FD2
20.882413184183413, -156.68198781652774	8/8/23	17:41		Roof of a house on fire at Kahoma Village Loop, house back to Kenui Street, 2 in from the corner with the highway.	MPD Body Cam
20.882427, -156.682522	8/8/23	17:41	T34	I got a couple units, uh fully engulfed on Kahoma Village. Right next to Hale Place.	MPD Audio
20.884076, -156.675568	8/8/23	17:41	4SA2	I got a vehicle fully engulfed in the parking lot of 1[redacted] Kupuohi Street.	MPD Audio
20.883218, -156.685320	8/8/23	17:42	UKN	We have a home on Front and Ala Moana Fully engulfed.	MPD Audio
20.882922, -156.682603	8/8/23	17:43	4B10	Kahoma Village has definitely been evacuated. Visibility is getting poor so we're getting out.	MPD Audio
20.877308779158295, -156.68048387700108	8/8/23	17:44		Post office on fire, Outlets of Maui on fire, cars too.	MPD Event Chronology
20.872662, -156.677738	8/8/23	17:44	418	Stop directing traffic down Front Street it's on fire all the way down to Market Street, Baldwin House is on fire there, It's not passable.	
20.87362870989807, -156.67768493333605	8/8/23	17:46	418	Dispatch from Command: Command we have Baldwin House on fire and the outlets.	Dispatch Audio FD2
20.869172, -156.671240	8/8/23	17:47	415	Lahaina Pool and across the street and Lahaina Aquatics [Center] are catching fire.	MPD Audio
20.869639365949354, -156.6745515867243	8/8/23	17:52		Video shot from 1[redacted] Shaw Street of a spot fire (tree on fire) in the Malu 'Ulu o Lele Park.	Civilian Video
20.868368, -156.673769	8/8/23	17:54	415	Just double checking fire's aware of this. We're engulfed from Honoapi'ilani down to Front Street by Shaw Street. Both sides.	MPD Audio
20.881431, -156.684687	8/8/23	17:55	4A20	By the Cannery headed Southbound, You cannot go that way, the fire blocks off at Kenui.	MPD Audio

continued

APPENDIX

Fire Progression Map Data

Lat/Long	Date	Time	Unit	Description	Source
20.880985, -156.684551	8/8/23	17:58	T34	There's also a structure fire at Kai Pali and Front Street.	MPD Audio
20.881039, -156.684467	8/8/23	17:59	4A20	Anybody on Front Street and Kenui? There's multiple buildings fully engulfed, stay out of that area.	MPD Audio
20.871862, -156.674366	8/8/23	18:00		Fire progressing from Waine'e to Front Street. along Prison Street. Also shows edge of fire plume.	Civilian Video
20.882420, -156.681696	8/8/23	18:01	T34	The house, in the corner, Kahoma Village, by Taco Bell is on fire, fully engulfed.	MPD Audio
20.884730, -156.684084	8/8/23	18:02	4A20	Fire is encroaching on the Cannery. The grass on side of the Cannery is starting to burn and move into it.	MPD Audio
20.88445863207333, -156.674919732332	8/8/23	18:05		Spot fire by road near 2[redacted] Kupuohi St., additional fires to the rear of the structure and adjacent to the Kahoma Stream.	Civilian Photo
20.882937118288858, -156.68175120471196	8/8/23	18:10		Spot fires on both side of the highway in the grass and trees. 1[redacted] Limahana Place on fire.	Civilian Video
20.881796923405787, -156.68230896593153	8/8/23	18:12		Several buildings in the Front Street Apartments on fire, House fire in area of Kenui and Front Street.	Civilian Video
20.883803, -156.672884	8/8/23	18:14		Entire Street of Komo Mai involved with structure fires. Additional structures on fire off in a distance all the way to the ocean. Strong winds in the area of the bypass and Keawe Street.	Civilian Video
20.8845200747805, -156.67250143776104	8/8/23	18:18		Houses at top of Komo Mai fully involved in fire.	Civilian Photo
20.880865155997324, -156.6843476415273	8/8/23	18:18		Houses at the intersection of Front Street. and Kai Pali Pl on fire ([redacted] Kai Pali Place.) Also Front Street Apartments on fire. Intersection is just out of the smoke plume.	Civilian Video
20.88384610176639, -156.6756599269747	8/8/23	18:18		Materials and vehicles on fire between 1[redacted] and 1[redacted] Kupuohi Street.	Civilian Photo
20.88474585534066, -156.67354183715415	8/8/23	18:18	RE1	Command: RE1 come over by Tamuras, those new apartment buildings, there is fire getting close to it, take a look at that. RE1, copy Tamuras, checking on fire. Command: New apartment building on top of Tamuras, I can't tell if the fire is on the other side of the stream or not.	Dispatch Audio FD2
20.860353415125513, -156.6687218720292	8/8/23	18:28		Video from Pualei Drive and Puailima Place showing dense smoke north of that location moving east to west.	Civilian Video
20.868632, -156.674248	8/8/23	18:47		1[redacted] Shaw well involved in fire. Structure on fire Just north of Shaw and Front Street.	Civilian Video
20.882937, -156.681694	8/8/23	18:48	T34	The fire is gonna jump the highway from Opukea onto the other side down the roadway.	MPD Audio
20.88682026715046, -156.67679027686208	8/8/23	18:57		Wind shifted the plume overtop of the complex, Ulupono Street. and the Church.	Civilian Video
20.867989, -156.675079	8/8/23	19:00	4B10	Shaw and Front to Māla and Front is all engulfed in flames. You can't see, so don't drive down there.	MPD Audio
20.884496019640324, -156.67899893480282	8/8/23	19:00		Spot fire in the trees along Oil Road, behind 4[redacted] Kupuohi Street.	Civilian Video

continued

Fire Progression Map Data

Lat/Long	Date	Time	Unit	Description	Source
20.883953388636105, -156.67312629437004	8/8/23	19:09		Houses along Komo Mai on fire across from Kaiaulu Apartment building.	Civilian Video
20.868944, -156.671235	8/8/23	19:10	4B10	This fire is about to jump into Lahaina Rec Center.	MPD Audio
20.867670, -156.674904	8/8/23	19:11	6B40	There's zero visibility by the Front 505 Shops [Shops at 505] .	MPD Audio
20.865968, -156.673639	8/8/23	19:14	6B40	400 Block of Front Street, you can not come down Shaw. You cannot see anymore.	MPD Audio
20.883391, -156.681818	8/8/23	19:20	4K15	Just advising the highway between Keawe and at least Hinau is unpassable. There's flames and wires down.	MPD Audio
20.883383924434256, -156.67768305004944	8/8/23	19:23	E11, RE1	E11 to Command: RE1 is trying to do a quick hit on that Emerald Plaza commercial right now with no effect, you want us to stand by at Island Grocery, it is protected by a masonry fire wall, we can standby here with a hydrant or do you have another assignment for us?	Dispatch Audio FD2
20.885183179860835, -156.6634673157302	8/8/23	19:26		Embers and spot fires right in front of this location, line of fire off in a distance all along the highway south of Lahainaluna to Puamana.	Civilian Video
20.868979, -156.671737	8/8/23	19:38	4Z20	The fire went jump over from Shaw Street into the neighborhood across the highway, first house is up in flames.	MPD Audio
20.881591, -156.684306	8/8/23	19:42	T34	Fire also jumped Kenui Street now onto Kahoma Village now.	MPD Audio
20.884246, -156.664368	8/8/23	19:48	4SA2	Ku'ialua had another flare up and I am transporting once (1) female to the Civic Center	MPD Audio
20.883241, -156.685288	8/8/23	19:49	T34	I am going to close down Front Street southbound from Ala Moana, there's multiple houses on fire and there's propane tanks in the area. Fire went into to check	MPD Audio
20.882903, -156.685262	8/8/23	19:51	T34	The back of 11[redacted] Front Street is on fire, coming from Māla Wharf, guess it jumped Ala Moana from the back.	MPD Audio
20.888063578148735, -156.6730001488292	8/8/23	19:57	T3, E3	T3 from E3: If you couldn't make access, reposition to the bypass and when it burns up there you can knock it down there.	Dispatch Audio FD2
20.885316, -156.678594	8/8/23	20:00	S40	Brush fire started right at the bottom by the bypass right by Minit Stop, visibility is pretty bad, Fire is right on it now.	MPD Audio
20.888822724205045, -156.67560508767806	8/8/23	20:01	RE14	Command from Central: Medics are saying, fire Keawe and the bypass, moving quickly toward structures. Command from RE14: We are coming Olowalu, do you have an assignment for us? Command: Confirm with Dispatch and check in that area. Dispatch to RE14: Keawe and the bypass.	Dispatch Audio FD2
20.888204, -156.675743	8/8/23	20:01	4B30	Fire is slowly creeping towards Wahikuli, we might have to start evacuating that neighborhood.	MPD Audio
20.883198, -156.685291	8/8/23	20:05	T34	I'm at Front and Ala Moana, everything's blocked. Southbound behind me. There's multiple fires, no visibility.	MPD Audio

continued

APPENDIX

Fire Progression Map Data

Lat/Long	Date	Time	Unit	Description	Source
20.889101821054805, -156.67409948082047	8/8/23	20:06	E3, RE14, RE11	Command from E3: This last brush fire has jumped the bypass and its above Wahikuli and is headed north Command: RE14 and RE11 head to that. RE11: Copy, rerouting. E3: This is going to be right behind Foodland Farms on Oil Road on the mauka side, it is unrealistic to put this out but we need to keep it on the mauka side of Oil Road which is Old Cane Road that runs behind Foodland Farms, we need to keep it from jumping the road.	Dispatch Audio FD2
20.87420337914371, -156.67692943090836	8/8/23	20:07		1[redacted] Dickenson, Lahaina Coolers well involved in fire.	Civilian Video
20.887531312570943, -156.67668072864734	8/8/23	20:11	RE14	Command from RE14: We just turned down Keawe, the fire has jumped the road from south to north, we are headed to the new apartments they are building.	Dispatch Audio FD2
20.8859853266448, -156.6784913312274	8/8/23	20:21	RE11	Command from RE11: We are about to lose the corner on Oil Road by Kula and Mauka, could use a Tanker, we are out of water.	Dispatch Audio FD2
20.861434, -156.668691	8/8/23	20:29		Fire impacts homes at Honoapi'ilani & 'Aholo Streets.	Civilian Photo
20.861434, -156.668691	8/8/23	20:29		Fire impacts homes at Honoapi'ilani & 'Aholo Streets.	Civilian Photo
20.890712856838366, -156.67658480269543	8/8/23	20:29	E11, RE14	E11 to RE14: What I am thinking is, standby here ready to peel out in any direction. Once it hits this corner and starts darkening down then go pay attention to the north side. RE14: It already jumped. Command from E11: The fire has jumped the road at Keawe, it is now north of Oil Road, making its way into Wahikuli, evacuate Wahikuli.	Dispatch Audio FD2
20.888901, -156.675465	8/8/23	20:30	499	4[redacted] from 4[redacted] there's fire going across Keawe Street at the top of the Bypass.	MPD Audio
20.874192, -156.664248	8/8/23	20:31	6B41	The fires almost up here to the topside of the Bypass, it's creeping up by mile marker 3.	MPD Audio
20.885142, -156.682311	8/8/23	20:36	4K15	The area around the Highway and Keawe intersection is bad. I am going to pull the guys back to the Highway and Fleming for now.	MPD Audio
20.865356, -156.669248	8/8/23	20:37	UKN	The fire's starting to cross over into Aulike.	MPD Audio
20.884952, -156.682136	8/8/23	20:39	415	There's fire over the road, somebody needs to be down here but this looks like this is going to jump Honoapi'ilani here also at Keawe.	MPD Audio
20.865690, -156.669263	8/8/23	20:46	4A40	There a few houses on Aulike that's starting to come engulfed, Aulike and Leoleo.	MPD Audio
20.865690, -156.669263	8/8/23	20:46	4A40	There a few houses on Aulike that's starting to come engulfed, Aulike and Leoleo.	MPD Audio
20.858885, -156.665792	8/8/23	20:53	UNK	Hōkiokio Highway, fire is approaching fast.	MPD Audio
20.885422, -156.676200	8/8/23	20:59	4SA2	The LDS church on Ulupono St is right in the fire.	MPD Audio
20.858744, -156.665852	8/8/23	21:01	4B30	The fire is 200 yards north of Hōkiokio and the highway, we gotta push them back further.	MPD Audio

continued

Fire Progression Map Data

Lat/Long	Date	Time	Unit	Description	Source
20.887565, -156.682956	8/8/23	21:24	4B10	Central, looks like this fire is creeping out into the north side of Kapunakea neighborhood and we have to push back to Fleming.	MPD Audio
20.89303578669163, -156.68092904731523	8/8/23	21:25	RE1	RE1 from Structure Group: RE1: Structure Group, be aware fast moving, fast moving. RE1 from Structure Group: Looks like the fire is coming down Akeke St off of Kahoma. Make a run through there and see if anyone wants to get out and make sure they are out of the area.	Dispatch Audio FD2
20.89112902796683, -156.6818607821767	8/8/23	21:28	RE1	Structure Group from RE1: We have a fast moving fire impacting Kahoma Street mauka.	Dispatch Audio FD2
20.891974, -156.681924	8/8/23	21:28	4Z20	Just advising back in Wahikuli, making another sweep, the fires right behind these houses.	MPD Audio
20.888826610580878, -156.68137781649023	8/8/23	21:29		Fire working its way around Keawe Street. ext / Lahaina Bypass and the back of the construction lot into Wahikuli homes.	Civilian Video
20.890329343842517, -156.68138410396762	8/8/23	21:31		Vehicle on fire on Oil Road and spreading into Kahoma Street homes.	Civilian Video
20.892211, -156.681554	8/8/23	21:32	4B10	Kahoma Street is pretty bad, you can't even see. The flames are in the backyard of a lot of topside houses on Kahoma Street.	MPD Audio
20.894107, -156.680668	8/8/23	21:34	4Z20	Behind 1[redacted] Fleming, they're coming pretty quick.	MPD Audio
20.893836423663483, -156.68074279140495	8/8/23	21:34	SG	Command from Central: Report of flames behind 1[redacted] Fleming. SG from Command: Is that near your area? SG: We are at the top of Fleming right now and it looks more toward Kahoma by Akeke Street.	Dispatch Audio FD2
20.890331340146567, -156.68138164506865	8/8/23	21:36	T3, SG	SG from Water Supply: There is a car on fire on Oil Road that's causing all the problems on Kahoma and Akeke, if T3 can make it up here he can make a huge impact. T3: Heading up Kahoma now, need to access off of Oil Road.	Dispatch Audio FD2
20.89114260654522, -156.68188620154987	8/8/23	21:39	RE1	Structure Group from RE1: Kahoma Street is heavily impacted mauka, we are having to abandon our position.	Dispatch Audio FD2
20.88473633660011, -156.67430517581886	8/8/23	21:42	E11	Command from E11: Be advised the 4-story apartment building in the industrial area is fully involved.	Dispatch Audio FD2
20.895594, -156.680137	8/8/23	21:45	415	So there's this fire that is behind Wahikuli headed toward the Civic Center.	MPD Audio
20.892666, -156.681517	8/8/23	21:46	4Z20	It's right at Akeke and Kahoma we stay looking at em right now. It looks like something went up. I think one house just caught. We stay on Fleming watching from this side.	MPD Audio
20.89082532065457, -156.68171379666114	8/8/23	21:46	WS	Water Supply to Command: Be advised we have 6 homes fully involved off of Kahoma. WS from Command: You were breaking up WS: We have 6 buildings fully involved, triage, (wind breaking up transmission)	Dispatch Audio FD2
20.892534929490978, -156.67722567474178	8/8/23	21:51	E11	E11: It's just moving north back into the road we are on, we are working to access Oil Road. Fire is moving between these two (2) roads.	Dispatch Audio FD2

continued

APPENDIX

Fire Progression Map Data

Lat/Long	Date	Time	Unit	Description	Source
20.894114, -156.680831	8/8/23	21:51	4Z20	Just advising the flames are coming up to the top part of Fleming.	MPD Audio
20.894062, -156.684933	8/8/23	22:08	415	Chief, the Wahikuli fire is coming up on Honoapi'ilani.	MPD Audio
20.890355879531384, -156.68222736516154	8/8/23	22:09		Fire Spreading west from 13[redacted] Kahoma Street, Video taken from 12[redacted] Nahale Street.	Civilian Video
20.896207, -156.683240	8/8/23	22:10	S40	Running through this Ainikea Park area again. The fire is moving pretty quick this way, and then we're gonna head towards Hawaiian Homes.	MPD Audio
20.89366285340213, -156.68505617077807	8/8/23	22:14	RE11, RE1	RE11 from Structure Group: Can you head to the beginning of Front Street where it's branched off at Fleming? It looks to be some trees on fire on one of the properties, see if you can hit it from the Front Street side. Command: RE1 can you head to Front Street, trees on fire off Front Street, can you handle that. Command: Head down Front Street to Fleming and you will see trees on fire there on the left hand side.	Dispatch Audio FD2
20.896745224879467, -156.67957849050927	8/8/23	22:16	RE14	Command from RE14: We just made it from above mauka of Oil Road, we made it down the second road north of Fleming and fire is impacting the top side of that road.	Dispatch Audio FD2
20.889634, -156.681801	8/8/23	22:18	RE14	Fire Reaches 3 doors down from 12[redacted] Nahale, fire is spreading south to the intersection of Kahoma Street and 'Ainakea Road.	Civilian Video
20.896217, -156.682998	8/8/23	22:18	4Z20	Just advising, I'm at the intersection of 'Ainakea and Mai, monitoring the fire, looks like it's coming up on Wahikuli, which is the next intersection over.	MPD Audio
20.893514, -156.684811	8/8/23	22:24	T34	The fire jumped the Highway just south of Fleming. There's multiple spots.	MPD Audio
20.893209066256517, -156.6850178911858	8/8/23	22:25		Command from Central: From PD, the fire has jumped Honoapi'ilani south of Fleming in multiple spots, fire's up to Wahikuli now.	Dispatch Audio FD2
20.895542, -156.682968	8/8/23	22:25	4Z20	The fire's up to Wahikuli, in that neighborhood right now.	MPD Audio
20.858293, -156.665470	8/8/23	22:29	W2	Central, fire jumped Hōkiokio.	MPD Audio
20.893931, -156.681878	8/8/23	22:29		Fire is moving from east to west down Fleming Road. Behind 1[redacted] Wahikuli Road.	Civilian Video
20.893347, -156.684875	8/8/23	22:29	Central	That old Five Palms is now involved.	MPD Audio
20.89311647165839, -156.6850274170399	8/8/23	22:29		Command: You said everything south of Five Palms is unpassable and units should go north. MPD said the old Five Palms is on fire so they are advising all MPD units to go north.	Dispatch Audio FD2
20.859714630543213, -156.66454064545584	8/8/23	22:25		Command: Also Hōkiokio, the fire has jumped Hōkiokio. Central: Correct per MPD the fire has jumped Hōkiokio.	Dispatch Audio FD2
20.88956582649156, -156.68200651120364	8/8/23	22:40		Fire has spread south to 12[redacted] Kahoma Street.	Civilian Video
20.895285, -156.682952	8/8/23	22:40	4Z20	Just advising the fire is still south of Wahikuli Street and 'Ainakea.	MPD Audio

continued

Fire Progression Map Data

Lat/Long	Date	Time	Unit	Description	Source
220.858120178980396, -156.66493440264927	8/8/23	22:41	E11	Command from E11: The fire has jumped Hōkiokio, it is now south of Hōkiokio, making its way makai towards Puamana.	Dispatch Audio FD2
20.889597950503408, -156.6825572487891	8/8/23	22:44		Fire is spreading from structure to structure from 12[redacted] Kahoma to 12[redacted] to 12[redacted] to 1[redacted] Hiki Pl to 1[redacted] to 12.	Civilian Video
20.901624, -156.679816	8/8/23	22:49	415	The fire's coming up Leiali'i.	MPD Audio
20.895164, -156.682937	8/8/23	22:54	4Z20	TIt looks like the fire crossed over Wahikuli, 'Ainakea side, it's coming over.	MPD Audio
20.883549, -156.666587	8/8/23	22:55	4A20	Luna and Bypass, heavy, heavy black smoke.	MPD Audio
20.894884, -156.684913	8/8/23	22:56	418	Medics aren't going to make it past Fleming Rd. It looks like it may even be jumping over the road at this point.	MPD Audio
20.861004, -156.668546	8/8/23	23:01	4B30	The fire is moving. It's slow, moving slowly to the south. It didn't even - It's just getting up to near Puamana.	MPD Audio
20.860592, -156.661379	8/8/23	23:12	6B41	Fire's posted on the top side of Hōkiokio and Bypass. The fire's almost up here.	MPD Audio
20.88944244032484, -156.68180368237216	8/8/23	23:14		13[redacted] Kahoma Street is on fire.	Civilian Video
20.89792544864109, -156.6796634916685	8/8/23	23:39		Support from Command: Be advised we abandoned Station 3, I'll ask you guys to make your way to Highway 30 north of Station 3. Support: This thing is, the brush is on fire above Malanai making its way to Kaniau, impacting some of these top homes again.	Dispatch Audio FD2
20.88925438771646, -156.68192601749166	8/8/23	23:59		12[redacted] and 12[redacted] Nahale St. catch fire.	Civilian Video
20.904846, -156.682892	8/9/23	0:18	401	The fire is slowly creeping toward the station.	MPD Audio
20.89664727086807, -156.67948849261754	8/9/23	0:20	Mini1	The fire is at Malanai Street so if you are not out of there, it's time to go. Mini1: Only a couple left. We are on the way.	Dispatch Audio FD2
20.888801419849596, -156.6820504158711	8/9/23	0:33		12[redacted] Nahale Street on fire.	Civilian Video
20.883450, -156.666587	8/9/23	0:49	4A20	You can advise Fire, that Lahainaluna and the bypass, the fire is beginning to go Mauka.	MPD Audio
20.90170046826648, -156.67975894569625	8/9/23	0:53		Command from Central: Per MPD, they have embers flying near Leiali'i Parkway.	Dispatch Audio FD2
20.888700097901186, -156.6823327045035	8/9/23	1:17		Homes on fire in the area of 12[redacted] 'Ainakea Road.	Civilian Video
20.901908, -156.682571	8/9/23	1:46	418	Flame's probably about 100 yards south of Leiali'i at this point in time.	MPD Audio
20.901394, -156.682671	8/9/23	1:54	401	Fire is slowly surrounding Leiali'i Village.	MPD Audio
20.888626341442098, -156.6820217085678	8/9/23	1:56		12[redacted] Nahale Street catches fire.	Civilian Video

continued

APPENDIX

Fire Progression Map Data

Lat/Long	Date	Time	Unit	Description	Source
20.861661, -156.662138	8/9/23	2:02	W2	The fire jumped mauka of the bypass on Hōkiokio, going upwards.	MPD Audio
20.888419559402834, -156.68197058273282	8/9/23	2:30		Fire burning the fence of 12[redacted] Nahale Street, but it did not ignite the home.	Civilian Video
20.892758, -156.684684	8/9/23	2:51	401	The flames are still mauka of the highway except for the area of Fleming, like it crossed over.home.	MPD Audio
20.904611, -156.683897	8/9/23	4:23	401	Central, smoke is engulfing the Civic Center and the Police Station already.	MPD Audio
20.905234, -156.683230	8/9/23	5:23	401	At the moment it appears the fire went around the other buildings by the Civic Complex.	MPD Audio
20.899615002963426, -156.67386377651735	8/9/23	5:35		Video showing grass fire line east of Wahikuli from Wahikuli Road toward the Civic Center.	Civilian Video
20.88495099044418, -156.67436540404947	8/9/23	5:35		Kaiaulu o Kupuohi apartment building on fire (2[redacted] Kupuohi St) and numerous structures on fire in the Wahikuli area.	Civilian Video
20.905052, -156.684495	8/9/23	5:39	401	It appears the fire and police station were not affected. It's just smoky right now in the area. The fire is moving up the mountain.	MPD Audio
20.88495099044418, -156.67436540404947	8/9/23	5:59		Kaiaulu o Kupuohi apartment building on fire (2[redacted] Kupuohi St) and grass fire backing upslope from Wahikuli Road.	Civilian Video
20.895643930595885, -156.67348845628254	8/9/23	6:07		Fire spreads in the grass to the south of Wahikuli Rd, adjacent to the water tank.	Civilian Photo
20.850123130664887, -156.6465060904346	8/9/23	6:29	S2	Flames about 200 yards from 1[redacted] Haniu. Uh, checked the residence.	MPD Audio

This page intentionally left blank.

6.14 FSRI Research Team Biographies

Steve Kerber
Vice President and Executive Director, FSRI

Steve Kerber is Vice President and Executive Director of UL's Fire Safety Research Institute (FSRI). He leads a fire safety research team dedicated to addressing the world's unresolved fire safety risks and emerging dangers to reduce death, injury and loss from fire. Steve has led research in the areas of fire safety engineering, firefighter safety, fire forensics, and fire science. He received his bachelor's and master's degrees in fire protection engineering from the University of Maryland and completed his doctorate at Lund University in Sweden after defending his thesis titled, "Utilizing Research to Enhance Fire Service Knowledge." Steve is also a 13-year veteran of the fire service, with most of his service at the College Park Fire Department in Prince George's County Maryland where he served at ranks up through Deputy Chief. Steve has also been appointed to the rank of Honorary Battalion Chief by the Fire Department of New York, was named the 2014 ISFSI and Fire Engineering George D. Post Instructor of the Year and was awarded the 2019 Metropolitan Fire Chiefs President's Award of Distinction.

Derek Alkonis
Research Program Manager, FSRI

Derek Alkonis is a Research Program Manager for UL's Fire Safety Research Institute. In this role, Derek manages the implementation of organizational initiatives related to firefighter health and safety and spearhead FSRI's efforts in addressing wildland urban interface, a priority expansion area for our research. Prior to joining FSRI, Derek served 31 years with the Los Angeles County Fire Department, most recently as Assistant Fire Chief in charge of the Air and Wildland Fire Division. During his tenure with LA County, he helped establish the department as a leader in fire ground safety and fire service wellness-fitness. As a firm proponent of training, he has developed and implemented innovative programs supporting fire ground tactics, survival, and firefighter health. He is a member of the IAFF/IAFC Fire Service Joint Labor Management Wellness-Fitness Initiative Technical Committee and holds a bachelor's degree in biology from the University of California San Diego.

Darus Ane

Eighteen years concentrated in the WUI environment in Los Angeles County and throughout the State of California. Represented Los Angeles County Fire Department as Agency Representative on major conflagrations throughout the State of California. Collaborated with Federal, State, and Local agencies under the California Disaster and Civil Defense "Master Mutual Aid Agreement". Ane held the positions of Incident Commander, Operations Section Chief, Branch Director, or Division/Group Supervisor on multiple WUI Incidents. Coordinate with multiple public and private agencies to meet incident objectives. Ane has 33 years of experience with the Los Angeles County Fire Department as a firefighter, paramedic, engineer, camp foreman, captain, camp superintendent, battalion chief in structure operations, and a battalion chief in the Air and Wildland Division. He has served in the following positions: Fire Academy Wildland Instructor, Foreman Training Instructor, and Wildland Command Instructor.

James Barnes

James Barnes is currently the Chief Investigator for the Solano County District Attorney's Office. Prior to Solano County, James Barnes worked for the Sacramento County Sheriff's Office for approximately 25 years. Barnes worked assignments in corrections, patrol, investigations, and ascended through the ranks prior to retiring as the Undersheriff. Barnes was responsible for 2300 employees and directed operational and administrative functions for the Sheriff's Office. Barnes has always had a passion for investigations and worked as a Sexual and Elder Abuse detective and in the Homicide Bureau as a detective and supervisor. Barnes was awarded Centralized Investigations Division Employee of the Year as a Homicide detective and supervisor.

Leonard Casson

Leonard Casson is an Associate Professor of Environmental Engineering in the Department of Civil and Environmental Engineering at the University of Pittsburgh. Dr. Casson received B.E. and M.S. degrees from Vanderbilt University in 1980 and 1982, respectively. He received

continued

6.14 FSRI Research Team Biographies

his Ph.D. in Civil Engineering from The University of Texas at Austin in 1987. Dr. Casson is a registered Professional Engineer in Florida and Pennsylvania. Dr. Casson is also a Board Certified Environmental Engineer (BCEE) in the specialty of Water Supply and Wastewater by the American Academy of Environmental Engineers. He is also credentialed as an Envision Sustainability Professional by the Institute for Sustainable Infrastructure. His research interests include the adsorption, fate, transport and transformation of chemicals, particles and environmental pathogens in unit operations and the natural environment. Previous research includes investigating the presence and viability of HIV and Ebola in wastewater systems. His ongoing research has focused on novel disinfection technologies, sustainability and resilience applied to water treatment/distribution systems and wastewater collection/treatment systems.

Timothy Hagel

Chief of Police (Ret) for Ventura County Sheriff with 38 years of law enforcement and emergency operations management experience including numerous mass casualty disasters, airplane and commercial airline crashes, active shooters, mass shootings, homicides, earthquakes, floods, landslide fatalities, and train derailments. Law Branch management, part of the Statton schedule incident command system, on the Thomas Fire (the largest fire in California to as of 2017) emergency evacuation, and similar roles for the Woosley Fire, Spring Fire, Day Fire, Simi Fire, and numerous 100-acre to 70,000 acre fires also requiring large scale evacuations.

Todd Harms

Retired Fire Chief for Sacramento Metropolitan Fire District. In 2016, Harms was appointed as the 5th Fire Chief for the Sacramento Metropolitan Fire District. The Sacramento Metropolitan Fire District, "Metro Fire," serves a population of over 720,000 covering 359 square mile service area. Metro Fire is the 7th largest fire agency in the State of California with a current budget of $290 million. From 2017 to 2021, Metro Fire supported nine of the ten largest wildland fires

in California history. Due to the magnitude of these incidents, unprecedented resources were required. Metro Fire sent personnel including firefighters, command officers, and specialty personnel in addition to fire apparatus and air support. Harms was chair of the Sacramento County Fire Chief Association in 2017 and 2021 and the California Fire Chief Association Metro Fire Chief Section from 2020 to 2022. Harms was also a member of the Emergency Medical Services Authority advisory council and the California Homeland Security Committee. He holds a Secret-level clearance through the FBI. During his time at Metro Fire a Community Risk assessment funded by Assistance to Firefighters Fire Prevention and Safety Grant program was completed. Harms was a Public Safety lead for the Cap-to-Cap Program, for the Sacramento Metro Chamber. A delegation of hundreds of area officials and business leaders who travel to Washington, D.C., and meet with federal representatives. The Capitol-to-Capitol program is meant to secure funding and resources for high-priority projects in the region and raise local concerns to officials at the national level. Harms was a member of the Phoenix Fire Department in Phoenix, Arizona for 30 years prior to his position with Metro Fire.

Garrett Kim

Garrett Kim has over 20 years of experience establishing, leading, training, educating, and testing of/for various health and safety programs and projects, including serving as the Hawai‘i County’s COVID-19 Response Lead; Training, Education and Testing efforts for Hawai‘i County’s CoVID-19 response March – December 2020; Firefighter Cancer Support Network 2012 – Present; State Director for Hawai‘i Region of the FCSN; FireGround Survival Program Coordinator 2013 – Present; Applied for and was awarded an AFG grant to fund training and equipment to create HFD’s Fire Ground Survival program; Planned and delivered the largest fire-based training in the history of the department; HFD Fire Behavior Lead Instructor 2012 -Present; Teaching Science based fire dynamics, fire service strategies and tactics; Special Operations Chief, overseeing HFD’s Rescue, HazMat and Ocean Safety Programs 2018-2020; Wellness Fitness Program Coordinator 2008 – Present; Applied for and was awarded a half-million

continued

6.14 FSRI Research Team Biographies

dollar grant to fund HFD's Wellness- Fitness Program. Developed and oversees all aspects of the program; One of 15 FIT2THRIVE Master instructors for the IAFF F2T program, delivering industry leading training in the United States and Canada 2013 – Present.

Timothy Martin

Timothy "T.J." Martin graduated from Northern Arizona University with a degree in Criminal Justice studies in 1982. He joined the Phoenix Police Department and graduated from the Police Academy in December of that year. During a 35-year career he worked a variety of assignments at various ranks starting in Patrol. As a Sergeant he worked in Patrol, Organized Crime and Gang Enforcement. After being promoted to Lieutenant his assignments included Patrol, Patrol Administration, and the Homeland Defense Bureau. Upon being promoted to Commander, he worked in the Homeland Defense Bureau which he developed in coordination with the Phoenix Fire Department, City Emergency Managers Office, and the City's Public Health Manager. Martin also Commanded a Patrol Precinct, the Tactical Services Bureau, the Drug Enforcement Bureau, and the City Manager's Office. As an Assistant Police Chief, Martin oversaw the Strategic and Tactical Services Bureau. Martin received various awards over his career to include the Nobility of Policing Award and the Distinguished Service Award. During his career he achieved a certification as a Certified Public Manager from Arizona State University and was a General Instructor. Martin was in charge of the Emergency Operations Center in unified command with the Phoenix Fire Department for Super Bowl XLIX in 2015 and the NCAA Final Four basketball tournament in 2017.

Kevin Roche

Kevin Roche is a FACETS partner. He retired in 2014 as Assistant to the Fire Chief for the Phoenix Fire Department in Arizona. Roche has over 40 years of fire service management and consulting experience. Roche has experience as a leader and member of a number of management consulting projects in large fire departments. During his career in Phoenix, Kevin managed the fire department's planning, fire prevention, and logistics operations. Kevin earned a B.S. degree in Fire Protection and Safety Engineering Technology from Oklahoma State University and a Master's degree in Political Science with a Certificate in Public Administration from the University of Florida.

Elizabeth Pickett

Elizabeth Pickett is Co-Executive Director of Hawaii Wildfire Management Organization. Since 2008, she has worked with staff and partners across Hawaii and the Western Pacific to lead and implement multi-partner wildfire mitigation, education, and planning projects. She is a Co-PI of the Pacific Fire Exchange science communication project, co-led by University of Hawaii, and serves as Vice Chair of the Big Island Wildfire Coordinating Group. Elizabeth has developed the majority of Hawaii's Community Wildfire Protection Plans, and serves as director of HWMO's technical, mitigation, and collaborative action programs. Pickett completed her undergraduate degree at UC Berkeley and a Masters of Environmental Science at Yale School of Forestry and Environmental Studies.

Jessica Pickett

Jessica Pickett has worked in settings from the firehouse to the White House. She is a FACETS associate, founder/CEO of RPM Solutions Group, Inc., and also serves as executive director for the Fire Industry Education Resource Organization (F.I.E.R.O.). Pickett was a deputy emergency manager for the Montgomery County (PA) Department of Public Safety where she coordinated public health initiatives and training for EMS, fire, and law enforcement agencies serving a population of over 820,000 residents. She participated in multiple EOC activations, developed plans/exercises, and was a member of several county- and state-level EMS and 911 dispatch-related committees/initiatives. Prior to joining MCDPS, Pickett was a decorated all-hazards fire/paramedic lieutenant with the Fairfax County (VA) Fire & Rescue Department, a Technical Information Specialist for US&R VATF1, a Fire Rescue Academy instructor, and an active member of IAFF Local 2068 where she served as Chair of the EMS Committee. Jessica graduated with honors from George Washington University (Environmental Science/Biology), was awarded a Marshall Scholarship for study at Oxford University

continued

6.14 FSRI Research Team Biographies

University (Human Sciences) and has completed graduate-level coursework in public health/biostatics/epidemiology at Drexel University.

Adam Thiel

Adam Thiel co-founded FACETS Consulting in 2006. His public service career spans 33 years, across five states (MD, NC, VA, AZ, and PA), as a city/county manager fire chief, emergency manager, state-level deputy cabinet secretary, state agency head, company officer, fire and emergency services instructor, incident commander, hazardous materials team leader, paramedic, technical rescuer, structural/wildland firefighter, swiftwater rescuer, and rescue SCUBA diver. Thiel has directly participated in planning, response, and recovery efforts for multiple Presidentially-declared disasters and National Special Security Events (NSSEs),
including the 9/11 tragedy, hurricanes, tropical storms, floods, an earthquake, major blizzards, pandemics, and political/sporting events. He is an Eisenhower USA fellow, an Aspen Institute health innovation fellow, and a Leadership Philadelphia alumnus. A lifelong learner, Thiel has attended the University of Pennsylvania, the London School of Economics and Political Science, Arizona State University, George Mason University, the University of Maryland Global Campus, and the University of North Carolina at Chapel Hill; he is an adjunct faculty member at Georgetown University and George Mason University.

GLOSSARY

7.0 Glossary

TERM	DEFINITION
1015	Firefighter mayday signal
Central	911 Center
Conflagration	An extensive fire which destroys a great deal of land or property.
Ember	A small piece of burning or glowing coal or wood
Egress	Path of travel or means of exiting
El Niño	Long-term weather events that greatly exacerbate dry/wet season patterns, often increasing rainfall at the start of the event followed by severe, region-wide drought
Gated wye	A type of firefighting hose valve with gateable valves on each outlet, which gives the firefighter maximum control over the water flow
Handline	A firefighting hose that is operated and maneuvered by firefighters (usually a 1 ¾” in diameter)
Headloss	The pressure, or energy lost by water flowing in a pipe or channel as a result of turbulence caused by the velocity of the flowing water and the roughness of the pipe
Hoʻoilo	Native Hawaiian for winter season
Kau	Native Hawaiian for summer season
Kauaʻula winds	A strong wind from the mountains, occasioned by the breaking over of the trade winds; often destructive at Lahaina
Kuʻialua fire	See “Lahaina PM fire" in the glossary
Lahaina AM fire	Fire that occurred in Lahaina August 8, 2023 between 06:34 and 14:17 HST.

TERM	DEFINITION
Lahaina PM fire	Fire that occurred in Lahaina on August 8—9, 2023, between 14:55 and 06:00 HST. Also referred to as the Kuʻialua fire in some dispatch reports
Makai	Directional queue meaning “toward the ocean”
Maui Nui	The islands that make up Maui County: Maui, Molokaʻi, Lānaʻi, and Kahoʻolawe (and the islet of Molokini)
Mauka	Directional queue meaning “toward the mountain”
Med Comm	Emergency medical services for American Medical Response
Orographic effect	Also known as the “rain shadow” effect, this term refers to the drier southern and western sides of Maui caused by the mountain shielding of those leeward sides
Red Flag Warning	Used to warn of an impending or occurring Red Flag event. Its issuance denotes a high degree of confidence that weather and fuel conditions consistent with Red Flag event criteria are occurring or will occur in 48 hours or less
WebEOC	Portal for resource tracking and incident communication that is maintained/ monitored by HI-EMA and available to all county-level emergency management agencies across the State of Hawaiʻi
Wildland Urban Interface	The wildland–urban interface is a zone of transition between wilderness and land developed by human activity–an area where a built environment meets or intermingles with a natural environment

GLOSSARY

8.0 Acronyms and Abbreviations

ACRONYM	MEANING
AAR	After Action Report
AG	Hawai‘i Attorney General
ALS	Advanced Life Support
AMR	American Medical Response
ARFF	Aircraft Rescue and Firefighting
ATF	Bureau of Alcohol, Tobacco, Firearms and Explosives
AVL	Automatic Vehicle Location
CAD	Computer Aided Dispatch
CAP	Civil Air Patrol
CAT	Crisis Action Team
CERT	Community Emergency Response Team
CGSB	Coast Guard Honolulu Small Boat
Corp Counsel	Maui County Department of Corporation Counsel
CPR	Cardiopulmonary Resuscitation
CRA	Community Risk Assessment
DLNR	Department of Land and Natural Resources
DLNR-DOFAW	State Department of Land and Natural Resources- Division of Forestry and Wildlife
DOAG	Hawai‘i Department of the Attorney General
DOFAW	Hawai‘i Division of Forestry and Wildlife
DOI	United States Department of Interior
EAS	Emergency Alert System
EMC	Emergency Management Center
EMS	Emergency Medical Services
EMT	Emergency Medical Technician
EOC	Maui County Emergency Operations Center
ERT	Emergency Response Teams
ETA	Estimated Time of Arrival
EVOC	Emergency Vehicle Operations Course
FEMA	Federal Emergency Management Agency
FMAG	Fire Management Assistance Grant
FSRI	Fire Safety Research Institute
GPS	Global Positioning System
HAWAS	Hawai‘i Warning System
HC&S	Hawaiian Commercial & Sugar Company
HECO	Hawaiian Electric Company Although Maui Electric and Hawai‘i Electric Light brands were formally changed to Hawaiian Electric, the acronyms “HECO” and “MECO” are still used locally to refer to this organization
HFO	Honolulu Field Office, National Weather Service
HIANG	Hawai‘i Air National Guard
HIARNG	Hawai‘i Army National Guard
HI-EMA	Hawai‘i Emergency Management Agency
HIG	Hawai‘i Institute for Geophysics
HING	Hawai‘i National Guard
HWMO	Hawai‘i Wildfire Management Organization
ICC	International Code Council
IDLH	Immediately Dangerous to Life and Health
IMT	Incident Management Team, HI-EMA
IPAWS	Integrated Public Alert and Warning System
JOC	Joint Operations Center
KBDI	Keetch-Byram Drought Index
LG	Lieutenant Governor
LPG	Liquid Propane Gas
MDD	Major Disaster Declaration
MDF	State’s Major Disaster Fund
MECO	Hawaiian Electric Company Although Maui Electric and Hawai‘i Electric Light brands were formally changed to Hawaiian Electric, the acronyms “HECO” and “MECO” are still
MEMA	Maui Emergency Management Agency
MFD	Maui Fire Department
MG	Major General
MG	Million Gallons
MGD	Million Gallons Per Day
MPD	Maui Police Department

GLOSSARY

8.0 Acronyms and Abbreviations

ACRONYM	MEANING
NOAA	National Oceanic and Atmospheric Administration
NRT	National Response Team
NWS	United States National Weather Service
PA	Public Address
PAR	Personnel Accountability Report
PFX	Pacific Fire Exchange
PHNL	Honolulu International Airport
PIO	Public Information Officer
POV	Privately-owned Vehicle
RAWS	Remote Automatic Weather Stations
RBM	Response Boat - Medium
RFA	Request for Assistance
RH	Relative Humidity
SAAO	State Aviation Action Officer
SAR	Search and Rescue
SCBA	Self-Contained Breathing Apparatus
SEOC	State Emergency Operations Center
SESF	State Emergency Support Function
SITREP	Situation Report
SOC	Standards of Cover
SRV	Special response paramedic unit
SWP	State Warning Point, a state emergency communications center operated by HI-EMA and staffed 24 hours, 7 days a week
TAG	The Adjutant General
TD	Technical Discussions
UHM-CTAHR	University of Hawai‘i at Mānoa College of Tropical Agricultural and Human Resources
UL	Underwriters Laboratories
ULRI	UL Research Institutes
USAR	Urban Search and Rescue
USCG	United States Coast Guard
USDA	United States Department of Agriculture
VTC	Video Teleconference
WAS	Weather Alert System
WEA	Wireless Emergency Alert
WebEOC	Data management system used to manage EOC staffing and operations
WTP	Water Treatment Plant
WUI	Wildland Urban Interface (see Glossary)

As this report deals with topics related to Hawaiian culture, geography, environment, and language, FSRI chose to include Hawaiian diacritical marks, the ‘okina (‘) and kahakō (macron) over vowels, throughout this report when writing Hawaiian words. These markings are essential features of modern, written Hawaiian language, serving to represent the proper pronunciation and meaning. While we have made our best effort to use these marks properly, we acknowledge there may be unintentional errors. We did not include diacritical markings where we were unable to identify the proper spelling of a particular Hawaiian word (e.g., Aa Street) or in instances where the information is from a third party's direct record (e.g., social media posts). By including these marks, we aim to honor the Hawaiian language and show respect for its linguistic traditions — and for the people of Maui.

Lahaina Fire Comprehensive Timeline Report



UL Research Institutes
Christopher J. Cramer, Ph.D.
Interim President and Chief Research Officer

Steve Kerber, Ph.D., P.E.
Vice President and
Executive Director, FSRI

FSRI.org







© 2024 Underwriters Laboratories Inc.

WILDFIRE TODAY
WILDFIRE NEWS & OPINION
April 2022
Weather News & Opinion

Tag: Marshall Fire

Colorado's 2021 Marshall Fire investigation concluded

by Wildfire Today | June 8, 2021 | Wildfire - Last Updates, Colorado, Marshall Fire, Twenty Miles Fire

Authorities today ended their year- and- a- half- long investigation into the cause of the 2021 Marshall Fire in Colorado. They said that it was human caused, but declined to say whether it was accidental or arson, one of which is the burden for the person or source, with the other law enforcement agency from arising power lines.

Boulder County Sheriff's Office Commander Rick Brough said the fire was first seen on December 30, 2021 from fourteen and construction debris at a religious group's compound on El Dorado Springs Drive. According to a Colorado Public Radio article (CPR) the fire was first reported by the local fire department, which determined the fire had been extinguished. CPR's Bente Birkeland said the flash on that item on December 30 was not reported to the fire department. Then, about an hour later, sparks from an [Xcel Energy](#) power line ignited a second fire about 1,500 feet away.

Boulder District Attorney Michael Dougherty said no criminal charges would be filed against either Xcel Energy or the property owner. He said the fire was found to be accidental, "no arson, no malice." He said in essence: If we were to roll up our sleeves [King charges today, it would be wrong and unethical."

The [Denver Post](#) reported that the Marshall Fire was Colorado's costliest, it destroyed 1.6 billion in property and killed two people.



Marshall Fire, Louisville, Colorado. Photo by Photocrazy/Shutterstock, Dec. 31, 2021.

High winds, even with occasional hurricane- force gusts, are not unusual in the foothills region of Colorado, where the western prairies meet the Rockies. According to a [Denver](#) report, the Marshall Fire was driven by sustained winds between 80 and 100 mph. Some of the gusts were as high as 120 mph and in the foothills and mountains, the fire burned more than 6,000 acres, killed two people, and destroyed 1,084 homes. In addition, the wildfire's atmospheric pressure dropped sharply east of the Rockies, and strong downslope winds originate in the foothills west of Denver, and it grew quickly and reached 40 miles per hour.

Johnson and Dougherty spent more than an hour Thursday morning laying out details of their investigation and how Dougherty came to the conclusion that no criminal charges should be filed.

Investigators found no evidence that employees of the Twelve Tribes organization intended to start the Marshall Fire — or that Xcel Energy was negligent in maintaining its equipment, Dougherty said.

The Twelve Tribes Community is classified by the Southern Poverty Law Center as a "Christian Supremacist hate [group](#)." It has a local home in the foothills of the Rockies on Eldorado Springs Drive. "We have no evidence that they intended to start the fire," Dougherty said. "We have no evidence that they had malice. "Dherman is the one hundredth and millionth of an inch Xcel's Northern Rockies Remedial Action of the Bible's 1st day on down into Xcel one for another Listening such other's words Xcel's to see the kingdoms come the prophecies of the Bible as well as the Prophecies of the Apocrypha published as in depth look at the group.

The [Denver Post](#) published an in-depth look at the group.

Report released for the Marshall Fire which destroyed 1,056 structures southeast of Boulder, Colorado

by wildfire today | October 19, 2021 | Investigation - Colorado, Marshall Fire, report | 0 comments



Marshall Fire, Louisville, Colorado. Photo by Photocrazy/Shutterstock, Dec. 31, 2021.

On the morning of December 30, 2021 the Marshall Fire ignited south of Boulder, Colorado. Pushed by winds gusting well over 100 mph, hurricane-strength in some areas, it burned through subdivisions destroying 1,056 structures. By later the next day the winds had decreased and it was wavering on the 6,000- acre blaze.

At the request of the Colorado Division of Fire Prevention & Control a [Fire/Rural Investigation Analysis](#) team was formed. The report they published on Tuesday is a fascinating document, which in this case includes many illustrations, photos, and maps.



Marshall Fire, Louisville, Colorado. Photo by Photocrazy/Shutterstock, Dec. 31, 2021.

Topics covered are weather, fuels, fire behavior, communication, ordering, evacuations, utilities, ordered and mandatory evacuations, and the investigation. The report also includes several consecutive pleasing to prevent similar damage from inevitable wildfires, and manage them after they start.



Map of structures damaged or destroyed during the Marshall Fire which ended December 30, 2021 near Boulder, Colorado. Map sources: Esri, Maxar, Microsoft, Esri, [illegible]

Share this:

Sometimes they just need a hug

by Bob Hall | Jan 31, 2022 | Analysis, Fire Behavior, Marshall Fire, Video | 0 comments



Marshall Fire, Louisville, Colorado. Photo by Photocrazy/Shutterstock, Dec. 31, 2021.

By Bob Hall

When you have been impacted by a disaster of any kind you are frightened, scared, often very angry and you feel helpless. Many of the residents who lost their homes in the Marshall Fire experienced all of the [illegible] of fear. So why is it that the majority of our disaster assistance and recovery programs at all levels fail to understand that emotional issues can seldom be resolved by analytical processes?

In a Facebook instigation conference I once attended, the leader started using an [illegible] often in side conversations!). Sure we can be better with tactical hazard prepositions and mitigations" At all levels of government, we continue to fail to [illegible] the emotional needs of disaster victims. Why is this? I think there is a [illegible] in [illegible] concerns. That the largest risk components ever estimate that the root of a hazards damage is starting to become incalculable is scaring even the wealthiest countries. The big elephant in the room was the fundamental question of whether it is even possible to [illegible] a subject with massive emotional dynamics through analytical processes.

I had an opportunity to work a very different way? Any victim of a disaster in which there world has imploded in. Louisiana is outwardly frightened, upset, and scared. To introduce a program of any kind, on any subject, to a person who is experiencing such an event requires the slow additional issues, leading to complex issues leading for pain.



Tens of the presenters at the conference made a huge impact. Others from the Chickasaw Tribe of Oklahoma, Mississippi Choctaw Tribe, Alabama-Coushatta Tribe of Texas, and the Jena Band of Choctaws, interviewed. As now, they both answered the importance of learning your community and reaching to both a human and effectives systems way, or a better stated in eloquently "Yes, indeed we need to be effective in our response, but we must also be sensitive to the emotional needs of the people."

The Chickasha Inc Oklahoma, "a people of the many waters" has had famous disaster when the FEMA team got to their reservation from Hurricane Katrina, they had already taken care of some of the damages. Communication in the tribe took place mostly by word of mouth, with US radio assistance. Within 24 hours of the storm, the tribe had established a [illegible] and had begun [illegible] the needs of the people with all of emotion, both physical and emotional, among the displaced. Within a week, the tribe had [illegible] and many cases was complete. A major focus of the tribal council was on emotional support, and this can consistently throughout everything they were doing.

Sallie was doing something similar to the Chickasaw Nation devastated Hurricane Katrina community. That wildfire was one of the most destructive in Texas history. It took me two times, decreased 24/7 hours, forced tens of thousands to evacuate, and insurance claims topped $3,500. Sallie's response was to [illegible] a disaster recovery center where emergency workers and others could get food, physical and emotional support. Here are they personally drove to evacuation centers to bring food and water along their and gave anyone a hug who needed it. A truly shining example of "We Cares!"



Sallie Clark, a Commissioner for El Paso County, Colorado

Continue reading

Share this:

Coal underground may have been burning for 150 years near where the Marshall Fire started northwest of Denver

by wildfire today | January 26, 2022 | Wildfire - Last, Colorado, Marshall Fire



Coal mine at Marshall, Colorado, 1964, north east - arsonic

A subterranean station in Denver, Colorado, has found that in the general area where investigators are examining down the origin and cause of the Marshall Fire northwest of Denver an underground coal seam has been burning since the 1870s.

In December, 2021, after a portion of the burning seam emerged on the surface and started a vegetation fire, the Office of Surface Mining advised the City of Boulder, which owns the land. The report is available for the City of Boulder to remain on any regulations that could be applied to the land, such as begin a long-term maintenance and monitoring program for the area." he sent the spread of the fire was stopped quickly.

The City funded in 375 tons of gravel with the intention of least insulating the fire from the surface. But the fire continued to burn underground, creeping from west has to and into adjoins open fires. They are now in responsible to extinguish.

Athena reported that the M. P. Fire mine in the area operated from 1883 until 1958.

Pushed by winds gusting at 70 to 100 mph, the Marshall Fire spread rapidly as it destroyed more than 1,000 homes. Most were in the city of Louisville and the town of Superior.

The ultimate stakes below has been threats.

Officials are investigating smoldering coal mine as cause of Marshall Fire

by wildfire today | January 25, 2022 | Wildfire - Last, Colorado, Marshall Fire | 0 comments

The rapidly spreading blaze destroyed more than 1,000 homes northwest of Denver December 30

Investigators are looking at an old coal mine as the possible cause of the Marshall Fire northwest of Denver. The fire started on December 30 and destroyed more than 1,000 homes in the Louisville and Superior area. Authorities say it is also investigating a second fire that started on December 30 that burned dozens of trees till been hauled in with the intention of stopping the burning, or at least insulating the fire from the surface. But there widespread fires have a habit of creeping along their way back to the surface and too other ignites a vegetation fire.

The old mine was the intersection of Highway 93 and Eldorado Springs Road near the town of Marshall is one of 58 active underground coal fires in Colorado. In 2002 a burning underground coal seam ignited several wildfires in Jefferson County, Colorado which burned 12 homes and destroyed 138 homes.

Wildfire Today had an [article](#) in 2018 about an [illegible] of smoldering fires that were burning underground in Colorado. Some of them have been burning for more than a century. Some of the fires are in abandoned coal mines where, like that one on the [illegible], and included the city's plastic shed gas from second degree burns. If the fire had not "discovered" the fire, it could have burned underground for years. The cause of the fire remains unknown.

Pushed by winds gusting at 70 to 100 mph, the Marshall Fire spread rapidly last month as it destroyed more than 1,000 homes. Most were in the city of Louisville and the town of Superior.

Share this:

Analysis of how weather affected the spread of the Marshall Fire in Colorado

by wildfire today | January 29, 2022 | Wildfire - Colorado, Marshall Fire | 0 comments

It burned more 6,000 acres and nearly 1,100 homes northwest of Denver, December 30, 2021

Continued Marshall Fire Extension Sheet 1000

The Denver office of the National Weather Service has released an [analysis of the weather](#) that created the conditions on December 30, 2021 that allowed the Marshall Fire northwest of Boulder, Colorado to [illegible] and [illegible] [illegible] and a few homes over the miles to the east burning 6,000 acres and destroying nearly 1,100 homes with a total loss of more than $513 million.

The NWS described the winds the day of the fire:

Subscribe to receive notifications of new posts by email.
Join 1,000 other subscribers
Subscribe

SEARCH
Search

FILTER
Articles
Pages
Categories
Tags
Go

WILDLAND FIREFIGHTER FOUNDATION

COMMENTS
No new comments
Click here to view older.

RECENT ARTICLES
Significant spring wildfire risk in southern U.S. and Hawaii; more damage to grow this week
Wildland firefighter just barely survived the Marshall Fire in Colorado
Tropical 2019 was strange. Here were 5.
Wildfire Today's Wildfire Calendar for 2022
Little more than 40% of U.S. land is federal, but it owns most wildfire-fighting responsibility
New Zealand declares $7.4 billion NZ fighting to prevent wildfires from destroying homes from Weather Channel

INTERESTED IN ADVERTISING ON WILDFIRE TODAY?
CLICK FOR DETAILS

ARCHIVES
Select Month

Check out our companion site, the Incident Response Pocket Guide, also available free for [iPhone](#) and [Android](#) and [Kindle Readers](#).

High winds developed in the mid morning hours on Thursday, December 30th, 2021, the result of a mountain wave that developed as very strong westerly winds raced over the Front Range Mountains and Foothills and crashed down onto the plains. The mountain wave remained nearly unchanged through the rest of the day, resulting in very persistent and extremely high winds. Mountain waves are usually focused very close to the base of the foothills and adjacent plains. On this day, sustained winds of 50 to 60 mph with gusts of 80 to 100 mph were felt along Highway 93 and points east to around Superior and at times, Louisville.

On the map below, the final fire perimeter is outlined by light purple (upper center of the plot images), while the city of Boulder is located in the northwest corner. The black numbers are temperature (F), red numbers are wind gusts, and the wind barbs point to the direction the wind was from.

Wind gusts (in red), temperatures (in black) at noon, Dec. 30, 2021, Marshall Fire, NWS.

The surface plot for 12 PM MST above shows some of the strongest winds from this wind event. A peak gust of 115 mph was reported at the base of the foothills, just east of the intersection of Highway 93 and Highway 72. Note the 85 mph gust in south Boulder, and a 100 mph gust along Highway 93 (very bottom of the image below) at about noon.

Precipitation in the Denver area, 6 months before Marshall Fire, compared to previous dry periods. NWS.

After a very wet first half of the year that resulted in a lush, tall crop of grass, the six months leading up to the fire in late December were the driest in recorded history, by far. Drought affects moisture in the vegetation — the fuel moisture. The lower is it, the more easily and more intensely it burns in a wildfire. There were many areas in the fire with light vegetation, such as grass, that in December after it has cured would be more affected by recent rain (or the lack thereof) and relative humidity than long term drought. The relative humidity was in the mid-20s that day. But the National Weather Service said larger fuels such as shrubs and trees were plentiful in and around the affected subdivisions. Those fuels would be heavily affected by the historic drought and would have low fuel moistures in the live and dead vegetation.

Drought can also affect the home ignition zone. If gutters on homes are not kept clean of leaves, they can be ignited during an ember shower even if the fire is thousands of feet away. If the gutters have leaves during normal weather, especially in December near Boulder, they could also have water that is trapped by the leaves keeping them wet for weeks or months. But with historic drought, it is possible the water evaporated, making them susceptible for ignition by embers. A fire in a gutter can spread to the structure.

The lawns that in late December would often be covered by snow, were most likely brown and dry, making it possible for an ember to ignite the grass which could spread to homes. Mulch, such as bark or wood chips placed around ornamental plants and near structures would also be much drier than normal, making that fuel available. And remember, the winds were 50 to 60 mph with gusts of 80 to 100 mph.

As structures burned, millions of additional burning embers were lofted into the air with many of them igniting susceptible fuels out in front of the main fire. A burning home that in many cases was only 15 to 20 feet away from other houses could easily ignite through convective or radiant heat the neighboring residence.

Share this:
Share 18 SHARE Telegram WhatsApp Email Reddit

QUICK RESPONSE
Home
Publication Info
Overview Report
Research Design
Findings
Conclusions
References
Acknowledgments
Appendix

Tracking the Effects of the Marshall Fire on Pets and People

Leslie Irvine
University of Colorado Boulder

Liana Wells
Rocky Mountain Medical Group

Publication Date: 2022

Abstract

A wildfire driven by hurricane-force winds (>100 km/hour) in the Town of Superior, the City of Louisville, and unincorporated Boulder County on December 30, 2021. The fire consumed over 6,000 acres and destroyed 1,084 homes and 6 businesses. Over 35,000 people were evacuated, many overnight. Many more fled the danger zone before any official orders were issued. Authorities estimate that 37,500 companion animals were in the area when the fire broke out. Boulder County Animal Protection, Colorado Humane Society, Longmont Humane Society, and Animal Rescues Unlimited responded to the emergency. Within a week, they had reunited 85 percent of the animals with their people. This project tracks the recovery of companion animals from the fire by way of the lost-pet database. Data from the database are used to estimate the number of animals that died in the fire and to identify factors that contributed to the loss of animals. Results will be used to improve the response to future disasters. Preliminary findings are presented here. Data collection is ongoing, and more results will be forthcoming in the months ahead. Learn more.

Introduction

At 3:00 a.m. on December 30, 2021, a wildfire driven by hurricane-force winds (>100 km/hour) ignited in the Town of Superior, Colorado, and spread into the City of Louisville and unincorporated Boulder County. Within a week, the fire had burned 6,026 acres (9.4 square miles), destroyed 1,084 homes and 6 businesses, and damaged 7 others (Boulder County, 2022). Over 35,000 people were evacuated, many overnight. Many more fled the danger zone before any official orders were issued. Authorities estimate that 37,500 companion animals were in the area when the fire broke out (Boulder County Animal Protection, 2022). Boulder County Animal Protection, Colorado Humane Society, Longmont Humane Society, and Animal Rescues Unlimited responded to the emergency. Within a week, they had reunited 85 percent of the animals with their people (Colorado Humane Society, 2022). This project tracks the recovery of companion animals from the fire by way of the lost-pet database. Data from the database are used to estimate the number of animals that died in the fire and to identify factors that contributed to the loss of animals. Results will be used to improve the response to future disasters. Preliminary findings are presented here. Data collection is ongoing, and more results will be forthcoming in the months ahead. Learn more.

Literature Review

The research contributes to the literature on pet disaster evacuation and on the importance of the human-animal bond in disaster. Pet owners are more likely to evacuate if they can bring their companion animals with them (Heath et al., 2001; Irvine, 2009; Irvine & Cilluffo, 2007; Thompson et al., 2007). Some people refuse to leave their companion animals behind, even if doing so means risking their own lives (Irvine, 2009; Irvine et al., 2016). Pet owners comprise a majority of households that are pet owners (Irvine & Cilluffo, 2007). Although the number of companion animals who lost their lives in the Marshall Fire is not known, it is undoubtedly substantial (Boulder County, 2022).

Studies of disaster evacuation have found that people rely on their social networks to help them evacuate (Drabek, 1986; Irvine et al., 2016). Pet owners rely on their social networks to help them evacuate their companion animals (Irvine, 2011; Irvine et al., 2016; Irvine & Wilson, 2008). Pet owners are also more likely to have the human-animal bond in mind when they are making decisions about evacuation (Irvine, 2009; Irvine et al., 2016

The purpose of this report is to summarize the findings collected from interviews and other debriefs. The goal of this document is to describe overarching mission and activities, consolidate lessons learned, document best practices and share recommended improvement actions.

Marshall Fire Operational After-Action Report (AAR)

Contents

Summary 2
Introduction 3
Summary of the weather conditions for the Marshall Fire on December 30, 2021. 3
Prior to the Marshall Fire 3
The Marshall Fire Begins 4
Summary of Events of the Operational Response 5
What Worked Well 6
Marshall Fire Evacuations Zones 10
Fire Response AAR Improvement Plan 11
Law Response AAR Improvement Plan 12
AAR Improvement Plan Alert & Warning 14
AAR Improvement Plan Sheriff 911 Communications Center 17
Louisville Fire and Police 19
Significant Events Fire 19
Significant Events Police 20
What Worked Well 21
AAR Improvement Plan City of Louisville 23
Type 1 Incident Management Team 29
Significant Events: 29
Notable Successes: 30
Challenges and Resolutions: 30
Boulder EOC AAR for Marshall Fire 33
AAR Improvement Plan EOC 45
AAR Improvement Plan ESF 21 Animal Management 47
AAR Improvement Plan BCARES 50
Recommendations for Building Capacity and Improvements in the Future 54
Conclusion 54
After Action Report Methodology 54

Summary

The After-Action Review (AAR) process is useful for reflecting upon an incident after its completion, fostering organizational learning, identifying areas of improvement, and learning from successes, challenges and failures. The ultimate goal of the AAR process is to improve response to future disasters.

Conducting the AAR process takes into consideration the complexity of the incident or disaster, and the duration and size of the operational response to design an effective process. The Marshall Fire AAR effort brought together decision makers and tactical resources into targeted AAR discussions to obtain critical elements of information, establish timelines, recount experiences based on areas of effort and extract what went well and what gaps or needs were present. The AAR process focuses on the operational response to the Marshall Fire for the first 12-36 hours.

The AAR begins with an introduction describing the weather conditions and the operational environment that existed at the time of the Marshall Fire. The additional sections provide a timeline of events when possible, highlighting a summary of significant events based upon the input of individuals involved, defining what went well, identifying what did not go well and integrating recommendations into an improvement plan. The improvement plan addresses challenges that were faced or actions that did not go well. The gaps identified can be addressed through planning efforts, applying organizational capacity, dedicating resources, providing equipment, staffing, training and developing exercises to test and evaluate effectiveness of improvements made.

The improvement plan design identifies the capability area, observations from participants about what did not go well, and corrective action recommendations, and it identifies the lead agency, the name of the responsible person to lead the corrective action and a time for completion. The lead agency and person are responsible for facilitating or leading the corrective action program or process. Most if not all corrective action programs and processes identified in this report require the involvement of multiple jurisdictions and the engagement of their leadership, operational supervisors and personnel to be successful. Implementing the improvement planning effort is the most important step in the AAR process for continuous improvement to be successful in addressing gaps.

The After-Action Review provides analysis for lessons learned, best practices and recommendations for future planning, training, and exercise development. As improvement actions are identified and addressed, it is important that any relevant plans, policies and procedures are updated accordingly.

Introduction

Summary of the weather conditions for the Marshall Fire on December 30, 2021.

https://www.weather.gov/bou/HighWinds12_30_2021

On Thursday, December 30, 2021, the devastating Marshall Fire roared through unincorporated Boulder County, Superior and Louisville, Colorado. The fire started south of Boulder, Colorado and was fanned by intense winds along the Front Range Foothills. Wind gusts from 70 to 100 mph occurred right at the base of the foothills, including in Boulder and along Highway 93 south toward Golden. The strong winds fanned a destructive grass fire which originated near Marshall in unincorporated Boulder County, and then quickly spread east to Superior and Louisville. At last count, the Marshall Fire destroyed 1,084 homes, and seven commercial structures and damaged 149 homes and 30 commercial structures.

The very strong winds developed in the mid-morning hours on Thursday as the result of a mountain wave that developed from very strong westerly winds racing over the Front Range Mountains and Foothills. The mountain wave remained nearly unchanged through the rest of the day, resulting in very persistent and extremely high winds that was focused very close to the base of the foothills, along Highway 93 and points east to around Superior and, Louisville. It takes just the right combination of meteorological parameters, including stability, wind shear, and wind magnitude, to create a powerful and damaging windstorm like this one.

The second component that contributed to this disaster was the lack of precipitation during the latter half of 2021. The Front Range experienced a very wet first half of the year with much greater than normal precipitation and lush and tall grass growth. However, starting around July, a persistently dry weather pattern set up and held firm through the entire fall and early winter. Grasses, while typically dry this time of year, were exceptionally dry as very little snow had occurred through the entire fall season. The temperature and precipitation from July 1 through December 29 ranks as the 2nd warmest and by far the driest in the Denver's recorded history (since 1872). This same time period for Boulder was ranked 2nd warmest for precipitation, while 13th driest in recorded history.

Prior to the Marshall Fire

At 10:15 a.m. the Lefthand Fire Protection District responded to the Middle Fork fire north of Boulder, and the weather conditions and high winds caused rapid growth of that fire. The Middle Fork fire attracted multiple fire departments from Allenspark, Hygiene, Lyons, Boulder Mountain Fire Protection District, and Boulder County Sheriff Fire Management Team to provide fire suppression and 15 Sheriff's Office Deputies to evacuate residents in the area. First responders reported fire spreading quickly with high winds as they started to engage in fighting the fire and initiating evacuations. The Boulder Incident Management Team (IMT3) was requested and responded to the scene. The 911 center was receiving hundreds of calls reporting the fire and launching emergency notifications through the Everbridge system to residents. An evacuation site was established in Longmont at the Memorial Building for

evacuees of the fire. The Boulder Emergency Operations Center was not activated, but two staff members were supporting the IMT3 call out process and evacuation site efforts.

The City of Boulder Fire Department also was fighting wildfires during this time and into the afternoon along their western flank of the city.

The Marshall Fire Begins

At 11:05 a.m. the Boulder County Sheriff's 911 Center dispatched Mountain View Fire Protection District and Sheriff's Office Deputies to a line down near Marshall Road and Eldorado Springs Road. A fire had developed near that same area, and it spread rapidly in cured grass fuels (dry grass materials) with relative humidity around 20% and winds up to 100 mph. The fire, now known as the Marshall Fire, began consuming structures almost immediately. Resources were directed from the Middle Fork Fire at 11:15 a.m. due to the Marshall Fire starting. Fire crews discovered a shed on fire in the area and begin to attack the fire. The fire was spreading in other areas, but the spread initially was not detected because the wind was causing a tremendous amount of smoke, dirt, dust, and debris that concealed the fire's growth and direction. Once crews determined that the fire was spreading east, the fire attack broadened. Law enforcement began to call for evacuations immediately and started the door-to-door evacuation process. At 11:30 a.m. the Emergency Operations Center started to open, and notifications were made to Emergency Support Functions to activate for the Marshall Fire.

Evacuations were being done by deputies and fire firefighters in the area of Marshall Road, 76th Street, and Cherryvale Road. The 911 center saw a large increase in calls to report the fire and in calls for assistance. As the fire progressed towards the town of Superior and the large commercial area around Costco and Target, it was evident that the fire was going to significantly impact Superior and appeared likely to directly impact the city of Louisville. At 2:30 p.m., evacuation of Avista Hospital began. Evacuations continued, and coordination between the IMT3 and the Boulder County Law Branch was critical for successful evacuation of residents. As the evening continued, the devastation further extended into the town of Superior and the city of Louisville.

There were two fatalities during the Marshall Fire, one in the Marshall area and the other in the town of Superior. Both fatalities had been contacted by law enforcement during the evacuation process and advised to leave.

At approximately 6:30 p.m., the wind decreased to 25-30 mph and the fire behavior decreased in intensity and rate of spread. High winds continued into the evening, and by the morning of December 31 fire size was estimated at 6,000 acres.

The morning of December 31 brought a significant weather change: winds were less than 10 mph and snow was forecast for later in the day. The afternoon brought four to eight inches of snow which effectively stopped all forward spread of the wildland fire.

Summary of Events of the Operational Response

1024: Middle Fork starts and is drawing in fire resources and 15 deputies. Fire spreading quickly with high winds reported.

1105: Marshall Fire call is dispatched.

1123 Fire Command requests additional units to Marshall Fire. Fire moving east through property to homes.

1138: Evacuations start in Old Marshall and along Cherryvale north.

1150: Cherryvale Law Units begin evacuating South Vale and Wildflower Ranch.

1159: Fire begins running east down Marshall Rd. Middle Fork Incident Command calling for resources.

1200: BCSO fire command and law command tie in together and operational coordination established. Relocated ICP to 76th Street and Marshall Road.

1203: Fire is reported past water treatment plant moving at rapid rate toward Superior.

1206: Start evacuations for S 76th Sagamore, and Costco area. Flames reported at the back of Sagamore subdivision.

1215: Evacuation Orders issued through Everbridge system to unincorporated Boulder County and Superior and went to McCaslin. Door to door evacuations initiated for the next 30 minutes in the area.

1218: Costco evacuating, and fire is at Mohawk. Fire in parking lot of Costco and smoke obscuring everything.

1219: Flames have reached Sagamore.

1235: Mountain View Fire Department calls for Spanish Hills evacuations. Fire is there before evacuations.

1241: 911 Center started airing home addresses and was overwhelmed with reports.

1245: Fire reported behind Home Depot in Louisville.

1246: At 68th and South Boulder reports of fire in the area.

1250: Call for evacuations south of South Boulder Road also SCL Hospital evacuation, and McCaslin East to Sports Stable needs to evacuate.

1250: Decision is made to evacuate the entire town of Superior.

1256: Flatirons Mall contacted, and work started on getting access to use Nordstroms (closed/moved out) to take shelter from wind and set up ICP while waiting for Mobile Command Post.

1300: Law Division is established at Flatirons Mall. Teams are designated from arriving outside agencies for full Superior evacuation.

Teams of 10 are assigned radio designators of A-P and assigned to one of three tasks; Evacuations (overall evacuations of large areas), Critical or Tactical Evacuations (people needing help or in areas that had already been evacuated), and Road Closures/ Traffic control (including areas in Louisville).

1308 Louisville running operations and door to door evacuations.

1315: Mobile command post at the Flatirons Mall and the Law Branch was established boosting incident command from IMT3.

1402: Teams assigned to flush traffic eastbound only, at US36/ McCaslin and Rock Creek Pkwy/Coalton. Mountain View Fire assigned to help with evacuations at Urgent Care and then Avista.

1500: IMT provided planning, resource status, situation status, logistics, check in with divisions and branches, coordination with evacuation planning.

1520: Delegation of management of the fire to the Sheriff.

1530 Entire town of Superior Evacuated.

1537 Boulder Police SWAT Team assigned to assist Louisville with evacuations and began evacuating Zones 1, 2,3,4 and set their own staging at Monarch High.

1540: Delegated the fire to IMT3 as the Incident Commander.

1600: Delegated the fire to the state, evacuations and firefighting continuing.

1900: Wind shifting and making progress and the system started to catch up to the incident. South Metro Fire, North Metro Fire, Jefferson County Communication, State Emergency Operations Center and CO Division of Fire Prevention and Control all ordering resources.

2000 to 0700: The weather conditions are notably changed from the prior 9 hours. Fire crews continue to fight fires through the night. Evacuations continue door to door by law enforcement. Site access control planning begins to control access. BIMT continues to manage the incident and orders resources for the next day and completes incident action planning.

What Worked Well

Interagency Cooperation.

- Instructions and assignments were clear, and personnel knew exactly what was supposed to be done and were able to stay on the tasks at hand.
- Communications between multiple law agencies was effective because law enforcement had clear and concise information. Agencies used Law channel and cell phones for communication.
- Relationships with other agencies worked well. Pre-existing relationships, either from working on prior incidents together or through previous interactions, were great and key to operational successes.
- During extreme conditions and hardships not encountered on other incidents the commitment to work well together from all agencies was experienced throughout the operation.

Incident Command

- Establishing unified command by law enforcement with fire departments early on in both incidents increased effectiveness in making operational decisions and use of resources.
- Utility company presence and the development of a strong interface with the incident command post was effective in controlling utilities in the area, making it safe for first responders.
- IMT3 deployment and assumption of command added capacity to manage the complexity and escalation of the incident until the FEMA IMT1 team took the fire on January 1, 2022

Operational & Resource Management

- Assembling resources quickly and handing out assignments (from Longmont Police SWAT and Boulder Police SWAT) was critical to the effective door to door evacuations.
- Radio discipline within the law enforcement groups was excellent and prevented overloading operational channels preventing radio network failures. Personnel saved radio traffic for important information.
- There was great initiative. Numerous people saw a problem and took it upon themselves to rectify the situation as opposed to having to be ordered to. The ability to make decisions and resolve issues at the point of the problem created many operational successes and resolved significant challenges encountered throughout the incident.
- Diverting law and fire resources quickly from the Middle Fork Fire to the Marshall Fire assisted with bolstering the response to the Marshall Fire as resources were becoming scarce awaiting additional resources to arrive.
- The loss of life in any disaster is hard to accept, and tragically two people did lose their lives. Due to the speed of the fire spreading into multiple communities simultaneously the potential for many fatalities was present and fortunately did not manifest during this incident.
- Over 1,100 homes and businesses were lost in this fire, but thousands of homes were saved because of firefighting efforts.

Evacuations

- The initial alerts and warnings for the Middle Fork Fire and the Marshall Fire went out quickly and roadblocks were established immediately.
- Door to door evacuations needed to be executed immediately into the response and quickly throughout the Marshall Road 76th Street area. This included many residents and animals.
- Over 300 law enforcement resources assembled to perform door to door evacuations in Superior, Louisville, and unincorporated areas of Boulder County.
- The fire spread was so aggressive that in three locations it jumped Highway 36, which is a six-lane divided highway. The fire caused a traffic jam requiring all traffic to be re-routed by law enforcement.
- Traffic congestion was resolved at Coalton/Rock Creek by sending everyone east from Coalton in all lanes to Highway 36. This cleared out traffic jams in Rock Creek.
- Avista Hospital had to be evacuated in a short period of time due to the rapidly advancing fire. Through coordination of multiple agencies, evacuations were able to remove patients to other facilities. There was a phone call directly from an Avista Nurse (inquiring about evacuating the hospital). Having direct contact with employee from the facility provided real-time situational awareness for understanding the fire nearby. Due to information provided, the dispatcher advised to evacuate if in danger—same message provided to many callers.
- Multiple long-term care facilities also had to be evacuated at the same time. Residents were moved to other facilities due to effective facility emergency planning and transportation resources provided by ESF 1 Transportation.
- Additional dispatch staff brought into backfill, then identified a single dispatcher to manage evacuations and Everbridge.
- The Flatirons Crossing Mall provided a staging area large enough to support over 300 law enforcement personnel, 74 fire agencies and hundreds of fire personnel. This permitted an efficient incident base and operating space for the incident management teams operating the incident command post.
- The fire was moving faster than some of the evacuation orders could be developed and launched. Social media use by the community and messaging between the Town of Superior and City of Louisville assisted to provide messaging on social media about the fire.
- Communications to fire command was excellent between the 911 center to obtain information and relay critical updates.
- The evacuation of 37,500 people during a fast moving and multi-directional spreading fire in a relatively short period of time (3-4 hours) is unprecedented.

Communications/ 911 Center

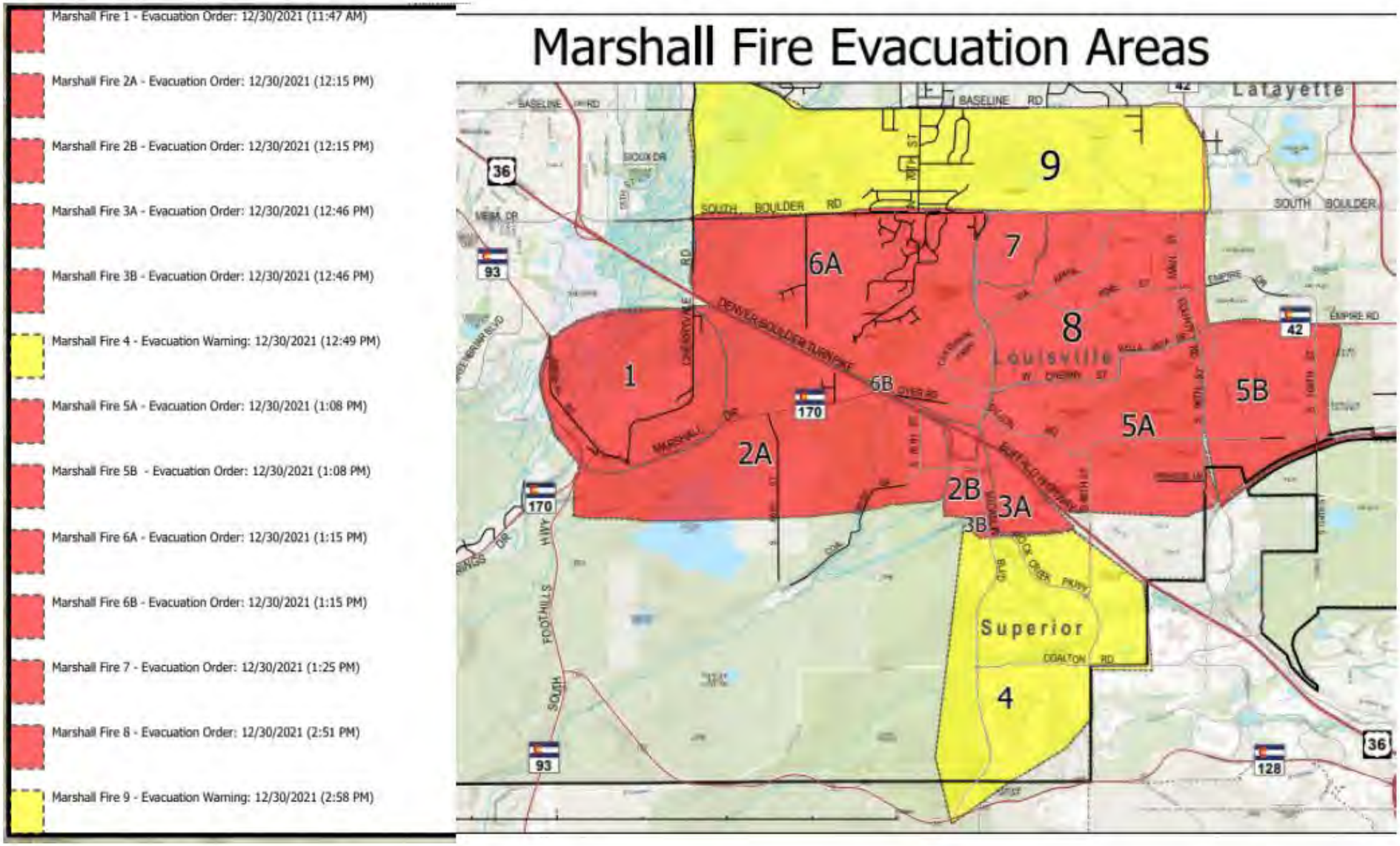
The Sheriff's Communication Center provides dispatching services for all law enforcement agencies in Boulder County except the City of Boulder, University of Colorado, and the City of

Longmont. In addition, the center also provides 911 dispatching and alert and warning services for fire agencies and rescue agencies in Boulder County. The 911 services and dispatching services for the Middle Fork Fire and Marshall Fire were managed through this center. The Middle Fork Fire already had supervisors of the communications center starting to arrange for additional staff due to the size and hazardous nature of the fire.

The additional staffing was present or was already enroute, due to the dispatch all-page sent for assistance during the Middle Fork Fire. Having these additional dispatchers added capacity by adding multiple fire dispatchers and one supervisor working the incident facilitated splitting roles and responsibilities. Back-up staff to assist with Computer Aided Dispatch for Fire and Law channels were also made available.

There was strong room awareness by dispatchers, considering we were working in a temporary location with less than half the space and different layout and consoles available. Incoming additional dispatchers knew where to go and who to back up. Additional supervisors were also available to make decisions and assist with dispatching, making concise and appropriate instructions to callers, specific to each situation.

Marshall Fire Evacuations Zones



Fire Response AAR Improvement Plan

Capability	Observation	Corrective Action Recommendations	Primary Responsible Agency	Agency POC	Start Date	Completion Date
Incident Command	Agency administrators were unfamiliar with the delegation process. Incident management team (IMT) Incident Commanders did not fully understand the multiple authorities and how to negotiate the relationship at times.	Agency administration meeting and training	Boulder Disaster Management	Mike Chard 303-565-7878 mchard@bouldercounty.org	May 2022	August 2022
Communications	Need to optimize communications between incident command and dispatch.	Facilitate operational discussion between Incident Command and Dispatch	Fire Consortium-Operations Committee	Boulder County Fire Chiefs (BCFC) Representatives and Steve Silbermann	TBD	TBD
Resource Management	County dispatch – resources, contact information	Verify all resources are properly listed in the dispatch centers and appropriate contact information is present.	Fire Consortium-Operations Committee	Bradshaw, Higgins, Beebe, BRETSA	May 2022	In Progress
Operational Coordination	Fire duty officer / Local resource coordinator (LRC)	Determine how to best staff this position and determine duties.	Fire Consortium-Operations Committee	BCFC Representatives to be determined. Office of Disaster Management Resource Management Section Chief	May 2022	In Progress
Planning	Structure Annual Operating Plan (AOP) model	Develop a structural model for response in the AOP for fires that start in wildland	Fire Consortium-Operations Committee	Seth McKinney and Brian Oliver	TBD	TBD

		/grasslands and move into urban structure environment				
Interoperability	Local 8oo MHz communications plan-	Need to develop a VHf and 800 MHz communications plan.	Radio / Communications Team	Scott Whitehead		April 2022

Law Response AAR Improvement Plan

Capability	Observation	Corrective Action Recommendations	Primary Responsible Agency	Agency POC	Start Date	Completion Date
Communications	Communications/ 800 communications plan	Develop 800 MHz Communications Plan	BCSO	Whitehead/ Wilber	April 12, 2022	April 2022
Operations	Rescue Task Force model for evacuations	Build Rescue Task Force model – a dedicated group that contains law enforcement, fire, and EMS that can be tasked as a group to handle projects/issues within the incident.	BCSO	Bonafede/ Wilber	April 12, 2022	In Progress
Incident Command	Consolidation of Incident Command/ Operations Directors earlier	Evaluate standard operating procedures (SOPs) and adjust support unified command or enhance command coordination earlier.	BCSO	Chamberlin / Wilber	April 12, 2022	In Progress

Evacuations	Controlling and maintaining intersections/ traffic flow	Ensure current evacuation policies and SOPs consider evacuation traffic patterns and cover traffic control objectives.	BCSO	Heathman	April 12, 2022	In Progress

AAR Improvement Plan Alert & Warning

Capability	Observation	Corrective Action Recommendations	Primary Responsible Agency	Agency POC	Start Date	Comp. Date
Emergency Evacuation Orders Using IPAWS	Evacuation orders or incidents involving imminent or immediate risk to life safety need to be managed by the 911 centers.	Wireless emergency alerts (WEA) /IPAWS integrated into 911 centers for use in immediate life safety situations.	911 Centers, ODM	Brian Zierlein, Steve Silbermann, Brad Riggins, Mike Chard	2021	April 2022
Multi-jurisdictional decision making	During a fast-moving incident having pre-established decision-making agreements will help with alert and warning challenges during response.	Hold meetings to develop agreements, or operational sop integration, or processes to facilitate multi-jurisdictional decision making.	Law Enforcement, Fire Agencies, 911 Centers, Disaster Management	Steve Silbermann & Mike Chard	May 18, 2022	Ongoing
Emergency Notification Database	Develop a database management policy or process within the Boulder Regional Emergency Telephone Service Authority (BRETSA) structure	Develop a database management policy or process with BRETSA 911 Centers that share the Emergency Notification System	BCSO	Steve Silbermann	June 2022	TBD
Polygons County Wide-911	Polygons exist west of HWY 36 and need to be expanded to other communities in the County East of Hwy 36 / 93.	Develop evacuation polygons for each community in Boulder County using existing systems or acquire proprietary software. Explore software options.	BCSO BPD 911, Longmont 911 Fire and law agencies.	911 center directors	APRIL 2022	TBD

Complex Escalating Response Environment-	During a rapidly escalating incident the ability to implement the concepts of unified coordination / command, staging and how to identify escalation is critical.	Need to continue to expand unified command process, how to manage escalation, staging and resource management.	BCSO, BCFFA, BCFC, Chiefs group	Josh Bonafede, Ops, Emergency Services, Fire Crew, 911 center.	May 2022	October 2022
Integrating with municipality Emergency Mangers & first responders to review alert and warning plan and evacuation planning for imminent life safety incidents.	Being able to leverage the local municipality emergency managers to assist with development of evacuation polygons and processes is needed.	Hold evacuation planning meetings and tabletop exercises with local municipal emergency managers and public safety leaders from each community.	Office of Disaster Management (ODM), 911 centers, fire and police agencies, local municipal emergency managers.	Mike Chard, Steve Silbermann, Brad Riggins, Kristine Mason, Longmont OEM, Kim Stewart, Pete Bradshaw, Dave Hayes, & BCSO	May 2022	September 2022
DHSEM Having Alert and Warning Support (IPAWS) Capability with the Boulder Sheriff 911 Center	During the fire Division of Homeland Security and Emergency Management (DHSEM) suggested they could assist to launch a WEA. Not acted on because no prior planning or ability to integrated with geotargeted evacuation zones.	Develop an agreement, process, and exercise cycle to develop and implement this capability with the DHSEM.	IPAWS Collaborative Operations Group (COG) Administrator 911 Center	ODM- Chard mchard@bouldercounty.org, 303-565-7878 911 Center- Steve Silbermann	2022	TBD

			DHSEM Field Manager	Kevin Keturich		
Siren activation	Sirens were not activated by first responders, sirens in area do not have a wildfire program installed.	Review siren use and activation process with first responders. Review with agency administrators if the siren programming needs to change.	ODM, BCSO, Towns and Cities, Fire Depts, Law	Mchard-mchard@bouldercounty.org 303-565-7878	2022	May 2022
Messaging	Create plan for multi-lingual messaging for alert and warning.	Explore funding for technical solutions during active messaging and translation services for outreach materials.	Dispatch and ODM	Steve Silbermann, Brian Zierlein, & Mike Chard	2021	Ongoing

AAR Improvement Plan Sheriff 911 Communications Center

Capability	Observation	Corrective Action Recommendations	Primary Responsible Agency	Agency POC	Start Date	Comp. Date
Alert and Warning	Develop policy surrounding alert and warning activation which allows for some autonomy of dispatchers to launch warnings if field units are too busy to request or cannot be reached.	Develop alert and warning agreements or procedures to streamline approval process	Dispatch, Operations Division and Fire Agencies	Brian Zierlein	January 2022	April 2022
Alert and Warning	Always have 1 dispatcher available for Everbridge/IPAWS launches.	Increase staffing (long term) and increase those trained (near term) to have this position in the 911 center	Dispatch	Brian Zierlein	2021	April 2022 and July 2022 for near term goal
Alert and Warning	Need to identify a consistent communication flow when Law and Fire ICs are not unified or making decisions in from the same location. Dispatch would get differing requests from Fire or Law resources. A proper ICS structure that supports efficient decision making and requests emergency notifications	Conduct escalating incident exercises with an emphasis on process development to ensure better operational coordination and or unified command.	Operations, ODM, & 911 centers	Steve Silbermann, Brian Zierlein, law and fire operations representatives & Mike Chard	May 2022	Ongoing

Operational Coordination	Review and develop processes for Info flow between LE Command Personnel on site and actively working dispatch alert and warning personnel. [NOTE: due to the temp location for dispatch, Law Enforcement Command Personnel could not fit in dispatch. Typically, they work from the dispatch floor]	Dedicate a liaison with IC structure within dispatch	BCC	Brian Zierlein & Steve Silbermann	June 2022	July 2022
Alert and Warning	Develop policy surrounding alert and warning activation which allows for some autonomy of dispatchers to launch warnings if field units are too busy to request or cannot be reached.	Develop alert and warning agreements or procedures to streamline approval process	Dispatch, Operations Division and Fire Agencies	Brian Zierlein	January 2022	April 2022

Louisville Fire and Police

Significant Events Fire

Early in the incident, visibility was extremely poor due to the high winds, dust, debris, and smoke. The scene was dynamic with lots of hazards to civilians and responders. It was challenging locating the fire at first, and once structures were involved, it began to grow exponentially. The heat coming off houses was amplified by the winds and hard to get a really good idea of what exactly was on fire and how to mitigate the spread. Crews reported that it seemed like every time they were feeling good about making a stop, a house down the street caught fire and potentially left them in a spot that would make their egress out of the area risky.

Initial responding crews describe the initial scene as chaotic saying that it was clear that the incident had exceeded their ability to control it early on. The fire was moving so fast that the wind reduced visibility and the ability to fight the fire significantly. There was nothing that could be done to stop it even with additional resources.

Conditions were deteriorating, with wind and heavy smoke in the area. As crews crossed over US 36 on McCaslin heading west, visibility was next to zero and they could not see the road or fire units responding in front of them. A decision was made to turn around and directed to go put out a small grass fire south of the skate park. This was around 1230 hours.

For a short time, traffic was blocked heading west on Via Appia in front of Station 2, and then a fire crossed the field toward Station 2. Crews ordered to drive into the field and deployed lines to fight the fire and efforts were successful.

Louisville Fire Protection District (LFPD) was advised by Chief Officers in the area to proceed to the area southeast of Louisville Station 2 and knock on doors to ensure homes had been evacuated. Upon arrival in the area near Pine Street and Nighthawk Circle and knocking on several doors, it appeared that the area had been evacuated. Crews did find a few citizens in the area, and all evacuated after being told to leave the area. It was determined that evacuations could be done in areas facing greater threat.

Louisville Fire units joined up with a wildland engine from Sable Altura and a Boulder Rural engine. Crews deployed wildland hoses and began fighting fires in the yards of houses along Trail Ridge Drive. The wind was so strong, it was difficult to stand up straight or open vehicle doors, etc. The crews put out small fires in yards, on decks, on fences, trees, but efforts were overcome. When conditions became too bad, crews moved with the strike team back a block.

Visibility was near zero continually, and responders feared striking parked vehicles. There were many times reported where crews were not sure where they were or what was their escape route. Crews encountered loss of water supply while handling multiple structure fires during the incident.

LFPD crews spent several hours driving on trails between houses in the neighborhood north of Station 2, putting out fires in yards and porches, while the rest of the strike team was hitting the fronts of the houses. Considerable time was spent putting water on the burning house at the northwest corner of W. Pine and Via Appia to keep the fire from spreading to other houses, which was successful.

Fire crews operating primarily between McCaslin and Tyler, north of Via Appia, reported that they experienced winds pushing fire from west to east at a high rate of speed. Homes and open space were burning quicker than crews could keep up with the fire spread.

In the Hillside Area, it was extremely windy, and the fire was blowing into back yards and crews were putting out hot spots. Multiple houses ignited, and the whole neighborhood was fully involved as crews shifted to evacuating the area. Fire crews experienced similar conditions the rest of the day at Cherrywood Street 2, and Mulberry. The wind finally calmed down late into the evening, and the crews were able to provide enough structure protection to stop the fire from advancing further down the street.

As fire crews progressed through the day, it became clear that being close to a hydrant and utilizing multiple master streams was the only effective tactic that even slowed the progression of the fire.

Winds died down around 2000 hours. Once the wind was reduced and other resources had arrived, crews were able to start making noticeable progress on the fire. At this point, limited relief crews, food, and other support resources started to become available.

Significant Events Police

Once notified of the fire, the Police Chief initially set up a command post in the briefing room staffed with a small number of other Police staff, and staff from Planning and Building Safety.

The Police Division Chief responding observed that the fire and smoke on Hwy 36 was extreme. Upon arriving in the City, the Police Division Chief immediately took command of law operations in Louisville. It took some time to get an appraisal of the situation and status of staffing. Initial objectives began with managing area and welfare checks. The fire had crossed Hwy 36 and spot fires were beginning to appear in Louisville and radio traffic was continuous. Officers began to report multiple structure fires. It was believed that the fire was moving northeast but other reports indicated the fire was traveling east on the north side of the city.

As the fire progressed in Louisville, the Police Chief had many conversations with Boulder County Communications Center staff regarding evacuations based on what was being reported regarding fire spread. The PD was working with BC Communications Staff to draw evacuation polygons (geographic areas) and execute the evacuations. The City was attempting to synchronize communications regarding evacuations with Boulder County Communications, but there were challenges in understanding timing around execution of evacuations. The Police Department was evacuating certain areas and setting up a command post at the King Soopers.

The Police Chief and City Manager made the decision not to evacuate all areas within the city immediately, but to phase them in an effort to limit traffic congestion. During the event the roadways did not have capacity for a city-wide evacuation without a staging component.

Communications on the radio was nearly impossible. Cell phone communication also proved to be difficult as cell towers quickly became overloaded, and calls did not always go through in timely manner.

Additional police resources were requested from Longmont Police for traffic control along South Boulder Road as evacuations were occurring. Police resources were directed to assist with evacuation traffic and Via Appia and eastbound South Boulder Rd was gridlocked. With the help of Longmont and Lafayette Police, direction was given to use any means necessary to allow traffic egress out of the city. The only avenues free from fire, at the time, was eastbound South Boulder Rd, eastbound Empire Rd, and eastbound Dillon. Several Larimer County Sheriff's Deputies were working notifications and door to door evacuations in the south end of the city directed by a command post that was set up in the Monarch High School parking lot. Later LPD staff made it the Flatirons Mall to work on unifying command.

What Worked Well

- People just showed up and made it work. Police patrol and professional staff were asked to complete tasks never assigned or trained for prior to the incident.
- Solid and safe decisions were made throughout, with no major injuries.
- Strong leadership made smart decisions, explained strategy, and kept personnel safe.
- Fire Station 3 - fire fighter rehabilitation was well stocked and organized
- Working with other agencies that we have never interacted with prior went very well.
- All crewmembers voiced their opinions on tactics, strategies, and safety, which helped everybody be on the same page.
- Decentralized decision-making was key to success during the fire. Radio communications were limited and being able to make decisions that were best for the community without prior approval was important. Able to communicate the "Leader's Intent" and allow line level leaders to innovate options to complete given their more informed position of conditions.
- 800 Radio system seemed to be strong with little gaps in coverage.
- No loss of life in Louisville.
- Many evacuations conducted including transport of individuals without transportation and those with special needs
- Door to door evacuations present throughout the incident. Strong coordination in the field and on the ground as door-to-door evacuations were rolled out.

- Traffic management assistance was requested and arrived quickly to provide some relief from evacuation and road-closure related congestion.
- Local staffing levels were adequate and surge resources came in quickly from regional law enforcement and fire agencies.
- Social media played a role in alerting people quickly of fire presence and need to evacuate.

AAR Improvement Plan City of Louisville

Capability	Observation	Corrective Action Recommendations	Primary Responsible Agency	Agency POC	Start Date	Comp. Date
COOP	No predetermined roles/expected actions for admin staff of PD and Fire Departments.	Develop staffing roles and procedures for administrative staff to support incident response.	Louisville Police and Louisville Fire	Chief Dave Hayes and Chief John Willson	July 2022	TBD
COOP	No plan for employee callbacks for Fire Department or Police Department. Those off duty did not know who to call or where to go. Police Department roster is continually changing but we have no current guidelines when more/all staff should be called in.	Develop call back procedures for Police and Fire staff.	Louisville Police and Louisville Fire	Chief Dave Hayes and Chief John Willson	July 2022	TBD
Operational Coordination	No defined strategy for the incident due to the rapidly unfolding event. The mission was never defined for Police and ranged from evacuations, welfare checks, to traffic control.	Develop rapidly escalating incident policy procedures and training program.	Louisville Police and Louisville Fire	Chief Dave Hayes and Chief John Willson	July 2022	TBD

Equipment	Inadequate Personal Protective Equipment (PPE), including eye protection and other protective gear necessary for the conditions encountered by both Fire and Police.	Assess personal protective equipment needs for response to high wind fire incidents and purchase.	Louisville Police and Louisville Fire	Chief Dave Hayes and Chief John Willson	July 2022	TBD
Equipment	No supply of sustenance (i.e., water/snacks at the stations to take along in rigs) to prevent exhaustion of firefighters and officers over the long duration of intense response activities. Patrols cars should be outfitted with "rehab" bags.	Need to create a 24-to-72-hour sustainability plan and purchase required supplies and equipment.	Louisville Police and Louisville Fire	Chief Dave Hayes and Chief John Willson	July 2022	TBD
Incident Command	Communication throughout the event was difficult. Numerous agencies using multiple radio channels, and multiple phones and other communication channels allowed for information to be missed.	Develop a radio plan for large scale incidents for police and fire departments.	Louisville Police and Louisville Fire Boulder County Communications Center	Chief Dave Hayes and Chief John Willson	July 2022	TBD

Operations	An earlier shift from firefighting to mass evacuations could have provided homeowners more time. However, with the fire jumping and not knowing the extent of each individual fire, firefighters were challenged in knowing where to evacuate first.	Provide controlled and specifically identified evacuations and communicate them clearly through multiple channels.	Louisville Police and Louisville Fire	Chief Dave Hayes and Chief John Willson	July 2022	TBD
Mitigation	Develop an understanding of the role and conditions of public lands and open space, and how that may impact emergency response for future events.	Participate in land management meetings and engage in mitigation planning.	Louisville Fire Department and City of Louisville Parks Department	Chief John Willson City Manager's Office	TBD	TBD
COOP	Keep COOP (Continuity of operations Plan) updated and relevant for a variety of events.	Update existing COOP for all departments	City of Louisville, Louisville Police and Louisville Fire Department	Emily Hogan Chief Dave Hayes, Chief John Willson	July 2022	TBD
Public Information	Be prepared to develop consistent messaging to the community, a strategic communications plan, a point of contact and a crisis communication plan. Ensure	Develop crisis communications plan and Public Information Office (PIO) plan.	City of Louisville, Louisville Police and Louisville Fire Department	Chief Dave Hayes, Emily Hogan, Chief John Willson	July 2022	TBD

	communication coordination points are in place.					
Public Information	PIO/ dedicated media contact appointed for disasters that can work across agencies (Fire and Police/City of Louisville).	Identify field PIO for Police and Fire Department.	City of Louisville, Louisville Police and Chief John Willson	Chief Dave Hayes Emily Hogan, PIO Chief John Willson	July 2022	TBD
Evacuation Communications	Need for communication from Boulder County Communications once evacuations are launched so the City can also push out the evacuation information immediately.	Identify primary points of contact for direct PIO during events. Establish communication protocols for when evacuations are launched through Boulder County Communications.	Boulder County Communications Center, City of Louisville, Louisville FD	Emily Hogan, PIO, Police Department, Fire Department	July 2022	
Evacuation Communications	Need for timely and coordinated communication channel updates regarding launch of evacuation orders (Boulder County ODM webpage, City of Louisville webpage, agency social media posts, etc.)	Identify primary points of contact for communication channel updates during events.	Boulder County Communications Center, City of Louisville, Louisville FD	Emily Hogan, PIO, Police Department, Fire Department	July 2022	TBD
Alert and Warning	Create pre-drawn evacuation area “polygons”, or distinct geographic evacuation areas that can be executed when a rolling/partial evacuation of the city is necessary.	Create a polygon system for Louisville for evacuation planning and response.	City of Louisville, Louisville Police and Louisville Fire Department	Chief Dave Hayes Ms. Emily Hogan Chief John Willson	July 2022	July 2022

Evacuation	Understand alternative evacuation route options based on potential disaster locations and associated traffic congestion impacts. Establish Public Safety Priority to prevent overcrowded cell towers-need during a disaster. Pre-prepare mass evacuation plan including control over traffic lights. Establish clear evacuation protocol and notification between Louisville Fire Department and Police Department/City of Louisville.	Develop an evacuation and traffic plan for Louisville.	City of Louisville, Louisville Police and Louisville Fire Department FirstNet or Verizon	Chief Dave Hayes Ms. Emily Hogan Mr. Chris Neves Chief John Willson	TBD	TBD
Incident Command	For large scale events, set up joint command with Louisville Fire. Define span of control land command structure in multi-agency event. Issue occasional "Recap/Status Reports" by dispatch to keep everyone on the same page.	Develop a large-scale incident command plan, provide training, and conduct exercises and drills.	City of Louisville, Louisville Police, and Louisville Fire Department Tabletop Exercise planned for June 2022	Chief Dave Hayes and Chief John Willson	July 2022	TBD

	Police and Fire to share daily line-ups with each other, including contact numbers to allow for single point contacts.					
Wellness	Mental Health/ self-care for employees, accessible during an event. Contact List/ Point of contact to stay in touch with significant others/ spouses.	Develop a rehab program for staff and a family and friends support network.	Louisville Police and Louisville Fire Department	Chief Dave Hayes and Chief John Willson	July 2022	TBD
Communications	Establish Public Safety Priority to prevent overcrowded cell towers- need during a disaster.	Contact First Net or Verizon to acquire capability for first responders to have priority communications	Louisville Police and Louisville Fire	Chief Dave Hayes and Chief John Willson	In-progress	TBD

Type 1 Incident Management Team

Significant Events:

- The term "unprecedented" has been overused in our culture. That said, this was truly an unprecedented situation. Long term drought resulted in historically low fuel moistures. Consider the time of year—December 30—with unusually warm daytime temperatures. And winds of up to 100 mph which carried the ignition quickly from a grass fire to a conflagration in which homes were the primary fuel and fire spread was from home to home. All attempts to halt the spread of this fire under those conditions were doomed to fail. Spread of this fire slowed and then halted only when winds subsided, and temperatures dropped prior to snowfall on December 31.
- Initial response to this incident included many mutual aid resources as well as other fire-fighting resources from various local jurisdictions.
- Some of the major hazards were numerous completely burned or partially burned single family and commercial buildings that included compromised powerlines, gas and water lines, congested road systems, sub-zero temperatures, and infectious disease.
- During an extraordinary initial attack effort, a significant amount of first responder equipment and supplies was damaged on the Marshall Fire. Many claims were settled locally, but larger claims for equipment will need to be settled by DFPC.
- On January 2, FEMA Administrator Deanne Criswell, US Representative Joe Neguse, US Representative Jason Crow, Senator Michael Bennet, the Governor of Colorado, and members of the Colorado cabinet viewed the damage caused by the Marshall Fire and response efforts to date. They met with incident management personnel, Boulder County staff, and members of the public.
- President Biden and First Lady Dr. Jill Biden traveled to the area on January 7 to view the damage caused by the Marshall Fire and response efforts to date.
- The Marshall Fire received national attention. The daily press conference held by the EOC, and Boulder County Sheriff answered many questions from the media and the public. IMT1 PIOs handled media requests from local, regional, and national outlets to assist the EOC/call center with workload.
- Liaisons facilitated a meeting between Xcel Energy, City of Superior, Louisville and Boulder County on January 1 to establish priorities for restoration of electric and gas services. Prior to the IMT1 arrival, coordination between parties was disjointed. Xcel located 2 key staff at EOC and Incident Command Post (ICP). This placement of Xcel Energy staff was instrumental in successful communication and coordination between municipalities. Xcel was able to complete gas recharging and electrification on the entire effected area by January 4, 2022.
- Cooperator meetings were conducted in conjunction with daily EOC calls with agency administrators and local stakeholders. Two key utility cooperators were added to the daily updates which efficiently and effectively allowed the team to share information and identify new issues.

Notable Successes:

- Early understanding that our typical standard metrics of success (e.g., percent contained) were not sufficient for this incident. The IMT1 developed an "all hazards" strategic operations plan which captured the needs of the Delegation of Authority and established several metrics by which to measure success. These included such activities as restoring gas and electricity, hazardous materials assessment, thermal imagining, etc.
- The incident and ICP were located one hour away from the Rocky Mountain Fire Cache which allowed for quick deliveries.
- Boulder County reacted quickly in ordering Team Rubicon to act as force multiplier in the Logistics Section. Team Rubicon performed as camp crew, drivers with vehicles, and filled other critical gaps.
- Caches of radio and radio accessories were quickly loaned to the IMT1 by the Boulder County Sheriff's Office, City of Boulder, Jefferson County Sheriff and SEOC.
- FirstNet arrived on scene quickly to enhance coverage and provide PTT phones and hotspots.
- The Avista Hospital worked with the IMT1 to install a portable repeater on their rooftop which ensured adequate radio coverage on the incident.
- The Communications Unit was setup in the Boulder County Sheriff's Office Mobile Communication Post and the City of Boulder's Police Communication Van equipped with radios, self-sufficient power system and a quiet work environment. The command truck enabled quick activation of the Communication Unit, a critical need for firefighter and first responder safety.
- The Fraternal Order of Police provided first responders breakfast, lunch, and dinner for many operational shifts with donated personnel, equipment, and food.
- Staffing an Infectious Disease Specialist to focus on COVID mitigations and compliance was appreciated by all responders. The availability of rapid test kits helps to ensure personnel testing was available.
- Boulder County EOC was in place when IMT1 received command of the incident. Information was maintained by the County with IMT1 working to support and share information through EOC. Twice daily calls and having a PIO Liaison in EOC helped facilitate information sharing.
- Messaging was drafted by PIOs after meeting face-to-face with law enforcement, incident operations managers, and structure assessment personnel. This allowed the messages to be created in a timely and efficient manner as well as being responsive to emerging events.
- The IMT1 staffed one COVID advisor who was supported by one assistant. Personal COVID tests were made available to all incident personnel. Positive tests were identified with both direct and indirect support personnel.

Challenges and Resolutions:

Challenge: All hazard incident within an urban setting managed with wildland resources. For example, having the proper resources to deal with "HazMat" calls. Most wildland resources are unfamiliar with what constitutes an actual "HazMat" situation and what does not.

- Resolution: Utilization of the right resources to complete the mission safely was key. Emphasized, during daily safety briefings, the importance of having properly trained and equipped resources before engaging in operations. Colorado Surge Engines and Boulder County Hazardous Materials Consortium were key resources in this regard.

Challenge: 800 MHz radios, during the beginning of the incident. Not all resources were familiar with the radios or the system, this made it difficult to convey information with resources and dispatch 911 calls.

- Resolution: Utilized group texts to ensure information was received.

Challenge: Tracking and filing financial paperwork for overhead and equipment without resource orders is always challenging. Lack of information led to more estimating (instead of actuals) for cost calculations of initial attack and mutual aid resources.

- Resolution: Division of Fire Prevention and Control (DFPC) assisted Finance with locating and developing resource orders (where appropriate) to create a relatively accurate record of responding resources. Where paperwork exists, complete financial records were created and sent home with resources.

Challenge: Initial tracking of approximately 300 resources, 150 of which were engines. These resources largely consisted of surge and mutual aid resources.

- Resolution: Ordered a virtual Resource Unit Leader (RESL) who was able to reconcile and enter the data on an Excel spreadsheet collected by the Type 3 team. The resources that stayed on the incident were given 5000 and 6000 numbers in e-ISuite and displayed on the 204s to help separate them from other resources and assist in financial tracking.

Challenge: It was a holiday weekend, so we were unable to get the copier/scanner we ordered for a couple days after we arrived.

- Resolution: The jail was able to support us with printing the required number of Incident Action Plans (IAPs) until a rental copier was delivered to ICP.

Challenge: The winter storm prevented travel of some IMT1 members and delayed travel of others.

- Resolution: We were able to bring in some local people from other IMTs to assist us in management of the incident.

Challenge: An experienced federal incident Buying Team was not ordered with the IMT1.

- Resolution: The Boulder County EOC acted as the Buying Team and provided the IMT1 with a process to order local purchase items.

Challenge: Approval of releases related to resident re-entry was challenging due to the number of reviewers at the EOC in addition to PIOs from City of Louisville and the Town of Superior. Initial releases were going out several hours after re-entry occurred delaying public notification.

- Resolution: IMT1 PIO requested one point of contact as "primary reviewer" for each entity. The primary reviewers were sent the release and could review and get input from others, if necessary, but it streamlined who was to respond as final reviewer. Streamlining the review process facilitated more timely information sharing.

Challenge: PIO Roles at EOC changed daily and IMT1 PIOs never knew who was in charge each day as the reviewer or primary contact. Roles were not clearly defined and transparent.

- Resolution: PIO Liaison to EOC talked to EOC staff and made recommendations for ways to streamline coordinated tasks and lend stability to the information operation despite changes that happened out of necessity. After that, roles stayed static as much as possible which helped process.

Challenge: Infectious disease protocols and measures in a traditional ICP setting.

- Resolution: Emphasized infectious disease risk mitigations such as mask use, social distancing, and good hygiene. Improved configuration of ICP and food lines, virtual options for briefing, and increased field briefings limited the number of personnel that congregated at ICP. The assigned COVID advisor acquired sufficient COVID test kits to make them available to all resources. Sanitizing wipes and hand sanitizer were available at individual workspaces

Boulder EOC AAR for Marshall Fire

The Boulder Emergency Operations Center (EOC) is the coordination, support and disaster management center for the City of Boulder and Boulder County. When a large-scale emergency or disaster occurs, the center is activated by the Director of the Office Disaster Management. The activation of the EOC takes time to bring all systems online once the initial request to activate the EOC goes out. The Office of Disaster Management Staff must arrive at the EOC within 1 hour of notification, launch notifications to emergency support functions, and start to gather information for briefings. A core or full activation occurs within the next 2-3 hours. The EOC is operational sometime during the next 2-3 hours but full integration with incident command usually takes an additional 1-2 hours. EOC activity is high during this period of the response as the need for sheltering, transportation, public messaging, developing situational awareness, setting up a call center and resource ordering are needed in all disasters.

The Incident commander manages the operations associated with crisis management particularly life safety, stabilizing the incident and property / environmental preservation. The EOC supports the established incident commands, coordinates with jurisdictional authorities, and handles all the consequence management needs through the emergency support functions that make up the Boulder Multi-Agency Coordination System (MACs).

The Multi-Agency System delivers capabilities needed to manage a disaster and is comprised of resources from Boulder County, the City of Boulder and other municipalities, non-profit organizations, Volunteer Organizations Active in Disasters (VOADS) and private sector organizations.

The EOC will stay activated through the response phase of the disaster and once the incident commands demobilize the EOC manages the transition into a recovery structure.

Emergency Support Functions (ESFs) activated during the Marshall Fire response.

EOC Director	Support agency administrators, coordination of jurisdictional authorities, EOC manager back up and Interface with Incident Management Teams
EOC Manager	Manages all systems, functions, and resolves problems associated with the operation of the EOC.
Situational Awareness Section	Develops and maintains situational awareness, conducts briefings and interfaces with IMT Planning
ESF 1- Transportation	Evacuation support
ESF 2- Communications and BCARES	Shelter communications and cellular system status.

ESF 3- Public Works	Infrastructure impact response
ESF 5- EOC	Operate the EOC DMS
ESF 6- Mass Care	Shelter and human needs
ESF 7- Resource Management	Order response resources, feeding, support equipment and personnel.
ESF 8- Public Health	Coordinate medical facility needs and access functional needs at evacuation sites and in shelters
ESF 11- Natural Resources	Address Parks and Open Space issues.
ESF 12- Energy	Coordinate power and gas response
ESF 13- Public Safety	Establish connection and coordinate with incident commands
ESF 14- Impact Assessment	Estimate impacts to the community and develop reports.
ESF 15- PIO	Message the community support alert and warning messaging and press requests.
ESF 18- Education and Schools	Coordinate school operations and provide bus resources for evacuation.
ESF 19-Volunteer and Donations Management Resource Management	Coordinate spontaneous volunteers and VOAD groups along with public donation processes.
ESF 21- Animal Management	Manage all animal evacuation needs.
ESF 23- Community Engagement	Monitor community needs and assist with establishing community meetings.
ESF 25- Meteorology	Work with the NWS to provide current forecasts and threat assessments.
ESF 26- GIS	Provide all GIS needs for the disaster response.
Call Center	Operates a call center the community to access instead of 911 centers for information.

EOC Highlights & Timeline First 12 hours

1132: First posting by ODM Staff of Middle Fork Fire and evacuations being ordered. Boulder IMT Notifications sent.

1139: The EOC activation notification sent ODM Staff in the EOC working.

1201: South Boulder Rec Center is evacuation point.

1210: ESF 6 Mass care advises Evacuation Point is Longmont Senior Center for Middle Fork Fire.

1230: Moving IMT to Flatirons Crossing and working on land use agreement.

1246: First EOC Briefing conducted indicating core emergency support functions are active.

1321: ESF 8- Public Health advises Avista is evacuating due to smoke.

1343: YMCA is new evacuation site in Lafayette

1345: EOC Briefing #2 Conducted

1352: ESF 1 Transportation deploying resources to Avista to assist with evacuations. Supporting evacuations from residences and facilities.

1356: Call center is activated

1513: EOC Briefing #3

1516: South Boulder Rec is closing, and North Boulder Rec is new evacuation site.

1600: EOC Briefing #4

1657: YMCA in Lafayette, North Boulder Rec, Fairgrounds open for animals and COVID Patients can go to the CRC shelter.

1717: ESF 1- Transportation is starting to increase activity from moving people from private residences and continuing to assist with long term care facility evacuations. This continues for the next 2 -3 hours.

1800: EOC Briefing

1852: Rocky Mountain Christian Church opened in Niwot as a Shelter by the Red Cross

1936: Boulder Fairgrounds at capacity coordinating with Larimer and Jefferson County to open fairgrounds to handle animals.

1945: EOC Briefing #5

2130: EOC Briefing #6

2154: ESF 1 Transportation holding drivers on standby for evacuations if needed overnight.

2200: Middle Fork Fire turned over to Lefthand Fire from the Boulder IMT Incident Commander.

2245: EOC Briefing #7

0130: EOC placed in a tactical pause until 0600 the next day.

EOC activation period: December 30, 2022, to January 17, 2022

Over What went well themes:

- Remote/hybrid EOC worked well due to the amount of practice with it since 2020. Remote briefings and WebEOC were mentioned frequently as effective coordination tools.
- Integration with partners, especially the state, neighboring counties who assisted through mutual aid, and utility companies.
- Despite prolonged incident fatigue, many people mentioned that they felt supported, that people showed up when they needed to, and helped with the overwhelming needs of this incident.
- System of the EOC worked well; remote briefings worked well.
- Sheltering: standing up 3 shelters on first day to deal with unknown capacity
- EOC resource ordering available and ready staffing; people had previous experiences needed to execute the heavy lift ordering resources.
- Structures/relationships in place due to the pandemic and other disasters.

Comments on hybrid and remote coordination tools:

WebEOC

- All respondents found WebEOC very useful or useful with only minor issues.
- In interviews, some sections reported that their systems are not in WebEOC, so they relied on Teams instead (e.g., resource mobilization, donation management).
- People suggested refresher training on WebEOC, especially as not all ESF boards are nested under the same menus, some people need access to multiple ESFs ESF 1 / 3.
- WebEOC does not display as well on phones, so it was difficult to access from the field.

Situation Reports

- Overall, Sit Reps were described as useful and particularly useful if information was missed on a coordination call, or as a later reference after coordination calls.

Zoom Briefings

- Respondents found virtual briefings very useful or useful with only minor issues.
- Interview participants similarly found virtual briefings very helpful.
- Suggestions included:
  - Define attendance expectations for those with limited roles.
  - Remind participants of the CAN structure at the start of each meeting and that ESF leads are sharing information.
  - After the first few day's briefings were too frequent.

Public Information Map

- Respondents said the public information map was very useful or useful with only minor issues.
- In interviews, some ESFs said they did not need to use the map. The most common usage reported was to provide information to the public.

Overview of Work by ESF:

EOC Manager

- Limited space in the EOC was a challenge, along with staff being remote.
- Quickly understood the scope of this disaster and began working to bring in partners and conducted impact assessment based on best estimate.
- MAC Group partners and ESF capabilities responded quickly as many personnel were off duty or on leave.
- Frequent briefings helped to maintain situational awareness of EOC efforts.
- Difficult to obtain situational awareness of the fire's location, evacuations, and operational efforts until late in the afternoon.

Call Center

- Call takers felt supported by managers and remote call center was effective
- Training and call center FAQ page were helpful
- Securing call center licenses created a lag in bringing in new call takers
- Consider staggering the shutdown of the Disaster Assistance Center and Call Center

ESF 1 (Transportation)

- Had good responsiveness from the transit partners and Via to help with approximately 100 evacuations in less than 12 hours
- There was a bit more of a lag to get CU buses or RTD buses--CU was in part due to the winter break, same with school districts
- Decided to pull services out of Boulder so that operators would be ready to assist, this was helpful during initial evacuations
- This unfolded so quickly that transit partners were going down streets with roadblocks, navigating near fire
- Getting information about fire conditions on the ground was difficult due to changing conditions
- Need to make sure that everyone has WebEOC information and is ready to log in

- Staffing was a challenge due to the holiday
- Had experience from Calwood Fire, it was helpful to have that before this more intense event
- Via will do more emergency training for operators, might need a way to support them in dangerous areas or in the face of roadblock, have a debriefing with Via about their perspective

ESF 2A: BCARES

The Marshall Fire resulted in the activation of the BCARES EOC radio communications position including the establishment of communications with ESF-5 Situational Awareness, ESF-6 Mass Care, and ESF-13 Public Safety for the duration of the activation. As the Marshall Fire expanded, evacuation center support was requested for the following evacuation centers: YMCA – Lafayette, North Boulder Recreation Center – Boulder, Rocky Mountain Christian Church – Niwot.

These BCARES operational positions provided on-site situational reports (SIT-REPS). These reports were obtained using the BCARES digital messaging system (*WINLINK*) with remote stations established at each evacuation center. Hourly status reports were submitted on ICS-213 forms to ESF-6 Mass Care in concert with the hourly EOC briefings.

Element # 1: Activation of the BCARES ESF-2A BCARES Position at the Boulder County Emergency Operations Center. (Initial activation)

Element # 2: Activation of the following radio networks within Boulder County: BCARES Radio Network – Primary Net, Mountain Emergency Radio Network (MERN), Allenspark Neighbors Emergency Network (ANEN) and Airlink (Alternate Access Radio Network).

Element # 3: Establishment of BCARES voice and digital messaging communications capabilities at each of the reporting and evacuation centers. Evacuation Centers YMCA – Lafayette, North Boulder Recreation Center – Boulder, Rocky Mountain Christian Church – Niwot.

Element # 4: Activation of the Mountain Emergency Radio Network (MERN) covering mountain communities due to high wind event.

ESF 3 (Public Works)

- People were ready to help, City of Boulder assistance despite lack of impact was helpful.
- Utility restoration went well and proceeded quickly, good collaboration with utility partners.
- Need to develop a stronger connection between resource mob/public works to document mutual aid.
- Need to keep personnel connected in the transition from response transitions to recovery.

- Guidelines on record keeping and notetaking for those new to the EOC would be helpful.

ESF 5 (Situational Awareness)

- Coordination and getting people connected after briefings went well.
- Could do more automation to lessen the load, for example, shift lists could be automatic in WebEOC.
- Need to consider ways to update the Incident Display Board; possibly use a location in WebEOC.
- Did well with scheduling briefings, ESFs did a good job using CAN structure
- Give people publishing the sitrep a break from other duties to focus on creating that at the end of the day.
- Remind people of CAN structure (perhaps in MACS meeting ahead of time) on briefings and that the leads present out so that others from each section know their role is to listen.
- Establish a workflow for SAS staff so that they know which information to gather at various points throughout the day as it is updated.
- Establish a common file naming system starting with date.

ESF 7 (Resource Mobilization)

- Remote ordering system continued to work well.
- Uncommon and large orders involving partners (water, heaters) but we adapted quickly.
- Resource mob staff was using personal vehicles to pick up resources, need a different system for this.
- Ability to work remotely was helpful.

ESF 6 (Mass Care/DAC)

- Shelters set up quickly, but bench was depleted for shelter leads. Need more training so that we have more people ready to take leadership roles. Would be good to do more public outreach between events to get volunteer sign-ups that we can use during emergencies.
- Second part of sheltering went well and was adequately staffed.
- Mental health partners at shelters were helpful.
- Shelter partnerships between the facilities, ODM and Red Cross could be ironed out more, especially with new shelter sites.
- We have a standing MOU with Red Cross to get intake information about shelter occupants, but this agreement needs to be reviewed.
- ESF 6 Incident Managers were responsive and helpful. Incident Manager and Liaison should both be in EOC in person during the intense part of the incident.

- The DAC leads should assign people to specific roles/responsibilities and make connections to the EOC. The policy team was making management decisions and staffing roles instead of making policy-level decisions. Should have streamlined ordering through the EOC.
- Need to update DAC training materials and "DAC in a box" with relevant supplies.

ESF 8 (Public Health)

- Hospital evacuation was successful despite rapidly unfolding situation.
- Partnerships with long term care facilities were strong due to pandemic.
- ESF 6/8 connection could be strengthened, especially about planning, when preoccupied with evacuations could have moved ESF 8 liaison role to the EOC.
- Clarifying the abilities of the EOC with the hospitals so hospitals understand that they should coordinate with the IMT initially.
- The EOC truck will be helpful to move available supplies to shelters quickly
- Should have anticipated that mental health support would have been needed at shelters.
- A deeper bench was needed.

ESF 13 (Public Safety)

- See the Fire and Law AAR.

ESF 14 (Damage Assessment)

- Damage assessment occurred quickly and worked well with law enforcement liaisons.
- Crisis Track software support was key--work to establish contract for this ahead of incidents.
- Team Rubicon assisted with wind damage assessment for mobile home communities.
- City of Boulder helped support other jurisdictions.

ESF 15 (PIOs)

- Emergency Services PIOs of Colorado were able to help with staffing during the incident, very helpful.
- Translation team worked well with PIOs getting Spanish translation messaging out almost simultaneously.
- Utilizing Teams worked well to keep PIOs integrated once the snags of involving outside agency personnel.
- Significant amount of messaging pushed out on social media and blog for the entirety of the incident went well.
- 5 different media briefings with American Sign Language services.

- Need to rebuild PIO bench so that PIOs can fulfill needs and rotate in/out.
- Mutual aid helped greatly with filling PIO spots, having the relationships to get help.
- Consider a designated media liaison specially to answer local media questions.
- Need to capture questions and answers from the live briefings and post them.
- Would be helpful to create public awareness about ODM in between events so that public/media knows what ODM does.
- It took time to get PIOs access to the various platforms, passwords created issues when bringing in non-city/county staff.

ESF 19 (Volunteer/Donations)

- Donation button on the OEM website worked well once set up and exported into Excel, entering donations manually was time-consuming. Overwhelmed by spontaneous donations, this improved once we identified what donations would be most helpful.
- Available donations list could have been more organized to check for resources.
- Community pick up point (for water, heaters) should be separate from shelters, ESF 6 ended up dealing with donations.
- Consider if accepting used items would be beneficial (more ecofriendly).
- Requested state activate their MOU with the Adventist Church, they stood up a donation center quickly.
- Need to create a planning document and circulate in the morning so that everyone is on the same page.

ESF 21 (Animal Control)

During a disaster the Emergency Support Function (ESF) 21 Animal Management is notified to respond. The actual Sheriff Animal Management Officers operate under the incident command structure developed. All animal shelters are managed under the EOC management structure until the need is resolved usually once residents are allowed back into evacuated areas or other arrangements are in place. The resources of ESF 21- Animal Management are from the Sheriff's Animal Management Team, City of Boulder Animal Management, NCR Animal Management Committee, Boulder and Longmont Humane Society, and Boulder County Fairgrounds Staff.

During the Marshall Fire ESF 21 Animal Management evacuated hundreds of animals domestic and large agriculture animals. They also coordinate animal reunification processes for evacuees who are separated from their animals. Lastly, ESF 21 animal management also manages the decedent animals found as result of the disaster.

Response Overview

- Animal Control Officers were activated immediately and requested our volunteer Sheriff's Office animal evacuation team. Additional resources called included neighboring Animal Control teams and national partners that are locally based.
- Animal sheltering partners were notified immediately: Humane Society of Boulder Valley, Longmont Humane Society, Boulder County Fairgrounds. Within hours notified neighboring partners: Jefferson County Fairgrounds and Animal Control and Larimer the Ranch Fairgrounds. The State Veterinarian made contact within that first operational period to extend support.
- Boulder Office of Disaster Management decided to publish a Survey 123 questionnaire on social media to request animal evacuations. This relieved call load on dispatch and call center.
    - Received 183 requests through the survey and became multi-jurisdictional quickly.
    - When we ended it on day 3, we transitioned to a link for reporting lost pets on the Humane Society website.
    - It was difficult to manage the public, there was a Facebook page called "Boulder County Fire Lost & Found Pets", but it was not managed by any official partners. Many members of the public also drove to the fire area to attempt to rescue animals. Rescued animals were taken to shelters outside of local jurisdictions, which made it difficult to pay for services and locate owners.
    - It was difficult to track numbers of animals evacuated and deceased.
    - Need animal preparedness throughout our communities and not just in mountain areas that expect wildfires.

Day 2 Response Planning

North Central Region All Hazards Planning Area (NCR) Animal Emergency Committee convened on day two. Efforts continued daily over the next week. The leader of North Central Region All Hazards Planning Area (NCR)- Animal Evacuation Committee took amazing notes and distributed a spreadsheet daily for notes and resources. The planning group added additional partners to meetings from neighboring agencies that are not part of the NCR. State ESF 6 Mass Care & ESF 11 Natural Resources & Agriculture were represented at this meeting and at the other mass care meetings, donations, and volunteer management meetings to make sure animals were included in the planning processes.

During the planning meetings planning occurred to address sheltering needs for companion animals and livestock and other agricultural issues: feed/backyard animals (cows, chickens, and bees), hay/feed options, carcass disposal (planned for large-scale mortalities), and soil issues. Coordinated with a local partner agency, Colorado Horse Rescue, to manage a hay bank for

affected livestock owners. They also had limited financial support to rebuild fences and shelters.

Discussed options for animal rendering and small animal cremation. Local Humane Societies offered free cremation to families if deceased pets were found on properties.

CSU Extension modified an existing guidebook for community members about what to do after a disaster that included several pages about animals.

ESF 21 arranged for staff at the Disaster Assistance Center animal table with volunteers/staff and provide pet food.

ESF 22 (Cultural Resources)

- The planned activities went as expected and included comparing perimeter map with known or potential historic resources, talking to community members about the resources in their areas.
- Remote work was successful.
- There were few people available to staff the position and a need to play a role with ESF 14.

ESF 23 (Community Engagement)

- Translation services and sign language services went well.
- Could use more time before public briefings for translators to see content of those briefings.
- Town Hall came together quickly.

ESF 25 (Meteorology)

- There were strong relationships in place already.
- NWS could have provided a spot fire forecast if asked.
- Need to prepare for fires on high wind days whether we meet red flag parameters or not.
- Anticipated a request to active EAS.
- Could use single office WebEOC login, if allowed.

ESF 26 (GIS)

- Many folks stepped up to volunteer for shifts.
- The GroupMe callout for staffing was not received by many people so there were not many volunteers to staff initially.

- Need more training so that GIS staff feel more comfortable volunteering to take shifts.
- There was some lack of clarity on the purpose of the public information map and what to include and leave out. GIS should predetermine what will be included and excluded.
- Teams caused some issues when switching between city and county channels.
- Communication around road closures is still poor. Need to determine a standard for displaying road closures ahead of time.
- Need others to have editing capability for SAS map.

AAR Improvement Plan EOC

Capability	Observation	Corrective Action Recommendations	Primary Responsible Agency	Agency POC	Start Date	Comp. Date
EOC Staffing	Many ESFs mentioned the state of turnover of government employees and that institutional knowledge had been lost in recent years. Many ESFs stated a need to build a deeper bench of staff so that ESFs could rotate in and out and rest.	Perform recruiting program and provided on-boarding training and exercises. ODM staffing levels: 2 people not being here right away slowed down setup time, need more staff and staffing PIO capability depleted due to personnel changes (ESF 15); didn't do media inquiries because of this	Office of Disaster Management	Mike Chard mchard@bouldercounty.org 303-565-7878	In progress	Recruitment program completed in 2022. Start training programs in late summer or early fall 2022
Public Information	Issues related back to public communication, include alert/warning messaging and communicating with local media.	Need to develop automated or enhanced messaging on website and social media to support alerts while EOC is activating.	Office of Disaster Management	Mike Chard mchard@bouldercounty.org 303-565-7878	In progress	May 2022

		Need to examine ESF 15 and field PIO interface, also more PIO for media inquiries during EOC activation.				
Multi Agency Coordination	This incident impacted unincorporated parts of Boulder County, so there was some negotiation of how to help the various impacted areas and how to coordinate across partners with Superior and Louisville.	Needed to hold a MACS Agency Administrator meeting to develop pre disaster agreements on how to interface communities form response into recovery.	Office of Disaster Management	Mike Chard & agency administrators mchard@bouldercounty.org 303-565-7878	July 2022	August 2022
EOC Operations	The variety of technologies available to check-in led to some platform fatigue.	Need to deploy new WebEOC system -More training on Crisis Track for DA before event	Office of Disaster Management	Mike Chard mchard@bouldercounty.org 303-565-7878	In progress	2022-2023
EOC Operations	Being remote reduces situational awareness Need clearer liaisons/plans with some other ESFs More staffing/longer	Further define the liaison problem and develop solutions. Work on ESF recruitment	Office of Disaster Management	Mike Chard mchard@bouldercounty.org 303-565-7878	June 2022	Dec 2022

	term staffing					
Public Information	The most common issues reported were that the maps caused issues for homeowners trying to submit insurance claims, and the map of utility outages was not up to date, so people stayed in shelters for longer than necessary waiting to confirm their utilities had been restored.	Suggestions included: Make the map easier to find on the website with a single click. The map should not stop at our county line when incidents are multijurisdictional.	Office of Disaster Management ESF 15 GIS	Mike Chard mchard@bouldercounty.org 303-565-7878	June 2022	TBD

AAR Improvement Plan ESF 21 Animal Management

Capability	Observation	Corrective Action Recommendations	Capability Element	Primary Responsible Agency	Agency POC	Start Date	Comp. Date
EOC Staffing	No lead in the EOC due to short staffing from partner agencies and no trained volunteers.	Develop staffing for EOC / ESF 21 Position	EOC Operations	BCSO and COB	BCSO-Sara Spensieri 303-859-0408 COB-Jennie Whittle 720-447-6023	3/1/22	August 2022
Training for ESF 13	ESF 13 Law enforcement had a representative	Develop ESF 13 Public Safety Training	EOC Operations	BCSO and COB	BCSO-Sara Spensieri 303-859-0408	June 2022	July 2022

	who was helpful but not entirely trained.	program for ESF 21 support.					
GIS Support for Survey 123	Still working with GIS to work out the kinks in the mapping process with Survey 123. This caused frustration.	Get with County GIS staff to work through work processes.	EOC Operations	BCSO County GIS	BCSO-Sara Spensieri 303-859-0408 GIS Molly Watson	1/24/22	2/28/22
GIS Support for Survey 123	Still working with GIS to work out the kinks in the assignment process with Survey 123. This caused lots of frustration to first responders.	Get with City and County GIS staff to work through work processes and notification requirements.	EOC Operations	BCSO County GIS City GIS	BCSO-Sara Spensieri 303-859-0408 GIS Molly Watson	1/24/22 County IT	In Progress
ESF Coordination	ESF 21 had no direct contact with ESF 6.	ESF 21 needs to develop connection / integration process for regional and state resources with ESF 6 Mass Care.	Operational Response	BCSO and COB	BCSO-Sara Spensieri 303-859-0408	June 2022	July 2022
Agriculture Assessment	Not sure how to do a quick agriculture damage assessment, nor how to reach ag partners with specific	Develop an impact assessment process for agricultural affected businesses, farms, or animal populations.	Impact Assessments	BCSO and CO Dept of Ag	BCSO-Sara Spensieri 303-859-0408 Dept of Ag-Dr. Maggie	TBD	TBD

	resources (FSA, USDA, Farmers.gov)				Baldwin 720-668-2050		
Disaster Assistance Center capability	Need a DAC go kit and to have a better staffing plan for an animal table.	Develop a go kit standard also identify staffing.	Mass Care	BCSO and HSBV	BCSO-Sara Spensieri 303-859-0408 HSBV-Jan McHugh-Smith 719-330-1402	TBD	TBD
Preparedness and COOP	Recognized a shortfall in PACFA for animal facilities, they need an official emergency plan for all animal daycare/boarding places and animal hospitals.	Develop a COOP standard plan for animal facilities to use along with emergency plans	Preparedness	PACFA Dept of Ag	Program Section Chief: Nick Fisher 303-869-9146 And HSBV-Jan McHugh-Smith 719-330-1402	2/1/22 Jan HSBV	In Progress

AAR Improvement Plan BCARES

Capability	Observation	Corrective Action Recommendations	Primary Responsible Agency	Agency POC	Start Date	Comp. Date
Activation of BCARES Net	Activated at 1500 hours with adequate staffing for the first operational period.	None currently	BCARES	Emergency Coordinator & Chairman abishop1150@comcast.net (303) 437-7835 mobile	TBD	
Activation of ESF-2A Position	Allowed BCARES to get ahead of the mission growth curve early on.	None currently.	BCARES	Emergency Coordinator & Chairman abishop1150@comcast.net (303) 437-7835 mobile	TBD	
Establishment of ESF reporting	Using ICS Form 213, hourly reports were provided to ESF-6 as evacuation center populations Continued to grow.	Refresher training on use of ICS forms.	BCARES	Emergency Coordinator & Chairman abishop1150@comcast.net (303) 437-7835 mobile	TBD	

	The 213 forms were not filled out correctly. Date and time stamps were not filled in, resulting in the lack of ability to chronologically list the 213s as they were sub-mitted.					
Situational Status reports	The MERN networks were activated without delay due to the presence of BCARES members already in place at the mountain residences. The amount of voice traffic at times tended to overwhelm the primary BCARES net.	Additional staffing will have to be committed to early on so that a "Resource Net" can be established as radio traffic increases	BCARES	Emergency Coordinator & Chairman abishop1150@comcast.net (303) 437-7835 mobile	TBD	
Stand Down of Field Locations	As evacuation sites were closed BCARES members who were providing radio links to the EOC stood down their operations on a timely	None currently.	BCARES	Emergency Coordinator & Chairman abishop1150@comcast.net	TBD	

	basis and returned to their homes.			(303) 437-7835 mobile		
Staffing	9 out of approximately 60 members deployed with 0 additional available for expanded operational periods. Additional staffing had to be requested from other regional / section ECs. A continuing issue of poor response has jeopardized the capabilities of BCARES. This lack of commitment by members compromises our MOU agreement.	The actual number of volunteers will continue to be reduced making staffing a challenge if the COVID-19 pandemic continues. To offset this situation, it will be necessary to continue to rely on outside resources within the ARES framework.	BCARES	Emergency Coordinator & Chairman abishop1150@comcast.net (303) 437-7835 mobile	TBD	
Operations Period Support	Due to the EOC's initial operational period of 24 hours, the demand on BCARES staffing was met with the initial Everbridge activation.	The re-invigorated membership is needed to ensure members understand the importance and commitment of emergency communications providers.	BCARES	Emergency Coordinator & Chairman abishop1150@comcast.net (303) 437-7835 mobile	TBD	

	Once the EOC's operational period continued for a second 24-hour operational period, BCARES was not capable of staffing assigned tasks with its own members.					

Recommendations for Building Capacity and Improvements in the Future

The After-Action Improvement Plan matrix provides the outline for each operational or functional area to develop improvement planning areas of effort. To effectively build capacity, improvement goals and objectives need to be supported at the policy level to foster the necessary strategy development and resource support to effect meaningful change. As in all capacity building, the goal is not only to improve in areas of need but to also ensure that best practices and reliable capabilities are sustained into the future.

Conclusion

The Marshall Fire is the most destructive fire the history of the State of Colorado. The weather conditions added complexity to this incident and challenged the entire first response and disaster management capabilities of the county, metropolitan region and state.

Throughout the incident the support from all municipalities across the county during response and recovery helped to keep capabilities engaged and provide services to the community.

The previous two years of disaster experience has provided real-world experience and a constant test of systems. It also has caused fatigue in the personnel performing disaster response and interrupted the ability to make expeditious improvements to address gaps or implement new programs. Despite this fatigue the responders and members of the Boulder Multi Agency Coordination Group always answer the call and find a way to get the job done. The value of debriefing performance and improving has always been present whether informal or formal post incident.

After Action Report Methodology

This AAR is only a comprehensive review of and report of the operational functions that participated in the process. It is in no way representative of an overall AAR for the entire incident for all organizations, local governments and first response agencies that provided direct assistance, support, or coordination.

The goal of the After-Action Report is to identify the important gaps that can improve the response systems and service to residents and communities of Boulder County.

Specials on 2024 New Trucks
Take Truck Sales Here Too. Save Big on Top Brands. Lease Models.
Cockeyed.Com
Open

Sponsored Content

2 years after the Marshall Fire: Some families rebuild, others stuck in limbo

It's been two years since the Marshall Fire started. It burned more than 6,000 acres and 1,084 homes, becoming Colorado's most destructive wildfire.

RETOOL YOUR SCHOOL
Join us on Dec. 6 for a free, hands-on workshop to learn how to use AI tools in your classroom. Space for 100 only.
Learn More

Author: Rachel Kraut
Published: 6:00 AM MST December 30, 2021
Updated: 6:00 PM MST December 30, 2021

LOUISVILLE, Colo. — It's been two years since the Marshall Fire started in Boulder County. It burned more than 6,000 acres and 1,084 homes, becoming Colorado's most destructive wildfire.

Two people didn't make it out as the Marshall Fire burned.

Robert Sharpe died in his home near Marshall Road, close to where the fire started. His family said they believe he stayed to get personal mementos. He was 80 years old.

89-year-old Nedelka Turnbull died in her home in Original Town Superior Boulder County Sheriff's Office said she had mobility issues and was found in her home.

Two people lost their lives and more than 1,000 families lost their homes in a matter of hours.

But all around Boulder County, the sight of construction work is present. As many families break ground or wrap up work on their new homes, others are still fighting to get what they need to move forward.

In Louisville, one woman whose home burned down is now getting ready to start a new journey forward.

"It's not home. I mean...it's a house or a unit where you used to live," said Lisa Hughes.

The home she and her husband shared their family in was burned down two years ago, on Dec. 30, 2019 as the devastating Marshall Fire swept through.

Lisa said she and her family had risen in the mountains, her neighbors watching the fire. Hughes said they were all in disbelief.

"So we were actually coming down ITO when we heard about it. And our neighbors were actually texting us saying, 'Hey, we're watching your house burn down,'" said Hughes. "And we were like, no, we're not coming down. We'll call you. It's only the middle of the night. You're not really sure."

That fire burned thousands of acres and nearly 1,000 homes - including Lisa's. The destruction left behind is the view that followers was next to compromise.

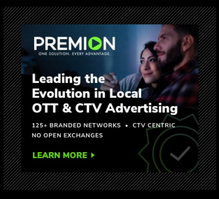
"It was really difficult. And I mean, the whole neighborhood burned down so it was pretty devastating," said Hughes.

Lisa says it seems like a very long time ago. But for so many of us, we're still living it. Hughes moved to Louisville over Superior. It's like a new community," said Rep. Ayla Brown (D), Colorado Dist. 5. "We're still reliving those days. And today, on the anniversary of the Marshall Fire, it's a day of remembrance and healing for many people in our community. And I think it's also a day of reflection and seeing just much lives and our area, and we're still we do. It's a very difficult time for us."

Brown has spent most of his life in Louisville.

"Been a year ago, there homes weren't even up" Brown said while standing in the neighborhood. "Now, you're starting to see families moving back in. And it's a — it's a — it's a very emotional time for us. It's a very exciting time for us, but it's also very — it's very — it's just — it's a — it's a — it's a

Research papers published Monday by the University of Colorado Boulder are the first to explore air quality inside the smoke- and ash-damaged homes and to assess the health impacts on people who live in them.



When homeowners returned to their houses in the months after the Marshall fire, "there was ash everywhere and it smelled different," said University of Colorado chemistry professor Joost De Jouw.

Colleen Reid, associate professor of geography and co-author of the studies, added that the research "suggests that there could be important health impacts for people returning to smoke- or ash-damaged homes after a fire and that we need to have systems in place to protect them."

On Dec. 30, 2021, the Marshall fire burned 1,084 buildings in Louisville, Superior, and unincorporated Boulder County, took two lives and forced 37,000 people to evacuate.

The study results come as fires in the wildland-urban interface (WUI) like those in Lahaina, Hawaii, in 2023, grow more common.

> Read the full story at the Denver Gazette.



Researchers from CU Boulder began taking measurements 10 days after the fire and continued gathering data for five weeks after that.

Close Ad



I'm a massive savings nerd: Here are 15 tricks that are saving me money in 2025

Betterbuck | Sponsored

Read More



Seniors Born 1941-1979 Receive 55 Benefits This Month if They Ask

WalletJump | Sponsored

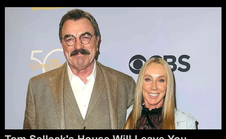
Learn More



Simple Spray Improves Hearing Naturally

Hear Clearly Again | Sponsored

Learn More



Tom Selleck's House Will Leave You Speechless – Take A Look

Finance Nemo | Sponsored



What is Your Car's Market Value? You May Be Amazed!

Topicsift | Sponsored

Learn More



Denver Botanic Gardens reveals star-studded 2025 concert lineup

KUSA



Denver barbecue restaurant closes after staff walks

KUSA



LOADING NEXT ARTICLE...



WILDFIRE TODAY
Since 2005
Wildfire News & Opinion

Photos show devastation after the 6,000-acre Marshall Fire in Colorado

Bill Gabbert January 1, 2022 Wildfire Colorado, fire codes, home ignition zone, Marshall Fire, NWS, zoning

The surviving homes in subdivisions that were destroyed had a common feature



Marshall Fire, Louisville, Colorado. Photo by WxChasing Brandon Clement, Dec. 31, 2021.

Early Friday morning, about 30 hours after the Marshall Fire ignited, a video created by Twitter user WxChasing/Brandon Clement flew over subdivisions that were devastated by the December 30 fire. It found block after block of ash piles, some still smoldering. In many scenes there was scarcely a structure still standing. (Scroll down to see the video.)

To see all articles on Wildfire Today about the Marshall Fire, including the most recent, click here: https://wildfiretoday.com/tag/marshall-fire/

All of the reasons why some houses did not burn even though some around them were consumed could not be determined from the video, but there was one common feature — the survivors were more distant from the neighboring homes. Many houses in the subdivisions were only 10 to 20 feet apart based on archived imagery in Google Earth.



The fire was driven by very strong winds gusting at 60 to 100 mph, extremely dry conditions after months of drought, and relative humidity in the mid-20s. These are the very worst fire conditions. The weather paired with the nearby built-in hack structures led to the fire spreading through a continuous human-made fuel bed that would not have burned the connective fuel bed that existed prior to neighbor, which ignited its neighbor, etc.

The fire in the vegetation and structures lofted burning materials far downwind, creating distant spot fires in the home ignition zone on home dry lawns, mulch beds around ornamental plants, and on structures. It is unknown at this point how many had been designed and built to be fire resistant, such as the characteristics of the roof, vents, siding, doors, windows, foundation, fences, eaves, and decks. A FEMA publication (1.36M) has excellent detailed recommendations. Headwaters Economics found that the typical cost of building a fire-resistant home is about 1% more than standard. Local building codes could regulate these features. But if the lot size is so small that residences are only 10 to 20 feet apart, if one becomes fully involved, the neighbors also burn, especially during windy conditions.

So far we have listed some factors that affect the vulnerability of structures during a wildland -urban interface fire: home spacing and lot size, the envelope of the structure itself, fire-codes, and the home ignition zone-others are:

- Evacuation-capability and planning;
- Safety zones where residents can shelter in place;
- Road and driveway width, wide enough for large fire trucks;
- Turnarounds at the end of roads;
- Signage, and
- Emergency water supply.

The video below of the Marshall Fire devastation was shot by WxChasing/Brandon Clement at first light on Dec. 31, the day after the fire started. He said, "Every single block, was leveled, no house falling. The National Weather Service in Boulder recorded an accumulation of eight inches.



Typos, let us know HERE, and specify which article. Please read the commenting rules before you post a comment.

Share this:
Share on Tumblr Telegram WhatsApp Email Reddit

Related



Report released for the Marshall Fire which destroyed 1,010 structures in the town of Boulder, Colorado

October 29, 2022



Photos before and after the Marshall Fire in Boulder County, Colorado

January 5, 2022



Mapping shows Marshall Fire has burned thousands of acres

December 31, 2021

Author: Bill Gabbert
After working firefighter in wildland fire for 32 years, he continues to learn, and strives to be a Student of Fire.
View all posts by Bill Gabbert

13 thoughts on "Photos show devastation after the 6,000-acre Marshall Fire in Colorado"

Gary
January 1, 2022 at 10:58 am

At about 1:16 in the video, you can see one house standing unburnt. It appears to be located at 185 Arapahoe Circle in Louisville and the neighborhood is just south of Harper Lake. It is on a corner that is directly to the NE of the intersection of Arapahoe and Willow Place. It's a great example of not being immediately adjacent to another structure in the direction of wind flow, which was coming from the SW at that time. My daughter and her family live in Superior in the Rock Creek neighborhood. Fortunately their home and others around it were spared, mostly because the wind moved to the SE only at the end of the afternoon. Homes along Colorado Drive that lacked the open space were destroyed, while homes across the street to the north survived due to wind direction and fuel availability (dry grass and brush). All of the destroyed homes along Eldorado were 2,685+ structures, backing the open space with large wooden decks. Wood forces line the entire neighborhood and were mostly ignited when their homes burned.

1
0

Devin Dezzi
January 1, 2022 at 11:02 am

The data on the distance between homes and the spread of fire is important. In some areas, single family zoning has been abolished and the construction of a second home on an existing small lot is encouraged. Your data would seem to indicate that this practice may increase death and construction. IMO, you should share this information in a separate article which does not seem to be about photographs. People and communities need guidance about how far apart to space homes and other structures.

1
0

Roberto Estrello DeMar
January 1, 2022 at 11:04 am

Proximity of fuels is a serious factor in the spread of fires. If people build big houses on their little-bitty lots, (as the building industry, taxing authority, lenders and the real estate promoters pressure them to do) they collectively create an unsafe environment for fire. The cultural and community dynamics call for changes in the markets and building codes…be realists, however, would how?

1
0

J Smith
January 1, 2022 at 11:08 am

In my neck of the woods you can't get home owners insurance with shake roofs.

1
0

CU Ralphie
January 1, 2022 at 11:11 am

Absolutely spacing made a difference. Developers want to maximize profits on cheap land. Look at infill housing. Lot line setback requirements have been gutted. Now you have tranmatained families with gutted neighborhoods.
Everyone hates it by the time the entire unregulated communities?
High end housing is made of rock stone brick and block NOT petroleum products.
Basically these houses were built in high risk areas and marketed to those wanted to say they lived in Colorado. Now?
Stop giving out mortgages and homeowners insurance when this much stupidity is in play. Same for flood zones.

1
0

Glenn
January 1, 2022 at 11:13 am

No shakes in these neighborhoods. All were architectural asphalt shingles. Higher end homes for the most part.

1
0

Aniba Live
January 2, 2022 at 7:51 am

Quite a few roofs, including my in-laws', in northwest Lakewood have shakes. I agree that they are a bad idea.

1
0

kelly
January 2, 2022 at 12:44 pm

The City of Boulder years ago issued a mandate to help protect residents from fire. This mandate requires that homes within the City of Boulder with a roof consisting of more than 50% wood by volume MUST BE REPLACED by January 1, 2014. Eight years ago.

https://cityofmanitou.com/boulder-wood-roof-mandate/

1
0

Sammi
January 1, 2022 at 3:01 pm

Boulder Office of Emergency Management
https://www.bouldercounty.com/new-damage-assessment-information/
JANUARY 1, 2022, 3:30 PM ALERT
Sheriff Joe Pelle has updated the latest damage assessment related to the Marshall Fire. Total numbers are 991 structures destroyed and 127 damaged. Here are the local breakdowns:
- Louisville:
Destroyed — 553
Damaged — 45
- Superior:
Destroyed — 332
Damaged — 60
- Unincorporated Boulder County:
Destroyed: 106
Damaged: 22

1
0

Aniba Live
January 1, 2022 at 3:05 pm

My husband has said for years that houses are built too close together. His "rule" is that you should be able to tip each house on its side and not touch the next house. Looks a lot better, too!
One news broadcast mentioned shake roofs as more flammable than asphalt. Asphalt is basically thick oil.

1
0

Chad
January 1, 2022 at 4:31 pm

It doesn't matter how far apart they are. When winds are 60 — 100 mph, spot fires start, embers land on roofs, land on tree traps, travel and the fire can start up anywhere. In that case it went matter if your home is spread out from others. Has your husband been USFS Hotshot FireFighter, Helitak, Smoke Jumper at one time.

1
0

(another) Bill
February 5, 2022 at 8:33 am

Actually, it does…..certainly does not guarantee that hot fire brands will not start other structures on fire, but not here or most of spacing would have dramatically reduced the damage. In this case radiant heat was the main driver once structures at the head of the fire ignited. I've worked enough fires in the wildland / urban interface to understand this behavior. The Fourmile Fire in Grand County, CO showed this type of patchwork burning – some structures burned, but many spaced close together survived. Fire ignition processes is without too much danger to firefighters – we could identify safe zones and radiant heat build-up was not overwhelming.

1
0

BRIAN KLUESNER
January 1, 2022 at 4:52 pm

A shake /shingle roof is basically a pile of tinder but are cheap. They are often treated with chemicals to make them water and mold resistant, which further dries them out. Asphalt shingles are less likely to catch fire when an ember lands on them and require no maintenance, however the need to a metal roof which can resist direct flame impingement, embers and burning sticks. Zoning laws and building regulations are needed to limit fire danger and flammability. Where there are no rules, it all comes down to what is cheapest and can make the developer the most money. For more information on making your property resistant to fire, go to, firewise.org
https://www.nfpa.org/Public-Education/Fire-causes-and-risks/Wildfire/Firewise-USA

1
0

Comments are closed.

Previous
Betty White, advocate of wildfire prevention, dead at 99

Next
County Sheriff says 991 structures destroyed in Marshall Fire southeast of Boulder, Colorado

SUBSCRIBE VIA EMAIL
Enter your email address to receive notifications of new posts by email.
Email Address
SUBSCRIBE
SEARCH
Search …
FILTER
Month Year
State Countries
Topics GO
WILDLAND FIREFIGHTER FOUNDATION
MAFFS
FIRE BOSS ADVANTAGE
FEDS
COMMENTS
We love comments.
Click here for the rules.
RECENT ARTICLES
"Significant" spring wildfire risk in southwest U.S. due to below-normal snowpack and drought
Wildland firefighter pay boost approved by Congress after years of anxiety
Trump's EPA may change obscure rule in way that could benefit polluters
USDA hires back all 2,000 fired workers from past month, including public land firefighters
Mass firings erase 6% wildland firefighters
How the Eaton Fire destroyed a delicate bear-over Altadena's home
INTERESTED IN ADVERTISING ON WILDFIRE TODAY?
CLICK FOR DETAILS
ARCHIVES
Select Month
Professional Members of WILDLAND FIRE
Check out our compassion sites, Fire Aviation. Our publisher, the International Association of Wildland Fire, also publishes the International Journal of Wildland Fire and Wildfire Magazine.

Top 20 Largest California Wildfires

	FIRE NAME (CAUSE)	DATE	COUNTY	ACRES	STRUCTURES	DEATHS
1	**AUGUST COMPLEX** *(Lightning)*	August 2020	Mendocino, Humboldt, Trinity, Tehama, Glenn, Lake, & Colusa	**1,032,648**	935	1
2	**DIXIE** *(Powerlines)*	July 2021	Butte, Plumas, Lassen, Shasta & Tehama	**963,309**	1,311	1
3	**MENDOCINO COMPLEX** *(Human Related)*	July 2018	Colusa, Lake, Mendocino & Glenn	**459,123**	280	1
4	**PARK FIRE** *(Arson)*	July 2024	Butte, Plumas, Shasta & Tehama	**429,603**	709	0
5	**SCU LIGHTNING COMPLEX** *(Lightning)*	August 2020	Stanislaus, Santa Clara, Alameda, Contra Costa, & San Joaquin	**396,625**	225	0
6	**CREEK** *(Undetermined)*	September 2020	Fresno & Madera	**379,895**	858	0
7	**LNU LIGHTNING COMPLEX** *(Lightning/Arson)*	August 2020	Napa, Solano, Sonoma, Yolo, Lake, & Colusa	**363,220**	1,491	6
8	**NORTH COMPLEX** *(Lightning)*	August 2020	Butte, Plumas & Yuba	**318,935**	2,352	15
9	**THOMAS** *(Powerlines)*	December 2017	Ventura & Santa Barbara	**281,893**	1,060	2
10	**CEDAR** *(Human Related)*	October 2003	San Diego	**273,246**	2,820	15
11	**RUSH** (*Lightning*)	August 2012	Lassen	**271,911 CA / 43,666 NV**	0	0
12	**RIM** *(Human Related)*	August 2013	Tuolumne	**257,314**	112	0
13	**ZACA** *(Human Related)*	July 2007	Santa Barbara	**240,207**	1	0
14	**CARR** *(Human Related)*	July 2018	Shasta County & Trinity	**229,651**	1,614	8
15	**MONUMENT** (*Lightning*)	August 2021	Trinity	**223,124**	28	0
16	**CALDOR** *(Under Investigation)*	August 2021	Alpine, Amador, & El Dorado	**221,835**	1,005	1
17	**MATILIJA** *(Undetermined)*	September 1932	Ventura	**220,000**	0	0
18	**RIVER COMPLEX** *(Lightning)*	July 2021	Siskiyou & Trinity	**199,359**	122	0
19	**WITCH** (*Powerlines*)	October 2007	San Diego	**197,990**	1,650	2
20	**KLAMATH THEATER COMPLEX** *(Lightning)*	June 2008	Siskiyou	**192,038**	0	2

There is no doubt that there were fires with significant acreage burned in years prior to 1932, but those records are less reliable, and this list is meant to give an overview of the large fires in more recent times.
This list does not include fire jurisdiction. These are the Top 20 regardless of whether they were state, federal, or local responsibility.

10/2/2024

Climate graphic of the week **Climate change**

World breaches 1.5C global warming target for first time in 2024

Data for warmest year sparks fears climate change is accelerating faster than expected



Copernicus said 2024 was the warmest year on the books for all continental regions © Alex Arzaga/AFP/Getty Images

Attracta Mooney, **Jana Tauschinski** and **Steven Bernard** in London

Published JAN 9 2025

Stay informed with free updates

Simply sign up to the Climate change myFT Digest -- delivered directly to your inbox.

Enter your email address Sign up

The world breached 1.5C of warming last year for the first time, top international agencies said, as an “extraordinary” spike in the global average temperature sparked fears that climate change is accelerating faster than expected.

Europe’s Copernicus observation agency confirmed on Friday that 2024 was the hottest year on record, with average surface temperatures 1.6C above preindustrial levels after greenhouse gas emissions hit a new high.

It was the first calendar year that average temperatures surpassed the 2015 Paris accord target of limiting warming since pre-industrial times to well under 2C and preferably to 1.5C.

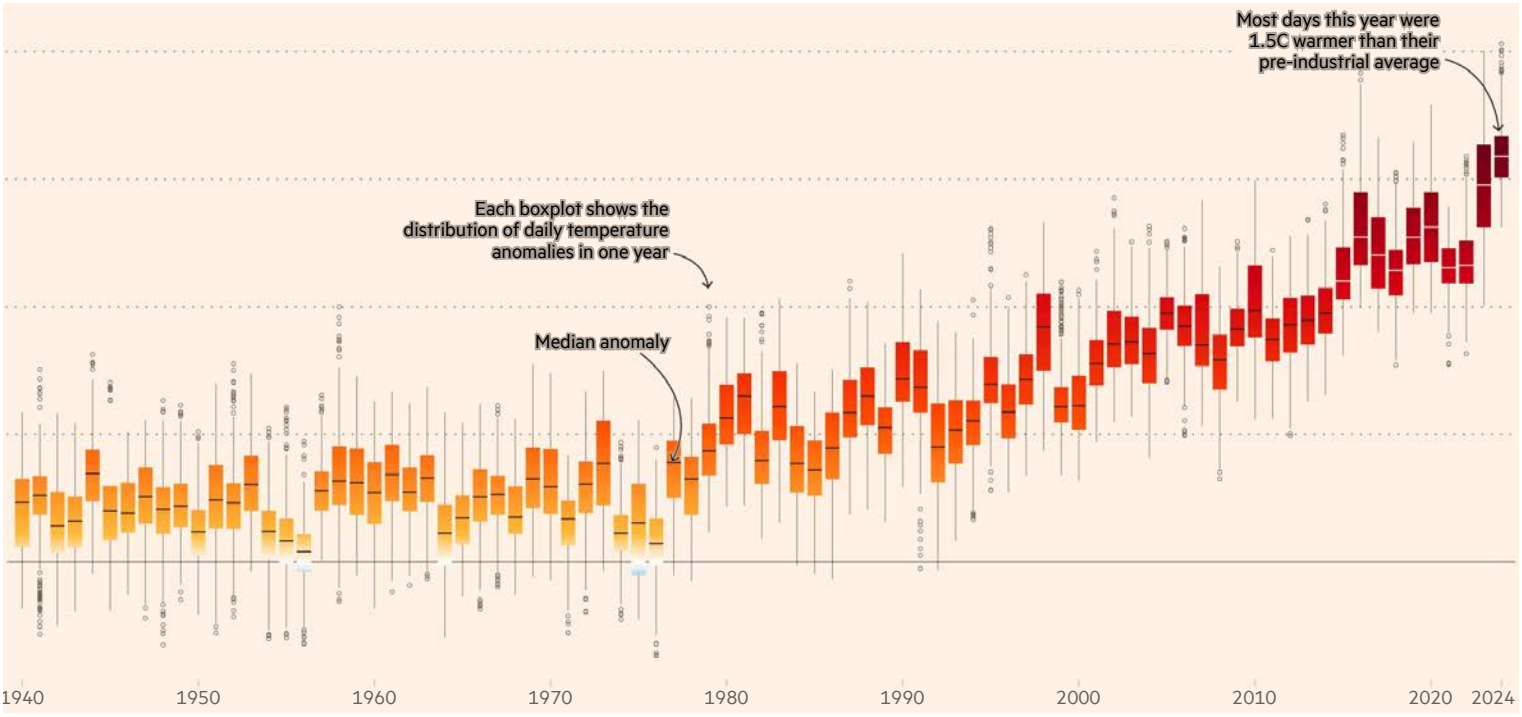
“Honestly, I am running out of metaphors to explain the warming we are seeing,” said Copernicus director Carlo Buontempo.

He added that a spate of climate disasters last year — ranging from floods to heatwaves — was not a statistical anomaly, but clearly linked to climate change driven by the rise in carbon dioxide and methane.

Copernicus said the years from 2015 to 2024 were the 10 warmest on record.

ɬ was the hottest year on record and the first to breach 1.5C

ɔution of average daily surface air temperatures compared with pre-industrial average, by year, degrees Celsius



ERA5, C3S/ECMWF • Pre-industrial period is 1850-1900 • Blocks show the interquartile range (IQR). Whiskers represent the daily temperature anomalies within 1.5xIQR from the first or third quartile. Values of this are shown as circles.

The co-ordinated release of 2024 data from six climate-monitoring organisations comes just days before president-elect Donald Trump is expected to withdraw the US from the Paris agreement to tackle climate change.

Some businesses around the world have also begun weakening climate targets and rolling back green efforts.

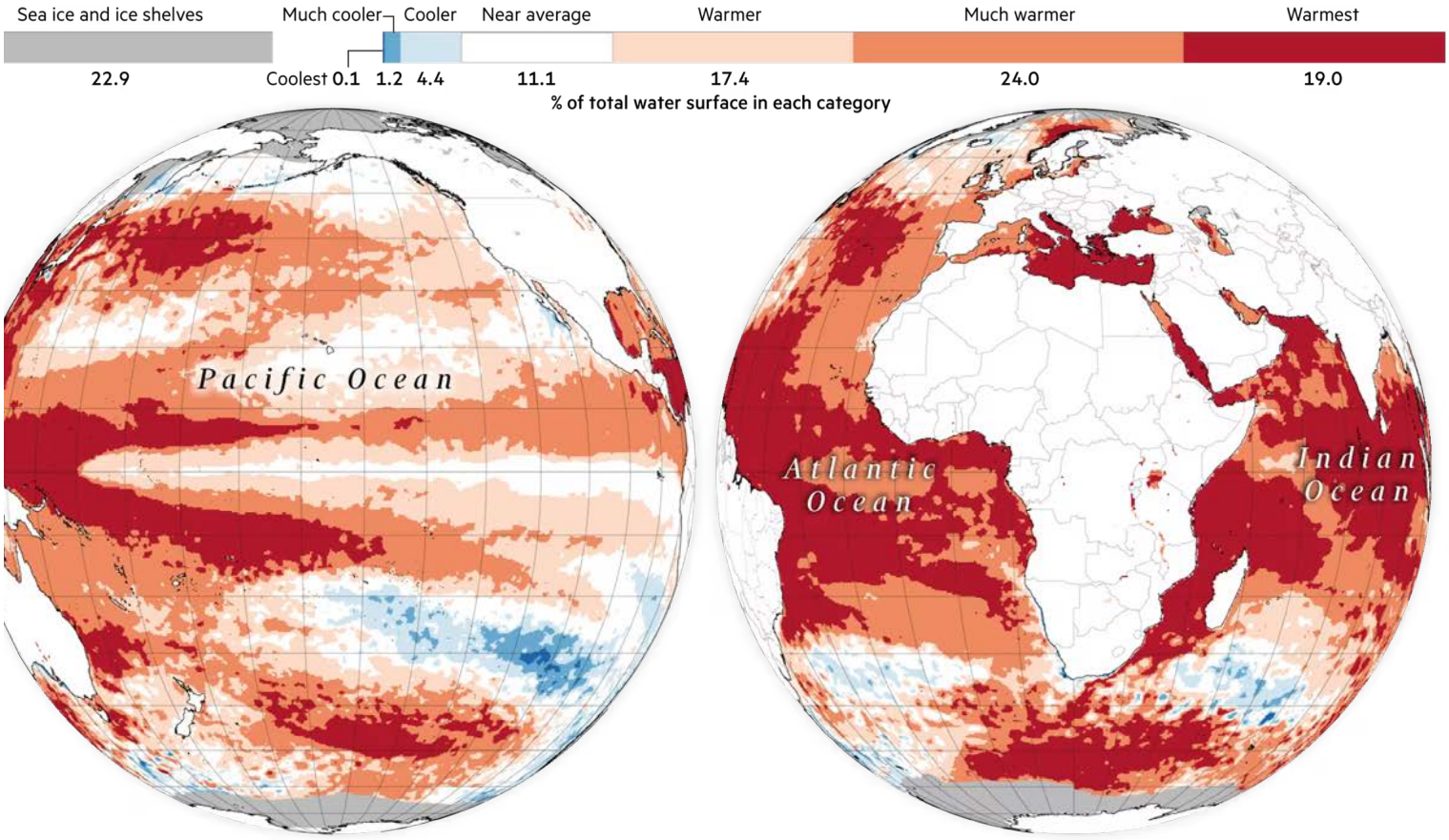
“Hitting 1.5C is like watching the first domino fall in a devastating chain reaction,” said Patrick McGuire, a climate researcher at Reading university. “We’re playing with fire. Every fraction of a degree unleashes more intense storms, longer droughts and deadlier heatwaves.”

The latest data does not represent a definitive breach of the Paris agreement, whose targets refer to temperature averages measured over more than two decades.

But concerns that climate change has gained pace have been fanned by evidence that the world’s oceans have been slower to cool than expected after the naturally occurring El Niño warming effect on the Pacific Ocean.

ost a fifth of the world's oceans experienced record heat in 2024

alies and extremes in sea surface temperature for 2024*



C3S/ECMWF; FT calculations

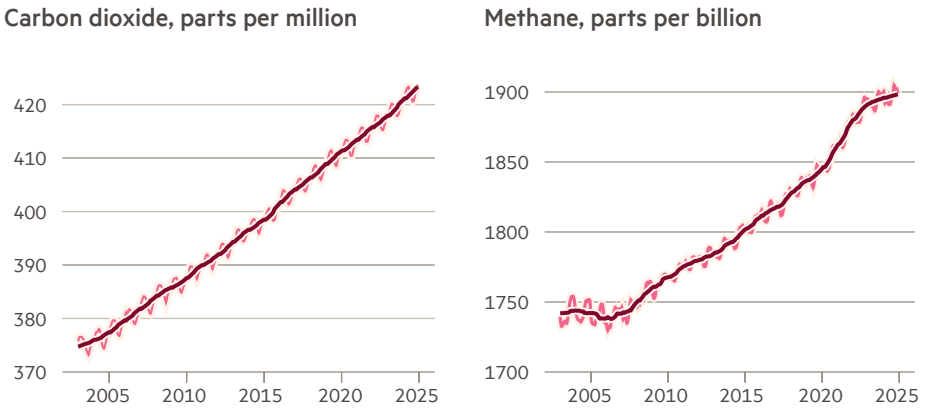
*percentiles of the temperature distributions for the 1991–2020 reference period.
The extreme ('coolest' and 'warmest') categories are based on rankings for the period 1979–2024

What is "most striking is how much warmer 2024 and much of 2023 have been", said Tim Lenton, chair in climate change and earth system science at Exeter university, noting that the size and persistence of the temperature increases over the period were "extraordinary".

He added: "This is a clear signal of destabilisation in the climate — a less stable system undergoes larger and more persistent fluctuations."

Concentration of greenhouse gases in atmosphere continues to climb

Monthly global mean column-average concentration and **12-month average** , 2003-2024



FINANCIAL TIMES

Source: C3S/Obs4MIPs, CAMS, GOSAT, GOSAT-2

Human-induced climate change was the main driver of the extreme air and sea surface temperatures in 2024, Copernicus said, while other factors such as El Niño, which officially came to an end last June, also contributed.

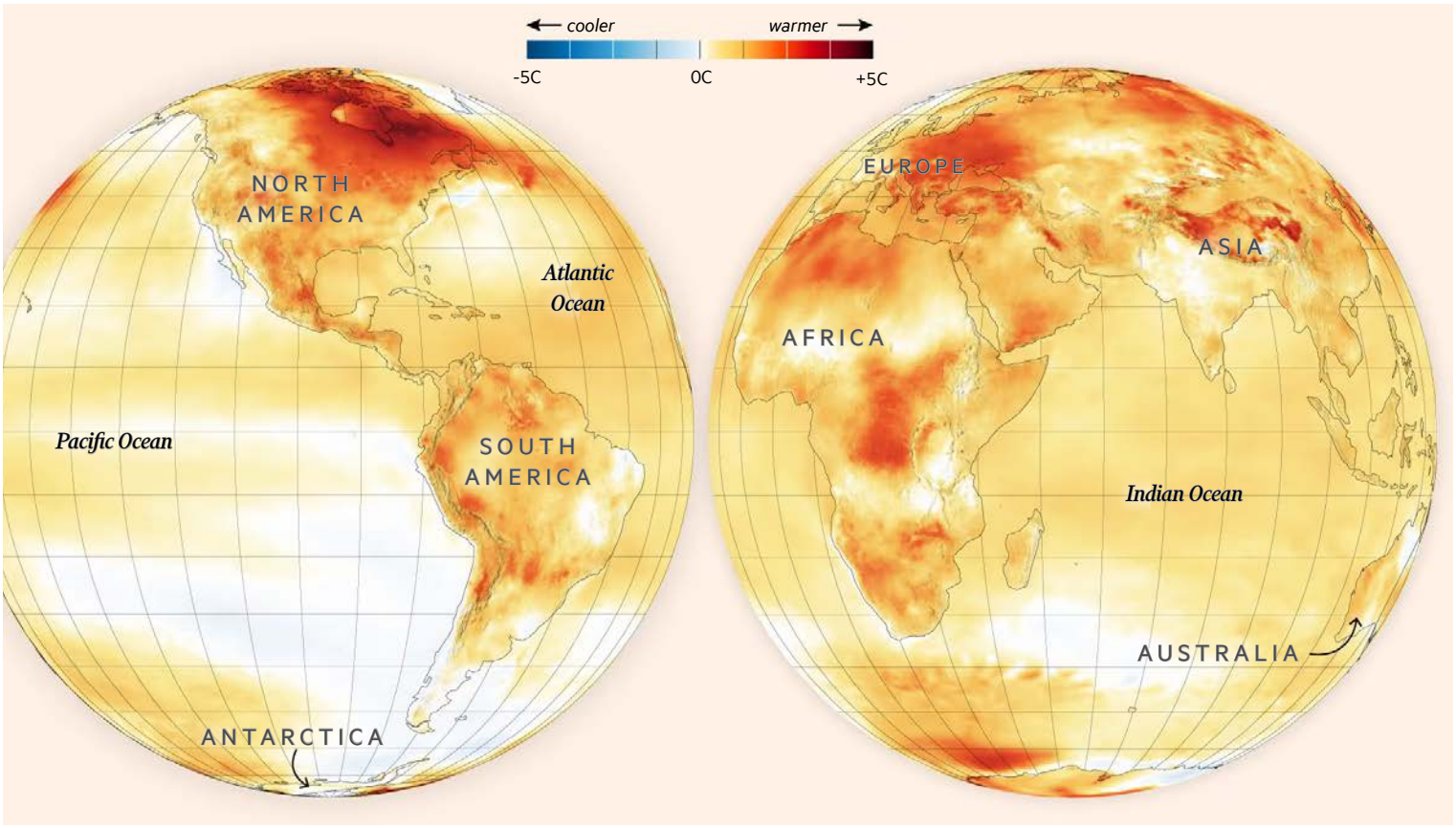
This year is expected to be cooler than 2024, partly because of the diminished impact of El Niño, which is cyclical. The onset of a weak La Niña cooling cycle was confirmed on Thursday by the US weather agency.

But Samantha Burgess, at the European Centre for Medium-Range Weather Forecasts, said it would still probably rank among the three hottest on record.

“We are now living in a very different climate than our parents and grandparents experienced,” she said, adding that it had probably been 125,000 years since temperatures had been as hot as they were today.

‡ brought exceptional heat to almost all regions across the world

ge surface air temperature compared with pre-industrial average, degrees Celsius



NCIAL TIMES

Source: ERA5, C3S/ECMWF • Pre-industrial period is 1850-1900

Copernicus said 2024 was the warmest year on the books for all continental regions, except Antarctica and Australasia, as well as for "sizeable parts" of the world's oceans, particularly the north Atlantic, Indian and western Pacific oceans.

Global atmospheric water levels in 2024 reached record levels, at 5 per cent above the 1991-2020 average, fuelling "unprecedented heatwaves and heavy rainfall events, causing misery for millions of people", Burgess said.

Climate Capital

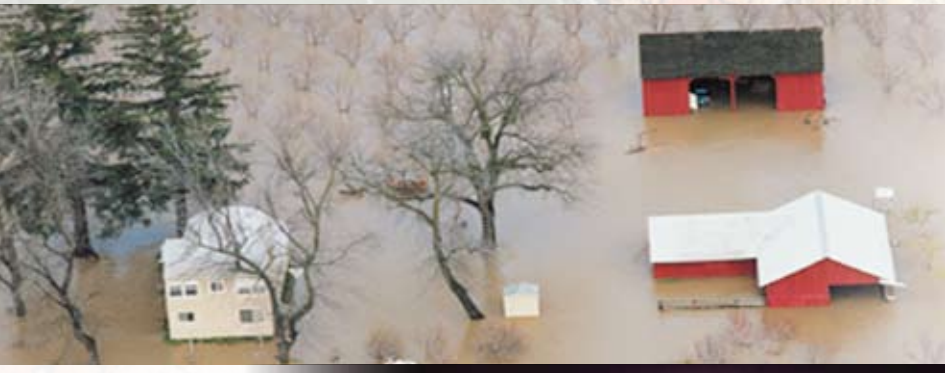


Where climate change meets business, markets and politics. Explore the FT's coverage here.

Are you curious about the FT's environmental sustainability commitments? Find out more about our science-based targets here

Availability and Affordability of Insurance Under Climate Change:

A Growing Challenge for the U.S.



Evan Mills, Ph.D.
Richard J. Roth, Jr.
Eugene Lecomte





December, 2005

Commissioned by

Ceres

Availability and Affordability of Insurance Under Climate Change
A Growing Challenge for the U.S.

Evan Mills, Ph.D. • Richard J. Roth, Jr. • Eugene Lecomte

Commissioned by



Ceres

This White Paper was commissioned by Ceres, a national coalition of investors, environmental groups, and other public interest organizations working with companies to address sustainability challenges such as climate change. Ceres also directs the Investor Network on Climate Risk, a group of 50 institutional investors from the U.S. and Europe managing nearly $3 trillion of assets. This update of the original report released September 7, 2005 contains expanded analysis, source material and discussion of lessons learned from Hurricane Katrina. Helpful comments were provided by Tim Wagner (Nebraska Insurance Director), Nettie Hoge (California Insurance Commission), Paul Epstein (Harvard Medical School), Richard Roth, Sr., (Actuary), Nancy Skinner (environmental policy analyst), Andrew Dlugolecki (insurance and climate expert), David Unnewehr (American Insurance Association), and Andrew Logan (Insurance Program Director, Ceres). The opinions expressed herein are those of the authors.

www.ceres.org

About the Authors

Dr. Evan Mills is a scientist with the U.S. Department of Energy's Lawrence Berkeley National Laboratory, where, for the past 10 years, he has led a research initiative on insurance loss prevention. He served as co-leader of the 2001 Intergovernmental Panel on Climate Change (IPCC) analysis of the potential impacts of global climate change on the financial services sector. He has published 50 articles and reports on the subject, including a recent article in the journal *Science*.

Richard Roth, Jr. specializes in the financial examination of insurance companies, reinsurance, workers compensation, automobile insurance, and insurance against natural hazards. He was Chief Property and Casualty Actuary for the Department of Insurance, State of California, for 20 years, and Assistant Commissioner from 1984 to 1990. He is now associated with Bickerstaff, Whatley, Ryan & Burkhalter, a leading actuarial consulting firm in the United States and internationally. He served as Chairman of the Casualty Actuarial (Technical) Task Force at the NAIC, and was active on the two catastrophe insurance committees addressing catastrophe insurance issues for all types of insured natural disasters. Mr. Roth served twice on the Board of Directors of the Casualty Actuarial Society, and has been one of the delegates representing the Society to the International Actuarial Association. He has testified on natural disaster and earthquake insurance before the California Legislature numerous times, and three times on earthquake insurance issues before the United States Congress.

Eugene Lecomte is President Emeritus of the Institute for Business and Home Safety. A veteran of more than fifty years in the insurance business, Mr. Lecomte has served as President and CEO of the Insurance Institute for Property Loss Reduction, the National Committee on Property Insurance, and the Property Insurance Plans Service Office. He also served as President of the Massachusetts Automobile and Workers Compensation Rating Bureaus, and Executive Director of The Earthquake Project.

Sponsored by grants from the Energy Foundation, The Pew Charitable Trusts, the Rockefeller Brothers Fund, and the United Nations Foundation/Better World Fund. The opinions expressed in this report are those of the authors and do not necessarily reflect the views of the sponsors.

TABLE OF CONTENTS

Foreword 1

I. Key Findings 2

II. Overview 5

III. The Erosion of Insurability 12

IV. Governments and Individuals as "Insurers of Last Resort" 13

V. Insurance Challenges Across the U.S. 16

VI. Pressure on Insurance Affordability and Availability Under Climate Change 30

VII. The Way Forward—Proactive Measures 32

Postscript—In the Wake of Hurricane Katrina 37

Foreword

Hurricane Katrina is a poignant reminder of the threat that extreme weather events pose to U.S. insurers, government and consumers. It is the clearest signal yet that insurers face a new era of risk from rising weather-related losses and that new strategies and approaches are needed, especially as climate change impacts become more pronounced.

This white paper was prepared immediately prior to Hurricane Katrina by a three-person collaboration that included a scientist, an insurance actuary and former regulator, and an insurance veteran of 50 years. The paper explores the insurability of risks from extreme weather events and climate change, and ways in which insurance affordability and availability could be adversely impacted in the U.S. in the coming years. It includes examples where affordability and availability of insurance are already at risk from rising weather-related losses and how future financial exposure for insurers, governments, businesses and consumers could worsen if current climate and business trends continue.

Hurricane Katrina will be a real-world "stress test" of how well the insurance industry, its customers, and governments can withstand catastrophic losses.

In the hurricane's aftermath, the authors updated this report with a "Katrina Postscript," outlining the enormous financial losses for insurers and the likely fallout for consumers, businesses and governments. Estimated insured losses are already ranging as high as $60 billion, double the record losses from last year's spate of hurricanes combined. Rating agencies are putting large insurers such as Allstate and State Farm on notice for possible ratings downgrades. Significant premium increases, tightening terms and market withdrawals are sure to come next, echoing what happened in Florida following last year's storms. (In fact, Allstate has already announced it will be scaling back its homeowner's insurance in the Gulf region due to "unacceptable" losses from Hurricane Katrina.) The bottom line: Katrina will be a real-world "stress test" of how well the insurance industry, its customers, and governments can withstand catastrophic losses.

One positive development in the wake of Katrina is that more insurance companies, investors and regulators are taking notice of this emerging problem. Insurance giant AIG is now saying publicly that climate change poses real risks to insurers and that actions are needed. A growing number of institutional investors, many of them members of the Investor Network on Climate Risk, are asking insurance companies to evaluate their financial risks from climate change. Even before Katrina, the National Association of Insurance Commissioners (NAIC) was planning to discuss climate change at its next membership meeting. That discussion will now take place in early December in Chicago since NAIC's fall meeting in New Orleans was cancelled.

The challenge now is taking concrete action. Despite U.S. catastrophic losses growing 10 times faster than premiums since 1971, insurers and regulators have done little so far to address the growing risks from weather-related losses and climate change. This report includes specific recommendations for addressing this growing insurance challenge and we hope they will receive serious consideration in the coming months from insurers, regulators and government officials.

Mindy S. Lubber
President of Ceres
Director of Investor Network on Climate Risk

I. Key Findings

History has shown that insurers and their customers can be adversely affected by weather extremes. Catastrophic weather-related insurance losses in the U.S. are rising significantly faster than premiums, population, or economic growth, and many smaller events are not even included in official totals (Figure 1). Even before Hurricane Katrina, rising losses were already being felt in parts of the country, and if trends persist, the impacts of climate change in the United States—which scientists believe is being caused primarily by human activities—will inevitably result in more insurance claims and increased costs. These higher losses, in turn, will lead to higher premiums and deductibles, lowered limits, and broader coverage restrictions. The convergence of climate change with demographic and socioeconomic trends, such as the tendency for people to move to high-risk areas, will further compound the impacts. Relevant weather- and climate-related factors include floods, windstorms, thunderstorms, hailstorms, ice storms, wildfires, droughts, heatwaves, lightning strikes, subsidence damages, coastal erosion, and a spectrum of health implications such as a rise in mold and pollen. Most insurance lines are climate-sensitive, although certainly to varying degrees.

Insured U.S. weather-related losses are growing 10-times faster than premiums and the overall economy, and even faster when compared with population.

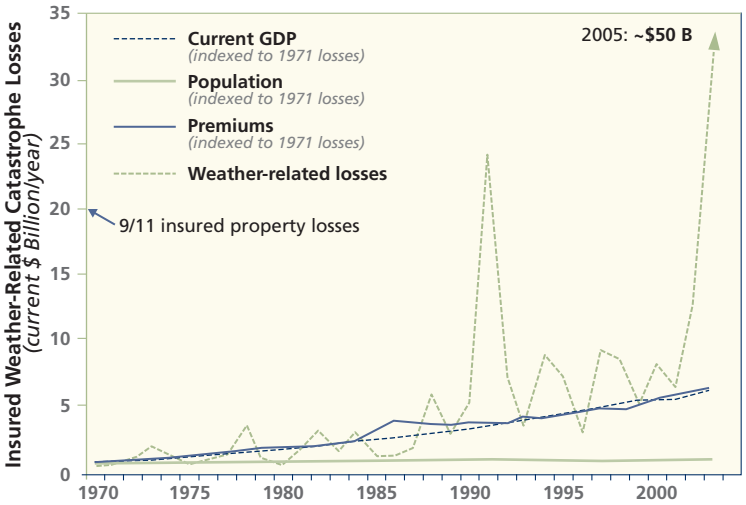


Figure 1. Insured U.S. weather-related losses are growing 10-times faster than premiums and the overall economy, and even faster when compared with population: 1971–2004.
The losses shown above include only the two or three dozen events per year that are tabulated, omitting thousands of small events each year not considered catastrophic. Non-weather-related losses have risen much more slowly than weather-related losses. In the figure, GDP, population and premiums are indexed to 1971 loss levels to facilitate comparison. Premiums include weather-sensitive segments and exclude workers compensation, automobile liability, medical malpractice, accident-health, surety, and other miscellaneous losses. Loss cost, premium, and GDP data reflect values in year incurred; relative changes are the same if inflation-corrected. Sources: Loss data from ISO/PCS and Munich Re NatCatService, Premiums from AM Best Aggregates & Averages; and the Insurance Information Institute

Climate stresses will also place more political and financial burden on reluctant federal and local governments as they assume broader exposures and are pressured to serve as insurers of last resort. The most recent example is renewed calls in the wake of Hurricane Katrina for the federal government to establish a national catastrophic insurance fund, which is essentially a reinsurance backstop to safeguard private insurers and their customers.[1] Governments also are compelled to address events for which there is no insurance at all, while paying for disaster preparedness and recovery operations. A recent example of this: federal and local governments are incurring substantial liability and expenses due to landslides in southern California, with losses averaging $100 million per year.[2,*] Business and consumers will be

* There have been occasional and minimally-subscribed private insurance offerings for landslides in California, priced several times higher than comprehensive homeowners insurance (and must be purchased on top of that insurance), with exclusions for neighborhoods that have experienced landslides in the past.

burdened because cash-strapped governments generally cap paid losses and shift greater portions of risk back to consumers. Risk sharing by consumers is certainly appropriate, to a degree, insofar as it encourages responsible behavior and loss prevention. Given the critical role that insurance plays in the U.S. and global economy, reduced access to affordable insurance would have profound impacts on both consumers and businesses, whether from reduced access to basic mortgage financing or loss of business-interruption insurance for offshore oil rigs.

Some of these far-reaching scenarios are already unfolding. In Florida, the wave of hurricanes in 2004 prompted substantial rate increases, despite which seven private insurers stopped writing homeowners policies in the state or withdrew from the market altogether. The effects of Hurricane Katrina—likely to become the costliest natural disaster in world history—will be even more significant than last year's four hurricanes combined.

In Massachusetts, the state's FAIR Plan* recently requested a substantial (up to 25 percent in some parts of the state) rate increase to cover ***future*** natural disaster losses. This is unprecedented; price increases have until now been predicated strictly on historical loss experience.[3] Meanwhile, government-provided crop and flood insurance programs are experiencing rising losses, wildfire events are causing two times more damage compared to a few decades ago, and coastal erosion insurance is entirely unavailable. The latter issue is an especially acute concern because climate change is expected to cause a twin combination of sea level rise and stronger storm surges, a direct physical threat to many coastal properties in the U.S.

Government-provided crop and flood insurance programs are experiencing rising losses, wildfire events are causing two times more damage compared to a few decades ago, and coastal erosion insurance is entirely unavailable.

Yet, despite its role in these emerging challenges, climate change has received relatively little attention to date in the United States from government, insurers, and regulators. Although we are witnessing a precipitous rise in weather-related losses in the U.S., and numerous projections that climate change will magnify those losses in the years ahead, only a small fraction of potentially impacted U.S. insurance companies have seriously examined the business implications, and fewer still work closely with climate scientists or present their analyses publicly. Nor has the U.S. government assessed its own financial exposure from weather-related disasters (e.g., as crop and flood insurer, provider of disaster recovery, or owner of at-risk infrastructure). Remarkably, the world experiences a "9/11" each year in weather-related catastrophes, yet the issue receives only a tiny fraction of the attention as does the problem of terrorism. In Nebraska, hailstorm losses alone are more costly on a per-capita basis than New York's losses from 9/11.[4]

Widespread data gaps and limited computer modeling capabilities hamper the industry's ability to respond. Insurers and their regulators as yet have no comprehensive capacity to assess the cumulative weather-related risks from both catastrophic events and the growing number of small-scale events, which represent 60 percent of insured weather-related losses globally.

It is incumbent on insurers, regulators, policymakers and other stakeholders to develop a better grasp of the physical and business risks from the climate change issue. A recent study[5] found that SEC disclosure of climate change related risks among publicly-traded insurance companies in the U.S. is very poor. Climate risk reporting remains comparatively low in this sector, with only four of the largest 27 property and casualty insurers reporting (15 percent). The five insurers reporting on climate change risks in their 2004 annual SEC filings were Allianz, Aspen Insurance, Chubb, Cincinnati Financial Corporation, and Millea. Allstate did so in 2003 but did not in 2004.

* Fair Access to Insurance Requirements (FAIR) and Windstorm Plans, are generally mandated by the state and administered by the insurers. Most insurers are required to be members of these so-called "Residual Market Mechanisms," which aim to make insurance available to those who have been unable to gain it through the voluntary market, and involve various combinations of public (State) financing and allocation of premiums and liabilities to all insurers in a given market. Today, they serve about 1.5 million policyholders and represent $345 billion in exposure. For a good primer, see Insurance Information Institute, http://www2.iii.org/media/hottopics/insurance/residual/

Armed with improved intelligence, the private sector would be able to better address potential market failures and thus reduce economic fallout on insurers of last resort (local, regional, and national governments). Tackling this challenge will require unprecedented cooperation and collaboration among various stakeholders (insurers, their regulators, governments, scientists, and insurance customers). Each group can bring valuable insight and talent to assessing the risks and implementing appropriate loss-prevention measures. There is a precedent for such cooperation. Devastating earthquakes in California prompted a far-reaching, positive collaboration in the 1980s among state and federal regulators, engineering firms, earthquake scientists, and other parties to better manage earthquake exposure and its potential impacts on the industry. These efforts improved the technical ability of state insurance regulators to supervise earthquake insurance companies, with the proviso that considerable affordability and availability problems remained.

Tackling this challenge will require unprecedented cooperation and collaboration among various stakeholders (insurers, their regulators, governments, scientists, and insurance customers).

We recommend the following actions by these key players:

Insurers

- Strive to improve loss data collection and enhance the actuarial analysis.
- Analyze the negative and positive implications of climate change on their business, investments, and customers, and share the results with shareholders.
- Vigilantly and vigorously promote and support advanced building codes, the "fortified building" concept, and tools to mitigate potential losses.
- Engage in weather/climate research and promote the use of scientific methods for enhanced climate modeling.
- Create an industry-driven activity improving on the climate change insurance working group that was briefly active in the mid-1990s.*
- Lead by example in reducing their corporate climate footprint.
- Encourage policy action and technical measures to achieve greenhouse-gas emissions reductions, especially where there are direct collateral benefits for the insurance core business.

Insurance Regulators

- Review the "standards of insurability"[6] to identify new challenges, domestically and abroad.
- Incorporate climate risks in solvency and consumer-impact analysis.
- Encourage insurers to collect and analyze more comprehensive data on weather-related losses.
- Elevate the practice for catastrophe modeling.
- Assess exposures of insurer investments and adequacy of capital and surplus to weather extremes.
- Explore the feasibility of developing a weather exposure (large and small events) questionnaire.
- Identify and remedy undue barriers to constructive insurer activities.

Governments

- Foster and participate in public-private partnerships for risk spreading.
- Reduce disaster losses through improved planning and post-event response.

* Members included The Alliance of American Insurers, American Insurance Association, The Insurance Institute for Property Loss Reduction, National Association of Independent Insurers, National Association of Mutual Insurance Companies, Reinsurance Association of America, and State Farm Insurance Companies. A letter from this group to then Vice President Gore is reproduced as Appendix F in Mills *et al.* (2001). This group existed for only a brief period and did not have any lasting impact.

- Comprehensively assess the government's overall financial exposure to changing patterns of weather disasters.
- Expand basic research on climate change and loss modeling, and issue climate change hazard maps.
- Take policy action to reduce greenhouse gas emissions.

Consumers

- Minimize disaster losses through the use of recognized pre-loss mitigation practices.
- Curb emissions that cause climate change, primarily by making cost-effective energy efficiency improvements and increasing the use of carbon-free energy sources.

Markets expect insurers and their regulators to be more than fair-weather friends with regard to climate change. A key next step is to develop a better understanding of the exposures and the potential physical and market consequences for the industry and its vast customer base. The task is surely daunting, but not nearly as much as coping with the impacts of a business-as-usual scenario.

In Florida, 15 to 20 percent of the losses from the 2004 hurricanes were borne by consumers.

II. Overview

At various points in history, insurers have encountered changes in their market environment that have precipitated structural shifts in their industry and the broader societal handling of risk.

The great dust bowl of the 1930s challenged crop insurers, urban riots of the 1960s challenged property insurers, and today terrorism simultaneously challenges multiple insurance lines, ranging from workers compensation to business interruption to political risk. The Great Midwest Flood of 1993, Hurricane Andrew in 1992, and the Northridge Earthquake of 1994 brought natural disasters to the fore and led to fundamental problems of affordability, exclusions, and insurability. Each event, in its own way, brought home the fact that the past is no longer a predictor of the future. These historic events all have a common element of surprise: they were not believed possible or existing science was ignored. Most recently, the Department of Homeland Security stated that the scale of Hurricane Katrina was beyond anything the department could have anticipated[7] yet there was significant prior understanding of New Orleans' vulnerability.[8] These events resulted in establishment of public-private programs, and many proactive responses such as improved catastrophe modeling and a host of loss-prevention activities. They also led to greater (and not always welcome) retention of risk by consumers and businesses (e.g., by shifting from fixed to percentage deductibles*). The effect of such changes is substantial. In Florida, 15 to 20 percent of the losses from the 2004 hurricanes were borne by consumers.[9]

First recognized by insurers in 1973,[10] climate change is expected to increase the damages from natural disasters, according to the latest International Panel on Climate Change (IPCC) Assessment. The problem centers on a build-up of "greenhouse" gases like carbon dioxide, methane, nitrous oxide, and chlorofluorocarbons caused by fossil fuel burning, industrial activity, certain agricultural practices, and deforestation. A key result is an increase in land and sea temperatures with numerous consequences for human settlements. Atmospheric levels of the most critical greenhouse gas, carbon dioxide, are projected to double from their pre-industrial levels within the first half of this century.[11]

Global climate change will present further challenges to many insurance lines. A recent report by the Association of British Insurers (in collaboration with two of the "big-three" U.S. CAT modelers, AIR Worldwide and RMS), stated that rising carbon dioxide emissions could increase average annual losses from the three major types of storms that affect insurers—U.S.

* Such deductibles exist in 18 states, including Connecticut, Delaware, Florida, Georgia, Hawaii, Louisiana, Maine, Maryland, Massachusetts, Mississippi, New Jersey, New York, North Carolina, Rhode Island, South Carolina, Texas, Virginia) and Washington, D.C. See: http://www.iii.org/media/hottopics/additional/katrina_faqs/

hurricanes, Japanese typhoons and European windstorms—by $27 billion a year, a two-thirds increase, by the 2080s.[12] The report cited recent scientific evidence suggesting that rising greenhouse gas levels and rising temperatures will boost the energy of the earth's weather, resulting in stronger storms. The report stated that U.S. hurricanes could exhibit wind speed increases of up to six percent, enough to upgrade a category-4 hurricane to a category-5. Losses from more rare and extreme U.S. hurricanes under climate change could increase by $41 to $62 billion above present-day losses of $60–$85 billion (for 100- and 250-year events, respectively), representing a 70 to 75 percent increase. This is equivalent to an additional two to three Hurricane Andrews in a single season (2004 prices and exposures). Losses under a low-emissions scenario were only one-fifth those of a high-emissions scenario.

Current day concerns include events ranging from large scale and abrupt hurricanes to diffuse and gradual impacts such as coastal erosion or moisture damage in buildings. In both cases, insurance systems have encountered difficulty in responding, often needing to raise prices and in some cases exclude risks. While more captivating, large catastrophic events cause less damage in an average year than the aggregated impacts of relatively small events (a 40/60 ratio globally). While these smaller events may be less consequential for the largest insurers, they can have significant adverse effects on state and regional insurers.

The largest homeowners insurer in Massachusetts will not renew 14,000 policies on Cape Cod and nearby islands because of projected increases in storm losses.

In some cases, the consequences range from availability and affordability problems for consumers to not-always-welcome expectations on governments to pick up the tab. As a case in point, although awarded significant premium increases in the wake of major hurricane losses in 2004, seven private insurers in Florida have decided to stop writing new homeowners policies or even exit the market. The largest homeowners insurer in Massachusetts will not renew 14,000 policies on Cape Cod and nearby islands because of projected increases in storm losses.[13] A similar situation is underway in Texas, where escalating mold and water-damage losses in recent years have prompted dozens of insurers to pull out of the market. These types of developments give rise to state mandated systems to maintain an insurance "safety net" for consumers.

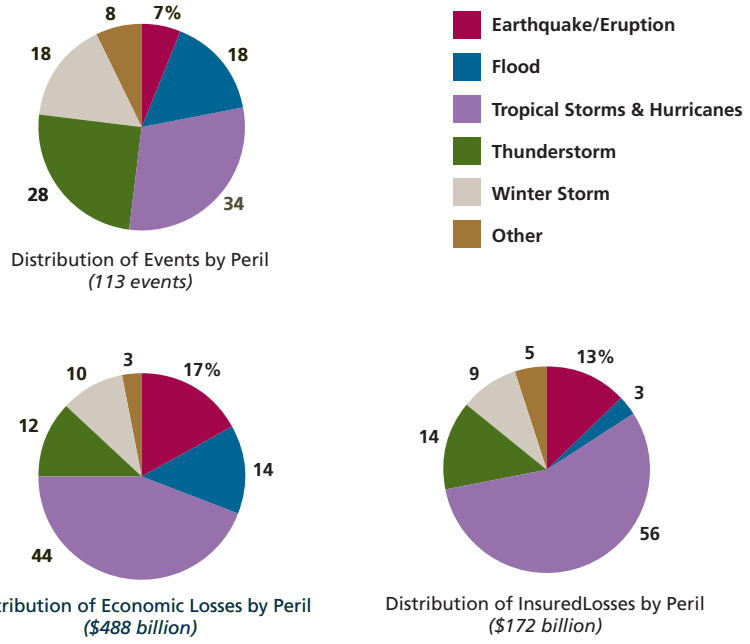


Figure 2. Weather-related events cause vast majority of catastrophic losses, 1950–2004.
Represent 93% of Catastrophe Events, 83% of Total Economic Costs, and 87% of Insured Losses. Includes only events with $1 billion or more in insured losses. Note that only 113 events are included. Source: American Re 2005.

In particular, the advent of insurance FAIR Plans shows rising risk and inadequacy of traditional insurance loss-spreading approaches. As a case in point, the Massachusetts Property Insurance Underwriting Association (or Massachusetts FAIR Plan—homeowner and commercial lines) has become the largest residential insurer in the Commonwealth, with ~$200 million in premiums. To manage growing risks of weather-related events in some parts of the country, mandatory percentage deductibles of up to 5 percent of insured values have recently replaced traditional fixed-dollar deductibles. Similarly, a new state-run company is Florida's second largest provider of homeowners' insurance. Government-provided insurance systems (flood and crop) are seeing rising exposures and losses as well.[14] Although rates may be set higher than market averages, FAIR Plan premiums are often inadequate to cover losses, resulting in assessments against the individual insurer members. These rates are not necessarily actuarially based, but are set by the regulatory authorities. FAIR, Wind, and Beach Plans are increasingly purchasing reinsurance.

Weather-related losses and associated liabilities are material risks for insurers in three ways: through their core business, the weather-sensitivity of their investments, and via indirect economic impacts of extreme weather and consequent effects on consumer purchasing of goods and services, including insurance. The Insurance Information Institute has shown that U.S. insurers' financial performance is more sensitive to energy price shocks and general economic slumps (both of which can be precipitated or compounded by extreme weather events) than the economy as a whole.[15] Insurers are also vulnerable to the causes of climate change, e.g. increased flood risk due to deforestation, and deterioration of respiratory health due to local air pollution resulting from fossil-fuel combustion as well as greater production of pollen (precursors to respiratory diseases such as asthma) in a CO_2-rich atmosphere.

Globally, inflation-adjusted economic losses from catastrophic events rose by 8-fold between the 1960s and 1990s and insured losses by 17-fold.

Globally, the number of weather-related events, the variability of total losses, and the economic impacts and demographic drivers are all on the rise.[16] Insured and total property losses ($45 billion and $107 billion in 2004, respectively) are rising faster than premiums, population, or economic growth both globally and in the U.S. (Figure 1). Globally, inflation-adjusted economic losses from catastrophic events rose by 8-fold between the 1960s and 1990s and insured losses by 17-fold.* The insured share of total economic losses from weather related catastrophes is also rising, from a negligible fraction in the 1950s to 25 percent in the past decade. The ratio is even higher in the U.S., with about 50 percent of total disaster losses insured in the 1990s.[17]

Inflation-corrected weather-related insurance losses in the U.S. property-casualty sector have risen from about $1 billion per year in the 1970s to $15 billion per year in the past decade, with a record high in 2004 that included $30 billion in hurricane losses alone. By August 2005, another new record had been set. Weather-related economic (insured plus uninsured) losses from the subset of events with over $1 billion in insured losses totaled $486 billion over this same period. Of the total losses, $172 billion were insured (inflation-corrected to 2004 dollars) (Figure 2). The annual average rate of loss rose from $3 billion per year in the decade 1950-1959 to $30 billion per year in the most recent decade (Figure 3). Averaged over the past 55 years, weather-related events have been responsible for 93 percent of all catastrophe events, 83 percent of the economic damages of natural disasters, and 87 percent of the insured losses. Important for insurance, the variability and hence unpredictability of losses has increased as well.

While often asked, it is a bit of a red herring to pose the question as to whether it is demographic/socioeconomic trends or climate change that underlie the clear and significant upturn in insured losses from extreme weather events. The observed upward trend in losses is consistent with what would be expected under climate change and with demographic factors. We believe that both factors are at work, with undesirable compounding effects (Box 1). Efforts to understand the relative roles of the two factors are important, and yet are very incomplete at present.

* Natural hazard statistics and losses from Munich Re, NatCatSERVICE.

The full extent of weather-related insurance losses is not known, and only 40 percent of known losses arise from headline-catching disasters. While natural disasters are seen as the primary cause for 8.2 percent of insurer insolvencies in the U.S., an unspecified additional number—such as a subset of those due to mismanagement and reinsurer failure—involve catastrophes as a contributing factor.[18] Unpaid claims from insolvent insurers are typically recouped from other insurers in the market via Guaranty Fund mechanisms.

Insured and total property losses are rising faster than premiums, population, or economic growth both globally and in the U.S.

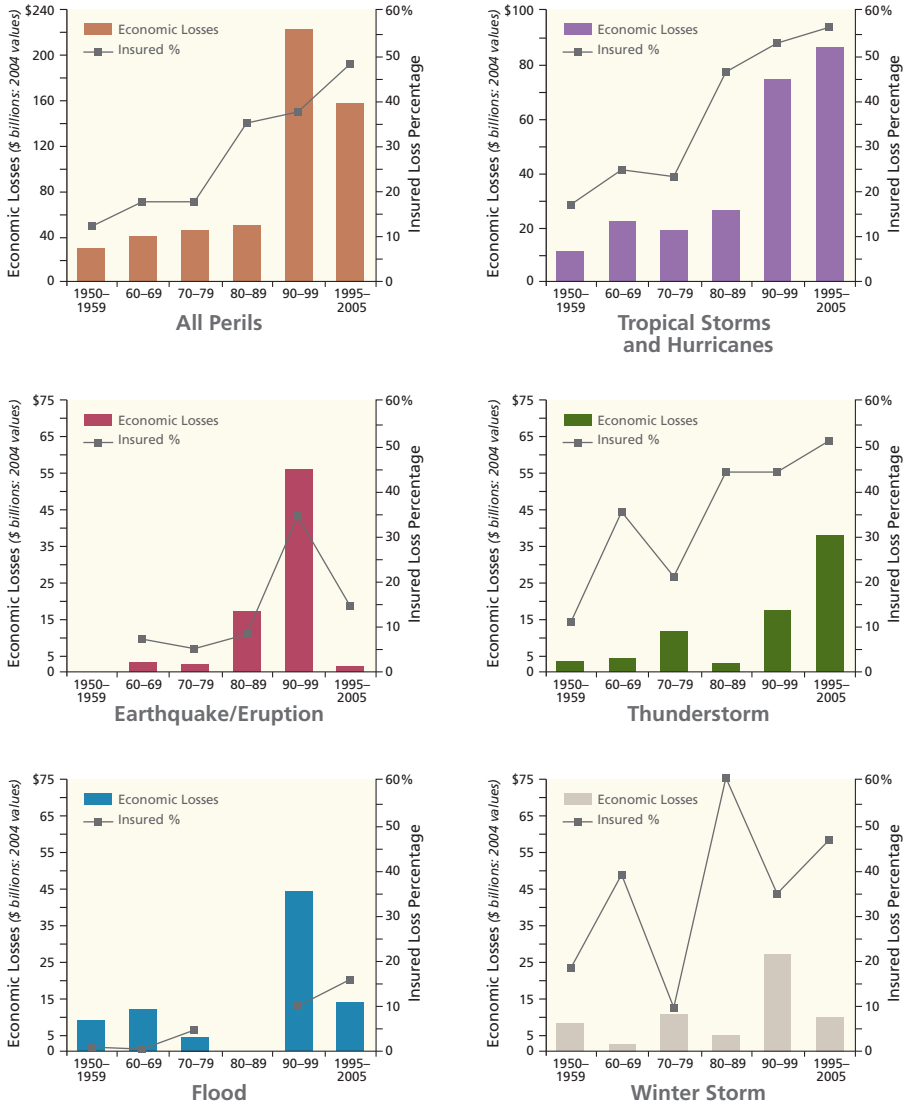


Figure 3. Rising u.S. Economic and insured losses from natural disasters. *Includes only events with $1 billion or more in insured losses. Source: American Re (2005).*

Weather catastrophe losses have a visible adverse effect on U.S. insurers' combined ratios (profitability) (Figure 4). This class of losses has not only risen significantly more quickly than premiums, but has become more unpredictable. As insurers from the U.S. and other industrialized countries race to develop footholds in the rapidly growing emerging markets (e.g. India and China) they also assume weather-related risks there.[19] A statistical review by Swiss Re found that foreign insurers' growth in emerging markets averaged more than

20 percent per year during the nineties.* During the late 1990s, the U.S. was leading the way,† with its primary insurers collecting approximately $40 billion in premiums for policies placed overseas, with an average annual growth rate of 10 percent between 1990 and 1998.[20] Some reinsurers provide backstop coverage to government-provided insurance in developing countries, e.g. flooding in Bangladesh.[21] The developing world is a new geographical locus of vulnerability for insurers. With current premium growth rates triple of that in industrialized countries, premium volumes from the developing world will represent half of the global total in the next few decades. Developing countries' lack of disaster-resistant infrastructure, high dependence on agriculture, and other factors render these markets vastly more vulnerable to climate change. This will curtail the expansion of weather-sensitive insurance markets.

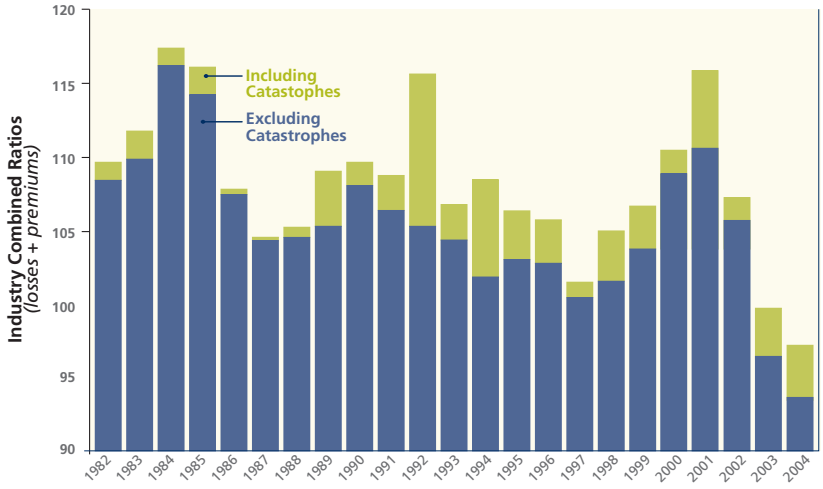


Figure 4. Natural catastrophes are a major challenge to overall insurance industry profitability in the U.S. *The role of catastrophe losses in U.S. property/casualty insurance sector profitability: 1989–2004. A measure of industry financial performance, the "combined ratio" is the ratio of losses plus expenses to premiums. Thus, an underwriting profit occurs when the ratio is less than 100. Including all weather-related events would increase the relative contribution of weather to the combined ratio, probably considerably. The combined ratio does not include investment income, which can compensate for underwriting losses when market conditions are good. Source: AM Best*

The developing world is a new geographical locus of vulnerability for insurers. With current premium growth rates triple of that in industrialized countries, premium volumes from the developing world will represent half of the global total in the next few decades.

Individual insurers from four continents have organized under the United Nations Financial Services Initiative, expressing concern about climate change, including firms from Australia, Austria, Canada, France, Germany, Italy, Japan, Netherlands, New Zealand, Norway, Russia, South Korea, Spain, Sweden, Switzerland, Thailand, and the United Kingdom. Some U.S.-domiciled insurers and other industry players have also expressed concern, while in a brief paper prepared in 1999 the American Insurance Association viewed it as a relatively minor issue.‡[22] With the exception of the AIA, no U.S. primary insurance trade associations have taken public positions or made recommendations. In the mid-1990s, however, U.S. insurance

* Foreign insurers participate either by establishing local offices or purchasing an interest in local insurers. Examples of the latter include Liberty Mutual's acquisition of the Venezuelan insurer Seguros Caracas; ING's 49 percent acquisition of Sul America, Brazil's second-largest carrier; MetLife's $962 million acquisition of Mexico's largest life insurer; Aseguradora Hidalgo SA, and Citigroup's stake in Mexican life insurer Seguros Banamex Aegon and Mexican pension-management company Afore Banamex Aegon (Ceniceros 2003; Pilla 2002).

† Notably: Aetna, AIG, CGU, Chubb, Cigna, Metropolitan Life, New York Life, and Prudential (Swiss Re 2000).

‡ At the time, AIA estimated that about 20 percent of U.S. insurance P/C premiums were associated with types of insurance with "significant" exposure to weather—related loss, 2 percent with "moderate" exposure, 66 percent with "minor" exposure, 9 percent with "minor to no" exposure, and 4 percent with "no" exposure. The large "minor" category is primarily auto insurance, which may have more vulnerability than assumed by AIA (see Figure 13). The paper did not evaluate other measures of vulnerability, such as profitability, solvency, or exposures according to other metrics; e.g., total insured property values for which the at-risk insurers are responsible. Effects of higher prices or reduced availability on consumers were also not evaluated.

leaders and several trade associations* issued a letter to Vice President Gore in which they recognized that climate change was an issue for their industry and pledged to explore it more fully.[23] However, this group was ephemeral, no subsequent communiqué was issued, and it appears that few U.S. insurers or regulators subsequently considered the ramifications of climate change in depth. This may be changing, as exemplified by The National Association of Insurance Commissioners' new initiative in this area.

As many U.S. corporate leaders have said in other arenas, "you can't manage what you don't measure." This adage certainly holds true in the case of preparedness for extreme weather events. While the collection of weather-related loss data is better today than in the past, there are huge gaps.† In particular, the insurance industry's Property Claims Services (PCS) database is not all-inclusive in terms of types of losses, and excludes from the definition of "catastrophe" an unknown number of "small" events (i.e., those with under $25 million in insured losses).‡ Among the types of events often excluded: power outages in the United States alone are estimated to result in a cost of $80 billion per year[24] and lightning strikes cause billions of dollars of losses each year.[25] In the case of wildfires, the PCS database contains 16 catastrophic wildfires spanning the past three decades, whereas there have been many tens of thousands of smaller fires. The result can be that entire classes of events expected to worsen under climate change (e.g., lightning or subsidence) are virtually invisible in the data. With PCS's acquisition by ISO, their data is no longer in the public domain, which is unfortunate for policy analysts.

While the collection of weather-related loss data is better today than in the past, there are huge gaps... Entire classes of events expected to worsen under climate change are virtually invisible in the data.

Lacking a comprehensive grasp of the historic trends, it is difficult to prepare for the future. Similarly, catastrophe models only address a subset of the types of insurance losses expected under climate change. In addition to being able to estimate catastrophe losses in the future, it is also important to know the effect of changes in inclement weather on motor vehicle accidents and lightning strikes, the melting of permafrost on insured infrastructure, or the effects of increased pollen on respiratory health costs. The combined effect of this lack of modeling and analysis means that even if insurers are interested in the issue, they cannot be expected to fully measure and manage their risk.

Box 1. The Attribution Puzzle[26]

Socioeconomic and demographic trends clearly play important—and likely dominant—roles in the observed upward loss trends.[27] As recognized by insurers and others, migration of populations to coastal and flood-prone areas, increasing reliance on vulnerable electric power grids, and rising material wealth are among the many drivers. However, changes in the incidence and impacts of extreme weather events and sea-level rise can also be observed, and it is logical to expect economic impacts to result from the physical drivers.[28, 29, 30, 31] Steady increases in demographic drivers also do not explain why the variability in losses has been increasing.

An astute article in the *Wall Street Journal* following the losses of Hurricane Katrina pointed out that this "natural disaster" was indeed quite unnatural, resulting from a combination of manmade factors including rampant development in at-risk areas, mal-adaptation through the use of inadequate levies, human destruction of wetlands that protect against storm surges, and climate change.[32]

* The signatories included The Alliance of American Insurers, American Insurance Association, Insurance Institute for Property Loss Reduction, National Association of Independent Insurers, National Association of Mutual Insurance Companies, Reinsurance Association of America, and State Farm Insurance Companies. This letter is reproduced as Appendix F in Mills et al. (2001).

† The retiring president of Sorema made this point strongly in his retirement speech, entitled *"Reflections On The Future—Climate Change And Its Impacts On The Insurance Industry"*.

‡ Also excluded from the ISO database are losses to utilities, agriculture, aircraft, ocean marine (including oil drilling platforms) and property insured under the federal flood insurance program. See http://www.iso.com/press_releases/2005/10_04_05.html.

Global weather-related losses in recent years have been trending upward much faster than population, GDP, or insurance premiums, and faster than non-weather-related events.[33] The same can be seen in the case of the U.S. (Figure 1). Specific event types have increased far more quickly than the averages. For example, damages from U.S. storms grew 60-fold to U.S.$6 billion/year between the 1950s and the 1990s.[34] Some assert that rising losses are due strictly to increased vulnerability. However, the attribution studies cited in support of these assertions have material limitations. They often review only a subset of impacts from a single hazard over narrow geographical areas. There is particularly scant treatment of important non-catastrophic processes such as soil subsidence, vehicle accidents, lightning, permafrost melt, the effect of mold and airborne aeroallergens on human health, coral reef decline, or crop diseases.

According to the latest Intergovernmental Panel on Climate Change (IPCC) assessment, climate change has played a role in rising costs of natural disasters.[35] More data in support of this observation have been published since IPCC's report was issued in 2001. As an illustration of the linkages, the distribution and frequency of lightning strikes is expected to be changing under climate change[36] and insurers indeed observe a notable increase in losses during periods of elevated temperatures.

According to the latest Intergovernmental Panel on Climate Change (IPCC) assessment, climate change has played a role in rising costs of natural disasters.

Many human activities mask losses that would otherwise manifest. These include improved building codes, early warning systems, flood control, crop irrigation, electric load-shedding to avoid blackouts during heatwaves, disaster preparedness and response, and land-use planning. Insurer exclusions or withdrawal from risky areas, higher deductibles, and lower limits, also produce a dampening effect on observed insured costs. As examples, inadequate building code enforcement was attributed to almost 70 percent of the costs from Hurricane Alicia and most of the homes damaged by the 2004 hurricanes were built before the code updates inspired by Hurricane Andrew.* Untangling these offsetting factors is a necessary part of any comprehensive attribution analysis and has not been dealt with satisfactorily in the literature. As leading researchers in this area observed in a discussion of flood risks:

> *One can easily hypothesize that increasing population and urbanization in the United States has led to a commensurate increase in population at risk. Yet, one can also hypothesize that the various societal responses may have more than compensated for population growth and in fact fewer people are today at risk."*[37]

It is important not to be lulled into complacency by factors that may only temporarily mask a rise in losses, or to become complacent as a result of selective reporting of data by climate contrarians. Adaptation to climate change will have certain limits.

In any event, the consequences of future climate change will be amplified by economic development and the tendency of populations to move into harm's way. For example, as of 2004 there was almost $7 trillion of insured property value (16 percent of total insured values) along U.S. Gulf and Atlantic coastlines, about half of which is in the Gulf.[38] Some cursory studies have assessed insurers' exposures to climate change based on premiums, rather than insured values.[39]

Regardless of the relative weights of anthropogenic climate change and increased exposure (quantification is premature), projected future climate changes are vastly more significant than observed changes to date. Rising uncertainty would complicate the fundamental actuarial and pricing processes that underlie well-functioning insurance markets. Moreover, even where there is doubt about the current "fingerprint" of climate change, the business of insurance involves anticipating future losses and taking steps to mitigate them before they rise to unmanageable proportions.

* See http://www.iii.org/media/hottopics/insurance/xxx/

III. The Erosion of Insurability

Not all risks are commercially insurable. A variety of definitions of insurability are found in the literature that differ in detail but share the common theme of accepting or rejecting risks based on the nature of each risk and the adequacy of available information. The insurability of natural disasters and extreme weather events may be affected by increases in frequency, severity, or unpredictability.

In essence, private insurers require that a series of conditions be met before they will offer insurance for a given peril/hazard or enter a given market. These conditions—sometimes referred to as "Standards of Insurability"—are intended to assure insurers' financial survival in case of catastrophic losses. Risks must be estimable and manageable yet random and sufficiently broadly spread among the population of those with insurance. Prices must be set via actuarial processes, be affordable to consumers, and fraud and complacency must be controllable. This process involves technical and subjective judgments, and history shows that insurers will relax the standards when investment profits are high. However, a worrisome situation arises when the "perfect storm" of large catastrophic losses coincides with a downturn in financial markets (whether or not there is a causal connection between the two events).[40]

The insurability of natural disasters and extreme weather events may be affected by increases in frequency, severity, or unpredictability.

Perhaps counter-intuitively, as societies develop they become more vulnerable to certain extreme weather impacts. For example, where once hurricanes did little damage until making landfall, it has been clearly evidenced of late that massive losses can occur to offshore oil production facilities. Very preliminary estimates place Hurricane Katrina's damages to offshore oil infrastructure at more than three-times that of Hurricane Ivan ($2.5 billion) the year before.[41] Intensifying reliance on electricity, and expansion of the electric power grid is another source of vulnerability. Losses from Hurricane Rita are expected to be even higher.

Climate change presents various challenges to insurability. These include:

Technical Risks

- Shortening times between loss events, such as an increased frequency of urban heatwaves
- Changing absolute and relative variability of losses
- Changing structure of types of events (e.g. different weighting of the impacts from various perils)
- Shifting spatial distribution of events
- Damages that increase exponentially or nonlinearly with weather intensity, and cascade in terms of numbers of insurance lines impacted*, [42]
- Widespread geographical simultaneity of losses (e.g. from tidal surges arising from a broad die-off of protective coral reefs or disease outbreaks on multiple continents)
- Increased difficulty in anticipating "hot spots" (geographic and demographic) for particular hazards†
- More single events with multiple, correlated consequences as evidenced by the handicapping of pumping capacity due to forced evacuation of pumping-station personnel and loss of electrical power following Hurricane Katrina and the flooding in New Orleans.[43] Undesirable correlations were also well evidenced in the pan-European

* For example, wind damages rise with the cube of the wind speed and can cause abrupt loss increases when gradual changes cross thresholds, e.g., when the point is reached that roofs disconnect from walls or when hailstone diameters/weights reach the level that they break automobile windshields.

† Associated Press. 2005. "First-ever Seattle Heat Warning Issued." http://news.yahoo.com/news?tmpl=story&cid=533&e=6&u=/ap/20050528/ap_on_re_us/hot_seattle

heat catastrophe of 2003—where temperatures were six standard deviations from the norm.[44] Immediate or delayed impacts included extensive human morbidity and mortality, wildfire, massive crop losses, and the curtailment of electric power plants due to the temperature or lack of cooling water

- More hybrid events with multiple consequences (e.g. El Niño-related rain, ice storms, floods, mudslides, droughts, and wildfires)

Market-based Risks

- Historically-based premiums that lag behind actual losses
- Correlations between losses on the asset and liability sides of an insurer's balance sheet
- Failing to foresee and keep up with changing customer needs (e.g., new forms of risk management) arising from the consequences of climate change
- Unanticipated changes in patterns of claims, and associated difficulty in adjusting pricing and reserve practices to maintain profitability*
- Responses of insurance regulators[45]
- Reputation risks falling on insurers who do not, in the eyes of consumers, do enough to prevent losses arising from climate change
- Stresses unrelated to weather but conspiring with climate change impacts to amplify the net adverse impact on insurers' core business. These include draw-downs of capital and surplus due to earthquakes or terrorist attacks and increased competition from self-insurance or other alternative methods of risk-spreading.

Governments assume a considerable share of the exposures to the costs of weather-related events.

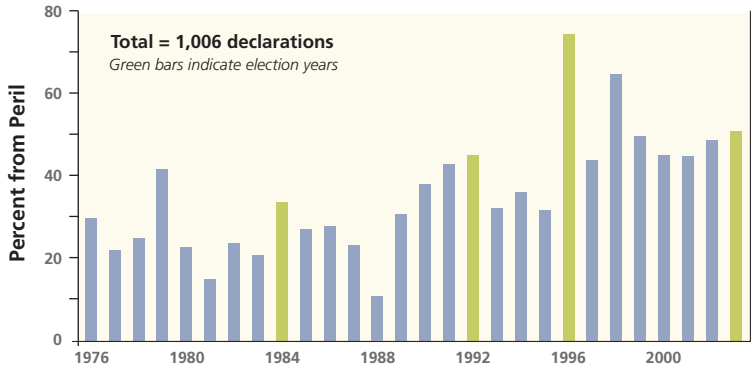
The public must understand that insurers have no obligation to serve, and can only be expected to do so when the standards of insurability are met. This can create market failures. Among the conclusions of a report commissioned to explore the relative roles of public and private insurance:[46]

> *"Since the passage of the War Risk Insurance Act of 1914, Congress has developed one overriding principle to determine under what conditions the federal government should provide federal disaster insurance. … Federal disaster insurance programs are permitted to correct a market failure in the private insurance sector. A market failure has been defined to exist when the private insurance industry is unable to provide primary insurance coverage at reasonable rates and/or does not have the capacity to provide reinsurance."*

IV. Governments and Individuals as "Insurers of Last Resort"

Governments assume a considerable share of the exposures to the costs of weather-related events. Requests for all forms of disaster relief (including those for the agriculture sector) and corresponding declarations doubled between the mid-1980s and mid-1990s (Figure 5-6), and total federal disaster-related payments amounted to $119 billion between 1993 and 1997 ($1993).[47] Federal aid for Hurricane Katrina alone is anticipated to top $200 billion.

* Exposures are still often expressed in terms of probable maximum losses for single events rather than for entire insurance seasons. The limitations of this approach were evident in the 2004 U.S. hurricane season, with its $60 billion of economic losses (half of which were insured). However, it should be noted that lessons learned from Hurricane Andrew helped insurers to manage these losses better than would otherwise have been the case.



We find that a wide range of insurance lines would be affected by climate change... We project that insurance buyers will be expected to pay higher prices and deductibles, with lower limits on losses payable in many cases and that governments will be asked to assume an increasing share of exposures.

Figure 5. The annual number of major U.S. disaster declarations doubled between 1976 and 2003. *Source: Federal Emergency Management Agency (FEMA).*

The costs of natural disasters to government have increased steadily in recent decades. Inflation-corrected federal relief payments for weather disasters grew 6-fold from the late 1960s to the early 1990s.[48] Of particular note, between the 1940s and the 1990s, flood damages (insured and uninsured)—a major government-paid risk—grew 6-fold to $6 billion per year (inflation corrected to $1997).[49]

Surprisingly, the U.S. government's full exposure to extreme weather events has never been assessed. It ranges from formal insurance programs (flood and multi-peril crop), to other forms of assistance such as disaster recovery and construction of flood defenses. As of mid-2004, the National Flood Insurance Program alone provided $723 billion in coverage for 4.5 million policyholders, up from about $50 billion in 1978. The program pays out over $1 billion in some years.*

The public sector has had mixed success in its role as a partner in understanding and managing weather-related risks. With the movement of FEMA into the Department of Homeland Security, observers have expressed concern that the shift of national focus to "manmade" disasters, as well as new layers of administration could inhibit FEMA's effectiveness.[50] Compounding the problem, more and more disaster preparedness and recovery has been pushed to the cash-strapped states.

Where voluntary private insurance is not available, state governments can mandate the creation of insurance pools to be operated by private insurers. One of the better known is Citizens Property Insurance Company in Florida. All insurers seeking to operate in Florida must fund the operation and claims paid by Citizens, which is closely supervised and governed by a state-appointed board and required to provide insurance to all customers. Citizens currently covers 745,000 homeowners and businesses in the state. Their plan of operation provides for the assessment of insurance consumers and member insurers, which resulted most recently in a 7 percent assessment to assist in offsetting the aforementioned hurricane losses.[51] A similar system is operational in Louisiana.

* See http://www.fema.gov/nfip/10110409.shtm

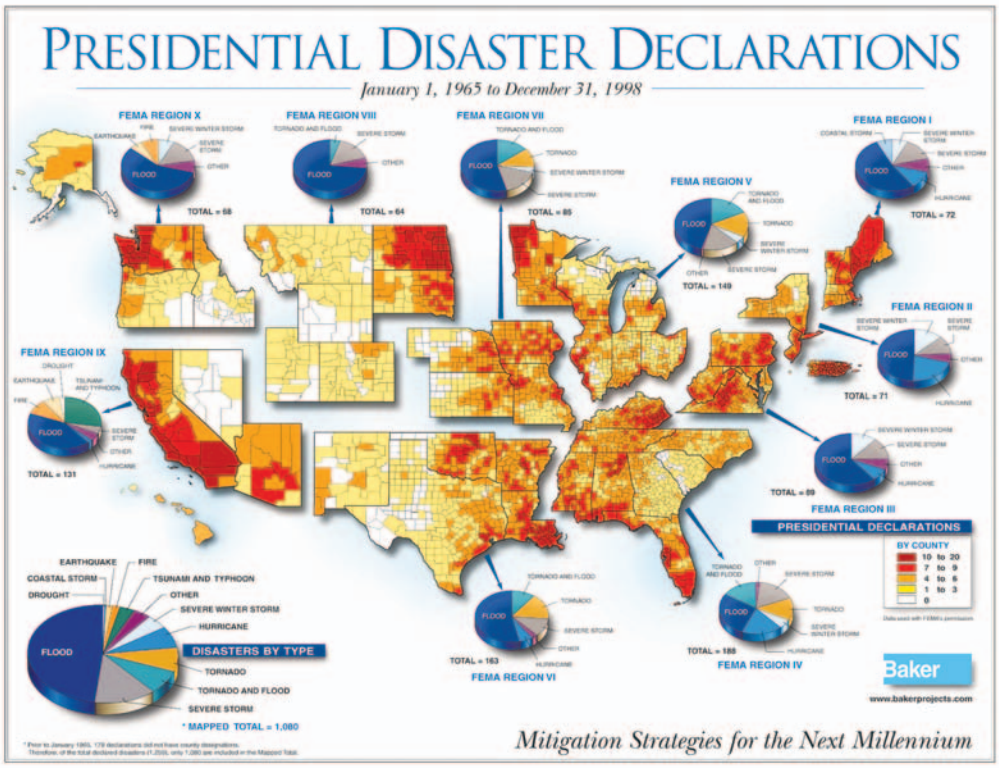


Figure 6. Impacts from natural disasters on the government sector are also diverse and growing

Governments typically play a leadership role in relevant research. While the United States government is a major sponsor of climate change research, the deficiency of economic impacts analysis and adequate models means that the results are rarely directly usable by the private sector. In contrast, this linkage is made relatively well in the case of earthquake research and modeling.

Governments cannot be expected to handle losses on their own. As an illustration of the importance of insurance, $40 billion of the total $66 billion cost of rebuilding New York after 9/11 flowed through the insurance sector,[52] with most of the balance assumed by the federal government.

The U.S. Government Accountability Office (GAO) recently warned that insurers may increasingly look to government to share the economic risks of natural disasters.[53, 54] Yet, government is increasingly a reluctant partner. With the country's shift of emphasis from natural disasters to terrorism, FEMA's role in disaster preparedness is being phased out.[55] In the end, the costs of climate change will increasingly fall on consumers and businesses. Important socioeconomic implications will arise depending on the extent to which the cost is spread through insurance, reinsurance, government taxation, or borne directly through formal or informal self insurance.* While insurance rate increases must be approved by insurance regulators, they, in many instances, lack the technical capacity to discharge this responsibility. For example, most state insurance regulatory offices don't have staff actuaries.

The U.S. Government Accountability Office (GAO) recently warned that insurers may increasingly look to government to share the economic risks of natural disasters. Yet, government is increasingly a reluctant partner.

* There are a variety of alternative risk transfer approaches, which today are roughly equal in size to the traditional U.S. commercial insurance market. These include informal self insurance, Captives, Risk Retention Groups, Weather Derivatives, Catastrophe Bonds and other capital market schemes. Some entities that self-insure purchase commercial reinsurance for catastrophe losses.

V. Insurance Challenges Across the U.S.

In the remainder of this paper we examine the implications of climate change for the insurability of extreme weather-related events (large- as well as small-scale), and the consequences for insurance affordability and availability. We offer separate discussions of the following insurance lines:

- Property (structures, industrial, auto, inland marine, aircraft)
- Crop
- Health/Life
- Business Interruption
- Liability

We project that insurance buyers will be expected to pay higher prices and deductibles, with lower limits on losses payable in many cases and that governments will be asked to assume an increasing share of exposure.

We find that a wide range of insurance lines would be affected by climate change. We project that insurance buyers will be expected to pay higher prices and deductibles, with lower limits on losses payable in many cases and that governments will be asked to assume an increasing share of exposures (Table 1). These conclusions are based on trends already underway in various U.S. business/insurance sectors and the projected impacts as these trends play out further, assuming middle-of-the-road climate change projections and current response strategies on the part of the insurance industry (i.e., responses similar to those seen in the face of past disasters). It is important to note that not all prospective impacts are negative. Several beneficial outcomes are noted in Table 1, although on balance the impacts are highly undesirable.

Key variables include how insurance regulators and governments respond to changing conditions (allowed rate increases, changes in terms, etc.). In some areas, the dual regulatory authority of federal and state governments converge, and can create potential points of conflict. While insurance regulation occurs primarily at the state level, disaster management is overseen at the federal level. For example, the federal flood and crop insurance programs and now terrorism backstop reinsurance are handled from Washington. The difficulty in establishing and now continuing the Terrorism Reinsurance Act evidences how difficult it can be to find a balance acceptable to insurers and governments alike.

Implications for various insurance lines

There is no ideal way to segment the various hazards, perils, and lines of insurance. Most consequences of climate change affect more than one line of insurance. For example, extreme heat episodes have caused simultaneous insurance losses ranging from loss of life, to wildfire-driven property loss, to crop damages, to electric power plant shutdowns, to associated business interruptions. In turn, wildfire losses touch many lines (Box 2). Similarly, a given customer class experiences many hazards, e.g., the energy sector experiences service disruptions from lightning strikes on the power grid, outages from lighting strikes or wildfires, and property damages from hurricanes that damage underwater pipelines (Box 3). These types of linkages are reflected in Table 1. Here, we organize the discussion in terms of major insurance lines. The treatment is indicative rather than comprehensive.

Projected Changes during the 21st Century in Extreme Climate Phenomena	IPCC Assessment of Change Likelihood[A]	Representative Examples of Projected Impacts[B] *(all high confidence of occurrence in some areas[C])*	Peril or Hazard	Insurance-sector Impacts *("+" = increased losses "−" = reduced losses)*							Insurance Customer Impacts		
				Property (structures; industrial)	Property (autos/ marine/ aircraft)	Liability: Business Interruption	Crop	Health	Life	Public Insurance	Pricing	Exclusions	Availability
Higher maximum temperatures; more hot days and heat waves[D] over nearly all land areas	Very Likely	Increased hospitalizations over broad demographic range; incidence of death and serious illness in older age groups and urban poor	Heatwave					+	+	+			
		Increased heat stress in livestock and wildlife	Heatwave				+			+			
		Increased risk of damage to a number of crops	Heatwave				+			+			
		Increased soil subsidence	Subsidence	+		+				+			
		Decreased ice in northern maritime shipping lanes	Float ice		−					+			
		Increased roadway accidents (slower reaction time)	Road conditions		+					+			
		Increased electric cooling demand and reduced energy supply reliability	Power Outage			+				+			
Higher (increasing) minimum temperatures; fewer cold days, frost days, and cold wavesdover nearly all land areas	Very Likely	Decreased cold-related human morbidity and mortality	Coldwave					−	−	−			
		Decreased risk o.5f damage to a number of crops, and increased risk to others	Heatwave				−			−			
		Extended range, reproduction, and activity of some pest (e.g. pine beetle) and disease vectors	Infestation	+		+	+	+	+	+			
		Increased avalanche risk	Avalanche	+		+							
		Increased permafrost melt	Subsidence	+		+				+			
		Increased incidence of lightning	Lightning	+	+	+	+			+			
More intense precipitation events (Very Likely[A] over many areas)	Very Likely, over many areas	Increased flood, landslide, avalanche, and mudslide damage	Flood, landslide, avalanche, mudslide	+	+	+				+			
		Increased soil erosion	Rain	+	+		+			+			
		Increased flood runoff could increase recharge of some floodplain aquifers	Flood				−			+			
		Increased roadway accidents (driving conditions, visibility)	Road conditions		+					+			
Increased summer drying over most mid-latitude continental interiors and associated risk of drought	Likely	Decreased crop yields	Drought				+			+			
		Increased damage to building foundations caused by ground shrinkage	Subsidence	+									
		Decreased water resource quantity and quality	Drought			+	+	+		+			
		Increased risk of wildfire	Wildfire	+	+	+	+	+	+	+			
Increase in tropical cyclone peak wind intensities, mean and peak precipitation intensities[E]	Likely	Increased risks of property damage, business interruption, loss of human life, infectious disease epidemics.	Wind, disease							+			
		Increased coastal erosion and damage to coastal buildings and infrastructure	Tidal surge	+						+			
		Increased damage to coastal ecosystems such as coral reefs and mangroves	Tidal surge	+				+	+	+			
Intensified droughts and floods associated with El Niño events in many different regions	Likely	Decreased agricultural and rangeland productivity in drought- and flood-prone regions	Drought				+			+			
		Decreased hydro-power potential in drought-prone regions	Drought			+				+			
Increased intensity of mid-latitude storms[D]	Little agreement between current models as of 2001.[F]	Increased risks to human life and health	Storm					+	+	+			
		Increased property and infrastructure losses	Storm	+	+	+	+			+			
		Increased damage to coastal ecosystems, including loss of mangroves and coastal wetlands	Storm	+	+	+				+			

A. Likelihood refers to judgmental estimates of confidence used by Intergovernmental Panel on Climate Change (IPCC) Third Assessment Report (TAR), Working Group I: very likely (90–99% chance); likely (66–90% chance). Unless otherwise stated, information on climate phenomena is taken from the IPCC Summary for Policymakers, TAR WGI.

B. These impacts can be lessened by appropriate response measures.

C. Based on information from chapters in the IPCC Third Assessment Report; high confidence refers to probabilities between 67 and 95% as described in Footnote 6 of TAR WGII, Summary for Policymakers.

D. Information from TAR WGI, Technical Summary, Section F.5.

E. Changes in regional distribution of tropical cyclones are possible but have not been established.

F. Subsequent research (Knutson/Trenberth/MIT/ABI) has shown increased likelihood of hurricane damages.

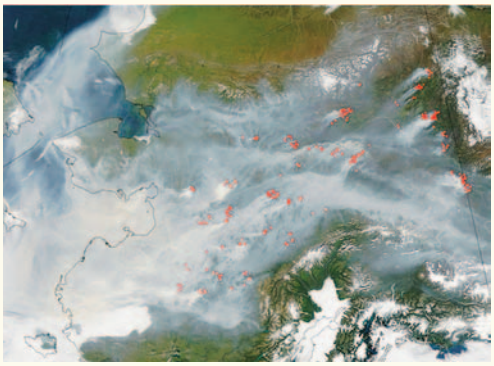
***Table 1. Examples of impacts resulting from projected changes in extreme climate events**, and associated insurance implications. (Adapted from IPCC/Vellinga et al., 2001)*

Box 2. Wildfire

The Oakland/Berkeley Tunnel Fire of 1991 demonstrated the enormous damage potential of even a single fire in the wildland-urban interface. The third costliest fire in U.S. history, it resulted in $2 billion in insured losses (at 1997 prices), including the destruction of 3,400 buildings and 2,000 cars.[56] This compares with the losses resulting from a major hurricane. Added to this were extensive losses of urban infrastructure (e.g., telecommunication, water, and transportation systems); the costs of which are borne largely by local government. The insured losses from this single fire were twice the cumulative losses experienced nationwide during the previous thirty years. The Swiss Reinsurance company cited global climate change as a possible factor influencing the extent of damages caused by this and future wildfires.[57]

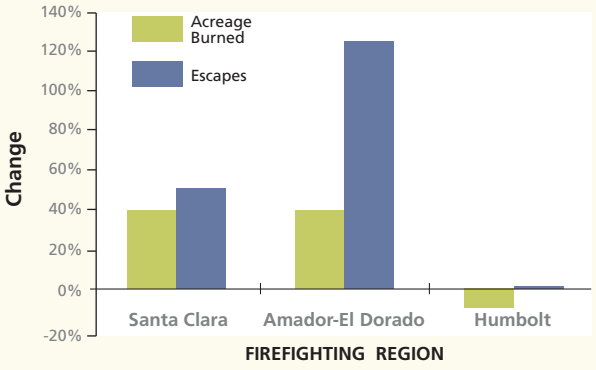
Under climate change, wildfire damages increase considerably in parts of California.

Wildfire impacts are not limited to property loss. Fires this summer in Montana caused a 90 percent increase in hospital admissions for respiratory problems and 57 percent for cardiac problems.[58] Pervasive fires in Alaska are shown in the photo below. In areas where a high probability of wildfire loss is present, if insurance is not available through primary insurers it can often be purchased if legislatively mandated insurance pools, known as FAIR Plans, are present. An inspection is required and generally a surcharge applies.[59]



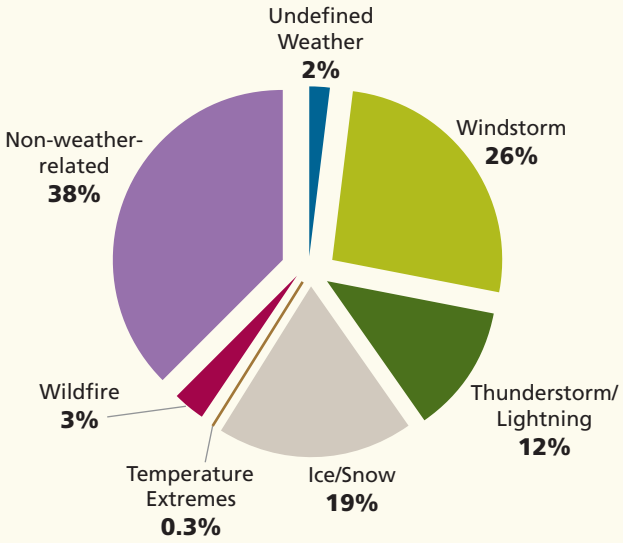
***By mid-August 2005, 584 fires had burned more than 3 million acres in Alaska**, at which time weather conditions were causing the smoke to linger across the interior, with consequent unhealthy air quality warnings for much of the state. Air quality warnings had been issued for about 90 percent of the interior, with conditions ranging from "very unhealthy" to "hazardous" in many locations, including Fairbanks. This image was captured by the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Terra satellite.*

***Under climate change, wildfire damages increase considerably in parts of California.** The chart shows percentage change in wildfire outcomes under a doubling of CO_2 from pre-industrial levels. For example, in the Amador-El Dorodo region (Sierra Nevada Foothills), the acreage burned (grey shading) by contained wildfires increases by about 40%, while the number of catastrophic escaped fires (black shading) increases by 120%. Some sub-regions exhibit up to a four-fold increase in damages. Results were calculated by coupling climate models with California Department of Forestry wildfire models, assuming full deployment of existing suppression resources. (Source: Torn et al. 1998).*



Box 3. Energy Sector Impacts

Increasingly extensive and interconnected energy systems enhance the quality of life, but also increase society's vulnerability to natural hazards.[60] Energy systems are exposed to large losses such as ruptured oil and electricity transmission systems and power plants due to permafrost melt throughout the northern latitudes. A particularly diverse set of risks exist in the electricity sector. The current U.S. baseline cost of electrical outages is $80 billion per year.[61] Under climate change, it is likely that businesses will seek increasing business-interruption coverage for such events. In addition, increasingly frequent drought conditions could result in power curtailments that cause further business interruptions in regions heavily dependent on hydroelectric power. Drought plus unacceptably higher cooling water temperatures forced curtailments or closures of nuclear and other thermal plants in France, Germany, Romania, and Croatia and price spikes in additional areas during the heat catastrophe of 2003. At the other end of the spectrum, the 1998 North American Ice Storm—likely linked to El Niño events, in turn expected to become more common under climate change—caused extensive power outages.



Causes of electric grid disruptions: 51.7 Million customers affected (North America 1982–2002). *The vast majority of outages (80-90%) occur in the electric distribution network, for which data by cause is not available. Source: North American Electric Reliability Council.*

Weather disasters can damage other types of energy infrastructure. Massive oil sector losses were caused by Hurricane Ivan in 2004 (approximately $2.5 billion, well in excess of the year's entire premium revenue for the sector)* (Miller 2004). Premiums for vulnerable oil infrastructure were projected to double after this event, and consumers faced higher prices due to the 500,000-barrel per day supply shortfall.[62] Electric utilities were also hard hit, with one utility's costs reaching $252 million.[63] The losses from Hurricanes Katrina and Rita are only now beginning to emerge, with 111 oil platforms completely lost and 52 extensively damaged. Concern has already been raised over potential elimination of insurance coverage for offshore oil infrastructure and associated business interruptions.[64]

* The Hurricane destroyed seven oil platforms, damaged six others as well as five drilling statements, and extensive pipelines were buried by underwater mudslides in the Mississippi Delta.

The losses from Hurricanes Katrina and Rita are only now beginning to emerge, with 111 oil platforms completely lost and 52 extensively damaged.

Property Insurance

Weather-sensitive segments of the property insurance market include homeowners, commercial lines, inland marine, as well as motor vehicles. Averages can be deceiving: the types of losses vary significantly from state to state (Figure 7) and from year to year.

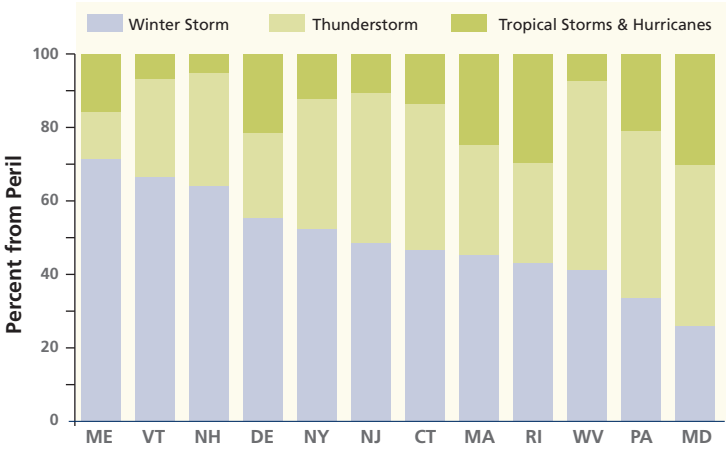


Figure 7. Percentage contribution of winter storms, thunderstorms, and tropical cyclones to total weather-related losses in the Northeastern U.S.: 1980–2004.
Source: American Re (2005).

A new study from MIT reviewed 50 years of data and found that over that time both the duration and wind speed of hurricanes has increased 50 percent.

Tropical Storms & Hurricanes: Windstorms are a major concern, and the largest single contributor to weather-related insurance losses in the U.S. In a real-world example, Allstate stopped writing commercial insurance policies in Florida and decided not to renew 95,000 residential homeowner policies (about 15 percent of its portfolio there), because of the four hurricanes that slammed Florida in 2004.[65] Losses from tropical storms and hurricanes are not limited to property damages. For example, $0.5 billion of insured crop losses resulted from hurricanes in 2004.[66]

The effects of climate change on hurricanes are extremely difficult to assess. Recent literature has pointed to more of a linkage than previously believed.[67, 68] A new study from MIT reviewed 50 years of data and found that over that time both the duration and wind speed of hurricanes has increased 50 percent.[69] It also identified a "high correlation" between this increase in intensity and the rise of surface water temperatures.

The insurance industry and others have made material progress toward improving society's resilience to hurricanes. Efforts included fortified building codes (and code compliance), the development of catastrophe modeling, and consumer education. Yet, vulnerabilities remain and the Insurance Information Institute notes "serious obstacles to reducing CAT losses."[70] These include unwillingness to significantly alter land use planning, political/lobbying efforts of special interests to defeat restrictions, homeowner opposition to added housing costs for disaster resilience, and subsidies (flood insurance, rate suppression), coupled with demographic trends (housing starts, population, rising replacement values).

Thunderstorms: The cumulative annual insured losses from U.S. thunderstorms have averaged $3 billion per year since 1980 ($2004), equating to those from a large hurricane in most years. One confounding factor in tracking thunderstorm losses is that some events are associated with hurricanes, and counted in that category. Thunderstorm losses have shown a significant increase over the past 25 years, even after correcting for inflation (Figure 8). The worst year in recent history (2003) saw nearly $8 billion in insured thunderstorm losses. Hail is an important consequence of thunderstorms. The costliest hailstorm* in Colorado history was $625 million ($1990).[71]

* U.S. property insurers pay out an average of $1.5 billion each year for hail-related claims, largely across the central U.S. (III 2000a).

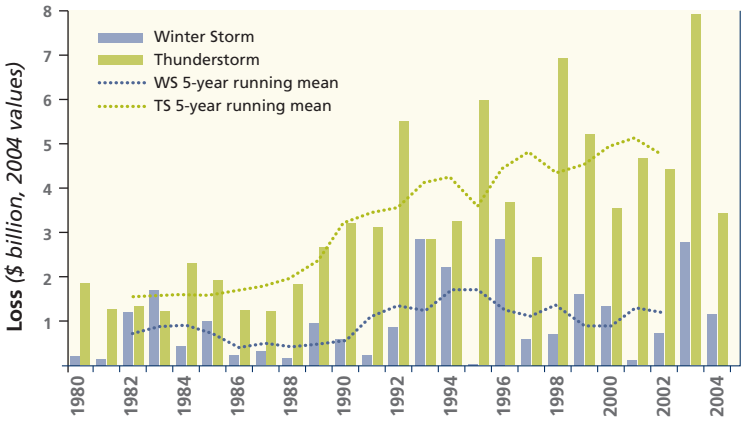


Figure 8. Thunderstorms on the rise: 1980–2004. *Annual insured losses due to thunderstorm and winter storm events. The five-year running mean is also shown. Source: American Re (2005)*

Winter storms in the United States often fall below the threshold of being cataloged among official loss statistics, yet cumulatively yield more than $1 billion each year in insured losses.

Winter storms: Winter storms are a significant contributor to weather-related losses in New England, the Pacific Northwest and the Rocky Mountain states, accounting for about 18 percent of insured catastrophe losses nationally, and ranging up to 60 percent in Maine, New Hampshire and Vermont.* They present a variety of hazards, including wind, tornado, snow, sleet, ice, hail, freezing rain, sub-freezing temperatures, and lightning, varying from storm to storm and region to region. Damages are similarly diverse, including frozen pipes and consequent water damage, ice-damming and roof damages, and increased vehicle accidents. Winter storms in the United States often fall below the threshold of being cataloged among official loss statistics, yet cumulatively yield more than $1 billion each year in insured losses.† For example, only one winter storm event in 2004 met Munich Re's criteria to be classified as a significant event, incurring economic losses in excess of $1 billion. The most costly winter storm in recent history was a $2.3 billion ($2004) event in 1993.

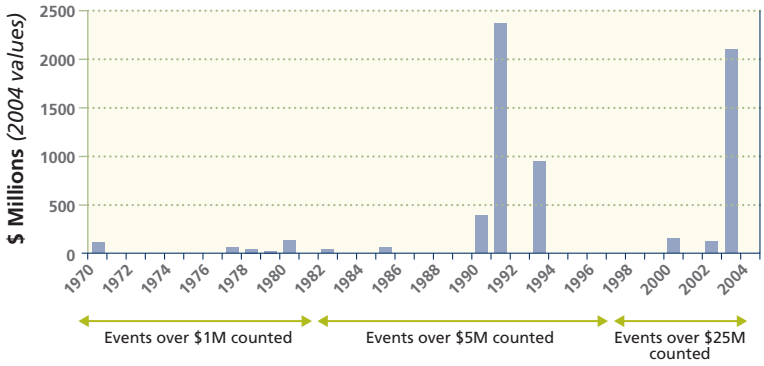


Figure 9. Rising U.S. catastrophic insurance losses, *despite fewer fires included in the sample. Source: Insurance Information Institute. Effective January 1, 1997, Property Claim Services (PCS) defines catastrophes as events that cause more than $25 million of insured property damage and that affect a significant number of insurance customers and insurers. From 1982 to 1996, PCS used a $5 million threshold in defining catastrophes. Before 1982, PCS used a $1 million threshold.*

* The Ice Storm of 1998 produced the largest loss in Canadian history, and combined Canadian and US stood in excess of $1.2 billion US.

† These events can be defined as any extra-tropical cyclone that incurs a majority of the insured losses associated with it through the effects of frozen precipitation, high winds associated with the storm's circulation, and/or excessively low temperatures from one or more preceding or subsequent high-pressure systems

Wildfire: Wildfire is another major weather-related hazard, and one that will be exacerbated by the combination of climate change, population growth, and migration to and development in at-risk woodland-recreational areas. Wildfires have over the years plagued areas of the United States from New Hampshire and Vermont, to Colorado, to California. From 1985 through 1994, U.S. wildfires claimed more than 9,000 homes[72] at an average insured cost nearly ten-fold greater than during the three decades prior to 1985. According to the Insurance Information Institute, the total U.S. losses from catastrophic wildfires (a small subset of the total defined in terms of events tabulated by the Property Claims Services) was $6.5 billion ($2004) between 1970 and 2004, corresponding to an average insured loss of just over $400 million per fire (Figure 9), with damages rising from about 40 acres per fire in the 1970s to 80 acres per fire in recent years (Figure 10).

From 1985 through 1994, U.S. wildfires claimed more than 9,000 homes at an average insured cost nearly ten-fold greater than during the three prior decades.

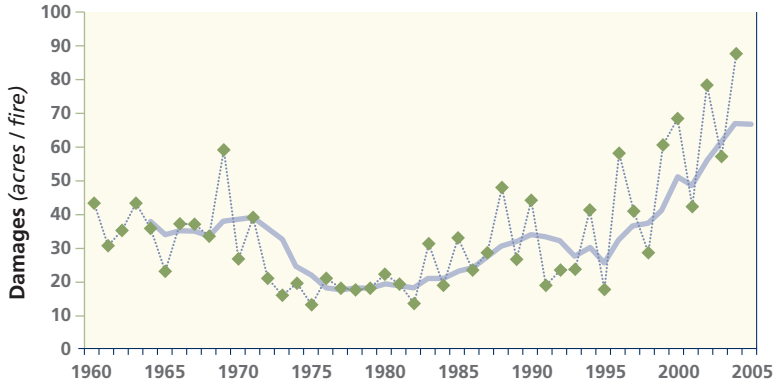


Figure 10. U.S. wildfire intensity has doubled since 1960.
Source: National Interagency Fire Center

Wildfires can be costly disasters for property owners, governments (federal, state and municipal), and insurers. Two fires in California in 2003 caused combined insured losses of $2.1 billion,[73] comparable to those from the Oakland Hills fire of 1991. According to the U.S. Department of Agriculture, nearly every state has experienced wildland/urban interface fire losses.[74]

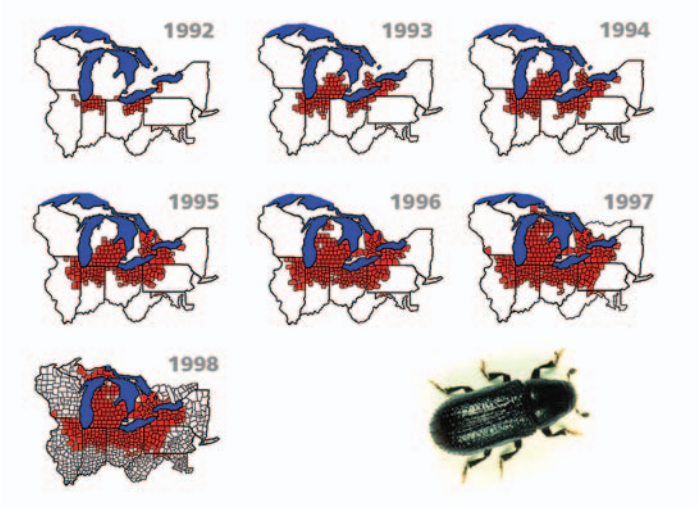


Figure 11. Temperature-Induced Spreading Pine Beetle Causes Elevated Wildfire Risk.
The Pine Shoot beetle, an exotic species, is now found in twelve northern states: Illinois, Indiana, Maine, Maryland, Michigan, New Hampshire, New York, Ohio, Pennsylvania, Vermont, West Virginia and Wisconsin [http://edis.ifas.ufl.edu/IN596]. Beetle reproduction rates and geographical range increase with temperature.

Box 4. Examples of Lightning-Related Costs in the United States

Fires

- Half of wildfires in Western US (approximately 10,000 each year); $100 million in BLM suppression costs
- Over 3,000 structural and vehicle fires/year, at a cost of $35 million (1994–1999 average)
- Approximately 18% of lumberyard fires; 30% of church fires (Ohio)

Energy Sector

- About 30% of all power outages, with total costs ~$1 billion per year (1997)
- About 80% of accidents involving petroleum product storage tanks events to privately-owned plants between 1985 and 2000. Between 1990 and 2000, 346 incidents to 81 nuclear sites in US

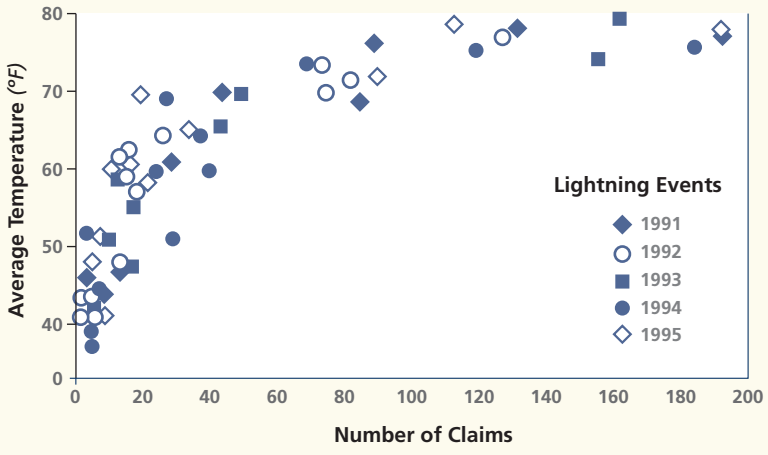
Other Types of Damages

- Worst Losses: $50 million warehouse (1997); $70 million Naval Air Rocket Test Station (1926)
- Over 50% of military aircraft weather-related in-flight mishaps
- Average $2 billion annually in airline operating costs and delays (1998)
- 101,000 desktop computer losses ($125 million) in the year 1997
- Extensive traffic signal outages

Insurance Losses

- Approximately 5% of all insurance claims, exceeding $1 billion/year (as of 1989)
- Saint Paul Insurance Co: $340 million/year, ~4% of total losses (1992–1996 average)
- State Farm Insurance Co: 307,000 claims/year, with $332 million paid claims
- Factory Mutual Insurance Companies: 3–4% of all claims paid

Source: www.lightingsafety.com



U.S. Lightning-Related Insurance Company Claims Rise with Temperature: 1990–1995. *(Mills 2005) Each symbol represents a lightning event in the continental U.S. Source: Hartford Steam Boiler and Inspection and Insurance Co. claims data (2000).*

Lightning is responsible for $332 million per year in claims paid by State Farm alone.

Weather-related drivers of wildfire include temperatures, humidity, wind, fuel-moisture content, and fuel types. Drought weakens trees and in many cases conspires with higher temperatures to foster super-infestations of forest pests (Figure 11), such as pine and spruce

beetles (which cause nearly 50-times the economic damage of wildfires[75]), with significantly elevated wildfire risk. Outbreaks in parts of Alaska—causally correlated with unusually high temperatures—have killed 90 percent of the spruce[76], Lightning, also a weather-related phenomenon, is a major source of wildfire ignitions (Box 4). As forests and shrubs are the primary terrestrial carbon sink, the fires and losses add substantially to the atmospheric accumulation of carbon dioxide. An analysis that included only the effects of temperature and wind, projected that wildfire damages in some parts of California would quadruple—even with today's full suppression resources brought to bear—under climate change.

Coastal Erosion: Coastal erosion is a hazard that is not insured by the public or private sectors in the U.S. However, the federal flood program will pay, indirectly, when there has been insured flood damage from a storm.[78] Under climate change, government-insured flood losses will increase due to the combination of sea-level rise and increased storm surges, and potentially stronger storms (Figure 12). This will be a future problem for both the National Flood Insurance Program and the increasing number of coastal property owners.[77]

An analysis that included only the effects of temperature and wind, projected that wildfire damages in some parts of California would quadruple—even with today's full suppression resources brought to bear—under climate change.

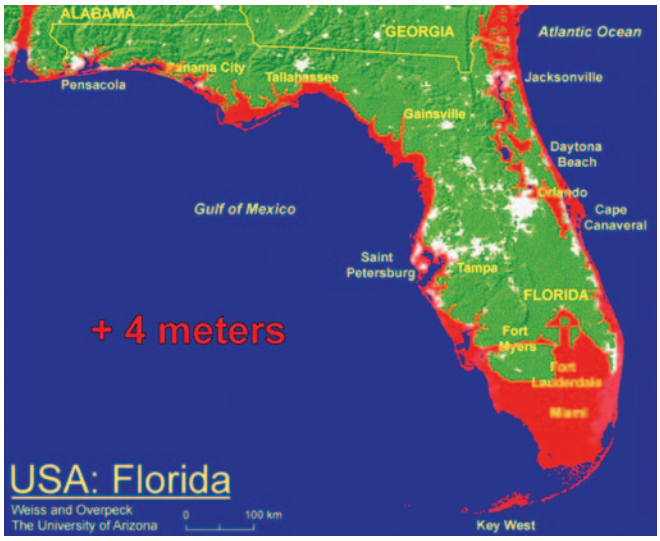


Figure 12. Coastal inundation arising from increases in sea level. *Includes only the effect of the thermal expansion of warming ocean waters. Excludes sea-level changes due to melting continental ice sheets.*

Flood and Other Causes of Water-Related Damage: One of the more well substantiated forms of observed climate change is the rise in precipitation, compounded by poor land-use planning and other activities that result in development in at-risk areas. In what is termed "cat-following-cat" events, flooding is also a consequence of hurricanes, and is predicted to be responsible for an unprecedented $15 to $25 billion in insured losses* for the flooding triggered by Hurricane Katrina.[79] There is a popular misconception that flood is not an insured risk. This is largely true for homeowners and small businesses in the United States (via the National Flood Insurance Program), but direct insurance or reinsurance for flood are often used in commercial lines. Moreover, vehicle losses due to flood are typically covered under the comprehensive portion of the standard auto policy. Business interruption insurance will apply to closures due to floods when there is commercial flood insurance. NFIP does not cover business interruptions.

Other causes of water-related damage have created a widely recognized crisis in several property insurance markets today,† linked to a number of weather-related factors, each of which is expected to become more severe under climate change. In an average year, small-

* This exceeds, by a factor of two, the total 1980-2004 inflation-corrected value of floods in the Munich Re database of U.S. flood events.

† Hotspots include California, Nevada, Colorado, Texas, the Carolinas, Florida, and New York.

scale weather-related events are collectively as, or more, significant than major catastrophes. This is reflected by a growing number of lawsuits that target builders, contractors, developers, sub-contractors, material suppliers, product manufacturers, and architects & engineers. The subject of these suits often center on construction defects claims arising from:

- Subsidence, collapse, cracks in walls & foundations.
- Leaking roofs, windows, doors, and foundations.
- Dry rot of wood or other building materials, pest infestations.
- Mold, code violations, improper specification of building materials.

In addition to the abrupt impacts of floods are the "longer-tail" water damages in waterlogged structures, agricultural settings, and environmentally related post-flood pollution liabilities (as was illustrated following the flood that accompanied Hurricane Katrina).

An average of 10 percent and up to 55 percent of the insured losses from catastrophes recorded by PCS were due to automobile damages.

Personal automobile insurance and coverage for other types of transport systems, including aviation: This sector is more weather sensitive than some realize. Windstorms, hail, flooding and earthquakes give rise to a surprisingly high number of automobile claims under the physical damage coverage, as PCS reports. This is due to direct damage (hail or flood) or flying objects (windstorm and earthquake). An average of 10 percent and up to 55 percent of the insured losses from catastrophes recorded by PCS were due to automobile damages (Figure 13). Vehicle accidents also increase during various forms of adverse weather, ranging from rainy conditions to heatwaves. The key point here is that under either property or liability coverage, unexpected types of claims from natural events already do occur and can be expected to occur in the future. Aviation losses are also significant, particularly from hailstorms.

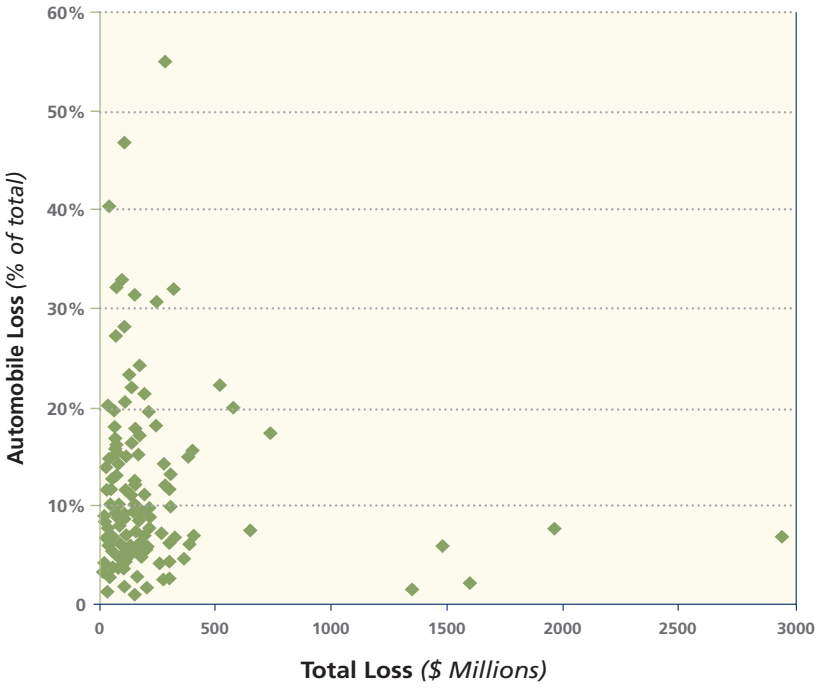


Figure 13. Correlation of U.S. catastrophe and auto losses (1/1996–9/2000). *Automobile losses can exceed 50% of total catastrophe losses. In the U.S., 16% of automobile accidents are attributed to adverse weather conditions as are one-third of the accidents in Canada. Autos also sustain insurance losses during natural disasters, amounting to $3.4 billion and 1.7 million claims between 1/1996 and 9/2000 (PCS 2000) and averaging 10% of total disaster related property losses, with much greater losses for some events, particularly hailstorm. The largest single auto loss was $171 million. Individual events have seen as much as 55% of total losses attributed to autos. These data systematically underestimate total losses because PCS records include only those events with total losses of $25M or more. Source: ISO/Property Claims Services.*

Crop Insurance

Agriculture is well-recognized as a climate- and weather-sensitive sector. Hazards include drought, excessive rain, flood, hail, heatwaves, windstorm, wildfire, insect infestation, and plant diseases. Drought is one of the most pervasive hazards, as illustrated by the $8.3 billion total economic losses in the U.S. in 2002.[80] Climate change is projected to cause extensive drying in most of the United States (Figure 14), with adverse effects on crops. Climate change impacts also include more vigorous weed growth (as a result of the well-known "fertilization" effect of increased CO_2 concentrations in the atmosphere). Heatwaves in Europe in 2003 caused $12 billion in crop losses, which could be a harbinger of things to come in the U.S. As shown in Figure 15, insured U.S. crop-hail losses climbed steadily from $40 million in 1948 to nearly $400 million in the early-to mid 1990s.[81]

Governments assume crop risks because private insurance firms find them too unpredictable and undiversified to insure at prices that the market will bear.

While some models predict increased crop yields under climate change due to more precipitation, this has been shown to be a flawed analysis. This arises from an assumption that increases in rainfall will be uniform, rather than the more realistic outcome of being concentrated in torrential downpours, which creates soil moisture saturation that is very damaging to crops. The 1993 U.S. Midwest floods resulted in losses of $6-8 billion, although most was due to excess soil moisture from rain as opposed to direct crop loss.[82] U.S. corn losses due to increased torrential rains under climate change are expected to double to $3 billion/year over the next three decades.[83]

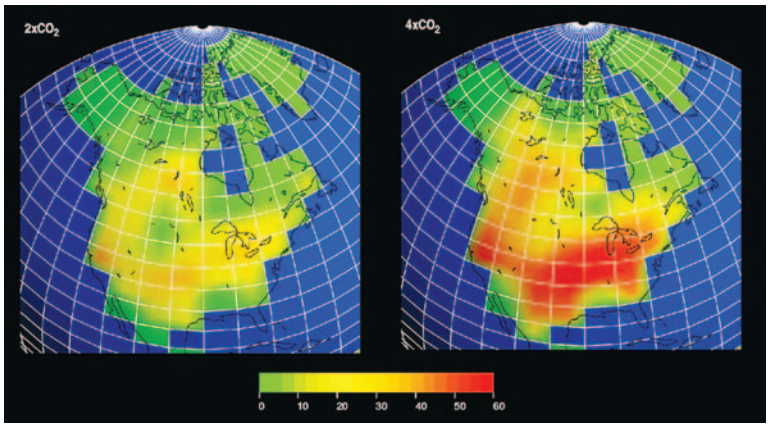
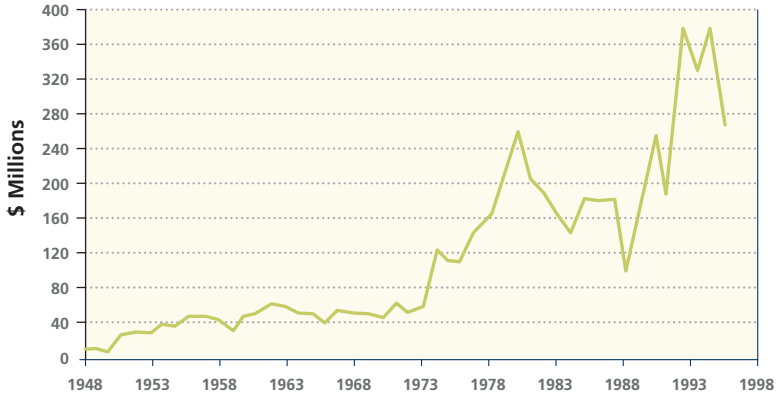


Figure 14. Potential effect of global warming on soil moisture in North America: percent reduction in June–August soil moisture content. *Drying of 20 to 40% is seen in much of the continental U.S. under a doubling of CO_2, and up to 60% in many areas under 4x CO_2. Drying underlies consequences for agriculture (moisture, pests, and diseases), forests, water supply, property (via subsidence), respiratory health (via airborne particulates), etc. Source: NOAA/GFDL.*

Governments assume crop risks because private insurance firms find them too unpredictable and undiversified to insure at prices that the market will bear. The Great Drought and ensuing "dust bowl" of the 1930s triggered the establishment of a "multi-peril" federal crop insurance program* in the U.S. to cover other hazards, including drought. Private insurers retained the crop-hail segment of the market (which also includes fire), and in 1980 were asked to administer the public program and share some of the risk with the federal government as well. By 2004, over 220 million acres of cropland were insured. The program provides $47 billion in coverage across 1.3 million policies in all 50 states, covering 350 distinct commodities.[84] The program is expanding into livestock (currently available in 19 states, and covers milk production in 12 states[85]), rangeland, and pasture. The federal government pays a portion of the premium for multi-peril and revenue-loss insurance (to cover administrative and claims-handling costs) and reinsures a portion of the losses. The government pays the entire premium for catastrophic losses. The government serves as "insurer of last resort" if private insurers fail to pay their intended share of claims. Those with insurance retain the costs associated with deductibles and caps on coverage.

* The Federal Crop Insurance Act of 1938.

Until "loopholes" were closed around 1985, only about a third of farmers purchased multi-peril crop insurance, the remainder relying on (free) disaster relief and emergency loans, which averaged $1.5 billion/year between 1988 and 1994.



Crop insurance losses have grown 10-fold in recent decades.

Figure 15. Annual losses under U.S. crop-hail insurance in the United States: 1948–1995.
Source: Changnon (1997)

Private crop-hail insurance represents a market of about $500 million/year in premiums and is generally profitable nationally, but losses in certain regions already significantly exceed premiums (e.g. in 2003 payouts exceeded payments by a factor of 2.4:1 in West Virginia and 1.4:1 in Kentucky).[86] Public multi-peril (or "all-risk") crop insurance represented a market of about $3 billion in premiums in 2003, with a payout/premium ratio of 1.24:1 (i.e., premiums not covering payouts). Since payouts are generally yield-related, farmers needn't experience a complete or catastrophic loss to make a claim. Those crops that are not covered by crop insurance are covered under the federal Noninsured Crop Disaster Assistance Program.

Crop insurers have recognized the risks posed by climate change.[87] Crop insurance systems are already under stress. Crop insurance losses have grown 10-fold in recent decades, and in some years the government's crop and flood insurance programs have been unprofitable[88, 89] Any increase in the frequency of loss events will further tax insurance systems by drawing down capital and surplus at a rate differentially faster than they can be replenished, and increasing the need for subsidies.

Weather-related events have already been observed to upset the financial stability of crop insurers. As a result of drought and bad fiscal management, the largest private participant (American Growers Insurance Company) became insolvent in 2002* after having operated successfully for 56 years. This event evidenced the weather sensitivity of the sector and risks to insurers and prompted considerable concern by the government. The U.S. Government Accountability Office issued a report finding that the federal agency designated to oversee the financial health of the crop insurance program needed to implement better methods to monitor and communicate with participating insurers and their regulators.[90] The transition cost the taxpayers $40 million. Nationally, the drought caused an increase in losses of approximately 33 percent ($1 billion) to the federal crop program. This story evidences the challenges. In 2002, $139 was paid in claims for every $100 collected in premiums.[91]

* Technically, the Nebraska Department of Insurance took control of the company in an effort to address the fiscal problems.

Health/Life Insurance

The life/health segment represents a large share of U.S. insurance premium volumes. Climate change is expected to adversely impact the prevalence of vector-borne diseases, heat stress, water quality, aeroallergens (such as pollens* and mold), and the health of natural systems that can cause economic and insured losses for humans (e.g., forest beetle infestations leading to timber loss and wildfire).[92] Natural disasters also have material impacts on mental health; the World Health Organization has estimated that up to 2.5 million people will experience moderate to severe psychological distress following the great Tsunami of 2004, with 25,000 to 50,000 experiencing persistent problems.[93] An in-depth treatment of health issues is provided in the "Climate Change Futures" study, conducted by the Harvard Medical School's Center for Health and the Global Environment and sponsored by Swiss Re and the UN Development Programme.[94]

More airborne allergens, rising temperatures, greater humidity, more wildfires, and more dust and particulate pollution may considerably exacerbate upper respiratory disease and cardiovascular disease.

The combination of more airborne allergens, rising temperatures, greater humidity, more wildfires,† and more dust and particulate pollution may considerably exacerbate upper respiratory disease (rhinitis [hay fever], conjunctivitis, sinusitis) and cardiovascular disease (e.g., due to reduced oxygen and increased carbon monoxide during fires). Cases of asthma, already causing greater impacts than Alzheimer's disease, would sharply increase. The baseline cost of asthma was $13 billion per year in U.S. alone as of the mid-1990s (half of which are direct healthcare costs). If a 30 percent increase took place in the U.S., the incremental cost of $4 billion per year would be on a par with that of a very large hurricane each year.

Large natural catastrophes have resulted in major loss of life, even in well-insured regions such as Western Europe (the heatwave of 2003 killed up to 35,000 people above the norm). Aside from individual events, life insurance losses are not likely to increase significantly in the U.S. However, losses would rise from current levels and could be quite significant in emerging markets (where U.S. insurers increasingly seek to do business).

Business Interruption Insurance

Losses due to the disruption of business operations typically range from 20 to 40 percent of claims resulting from hurricanes. Other weather-related triggers for business-interruption claims include lightning, flood, and wildfire. Visibility problems during wildfires in Malaysia this summer forced the closing of the country's largest port and many businesses.[95] Business interruption policies often have a "time deductible", i.e., only losses incurred after a fixed period (e.g. 3 days) following the loss event will be covered. There are various forms of business interruption insurance, e.g. "contingent" versions that cover indirect impacts such as supply disruptions due to events far from the insured's business.

Liability Insurance

Liability claims due to climate change are probably the least well understood class of exposures. They take several forms. During natural catastrophes, it is generally unusual for a claim to arise under liability insurance, since there must be a negligent act that causes damage to another's property. It could happen when a landslide damages a neighbor's property, or by not being attentive to poor road conditions in driving, as mentioned. Government entities are often sued after landslides. Contractors' liability and mold problems have been liability issues in California, but legal developments and policy changes will make these claims more difficult in the future.

Claims are already significant from property damages due to mold and moisture (product liability, professional liability). This has become a crisis for homeowners insurers in some

* Pollen has been observed to increase by 60 percent with a doubling of pre-industrial atmospheric CO_2 concentrations.

† In Western Montana, hospital admissions for heart and lung ailments increased significantly at the height of the 2004 wildfire season. Admissions for respiratory disease in Ravalli County increased by 90 percent and those for heart problems by 57 percent.

regions, as evidenced by claims of $3 billion nationally, and anticipated to become an issue in commercial lines in the future.[96, 97] While this has been aggravated by excessive litigation and media exaggeration, there was also an underlying fact of increased moisture-related losses (up more than four-fold in Texas the past several years compared to the prior decade, representing 60 percent of homeowners' claims value) and changes in construction practice that fostered mold production.* Data from the Insurance Information Institute† indicate that:

- $850 million in paid claims in 2001; $35,000/claim
- Water-related claims are 60 percent of the total in Texas, 30 percent in California
- All but 19 states had mold exclusions as of 2002
- Cost $444/household (premium increase) in Texas[98]
- The issue is "migrating" to commercial lines (property, liability, workers compensation, commercial liability, and business interruption)
- Insurers say that mold—a climate- and weather-related hazard—will threaten affordability, and is a major factor in insurers leaving the Texas market (Figure 16)

Insurers say that mold—a climate- and weather-related hazard—will threaten affordability, and is a major factor in insurers leaving the Texas market.

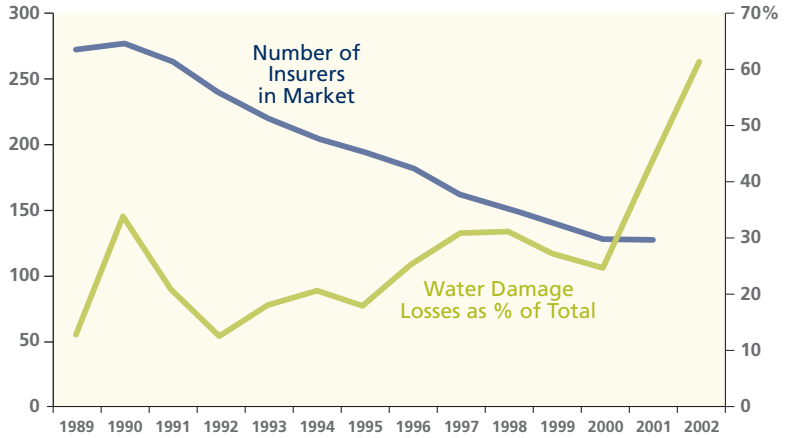


Figure 16. Texas insurers leave market as water-damage claims rise. *Sources: Texas Department of Insurance; Texas Coalition for Affordable Insurance Solutions from A.M. Best data via Insurance Information Institute (Hartwig 2003).*

In an entirely different form of liability claims, corporate liabilities may eventually arise from claims against large emitters of greenhouse gases.[99] This is being played out first in the U.S., as is evidenced by Attorneys General from NY, CA, CT, ME, NJ, RI, VT suing electric utilities to force three percent annual reduction of GHG emissions over 10 years. State Treasurers from CA, CT, ME, NM, NY, OR, and VT have called for disclosure of financial risks of global warming in securities filings.

Directors and Officers (D&O) liability has already been identified as an arena in which climate change impacts may be brought back to insurers. In the post-Enron, post-WorldCom marketplace, there is considerable concern about the ability of corporate leadership to proactively manage risks and anticipate business threats. Swiss Re is concerned that D&O policyholders understand the climate change risks that may influence the financial performance or even solvency of their companies, and has called for disclosures on corporate practices.

* A popular misconception is that energy efficiency is the cause of the mold/moisture problem. While bad application of energy efficiency features can cause such problems, the root cause is bad construction practice (efficient or otherwise).

† Information posted here http://www.iii.org/media/hottopics/insurance/mold2/, and in presentations on the site by Robert Hartwig.

VI. Pressure on Insurance Affordability and Availability Under Climate Change

Extreme weather events have already precipitated contraction of insurance coverage in some markets, and the process can be expected to continue if losses increase in the future. Impacts vary, of course, depending on the specific circumstances, and can be relatively minor (gradual price increases) or more significant. While not a weather-related event, the Northridge Earthquake of 1994 provides a sobering example of how trend changes in natural disasters can lead to serious questions of insurability and undesirable outcomes for consumers (Box 5).

Directors and Officers (D&O) liability has already been identified as an arena in which climate-change impacts may be brought back to insurers.

Box 5. The Retreat of Catastrophe Insurance: The Case of Earthquake*

- Northridge Earthquake of Jan 17th 1994 gave $15Bn market loss equivalent to 28 years of annual premiums
- Insurers demanded immediate increase in residential rates and Insurance Commissioner refused
- Insurers threatened to leave the state—fear for a collapse in the mortgage and housing market
- State set up the California Earthquake Administration as alternative provider of earthquake coverage (with policies managed by insurers)
- Under pressure from reinsurers and to reduce overall risk load CEA imposed 15 percent deductibles
- CEA policies are 2x as expensive and only give half the coverage of policies prior to 1994
- Earthquake insurance penetration dropped from 30 percent in 1993 to 10 percent today

* Excerpted from presentation by Robert Muir-Woods, Chief Research Officer, Risk Management Solutions, June 29, 2005 "The Future of the Insurance Industry under Climate Change."

While regulation is a key factor in the evolution of these changes, it must also be kept in mind that various forms of insurance (e.g., surplus lines and "county municipals") have limited, if any, regulation.* It is worth noting that insurance also comes under the purview of non-insurance regulatory bodies, e.g., the SEC for corporate governance and independent rating agencies, such as Standard & Poor's and A.M. Best & Co., and some industry observers say that the time may be coming where these groups have more influence than traditional insurance regulators.[100]

Based on the preceding insurance-line assessments, we offer the following U.S. outlook for the types of issues discussed in this paper, particularly the ways in which trends in extreme weather events are eroding insurability.

- **Flood**—currently a mix of public/private insurance and risk sharing. Under climate change, we expect insurability problems to extend from the present personal and small-commercial lines into larger commercial lines. To highlight this issue, one need only look to the enormous flood losses of Hurricane Katrina.
- **Windstorm**—a largely insured risk at present. We are already seeing considerable insurability problems and associated changes in terms and pricing, non-renewals, market withdrawal, etc. This could increase dramatically under climate change, resulting in further shifting of losses to governments and consumers.

* Most domestic reinsurers are fully licensed and regulated insurers. Foreign reinsurers must maintain deposits in the United States in order for the primary insurer to take credit for the reinsurance on its balance sheet.

- **Agriculture and livestock**—currently a public/private insurance partnership. Climate change will stress this sector considerably, with potential for impacts due to drought, flood, pests, or other events on a scale with the Great Dust Bowl of the 1930s. The public crop program could become insolvent, although it would likely continue to provide coverage for political and socioeconomic (public policy) reasons.
- **Wildfire**—currently largely privately insured. We anticipate an evolution similar to that seen from the earthquake hazard, i.e., more retention of risk by purchasers of insurance and more involvement by state governments, while insurers raise deductibles and reduce limits of liability and scope of coverage.
- **Mold and moisture damage**—largely commercially insured until the crisis emerged a few years ago. Now, many states have exclusions. A Federal Mold Pool has been proposed as House Bill 5040 and has been endorsed by some stakeholders,[101] which would shift this risk to the government sector.
- **Earth movement and coastal erosion**—primarily insured by government, if at all. Permafrost melt, subsidence of dry soils, and sinkholes will become more prevalent, as will mudslides and property losses from coastal erosion. As an example, sinkhole losses have been rising in Florida, with rate increases of 35 percent in loss-prone areas and calls for new insurance pools to help handle the risk.[102] Government programs covering storm-surge-driven losses on eroded property could be overwhelmed with losses under climate change, with the result of more retention by property owners.
- **Health impacts**—currently largely privately insured. Aside from the emergence of new diseases, we do not anticipate an insurability crisis under climate change. Certain forms of losses could increase sharply, however, particularly concerning respiratory disease. Impacts will manifest in the form of elevated health insurance prices. The U.S. government has assumed a steadily increasing share of health insurance costs, up from about 25 percent in 1965 to almost 50 percent today.[103]

As losses from climate change increase, consumers and businesses will be required to assume a larger proportion of a growing absolute level of losses, both via deductibles that precede paid loss as well as via costs that exceed coverage limits

The aggregate effect of the preceding observations is towards rising insurability problems resulting in structural changes that alter the current risk-spreading formula in the United States and the market share for insurers. This is exemplified by the growth in so-called "surplus lines" insurers (currently collecting $33 billion in the U.S. in 2005, up 65 percent since 2002)[104] that are largely outside the regulatory framework for pricing. It is not unusual for surplus lines providers to fill the vacuums created as conventional insurers leave particularly risky markets (e.g., in response to mold-related withdrawals from the Texas market or post-hurricane withdrawals in the U.S. Gulf states). While surplus insurers help address insurance availability problems, the combination of higher prices, absence of solvency regulation, and non-admittance to risk-spreading pools renders consumers availing themselves of surplus insurance more vulnerable.

Another example of the shifting of costs to consumers has been evidenced (according to the Insurance Information Institute) in hail-prone parts of Texas, Kansas, Kentucky, and other mid-western states where, in addition to tightening deductibles, some companies are providing coverage for roofs on a depreciated (actual cash value), rather than a replacement-cost basis.

Governments already play a role in preparing for or recovering from virtually each class of climate-related loss we have examined, and will be called upon to do more. As losses from climate change increase, consumers and businesses will be required to assume a larger proportion of a growing absolute level of losses, both via deductibles that precede paid loss as well as via costs that exceed coverage limits [essentially as "self (re)insurers"], either directly or as taxpayers who pay for government assistance in the aftermath of extreme weather events. As seen with the existing flood program, governments set relatively low limits on losses ($250,000 for personal lines and $500,000 for commercial lines), and exclude coverage for temporary living expenses or business interruptions.

Insurers can be largely insulated from the impacts, as long as regulators award an adequate combination of rate increases and permission to change terms and market participation.

However, this could translate into some slowing of growth in commercial insurance premium volumes, but also lower claims.

VII. The Way Forward—Proactive Measures

There exist a host of responses that are desirable for the business community and consumers alike. They require, however, successfully overcoming and integrating responses to a combination of technical and policy related hurdles. Thus, there must be a willingness to seek solutions and to build the structure for policy implementation, as well as good actuarial analysis and catastrophe modeling.

Success will depend on emphasizing science rather than rhetoric (at either end of the political and ideological spectrum), and fostering understanding rather than polarization. Such polarization can have a counterproductive effect on sound analysis and risk management. Proof of climate change claims and counter-claims by "vigorous assertion" and research based on preconceived outcomes, make for dramatic news headlines but fail to genuinely address the nonpolitical and hopefully multi-partisan desire to safeguard homeowners and businesses from the fallout of natural disasters.

Proof of climate change claims and counter-claims by "vigorous assertion" and research based on preconceived outcomes, make for dramatic news headlines but fail to genuinely address the nonpolitical and hopefully multi-partisan desire to safeguard homeowners and businesses from the fallout of natural disasters.

We offer some specific recommendations below, indicating logical leadership roles from various key players: Insurers, insurance regulators,* state and federal governments, and insurance consumers. In practice, solutions require collaboration and risk-sharing among these stakeholder groups. Following are some thoughts on the roles these groups can play while working in unison. Public-private partnerships are clearly essential. Insurers and governments have devised and must continue to craft innovative means for spreading financial risk while fostering loss-prevention practices.[105, 106] Care must, of course, be taken that new activities are consistent with the anti-trust requirements of the Sherman Act.

Insurers

- **Strive to improve loss data collection and actuarial analysis.** Better (more thorough) data collection and analysis of observed trends are essential (coupled with attribution analysis—what is the role of climate change versus socioeconomic/demographic drivers?)
- **Analyze the negative and positive implications of climate change on their business, investments, and customers, and share the results with shareholders.** It would be prudent for insurers to comprehensively examine the full range of potential effects of climate change on their businesses, including property/casualty lines, life/health lines, and their investment portfolios. Such analyses should include effects of changes in frequency, type, and intensity of extreme as well as small-scale events on insurability and surplus, and shifts in market share to or from alternative risk transfer mechanisms such as self insurance, catastrophe bonds, or weather derivatives. The U.S. Government Accountability Office has expressed concern about the relative risks of some of these alternatives compared to traditional insurance.[107] Responding to climate change will also present opportunities for insurers and their shareholders, as noted by AIG, Allianz (owner of Fireman's Fund and PIMCO),[108] and other insurers.
- **Vigilantly and vigorously promote and support advanced building codes, the "fortified building" concept, and tools to mitigate potential losses.** For example, when indoor air quality issues first arose, insurers, fearing catastrophic and unmanageable losses, excluded coverage.[109] As the years passed, insurers have learned more about building science and ways to pre-empt problems through better building design and operation, with the result that the situation has begun to shift from "problem" to "opportunity".[110] It takes courage to constantly and universally promote strong building codes and land use control measures. As evidenced by the modest scale of beneficial activities such as those of the Institute for Business and Home Safety, the insurance industry considerably under-invests in risk management and loss prevention.

* The McCarron-Ferguson Act of 1945 placed the regulation of the insurance industry under the states

- **Engage in weather/climate research and promote the use of scientific methods for enhanced climate modeling.** While insurers should not be expected to conduct basic research, their deep understanding of risk assessment and management, coupled with their traditions of data collection, represent potent ways in which they could augment existing climate science. One of the potential outcomes—better modeling— could significantly improve the quality and applicability of data and risk analyses, facilitating availability of insurance in regions where the current lack of information is an obstacle to market development (Box 6). One potential area might be flood risk, which has often been viewed as uninsurable. This would constitute a major sea-change in the perspective of insurers regarding this particular hazard (Swiss Re 2002). CAT modelers recognize the need for this.[111] A very positive precedent for this type of work has been set in the case of earthquake insurance.

Box 6. Coupled Climate and CAT Models for Better Strategic Intelligence

Disjointed modeling traditions hamper insurers' ability to assess weather-related risks and regulators' ability to safeguard both insurers and consumers.

Disjointed modeling traditions hamper insurers' ability to assess weather-related risks and regulators' ability to safeguard both insurers and consumers. Insurers' weather-related loss models focus primarily on single catastrophic events (to the exclusion of a broader array of small-scale events that have larger aggregate impacts), are predicated on extrapolating historical trends to normatively defined areas of exposure, and largely neglect life/health impacts. The models are typically applied to hypothetical disaster scenarios at the individual insurer level, rather than to probabilistic regional or national scenarios based on expected trends. They are also based on isolated events (e.g., single hurricanes), rather than aggregate seasonal effects across a range of perils. One of the "big-3" modeling firms noted that Hurricane Katrina revealed a number of shortcomings in existing models, shortcomings that yield systematic underestimation of exposures.[112] Not all relevant events are covered by insurance models (particularly the non-catastrophic events, e.g., permafrost melt, that yield large claims in the aggregate), and existing models and storm-rating scales are incomplete, e.g., covering the wind effects of hurricanes but not the ensuing water-related losses.[113]

In contrast, the climate change community's models are future-focused and yield longer-term results not easily applied to business decision-making or particularly abrupt climate change impacts.[114] Winterstorms are an important category of relatively small-scale event that is not well captured in current catastrophe modeling tools.

The climate- and catastrophe-modeling communities operate largely in isolation. The Reinsurance Association of America has noted the opportunity and imperative for integrated assessments of climate change impacts, stating to its constituents "it is incumbent upon us to assimilate our knowledge of the natural sciences with the actuarial sciences—in our own self interest and in the public interest".[115] An effort to bridge the gap, in the case of windstorms under climate change, yielded striking results.[116] While conducted by the Association of British Insurers, the CAT modeling was performed by one of the leading U.S. firms (AIR Worldwide, a subsidiary of the Insurance Services Office, ISO). U.S.-based RMS also contributed to the study. Predicted losses, technical prices (risk premiums), and capital requirements under a low-emissions scenario were one-fifth to one-eighth those under a high-emissions case. The value of improved data and modeling is central, as evidenced by a potential shift in the industry (thanks in part to better models) toward accepting flood risks in areas where they previously had been viewed as uninsurable.[117]

Several insurance trade organizations, plus State Farm, endorsed this idea in a letter to then Vice President Gore in 1995,[118] yet little headway has been made in this direction in the ensuing years.

- **Create an industry-driven activity improving on the climate change insurance working group that was briefly active in the mid-1990s.*** There would be real benefit of new dialogue among trade associations, their member companies, and unaffiliated insurers. The original group existed for only a brief period and did not have any lasting impact.
- **Lead by example in reducing their corporate climate footprint.** While not among the major emitters of greenhouse-gas emissions, insurers nonetheless own and operate enormous numbers of buildings in which energy efficiency opportunities abound. Hartford Steam Boiler's headquarters was among the very first buildings to receive the Energy Star label for energy performance.
- **Encourage policy action and technical measures to achieve greenhouse-gas emissions reductions, especially where there are direct collateral benefits for the insurance core business.**[119] For example, FM Global has promoted energy efficient "torchiere" light fixtures because of their fire-safety benefits, as an alternative to the energy guzzling halogen models dominating the market.[120] An aggressive energy efficiency campaign in California avoided 50 to 150 hours of rolling blackouts during the summer of 2001.[121] Most energy efficiency strategies also provide peak demand reductions, which are beneficial in the event of power shortages e.g., during extreme temperature events. The American Insurance Association has endorsed various forms of emissions reduction strategies (as well as land-use planning), observing that some have the "win-win" benefit of reduced insurance hazards (Box 7). They also, rightfully, point out that care should be taken to ensure that climate change mitigation strategies do not have inadvertent adverse consequences on the insurance core business.

After New Orleans, it's becoming clearer that we are experiencing more frequent and more powerful weather events that pose huge challenges for the insurance industry… This is both a coastal issue and a heartland issue. We're seeing all kinds of extreme weather in the Great Plains, including drought, tornadoes, brushfires and severe hailstorms.

Tim Wagner, Director
Nebraska Department
of Insurance

Box 7. Energy Efficiency Strategies Endorsed by the American Insurance Association*

- **Speed Limits Have Both Safety and Environmental Benefits:** Experience during the 1970s and 1980s with national speed limits of 55 mph has conclusively shown that lower speeds not only save energy and reduce greenhouse gas emissions, but also lower deaths and injuries on the highways. The abandonment of a national speed limit and a return to 65, 70, or higher mile per hour speed limits in most states was an unfortunate societal development affecting highway safety, energy usage, and greenhouse gas emissions.
- **Energy savings and loss control:** Working with several property-casualty insurers, the U.S. Department of Energy's Lawrence Berkeley National Laboratory has identified areas where energy efficiency improvements also reduce fire, explosion, or winter storm hazards. Insurers can support improvements in energy efficiency as long as they do not create new, unanticipated risks to human safety and property, particularly when energy efficiency strategies measurably improve safety and loss control.
- **Public Transportation and Other Non-Driving Alternatives:** Property-casualty insurers are generally supportive of increased investments and improvements in public transportation, and other initiatives that encourage less driving including "smart growth" strategies, HOV lanes, and pedestrian and bicycle access. These strategies reduce energy usage and promote cleaner air. For auto insurance and highway safety, they reduce congestion in urban areas and stress on drivers that leads to increased accident rates. Public transportation also helps to enhance and preserve mobility options for young and very elderly drivers that tend to have higher accident rates.
- **Telecommuting:** Increased telecommuting takes drivers off the road during the highest morning and afternoon rush hours in the most congested urban areas where accident rates and insurance costs are the highest. Telecommuting also reduces energy consumption and emissions.

* Quoted from the American Insurance Association documents.[122, 123]

* The original members are listed in the Key Findings section.

Insurance Regulators[124]

- **Review the "standards of insurability" to identify new challenges, domestically and abroad.** Given the changing conditions, it would be prudent for regulators to revisit the standards of insurability and examine the various climate-related hazards (on a line-by-line basis) in this context. The potential for insurer-initiated risk management should be evaluated for risks that are deemed currently or potentially uninsurable. As U.S. insurers do more business overseas, the risks there must be assessed as well. Calling for disclosures of climate risks is one approach. In an indication of the willingness for insurers to disclose their risks and activities, Aetna, Allstate, AIG, Prudential, and St. Paul Travelers have voluntarily participated in the Carbon Disclosure Project.*
- **Incorporate climate risks in solvency and consumer-impact analysis.** In anticipation of a continued rise in losses (which are rising faster than premiums), regulators will need to redouble their efforts to ensure solvency and to encourage best practices among insurers and self insurers. This will, in turn, minimize adverse consumer impacts. An important example was the All-Industry Research Advisory Council's report in 1986, which surprised the insurance community by quantifying the considerable effect of multiple mega-catastrophes on insurer solvency.[125] It is remarkable that this work has not been replicated or updated over the intervening 20 years. Another area that merits analysis is the degree to which insurer investments may unexpectedly decline in value if they have not been thoroughly vetted for climate risk issues.
- **Encourage insurers to collect and analyze more comprehensive data on weather-related losses.** The existing floor of $25 million per loss erodes the value of the PCS data.† Relaxing this limit within PCS, or creating a new data-gathering body would be of value. Currently there is scant information on the role of weather events in vehicle accidents, power outages, and, especially, health-related losses. While catastrophe losses are relatively well documented, few comprehensive statistics exist for equally important "small-scale" events such as lightning strikes and soil subsidence. Basic insurance loss data should be more readily available in the public domain.
- **Elevate the practice of catastrophe modeling.** In order to assess exposures of insurers and their customers, CAT models (or other tools) should integrate the processes of climate change. The models should be subject to peer review. The Florida Commission on Hurricane Loss Projection Methodology may be a good model for replication and expansion to other perils.‡ Existing CAT models, however, only cover a subset of insurance-relevant climate change impacts. These voids should be filled with new modeling methods.
- **Assess exposures of insurer investments and adequacy of capital and surplus to weather extremes.** Extreme weather events affect the financial markets, real estate, and other assets in which insurer capital and surplus are invested. Insurers held over $3 trillion in stocks and bonds alone, as of the year 2001,[126] representing almost 9 percent of the total market, held primarily by life-insurers.[127] Analyses of the potential for erosion of capital and surplus or liquidity problems should include shifts in weather impacts. Insurers themselves must make this assessment, the result of which will be confidential and held by the insurer but accessible to regulators. While a $300+ billion insurer surplus is often cited as an adequate war chest for disasters, only a fraction of it is available for losses arising from extreme weather events, to any particular insurer, or to a specific category of loss.
- **Explore the feasibility of developing a weather exposure (large and small events) questionnaire.** Doing so for climate change would be more complicated, and certainly would have to be implemented at the level of specific perils (e.g., hurricanes). This could

Reinsurers who provide a backstop on large losses are engaged on the climate issue, but much more work needs to be done by the primary insurers who consumers rely on when catastrophes hit.

Joel Ario, Oregon Insurance Administrator
Vice President, National Association of Insurance Commissioners

* Their statements on the issue can be found at: http://www.cdproject.net/

† According to the Insurance Information Institute, when the floor was raised from $5M in 1996 to $25M in 1997, the number of catastrophes fell from 41 in 1996 to 25 in 1997, mostly due to this reclassification. See http://www.iii.org/media/hottopics/insurance/xxx/

‡ See http://www.sbafla.com/methodology/

be modeled partially after the California Insurance Department's annual Earthquake Questionnaire.

- **Identify and remedy undue barriers to constructive insurer activities.** Among the possible barriers to further insurer engagement in the climate change responses are the inability to recover climate research costs through rates and ways in which antitrust laws might impede the gathering and analysis of useful claims data. A thorough review of issues should be conducted.

Governments

- **Foster and participate in public-private partnerships for risk spreading.** If executed properly, potent synergisms can help maintain insurability where coverage could otherwise be withdrawn. Various levels of government (from local to international) can contribute here.
- **Reduce disaster losses through planning and post-event response.** Hurricane Katrina highlights the need for pre-event loss assessment, in-depth planning, and a higher level of preparedness.
- **Maintain (or even restore) insurability by improving resilience to disaster losses.** The American Insurance Association offered six recommendations to the OECD for mitigating catastrophe risk.[128] These included early warning systems, better land-use planning, improved building codes and catastrophe-resistant reconstruction, improved coordination and planning of national and international relief efforts, assistance in catastrophe contingency planning, and support for pre- and post-event mitigation and response. Local governments often have lead responsibility for the above-mentioned activities.
- **Comprehensively assess the government's overall financial exposure to changing patterns of weather disasters.** Governments are vulnerable to impacts on flood and crop insurance, outlays for emergency disaster relief, and as significant owners of weather-sensitive infrastructure.
- **Expand basic research on climate change and loss modeling, and issue climate change hazard maps.** By analogy, the hazard maps for earthquakes indicate risks of liquefaction and landslides. In the case of climate change, such maps could show the relevant projected impacts, by peril. Policymakers must reckon with the fact that budget constraints impede the implementation and updating of hazard maps.
- **Take policy action to reduce greenhouse gas emissions.** Governments are already engaged in efforts to reduce greenhouse gas emissions, and, in light of the potential impact to insurance customers, these efforts should be redoubled.

It has become evident that climate change will continue to challenge insurers and state insurance regulators. Inevitably, this will pose a threat to the availability of essential insurance coverages for consumers.

The National Association of Insurance Commissioners

Consumers

- **Minimize disaster losses through the use of recognized pre-loss mitigation practices.** Consumers (whether in households or the business sector) must ultimately understand and weigh the risks they face, adopt loss-prevention measures, and make informed insurance purchasing decisions.
- **Curb emissions that cause climate change, primarily by making cost-effective energy efficiency improvements and increasing the use of carbon-free energy sources.** Ultimately, it is insurance consumers (whether homeowners, renters, businesses, or industries) that consume energy and contribute to other causes of climate change. Whether heating and cooling in homes, lighting in office buildings, fuel-economy in vehicles, or industrial processes, a myriad of cost-effective energy-efficiency strategies are available to reduce energy use by 50 percent and more in many cases.

Postscript—In the Wake of Hurricane Katrina

Work on this paper began shortly before Hurricane Katrina struck New Orleans and the broader Gulf Region in late August 2005. The ripple effects of Katrina across public and private insurance highlight many of the questions of insurance availability and affordability discussed in this report.

The Insurance Information Institute* has stated that Hurricane Katrina is "the worst natural disaster the insurance industry has ever handled," and according to ISO's preliminary estimates, 1.6 million claims are expected (Figure 17). The storm's footprint was historic, and the storm surge may have exceeded 30 feet, causing ultra-rare "500-year return period" flooding in some areas.[129] The full extent of the losses are not yet known, but this historic event clearly created an intricate web of impacts involving almost all lines of insurance, plus additional economic impacts affecting the broader economy. Preliminary estimates include 500,000 left homeless, more than 250,000 properties and 200,000 cars destroyed, major crop and fishery losses and disruption of agricultural exports, temporary loss of 95 percent of the region's oil production, as well as interrupted foreign oil imports, elevated national and international energy prices to $70/barrel, and demands for tens of billions of dollars in federal disaster relief. Widespread pollution resulted from washed-out sewage systems, landfills, industrial sites, and gasoline and oil tanks (equivalent to two-thirds of the famous Exxon-Valdez spill).

The full extent of the losses are not yet known, but this historic event clearly created an intricate web of impacts involving almost all lines of insurance, plus additional economic impacts affecting the broader economy.

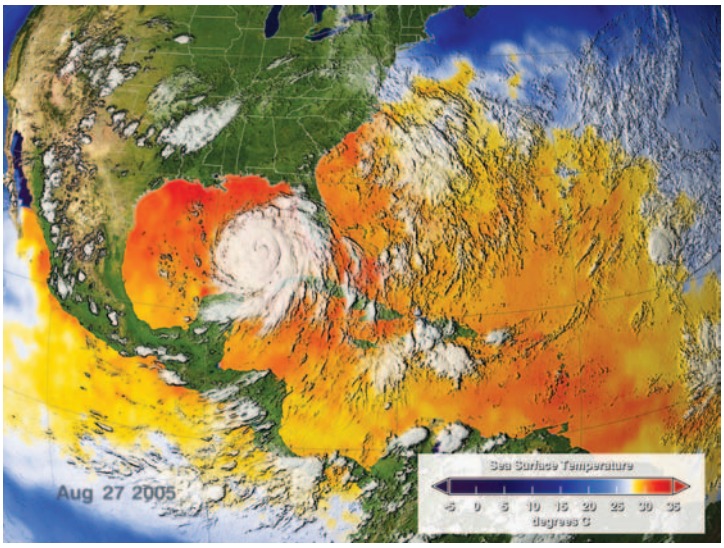


Figure 17. Warm ocean waters energize hurricanes*. This image depicts the three-day average of sea surface temperatures (SSTs) from August 25-27, 2005, and the growing breadth of Hurricane Katrina as it passed over the warm Gulf of Mexico. Yellow, orange and red areas are at or above 82°F, the temperature needed for hurricanes to strengthen. By late August SSTs in the Gulf were well over 90°F. Sources: NASA/GSFC/SVS*

The property losses stem from multiple factors, among them, wind (including tornadoes following the hurricane), flood, fire, looting, mold, and environmental contamination. Virtually every property-casualty insurance line has been impacted, including homeowners, commercial property, personal and commercial automobile, and environmental liability. Due to disruption of supply lines and the protracted recovery, extraordinary business interruption losses are expected, compounded by the outage of 30 electric power stations serving 1.3 million customers and forced evacuations of disaster management personnel, and disruptions to five of the top twelve U.S. ports. Significant losses occurred in lines of business and asset classes not normally significant in past catastrophes; these included cargo, inland

* See http://www.iii.org/media/hottopics/additional/katrina_faqs/. Most of the statistical information in this section comes from Risk Management Solutions (2005).

marine and recreational watercraft, floating casinos, onshore energy, and automobiles. Direct economic losses are compounded by local inflation (e.g., 15 percent higher lumber prices) induced by the event. With 1,200 deaths and uncounted healthcare costs, life and health insurance will be impacted as well. Rating agencies have put large insurers such as Allstate and State Farm on notice for possible ratings downgrades.[130]

With estimated insured losses currently ranging up to $60 billion—double last year's record of $30 billion in hurricane losses from four hurricanes in the U.S.—Katrina is a real-world "stress test" of how well the insurance system and its customers can withstand future catastrophic losses. It also focuses increased attention about the influence of climate change on hurricanes and the rising human vulnerability to such cataclysmic events. No doubt, Katrina will prompt a wave of insurance price increases, tightening terms and market withdrawals. The federal government, with 377,000 flood insurance policies in force in Louisiana alone, will have large numbers of claims through the National Flood Insurance Program (NFIP)—which provides $52 billion of coverage in Louisiana—and broader disaster relief efforts. Amid renewed calls for a national reinsurance backstop for catastrophes, both FEMA and NFIP will likely have to obtain new funds from the U.S. Treasury to compensate for insufficient reserves. Preliminary estimates of government aid and reconstruction—$200 billion or more—are comparable to the cost of the war in Iraq, and are double that of the Marshall Plan. Most low-income households will face the difficult circumstance of having no insurance at all.

No doubt, Katrina will prompt a wave of insurance price increases, tightening terms and market withdrawals.

As did Hurricane Ivan the year before, Katrina caused enormous offshore property losses to oil and gas infrastructure* and on-shore losses to the electricity sector, with associated business interruptions. Following the storm, the local power utility Entergy quickly filed for bankruptcy protection.[131]

Effects on Insurance Prices and Availability

As coverage is curtailed and prices increase, Katrina will have more acute impacts on insurance buyers than on insurance companies. Price increases (on top of those awarded after the active 2004 hurricane season) will extend out of the Gulf region, and, indeed, beyond the U.S. borders, reversing the downward global trend in reinsurance prices.[132] Florida-based homeowners insurers were awarded 15 to 20 percent premium increases to recover losses from 2004, and it is likely that similar requests will be put before the state regulators across the Gulf region given the even larger losses in 2005.

Caps on total losses payable under the government-funded National Flood Insurance Program (currently $250,000 for residences and $500,000 for small businesses) haven't kept pace with inflation or rising property values. As a result, there will be increasing demand for commercial insurance layers to pick up where public relief leaves off. Those policies will be priced quite steeply. For example, in the wake of the recent mold crisis in Texas, surplus-lines insurers entering that market to fill the vacuum left by departing homeowners insurers are commanding three-fold higher premiums. The recent string of hurricane losses could lead to a similar scenario.

The energy sector is sure to be hard-hit. Already absorbing price increases of 25 percent in some areas after hurricanes in 2004, similar or greater increases in the cost of business interruption insurance and property insurance will likely follow Katrina and Rita. Of more concern, some in the industry fear the loss of insurance availability altogether in some areas.

It's not only prices that are of concern. The losses of 2005 will no doubt extend the industry trend towards specifying percentage deductibles instead of fixed-value ones.

* Reflecting the combined effects of hurricanes Katrina and Rita, as of October 7, 2005, oil production in the Gulf was down by 78 percent and natural gas by 64 percent. In addition 111 oil platforms destroyed, 52 extensively damaged, 19 adrift, and 44 pipelines damaged. About 200 oil rigs and 1,300 platforms remained evacuated. Source: U.S. Department of Energy "Gulf Coast Hurricanes Situation Report #12".

"Wind deductibles" of 2 percent already exist in some markets. This would correspond to a $10,000 deductible for a $500,000 loss (compared to the $500 to $1000 fixed-level deductibles otherwise typical of homeowners policies).

For some insurers, higher premiums may not be enough to keep them in the market. Reduced availability of insurance may have greater long-term consumer impacts than price increases. This will place more pressure on governments to establish FAIR Plans and other "residual market mechanisms."

Growing Evidence of Climate Connections

Much more work must be done to understand the potential effect of climate change on hurricane activity, and to isolate the superimposed effects of natural cycles from human influences today and in the future. In August 2005, MIT professor Kerry Emanuel reported that the destructiveness (peak winds and duration) of tropical storms and hurricanes in the Atlantic and western North Pacific has more than doubled since the 1970s[133] and, in September 2005, Webster et al.[134] independently reported that the frequency of Category 4 and 5 hurricanes had also almost doubled in all ocean basins. These researchers independently found that the changes in storm intensity and the frequency of large storms were correlated with warming of the tropical oceans, and they projected that continued warming is likely to enhance storm intensity still further. Also in 2005, Scripps Institute of Oceanography reported that the ocean has absorbed 84 percent of the globe's warming—effectively delaying the effect of climate change on surface air temperatures—and that the trend is unmistakably associated with human activities.[135] Yet, despite this growing body of evidence, current techniques for characterizing hurricanes are crude. The category-based hurricane rating system does not reflect size, storm surge, rainfall, or inland flooding associated with these storms. Hurricanes also remobilize CO_2 sequestered in the oceans, and inject huge volumes of vapor into the atmosphere, both of which feed the climate change process.

Researchers independently found that the changes in storm intensity and the frequency of large storms were correlated with warming of the tropical oceans.

It is not appropriate to associate any single event with climate change. Climate is the long-term average of weather, and so it is the broader trends in weather events where climate change leaves its fingerprints. While climate change may have significant impacts on hurricane damages in the future, for two reasons hurricanes are the least likely place to find a climate change fingerprint in the historical record. First, the growth in population and values at risk along coastlines have been much more rapid than any expected climate change signal, making efforts to isolate the smaller effect from the larger one problematic. Second, far too few hurricanes make landfall to allow for a statistically meaningful analysis of trends.* Insufficient data and incomplete understanding of hurricane processes, however, are not synonymous with proof or disproof of a connection between past climate changes and past hurricane damages—it is just too soon to tell. There is more certainty, however, that climate changes will yield more severe hurricanes in the future.

* See discussion on Kerry Emanuel's website: http://wind.mit.edu/~emanuel/anthro2.htm

Endnotes

1. Rushing, J.T. 2005. "Nelson to Renew Call for National Catastrophic Insurance Fund," *The Florida Times-Union*, September 1.
2. Louis, A.M. 1998. "Landslide Insurance Offered But Many Ineligible to Buy Policies," *San Francisco Chronicle*, February 6, p A19.
3. Mohl, B. 2005. "Home Insurer Seeks 25% Rate Hike on Cape, Islands," *The Boston Globe*, p. C7, September 15.
4. Personal communication, Tim Wagner, Nebraska Insurance Director.
5. Chan-Fishel. 2005. "Fourth Survey of Climate Change Disclosure on SEC Filings of Automobile, Insurance, Oil & Gas, Petrochemical, and Utilities Companies," Friends of the Earth (September).
6. Originally formalized by Denenberg, H.S., 1964. *Risk and Insurance*, Englewood Cliffs, NJ: Prentice-Hall, Inc., p. 615.
7. Gosselin, P and A. Miller. 2005. "Why FEMA Was Missing in Action," *LA Times*. September 5. http://news.yahoo.com/s/latimests/20050905/ts_latimes/whyfemawasmissinginaction
8. Travis, J. 2005. "Scientists' Fears Come True as Hurricane Floods New Orleans," *Science* 309:1656.
9. Musulin, R. and J. Rollins. 2005. "Frequency Matters." *Best's Review*, January, p. 68.
10. Munich Re, 1973. *Flood Inundation*, Munich: Munich Reinsurance Company.
11. IPCC, 2001. *Climate Change 2001*, Geneva: Intergovernmental Panel on Climate Change, United Nations and World Meteorological Organization (found at: www.ipcc.ch).
12. Association of British Insurers. 2005. "Financial Risks of Climate Change," London, 40pp and "Technical Annexes," 139pp.
13. Mohl, B., 2005 (op. cit)
14. Harrington, J. 2005. "Nationwide to Stop Writing in Fla.," *St. Petersburg Times*, August 12.
15. Hartwig, R. 2001. "The Economic Slump: What it Means for P/C Insurers," Presentation, Boston: Insurance Information Institute
16. Mills, E. 2005. "Insurance in a Climate of Change," *Science* 308:1040-1044. http://eetd.lbl.gov/emills/PUBS/Insurance_Science.html
17. American Re. 2005. "Annual Review of North American Catastrophes 2004," American Reinsurance Company, Princeton, NJ.
18. *Bests Review*. 2004. "Insolvency Most Often Pinned to Insufficient Loss Reserves," (July l), p. 14. A value of 7% is given in 2004 Best's Insolvency Study: Property/Casualty, U.S. Insurers, 1969-2002, as cited by Sonnett (2005).
19. Mills, E. 2004. "Insurance as an Adaptation Strategy for Extreme Weather Events in Developing Countries and Economies in Transition: New Opportunities for Public-Private Partnerships," Lawrence Berkeley National Laboratory Report No. LBNL-52220. http://eetd.lbl.gov/emills/PUBS/Insurance_Emerging_Markets.html
20. III. 2003. "The III Insurance Fact Book: 2002," Boston:Insurance Information Institute.
21. Personal communication, Bruce Shepherd, Lloyds of London (RJ Kiln & Co, Ltd).
22. AIA. 1999. "Property-Casualty Insurance and the Climate Change Debate: A Risk Assessment," Washington, D.C.: American Insurance Association.
23. This is reproduced as Appendix F in Mills, E., E. Lecomte, A. Peara. 2001. "U.S. Insurance Industry Perspectives on Global Climate Change," Lawrence Berkeley National Laboratory Report No. 45185. http://eetd.lbl.gov/emills/PUBS/LBNL-45185.html
24. LaCommare and Eto. 2004. "Understanding the Cost of Power Interruptions to U.S. Electricity Consumers," Lawrence Berkeley National Laboratory Report No 55718.
25. Mills, E. "When the Lights Go Out," *Best's Review*, Oldwick, NJ: A.M. Best Company. July. pp. 73–77.
26. Adapted and expanded from discussion in Mills (2005).
27. Changnon, S.A., R.A. Pielke Jr., D. Changnon, R.T. Sylves, and R. Pulwarty. 2000. "Human Factors Explain the Increased Losses from Weather and Climate Extremes," *Bulletin of the American Meteorological Society*, 81(3):437–442.
28. Changnon, S.A. and M. Demissie. 1996. *Climatic Change* 32(4):411-421.
29. Zhang, K., B.C. Douglas, and S.P. Leatherman. 2005. *Climatic Change*. 64:41-58.

30. Easterling, D.R., G.A. Meehl, C. Parmesan, S. Changnon, T.R. Karl, and L.O. Mearns. 2000. "Climate Extremes: Observations, Modeling, and Impacts," *Science* 289: 2068-2074.
31. Karl, T.R. and K.E. Trenberth. 2003. *Science* 302:1719–1723.
32. Begley, S. 2005. "Man-Made Mistakes Increase Devastation of 'Natural' Disasters," *Wall Street Journal*, September 2, p B1.
33. Mills, E., 2005. op. cit.
34. Easterling *et al.,* 2000 (op. cit.)
35. Vellinga *et al.,* 2001 (op. cit.)
36. Reeve, N. and R. Toumi. 1999. "Lighting Activity as an Indicator of Climate Change," *Q.J.R. Meteorol. Soc.* 125:893–903.
37. Kunkel, K.E., R.A. Pielke, Jr., and S. A. Changnon, 1999. "Temporal Fluctuations in Weather and Climate Extremes that Cause Economic and Human Health Impacts: A Review," *Bulletin of the American Meteorological Society*, 80(6): 1077–1098.
38. AIR Worldwide Inc. 2005. "The Coastline at Risk: Estimated Insured Value of Coastal Properties," (September 21).
39. AIA. 1999 (op. cit.)
40. Swiss Re. 2003. "Natural Catastrophes and Reinsurance," Swiss Reinsurance Company, Zurich, *Sigma* 2/2003.
41. Rigzone. 2005. "Katrina: Damage to Oil Fields Worse Than Ivan," http://www.rigzone.com/news/article.asp?a_id=25005
42. Risk Management Solutions. 2005. "Hurricane Katrina: Profile of a Super Cat: Lessons and Implications for Catastrophe Risk Management," RMS, Newark, CA, (October), 29pp.
43. Risk Management Solutions (op. cit.)
44. Schar, C., P.L. Vidale, D. Luthi, C. Frei, C Haberli, M.A. Liniger, and C. Appenzeller, 2004. Nature 427:332-335.
45. In the wake of Hurricane Andrew, regulators limited or rejected insurers' requests for price increases or permission to cancel hundreds of thousands of policies. A decade later, in response to the four deductibles charged to some Florida homeowners following an intense year of hurricanes, regulators mandated reimbursement of 36,000 homeowners, forbade insurers from canceling or non-renewing victims, and required the instatement of "single-season" deductibles for the windstorm hazard.
46. Mittler, E. 1992. "A Fiscal Responsibility Analysis of a National Earthquake Insurance Program," University of California, Los Angeles, Prepared for the Earthquake Project of the National Committee on Property Insurance (NCPI).
47. Anderson, D.R., 2000. "Catastrophe Insurance and Compensation: Remembering Basic Principles," CPCU Journal, Society of Chartered Property and Casualty Underwriters, 76–89.
48. Easterling, D.R., Evans, J.L., P. Ya. Groisman, T.R. Karl, K.E. Kunkel, and P. Ambenje. 2000. "Observed Variability and Trends in Extreme Climate Events, a Brief Review," *Bulletin of the American Meteorological Society* 81(3):417–425.
49. Easterling et al., 2000 (op. cit.)
50. III. 2002. "The Lessons of Hurricane Andrew: Is Florida *Really* Ready?" Presentation by Robert Hartwig, Ph.D., Boston: Insurance Information Institute.
51. Harrington, J. 2005. "Insurance Bills up 7% for All," *St. Petersburg Times*, August 18.
52. Hartwig, R. 2003. "Trends & Challenges in the Property Insurance Business Today," Presentation to IBHS Meeting, November 12, Orlando, Boston: Insurance Information Institute.
53. U.S. GAO. 2005. Catastrophe Risk: U.S. and European Approaches to Insure Natural "Catastrophe and Terrorism Risks," United States Government Accountability Office, Februrary, GAO-05-199.
54. U.S. GAO, 2000. "Insurers' Ability to Pay Catastrophe Claims," US General Accounting Office, Washington, USA, report B-284252, 32 pp. http://www.gao.gov/corresp/gg00057r.pd
55. Holdeman, E. 2005. "Destroying FEMA," *Washington Post*, p. A17, (August 30).
56. Insurance Services Office, 1997 (op. cit.)
57. Swiss Re. 1994. "Fire of the Future," Swiss Reinsurance Company, Zurich.
58. Bible, R. 2005. "Breathless," *Wildfire Magazine*, http://wildfiremag.com/ar/firefighting_breathless/

59. Insurance Services Office. 1997. *The Wildland/Urban Fire Hazard*, New York: ISO,
60. Sullivan, L. 2003. "Depending on Technology," *Risk Management Magazine*, October, p. 6.
61. LaCommare and Eto. 2004. "Understanding the Cost of Power Interruptions to U.S. Electricity Consumers," Lawrence Berkeley National Laboratory Report No 55718.
62. See *The Energy Daily.* 2004. "Hurricane Ivan's Final Indignity: Higher Home Heating Costs," October 12, p. 3, and *The Energy Daily*. 2004. "Progress Energy's Hurricane Bill: $252 Million," November 3, p. 4.
63. The Energy Daily. 2004. "Progress Energy's Hurricane Bill: $252 Million," November 3, p. 4.
64. Beales, R. 2005. "Louisiana Governor Calls for Evacuation of New Orleans," *Financial Times*, August 31.
65. Harrington, J. 2005. "Nationwide to Stop Underwriting in Fla.," *St. Petersburg Times* (August 12).
66. III. 2005. "Crop Insurance," Boston: Insurance Information Institute.
67. Knutson, T.R. and R.E. Tuleya. 2004. "Impact of CO_2-Induced Warming on Simulated Hurricane Intensity and Precipitation: Sensitivity to the Choice of Climate Model and Convective Parameterization," *Journal of Climate*, Vol 17., No. 18: 3477–3495.
68. Trenberth, K. 2005. "Uncertainty in Hurricanes and Global Warming," *Science* 308: 1753–1754.
69. Emanuel, K. 2005. "Increasing Destructiveness of Tropical Cyclones over The Past 30 years," *Nature*, 436: 686-688.
70. Insurance Information Institute, 2002 (op. cit.)
71. Guy Carpenter. 2005. "Natural Hazard Review: 2004."
72. U. S. Department of Agriculture and U. S. Department of the Interior. 1995. *Federal Wildland Fire Policy*, Available at http://www.fs.us/land/wdfirex.htm.
73. Swiss Re. 2004. "Natural Catastrophes and Man-Made Disasters in 2003," *Sigma* 1/2004, Zurich, Switzerland.
74. U. S. Department of Agriculture and U. S. Department of Interior. 1995. (op. cit.)
75. Logan, J.A., Régnière, J., Powell, J.A. 2003. "Assessing the Impacts of Global Warming on Forest Pest Dynamics," *Front Ecol Environ* 1(3): 130–137.
76. Logan, J.A., Powell, J.A. 2001. "Ghost Forests, Global Warming, and the Mountain Pine Beetle (Coleoptera: Scolytidae)," *American Entymologist* 47(3): 160–172.
77. Fried, J.S., M.S. Torn, E. Mills. 2004. "The Impact of Climate Change on Wildfire Severity: A Regional Forecast for Northern California," *Climatic Change* 64 (1–2): 169-191.
78. Heinz Center. 2000. "Evaluation of Erosion Hazards," The Heinz Center, Washington, D.C.
79. Risk management Solutions, 2005 (op. cit.).
80. Wilhite, D. 2003. "Water 101: Understanding the Drought Hazard," National Drought Mitigation Center, University of Nebraska. Presentation.
81. Easterling, *et. al.* 2000 (op. cit.)
82. Rosenzweig, C., F. N. Tubiello, R. Goldberg, E. Mills, and J Bloomfield. 2002. "Increased Crop Damage in the U.S. from Excess Precipitation under Climate Change," *Global Environmental Change*, 12:197-202. LBNL-47985.
83. Rosenzweig *et al.* 2002. (op. cit.).
84. Davidson, R.J, Jr. and B. Doane. (no date.) "Agent & Adjustor Licensing," U.S. Department of Agriculture, Risk Management Agency (presentation).
85. Insurance Information Institute. 2005. "Crop Insurance," http://www.iii.org/media/hottopics/insurance/crop/?table_sort_544612=5
86. Insurance Information Institute, 2005 (op. cit.)
87. Gibson, S. 2004. "The Insurance Implications of Climate Change for Agriculture," Presentation, 17 March.
88. Heinz Center. 2000. *Evaluation of Erosion Hazards*, Federal Emergency Management Agency, 252 pp. http://www.fema.gov/nwz00/erosion.htm
89. Changnon, S.A., D. Changnon, E.R. Fosse, D.C. Hoganson, R.J. Roth Sr., and J.M. Totsch. 1997. "Effects of Recent Weather Extremes on the Insurance Industry: Major Implications for the Atmospheric Sciences," *Bulletin of the American Meteorological Society* 78(3):425–431.

90. GAO. 2004. "Crop Insurance: USDA Needs to Improve Oversight of Insurance Companies and Develop a Policy to Address Any Future Insolvencies," United States General Accounting Office, Report GAO-04-517, 55pp.
91. Insurance Information Institute, 2005 (op. cit.)
92. Epstein, P. 2005. "Climate Change and Human Health," *New England Journal of Medicine*, 353, 14:1433.
93. Miller, G. 2005. "The Tsunami's Psychological Aftermath," *Science* 309:1030.
94. Epstein, P. and E. Mills (eds). 2005. "Climate Change Futures: Health, Ecological and Economic Dimensions," Harvard Medical School. Swiss Re and UN Development Programme.
95. *USA Today*. August 11, 2005. "Malaysia Imposes Emergency as Haze Turns Air Hazardous," http://www.usatoday.com/news/world/2005-08-11-malaysiahaze_x.htm?csp=36
96. Hartwig, R. 2003. "Mold and Insurance: Is the Worst Behind Us?" Presentation to the Casualty Actuarial Society Seminar on Ratemaking, San Antonio, TS, March 27. Boston: Insurance Information Institute.
97. Hartwig, R. and C. Wilkinson. 2003. "Mold and Insurance," Insurance Issues Series, Volume 1, Number 4, Boston: Insurance Information Institute.
98. Hartwig, R. 2002. "Mold and Insurance: Truth and Consequences," Presentation. Boston: Insurance Information Institute.
99. Allen, M.R. and R. Lord. 2004. "The Blame Game: Who Will Pay for the Damaging Consequences of Climate Change?" *Nature*. 432:551-552.
100. Hartwig, R. 2002. "The Role of Governments in the Insurance Industry," Boston: Insurance Information Institute. Presentation to the Royal Institute for International Affairs, London.
101. Prahl, R.J. undated. "Mold: The $1 Billion Challenge," American Association of Insurance Services. http://www.aaisonline.com/articles/15rn11_02%20p082-085.pdf
102. *Insurance Journal*. 2005. "Insurance Regulation Report Recommends Sinkhole Fund; Fla. Legislators Considering Options," (April 14).
103. Hartwig, R. 2002 (op. cit)
104. *Business Insurance*. 2005. "Surplus Lines Premium s and Taxes by State," September 12, p. 20.
105. Mills, E. 2004 (op. cit.)
106. Linnerooth-Bayer, J., M.J. Mace, R. Verheyen. 2003. "Insurance-related Actions and Risk Assessment in the Context of the UN FCCC," Background paper for UNFCCC workshops.
107. U.S. Government Accountability Office. 2005. "Risk Retention Groups: Common Regulatory Standards and Greater Member Protections Are Needed," GAO-05-536.
108. Dlugolecki, A.. and S. Lefeld. 2005. "Climate Change & the Financial Sector: An Agenda for Action," Allianz and WWF.
109. Chen, A. and E. Vine 1999. "It's in the Air," *Best's Review*, January, pp. 79-80.
110. Perry, C. 2005. "Mold Could Grow Profits for Insurers," *Best's Review,* p 14, May 30.
111. Presentation by Robert Muir-Woods, Chief Research Officer, Risk Management Solutions, June 29, 2005 "The Future of the Insurance Industry under Climate Change."
112. Risk Management Solutions, 2005 (op. cit.)
113. Hoffmann, M.A. 2005. "Above-average Storm Activity Predicted," *Business Insurance*, September 26, p. 31.
114. Alley, R.B., J. Marotzke, W.D. Nordhaus, J.T. Overpeck, D.M. Peteet, R.A. Pielke Jr., R.T. Pierrehumbert, P.B. Rhines, T.F. Stocker, L.D. Talley, J.M. Wallace. 2005. "Abrupt Climate Change," Science 299:2005–2010.
115. Nutter F.W. 1996. "Insurance and the Natural Sciences: Partners in the Public Interest," Journal of Society of Insurance Research, (Fall), pp. 15-19.
116. Association of British Insurers, 2005 (op. cit.).
117. I. Menzinger and C. Brauner. "Floods are insurable!" Swiss Reinsurance Company, Zurich, 2002
118. Mills, E., *et al.,* 2001 (op. cit.)
119. Mills, E. 2003. "The Insurance and Risk Management Industries: New Players in the Delivery of Energy-Efficient Products and Services," *Energy Policy* 31:1257–1272.

Investor Network on Climate Risk
Ceres, Inc.
99 Chauncy Street
Boston, MA 02111
617-247-0700
www.incr.com

Get powerful productivity apps with Microsoft 365 Buy now
Advertisement

Insurers Fled California in Recent Years—Experts Say Their Return Depends On Homeowners

By ELIZABETH GUEVARA. Published March 04, 2025 07:00 AM EST



Allen J. Schaben | Los Angeles Times via Getty Images

KEY TAKEAWAYS

- Many insurance companies stopped offering home insurance policies in California amid more frequent instances of disasters and higher costs of rebuilding.
- New rules issued by the state to bring insurers back allow them to raise costs to the consumers, but critics say the rules fall short of their goals.
- The long-term solution to California's insurance issue is for communities to build and renovate homes to be more fire-resistant, experts say.

Insurers have left many California homeowners facing the consequences of devastating wildfires as they pulled out of the state, and experts say it's up to the homeowners to bring them back.

The cost of damages from the recent L.A. wildfires could total up to $275 billion, according to AccuWeather estimates. [1] Meanwhile, supply chain disruptions from the COVID-19 pandemic and higher costs for home-building materials continue to make it more expensive to repair and rebuild.

To make up for the increased costs of claims, insurance companies raised the price of insurance premiums for all customers and have backed out of some disaster-prone areas. State Farm, Farmers Insurance Group and Allstate (ALL), which were three of the four main provides of insurance in California, stopped selling new home insurance policies in the state in 2022. [2] [3]

The only way insurers can return to the state, experts say, is if homeowners make their homes resistant to fires. Till then, with fewer insurance options, homeowners staring at major losses may find little relief.

What Are Your Options?

Californian residents whose insurance company pulled out of the state can adopt a California FAIR Plan policy, a state-mandated plan that comprises California insurance companies. [4]

However, this policy only covers damages caused by fires and can be more expensive than traditional insurance premiums.

Another option can be the Sustainable Insurance Strategy, issued at the start of 2025 by the California Insurance Commissioner, which pulled back on some regulations so that more insurance companies will once again offer policies to Californian residents. [5]

PAID CONTENT FOR INTUIT QUICKBOOKS



One L.A. Entrepreneur Grows His Business

One commercial real estate broker has a success story that mirrors his thriving Inglewood community. Here's how he grew his business with Intuit QuickBooks.

LEARN MORE >

Paid content client promotion.

This regulation will also make it easier for companies to pay out claims, according to Janet Ruiz, director of strategic communications for the Insurance Information Institute, a data distributor for insurance companies.

It reversed previous rules that prevented insurance agencies from using catastrophe modeling while creating rates and that will allow insurance companies to pass reinsurance costs to customers. It also made rate approvals from the Department of Insurance quicker and less strict.

"Insurance companies can [now] charge what we would call adequate premiums for insurance policies," Ruiz said. "So, when we have catastrophes, we've taken in enough premium to pay the claims."

However, critics believe that the new rules fall short.

Insurance companies do not have to disclose the catastrophe models they use or how they create rates, and this regulation allows them to raise insurance prices immediately, said Carmen Balbar, executive director at Consumer Watchdog, a consumer advocate group.

"Insurance companies continue to cherry-pick only the people they want to cover, and consumers are left in the same boat. So we need different solutions," said Balbar.

Additionally, this new regulation will not force insurance companies to offer enough policies in California fire areas.

"Insurance companies continue to cherry-pick only the people they want to cover, and consumers are left in the same boat. So we need different solutions," said Balbar.

Making Homes Resistant to Wildfires

The long-term solution to bring insurance companies back to California is the communities that are making their homes more wildfire-resistant, Ruiz said.

Steps like ensuring there are no flammable plants near the home, installing ember-resistant vents, and having a fire-resistant roof can significantly reduce the chances of a home catching fire. This mitigates the risks of totally destroyed homes and will eventually reduce the amount and costs of claims.

A home that fits California's newer wildfire standards is about 40% less likely to be destroyed than an older home, according to a 2021 report by the National Bureau of Economic Research. [6]

In addition, a home is 6% less likely to be destroyed if its neighbor complies with wildfire regulations.

Customers who take steps to protect their homes from wildfires can find benefits like reduced fire risk and discounted insurance premiums. However, these discounts are negligible compared to the amount customers will spend on wildfire prevention renovations and insurance rate increases, Balbar said.

"These are proven risk reduction tools, and we are not funding them in the way we need to," Balbar said. "That means both big increases in government funding but also real commitments by the insurance industry to pitch in to solve the problem. The need for that is really crystallized by these fires."

Do you have a news tip for Investopedia reporters? Please customers will soon! tips@investopedia.com

SPONSORED

Financial Advice That Puts You First

Personal financial advice shouldn't cost a fortune. With Vanguard Personal Advisor®, you can get advice that's tailored to your unique goals and based on Vanguard's time-tested investment strategies. They'll partner with you to create a financial plan and help you stick with it over the long term. Learn more about the benefits of customized advice and see what Vanguard Personal Advisor® can do for you.

Paid non-client promotion.

ARTICLE SOURCES

Partner Links

Get daily insights on what's moving the markets and why it matters...

At E*TRADE, get the flexibility to trade stocks, options, and futures in an IRA

Find yourself on solid ground. Find Your Fidelity and apply today.

25 years' experience as a premium FX provider. Start trading with Oanda. Losses can exceed investment.

KING'S CROSSING RE
Open an account E*TRADE from Morgan Stanley
Fidelity CAREERS APPLY NOW
OANDA LEARN TO TRADE

Related Articles



PERSONAL FINANCE NEWS

Flood Risk May Surpass Wildfire Risk in California By 2025, Adding To Home Insurance Costs

By Elizabeth Guevara



PERSONAL FINANCE NEWS

Here's Where US Home Prices Are Rising—and Falling—the Most

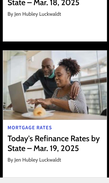
By Jordyn Bradley



PERSONAL FINANCE NEWS

That $285M Florida House Is Still for Sale—But a Nearby Home Recently Sold for $50M

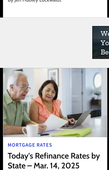
By Jordyn Bradley



MORTGAGE RATES

Today's Mortgage Rates by State – Mar. 18, 2025

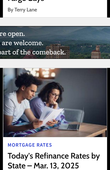
By Jen Hubley Luckwaldt



MORTGAGE RATES

Today's Refinance Rates by State – Mar. 18, 2025

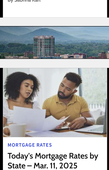
By Jen Hubley Luckwaldt



PERSONAL FINANCE NEWS

When Will Mortgage Rates Drop? Not for Years, Wells Fargo Says

By Terry Lane



MORTGAGE RATES

Today's Refinance Rates by State – Mar. 17, 2025

By Sabrina Karl

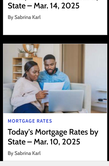


MORTGAGE RATES

Today's Refinance Rates by State – Mar. 19, 2025

By Jen Hubley Luckwaldt

We're open. You are welcome. Be part of the comeback.
Advertisement



MORTGAGE RATES

Today's Refinance Rates by State – Mar. 14, 2025

By Sabrina Karl



MORTGAGE RATES

Today's Refinance Rates by State – Mar. 13, 2025

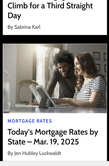
By Sabrina Karl



MORTGAGE RATES

Today's Mortgage Rates by State – Mar. 11, 2025

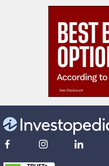
By Sabrina Karl



MORTGAGE RATES

30-Year Mortgage Rates Climb for a Third Straight Day

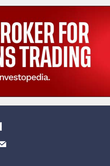
By Sabrina Karl



MORTGAGE RATES

Today's Mortgage Rates by State – Mar. 10, 2025

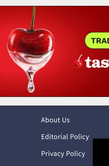
By Sabrina Karl



MORTGAGE RATES

Today's Refinance Rates by State – Mar. 11, 2025

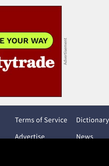
By Sabrina Karl



MORTGAGE RATES

Today's Refinance Rates by State – Mar. 10, 2025

By Sabrina Karl



MORTGAGE RATES

Today's Mortgage Rates by State – Mar. 19, 2025

By Jen Hubley Luckwaldt

BEST BROKER FOR OPTIONS TRADING According to Investopedia.
See Disclosure
TRADE YOUR WAY tastytrade
Advertisement

TRUSTe Certified Privacy Validation Terminated

Dotdash Meredith Investopedia is part of the Dotdash Meredith publishing family.

Where to Exchange Currency Without Paying High Fees CLOSE



$9,750 Senior Income Booster

Americans 55 and Older could get $9,750 back in savings this month. Read the full list.

TotalSaver Open

Advertisement

Flood Risk May Surpass Wildfire Risk in California By 2025, Adding To Home Insurance Costs

By ELIZABETH GUEVARA. Published February 24, 2025 06:09 PM EST



Allen J. Schaben / Contributor / Getty Images

KEY TAKEAWAYS

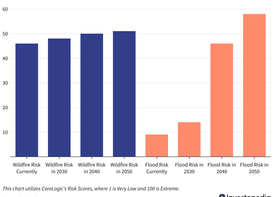
- The recent L.A. wildfires have destroyed critical vegetation, which typically absorbs rainfall and prevents floods and mudflows.
- By 2050, homes in Los Angeles, San Diego, and San Francisco will have a higher flood risk than wildfire risk.
- Many homeowners in the area may have to take up increasingly costly flood insurance to protect themselves and their homes.

The wildfires in California may hurt homeowners for decades to come as they heighten the risk of floods, forcing owners to shell out money for expensive flood insurance.

Flood risk in California is set to surpass the risk of wildfires in the state by 2050. Over a million homes in Los Angeles, San Diego, and San Francisco that currently have low flood risk will see their flood risk level increase by 40 points or more by 2050, according to CoreLogic's Risk Score. This score ranks risk levels from one, very low, to 100, extreme.[1]

The recent wildfires have left California's ground charred, barren and unable to absorb water. With the vegetation that typically absorbs rainfall destroyed, the area is more susceptible to flash floods and mudflows.[2]

The Flood Risk in Los Angeles Will Eventually Be Greater Than The Wildfire Risk



This chart utilizes CoreLogic's Risk Scores, where 1 is Very Low and 100 is Extreme.

Source: CoreLogic

Investopedia

Homeowners May Be Forced To Pay For Expensive Flood Insurance

As climate change has increased the number and severity of natural disasters, many insurance companies have raised premium costs and left disaster-prone areas.



PAID CONTENT FOR DISCOVER® PERSONAL LOANS

How to Manage Your Debt

With a Discover® personal loan and good spending habits, you could get back on track and focus on doing what you love most.

LEARN MORE

However, some homeowners in flood-prone areas may have to take out expensive flood insurance, as just one inch of water in a home can cost about $25,000 in damage, according to FEMA.[3]

While those in areas where private insurance companies have dropped out can get the federal government's last resort flood insurance, the National Flood Insurance Program (NFIP), even those prices have increased due to reinsurance rates. A recently adopted calculation formula has increased the cost of NFIP, specifically in areas with high flood risk.[4]

Do you have a news tip for Investopedia reporters? Please email us at tips@investopedia.com

Start Earning Quarterly Passive Income Today

SPONSORED

The Fundrise Income Fund offers a $500+ million diversified portfolio of cash-flowing assets designed for consistent quarterly returns. Check out the current yield by visiting Fundrise.com/income. Before investing, consider the Fund's objectives, risks, charges, and expenses. Prospectus available at Fundrise.com/income.

ARTICLE SOURCES

Related Articles

PERSONAL FINANCE NEWS
Insurers Fled California in Recent Years—Experts Say Their Return Depends On Homeowners

PERSONAL FINANCE NEWS
Natural Disasters Have Caused A Global Home Insurance Crisis—How Other Countries Cope

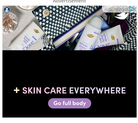
MORTGAGE RATES
Today's Mortgage Rates by State – Mar. 7, 2025

MORTGAGE RATES
Today's Refinance Rates by State – Mar. 7, 2025

MORTGAGE RATES
Today's Refinance Rates by State – Mar. 6, 2025

MORTGAGE RATES
Today's Refinance Rates by State – Mar. 5, 2025

Advertisement



Advertisement

Search for

1. WHAT DOES ECZEMA RASH LOOK LIKE
2. 5 BEST AUTO INSURANCE FOR SENIORS
3. BEST CAR INSURANCE SENIORS OVER 70
4. BEST VITAMINS FOR HAIR THINNING
5. BEST HOME AND AUTO INSURANCE DEALS
6. CHEAP HOMEOWNERS INSURANCE
7. ELON MUSK'S NO.1 STOCK TO BUY NOW

Suitable Answers

Advertisement



Advertisement



Wall Street Star

with 24-hour support.

Open an account E*TRADE from Morgan Stanley

Fidelity CAREERS APPLY NOW

PRACTICE TRADING

Partner Links

Get daily insights on what's moving the markets and why it matters...

Get up to $1,000 when you open an E*TRADE account. Terms Apply.

Find yourself on solid ground. Find Your Fidelity and apply today.

Sign up for our daily newsletters



21 Dumbest Things We Keep Spending Too Much Money On

The average American overpays for things constantly. Here are the 21 worst culprits...

WalletJump Learn More »

Advertisement

Related Terms

Catastrophe Insurance: Meaning, Types, Who Needs It
Catastrophe insurance protects businesses and residences against natural disasters, such as earthquakes and floods, and against human-made disasters. more

Flood Insurance: Definition, How It Works, Coverage, Example
Flood insurance is a type of property coverage that protects homeowners from water damage to the structure and contents of their property. more

Hurricane Insurance Isn't Real. Instead, You Need This Coverage for Storm Damage
Hurricane insurance usually refers to an extra deductible on a homeowners policy that specifically covers hurricane-related damage in high-risk areas. more

What Is a 2-1 Buydown Loan and How Do They Work?
A 2-1 buydown allows a homebuyer or seller to pay money upfront for a reduced interest rate on a mortgage for the first two years before settling into a permanent rate in year three. more

California FAIR Plan Insurance: What You Need to Know
California FAIR Plan insurance supplies coverage to homeowners and business owners who don't qualify for traditional property insurance. more

Broad Form Personal Theft Insurance: What It Is, How It Works
Broad form personal theft insurance covers the theft or loss of personal assets on an all-risk basis, meaning with no exclusions or limits. more

Top 20 Deadliest California Wildfires

	FIRE NAME *(CAUSE)*	DATE	COUNTY	ACRES	*STRUCTURES*	DEATHS
1	**CAMP FIRE** *(Powerlines)*	November 2018	Butte	153,336	18,804	**85**
2	**GRIFFITH PARK** *(Unknown)*	October 1933	Los Angeles	47	0	**29**
3	**TUNNEL - Oakland Hills** *(Rekindle)*	October 1991	Alameda	1,600	2,900	**25**
4	**TUBBS** *(Electrical)*	October 2017	Napa & Sonoma	36,807	5,643	**22**
5	**EATON** *(Under Investigation)**	January 2025	Los Angeles	14,021	9,413	**17**
6	**NORTH COMPLEX** *(Lightning)*	August 2020	Butte, Plumas, & Yuba	318,935	2,352	**15**
7	**CEDAR** *(Human Related)*	October 2003	San Diego	273,246	2,820	**15**
8	**RATTLESNAKE** *(Arson)*	July 1953	Glenn	1,340	0	**15**
9	**PALISADES** *(Under Investigation)**	January 2025	Los Angeles	23,707	6,833	**12**
10	**LOOP** *(Unknown)*	November 1966	Los Angeles	2,028	0	**12**
11	**HAUSER CREEK** *(Human Related)*	October 1943	San Diego	13,145	0	**11**
12	**INAJA** *(Human Related)*	November 1956	San Diego	43,904	0	**11**
13	**IRON ALPS COMPLEX** *(Lightning)*	August 2008	Trinity	105,855	10	**10**
14	**REDWOOD VALLEY** *(Power Lines)*	October 2017	Mendocino	36,523	544	**9**
15	**HARRIS** *(Undetermined)*	October 2007	San Diego	90,440	548	**8**
16	**CANYON** *(Unknown)*	August 1968	Los Angeles	22,197	0	**8**
17	**CARR** *(Human Related)*	July 2018	Shasta County, Trinity	229,651	1614	**8**
18	**LNU Lightning Complex** *(Lightning/Arson)*	August 2020	Napa/Sonoma/Yolo/Stanislaus/ Lake	363,220	1,491	**6**
19	**ATLAS** *(Powerline)*	October 2017	Napa & Solano	51,624	781	**6**
20	**OLD** *(Human Related)*	October 2003	San Bernardino	91,281	1,003	**6**

** Fires with the same death count are listed by most recent. Several fires have had 4 fatalties, but only the most recent are listed.
***This list does not include fire jurisdiction. These are the Top 20 regardless of whether they were state, federal, or local responsibility.
* Numbers not final . Preliminary pending coroner confirmation.

CAL FIRE SINCE 1885

2/7/2025

INSIGHTARTICLE

Five years on since California's camp fire: The fate of paradise

November 08, 2023

Robert Muir-Wood
Chief Research Officer

Share article

Will the Californian city of Paradise ever fully recover from the devastating fire that consumed 95 percent of its houses, now five years ago in November 2018?

In a state that saw a slight overall population decline, Paradise was recently named California's fastest-growing city. But, as of August 2023, the population of Paradise had reached a third of the 26,000 that lived there in October 2018.

Five hundred new properties were constructed in Paradise last year. At that rate, it would still take thirty years to complete the rebuild, and many former residents surveyed about their intentions have already declared they will not be returning.

Throughout the centuries what condemns a city devastated by catastrophic damage is a spiral of debt as fewer residents generate lower income so that amenities suffer, blight deepens, and more people leave.

Yet every event, even one unfortunately billowing with wildfire smoke, may reveal a silver lining. If the fire that destroyed Paradise had been ignited by lightning, there would have been no one to sue.

But it was electrical equipment owned and operated by Pacific Gas and Electric (PG&E) that was acknowledged to have triggered the blaze, and PG&E is one of the largest combined natural gas and electric energy companies in the United States, supplying electricity to 5.5 million customers in northern and central California.

The bankruptcy settlement agreed with PG&E means that money is not going to be a problem, at least for the next few years. The town of Paradise received US$270 million from the PG&E settlement. Butte County another US$252 million, and the Paradise Recreation and Parks District received US$47.5 million.

Now the challenge: how to spend that money on improving amenities to significantly reduce the chance of a repeat catastrophe.

Living in the forest

The problem is the city's intrinsic riskiness. Paradise sprawls over 18 square miles (47 square kilometers), and the people who came to live here wanted to live in large lots surrounded by forest, with views of foliage, not their neighbors.

Proximity to trees is also the hazard. The city is not on the edge of the wildlands, like Santa Rosa in California, which experienced the Tubbs Fire in 2017. Paradise is surrounded by, and immersed in, forest. Previous fires have burnt right up to the edge of the settlement.

Half of the city's 200 miles (322 kilometers) of roads are privately owned, with many only providing access to homes across the mountain ridges: potential death traps in a wildfire evacuation. There is only one road out of town. This system has made it impossible to link house construction with other amenities.

The residents also value their freedom and independence, and have shunned citywide infrastructure projects in the past – the city is notorious for being the largest west of the Mississippi without a sewerage system. The last attempt to fund a city-wide sewerage system was rejected by the city's voters in 1992.

But there are now plans to use some of the PG&E money to fund a US$233 million sewerage system and construct an 18-mile (29-kilometer) pipeline to carry Paradise sewage westwards down to the pre-existing treatment works in the nearby city of Chico.

Yet the new Sewer Service Area (SSA) will mainly serve land parcels in the city's urban core focused on three main roads, Skyway, Pearson Road, and Clark Road. No other connections are included in this project. Access to sewerage is being used to encourage housing 'densification.' People originally moved to Paradise to be among the trees, and now the council wants them instead to value a sewerage hook-up.

Creating a new city

The Paradise Council would like to create a different kind of city, a city where houses are closely spaced, a city that would be like many others across central California. A city that would be easier to defend in a fire. Yet densification can bring new risks, as seen in the northern suburb of Santa Rosa in 2017, fires can spread house to house in an urban conflagration.

Meanwhile, much of Paradise has become an informal trailer park, as many residents await further money to rebuild. They look to the PG&E funds to top up insurance compensation for policies that generally underestimated rebuild values, and therefore on their own would not be enough to fund constructing a new property.

As a result of the 2018 fires and the subsequent tree clearance, the land across the city is scarred with a million tree stumps. Left to itself, new shoots will grow, fresh saplings take root, and the forest will return, bringing with it both the amenity of the leaves and the hazard of wildfire.

Buffer zones

The most ambitious part of the proposals to convince prospective residents that the risk from wildfire has now been tamed is the plan to create five large 'green belt' buffer zones around the city, with trees and foliage cleared.

Widely publicized, this plan is more of a pipe dream. The buffer zones would cover 32,000 acres (12,950 hectares), almost all of which is currently privately owned, in 2,200 plots located all around the 18-mile (47-kilometer) city boundary.

Many plots are the former sites of houses destroyed in 2018, awaiting their owner's intentions to rebuild. Even at a knock-down price of US$2,000 an acre, acquiring the land would cost US$60 million, money that the local Parks and Recreation Department does not have.

The latest published estimate as to how much land has been acquired for buffer zones was from the summer of 2022 when the department announced they had 100 acres, equating to 0.3 percent of the plan. And that is before one costs up the land management that would be required to keep the buffer zones free of vegetative fuel.

It is instructive to compare the actions that follow a catastrophic flood to a catastrophic wildfire. After any disaster, there is a window of opportunity that lasts, perhaps, two to five years, according to the severity of the event, when communities can be motivated to put money aside to fund some solution to prevent a repetition.

And then, as the memory fades, it gets harder to argue to fund infrastructure that has no function other than to mitigate a rare catastrophe – there are much more immediate needs: like schools, highways, and fighting crime.

For the response to a flood, this can work quite well – the money becomes available to build a flood defense and once constructed, it requires little maintenance and can provide many decades of protection. Compare that with buffer zones and wildfires. The costs for vegetation clearance continue year after year without end until almost inevitably the funding gets cut as people focus on more immediate priorities.

Such wide buffer zones have not been implemented or tested before. The new generation Moody's RMS high-definition wildfire models are designed to facilitate testing the outcome of the full range of mitigations' individual property vegetation management, fire-resistant construction, hardening electric power networks, and buffer zones.

Embers, carried by a fierce wind, can jump one to two miles before settling on a pile of leaves or a cedar shingle roof to trigger further fires. It is those fires blown by strong winds that evade control and are at the same time those in which the embers will travel the furthest.

The Parks and Recreation Department in Paradise is not prepared to force 'eminent domain' to acquire land. So, the best that hope could end up being a patchwork of cleared land and thick undergrowth with little expectation that this would provide any kind of barrier to an advancing firefront.

Yet the buffer zones have captured the imagination. We all have an appetite for good-news stories about curing catastrophes. But we also need to be realistic about how such situations often turn out; underfunded, partially realized, abandoned.

Former residents considering whether to return need proof that the fire risk has been reduced to tolerable levels.

Paradise was always an inexpensive place to live, attracting many older and disabled residents, who did not realize how much they were at risk.

The mean age of the eighty-five who died in the Camp Fire was 72 years, with many forgotten in the early morning evacuation. Paradise's former hospital closed permanently after the fire, and access to healthcare is paramount – making it difficult for older residents.

History of fires

The Camp Fire is by no means the first time Paradise has been under threat. In June 2008, 9,300 people had to evacuate southwestern areas of the city when a fire burnt the land between Paradise and Chico. A month later, thousands evacuated the northern side of the city as a fire raged in the neighboring Feather River Canyon.

In August and September 2020, the lightning-triggered 300,000-acre North Complex fire (twice the size of the 2018 Camp Fire) burnt right up to the edge of the Camp Fire burn scar, not proceeding further into Paradise because vegetation clearance had left nothing more to burn. Yet this experience has given some confidence that future fires could also be stopped at the city limits.

Five years on

How would one summarize a five-year report card on Paradise and wildfire risk? The risk is being successfully reduced. New builds will all have to satisfy more stringent, and more expensive, fire-resistant building codes.

PG&E is hardening its network in and around the town, becoming more rigorous in tree clearance and putting some of the riskiest lines underground. While the buffer zones may not fly, tree clearance within the city's footprint should be sustained, at least until residents once again prioritize foliage.

The city is not, as one might say 'out of the woods' yet. The mayor Greg Bolin has admitted that before the fire the city's government was 'barely scraping by.' Unless it can rebuild its population the city's finances cannot be sustained once the PG&E settlement has been exhausted.

It is not only the risk but the expense, for the predominately low-income former residents. Within the last year, both State Farm and Allstate have stopped writing new policies in California because of the threat of wildfires.

Homeowners in Paradise must accept higher insurance costs and restricted coverage from the residual market California FAIR Plan schemes. The future climate is likely to be creating more fuel, roasted in longer and hotter fire seasons.

Realistically Paradise will end up with perhaps half, at best two-thirds of its former inhabitants. The town remains on probation. In history, two catastrophes in a decade have been enough to end the prospects for other devastated towns, like the Texan port of Indianola.

The recurrence of a significant fire, in particular, one that destroys newly rebuilt properties, could condemn Paradise to become the first North American climate-change ghost town.

And while Paradise is in the vanguard in confronting the risk, it is by no means alone. In California, an estimated 2.7 million people live in areas zoned as 'very high wildfire hazard'[1].

[1] Sabalow, R., Reese, P. & Kasler, D 2019

LEARN MORE

Catastrophe modeling

In an unpredictable world, discover how Moody's best-in-class approach to catastrophe modeling, which integrates innovative analytics, technology, and science, is helping clients to quantify the potential impact of catastrophic events.

Learn more

Note: Moody's Corporation is comprised of separate divisions. Moody's Ratings publishes credit ratings and provides assessment services on a wide range of debt instruments, systems and facilities, and the entities that issue such obligations in markets worldwide, including various corporate, financial institution and governmental obligations, and structured finance securities. Moody's Ratings products are set out here. All other products and solutions described on this site are provided by Moody's, a global provider of data and information, research and insights, and decision solutions.

Who We Serve

Banking
Buy-side
Insurance
Corporations
Public Sector

Solutions

Ratings
Investment Research
Third-Party Risk
Lending
Financial and Regulatory Reporting
Balance Sheet Management
Insurance Underwriting
Portfolio Management
Model Risk and Governance

Capabilities

Catastrophe Modeling
Credit Risk
Climate Risk
ESG Risk
Cyber Risk
Company Reference Data
Economic Data
Commercial Properties
Structured Finance
AI and GenAI

Contact Us

Careers
Moodys.com Support
Insurance Solutions Support
Contact Us
FAQs
Submit a Complaint

Moody's Integrity Hotline

Via the Internet:
moodys.ethicspoint.com

By telephone from the United States:
Dial 1-866-330-MDYS (1-866-330-6397)

By telephone from outside the United States:
Dial the AT&T Direct Dial Access® code for your location. Then at the prompt, dial 866-330-MDYS (866-330-6397)

Company Information

About Moody's
Trust Center
Legal
Moody's Code of Business Conduct
Modern Slavery and Human Trafficking Statement
Gender Pay Gap Reports

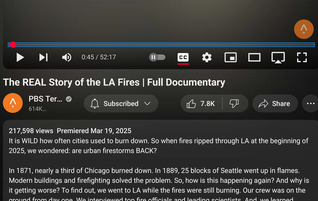
Regulatory

ratings.moodys.com

Note: Moody's does not post ratings to its social media accounts

Terms of Use | Privacy Policy | Do Not Sell My Personal Information | Cookies Settings

© 2025 Moody's Corporation, Moody's Investors Service, Inc., Moody's Analytics, Inc. and/or their licensors and affiliates (collectively, "MOODY'S"). All rights reserved.



The REAL Story of the LA Fires | Full Documentary

PBS Ter...
614K...
Subscribed
7.8K
Share

217,598 views Premiered Mar 19, 2025

It is WILD how often cities used to burn down. So when fires ripped through LA at the beginning of 2025, we wondered: are urban firestorms BACK?

In 1871, nearly a third of Chicago burned down. In 1889, 25 blocks of Seattle went up in flames. Modern buildings and firefighting solved the problem. So, how is this happening again? And why is it getting worse? To find out, we went to LA while the fires were still burning. Our crew was on the ground from day one. We interviewed top fire officials and leading scientists. And, we learned exactly what went wrong in LA - and the ONE THING that could stop these UNSTOPPABLE fires.

*****
PBS Member Stations rely on viewers like you. To support your local station, go to: http://to.pbs.org/DonateTerra
*****
Subscribe to PBS Terra so you never miss an episode! https://bit.ly/3mOfd77

And keep up with PBS Terra on:
Facebook: pbsdigitalstudios
Tiktok: pbsterra
Instagram: pbsterra

Transcript

Follow along using the transcript.

Show transcript

PBS Terra
614K subscribers

Videos About

Show less

Live chat replay
See what others said about th... Open panel

1,332 Comments

Sort by

Add a comment...

@Emily.Jelassi 2 days ago
My uncle, before he passed was a fire spotter flyer for the LA County Fire Department, and I'm very proud of his service
326 Reply
3 replies

@anastasia7 2 days ago
Thank you for everyone who contributed and made this film possible! I watched one of your channel's shorts today and then got suggested this premiere and I don't regret a second spend watching it. So educational and well made! I'm going to rewatch it later again!
168 Reply
2 replies

@technick6418 2 days ago
"But dry, windy conditions change everything".

This. Former firefighter here. The weather-especially wind speed and direction-plays a critical role in fire behavior. ..
Read more
315 Reply
14 replies

@Busop 2 days ago
I lived in Paradise Ca, where the Camp Fire burned in 2018. My condo survived because the complex was hardened. 90 percent of the town burned. 17,000 homes. Mine didn't. Hardening works
225 Reply
45 replies

@isaacthedestroyerofstuped7676 2 days ago
Special note for those outside of California:

They aren't the only ones who have to concern themselves with this!

.
Read more
108 Reply
10 replies

@TannerCharlesYT 2 days ago
Yall did a great job on this, especially with the insane fast turn around time. Grateful to have contributed to this.
198 Reply
2 replies

@TrailsTrailsTrails 2 days ago
Country Australia here; the exact same lessons were learned here in 2009. Our vegetation loves to burn so our homes must be hardened. Check out the BAL (Bushfire Attack Level) building codes.
88 Reply
2 replies

@kenluskin 2 days ago
This is the money quote: " it's a home ignition problem, not a wildfire problem"
395 Reply
38 replies

@stenorio90 2 days ago
3:21 Living in California, seeing people around you affected by natural disasters, acting like it can't happen to you, and then blaming someone else when it does is like living on the east coast, seeing hurricanes destroy whole communities, and then blaming FEMA or NOAA cause they couldn't divert the wind or the rain.
33 Reply
1 reply

@b.a.d.2086 2 days ago
Excellent documentary! I watched these particular fires on media and I would add that if you need to evacuate, put on clothes and sturdy shoes and socks. Put on cotton or wool and never synthetics. Put on denim full length jeans and denim jackets that have good amounts of cotton in them. It will help protect you and is even a tiny bit cooler if you're ..
Read more
31 Reply
2 replies

@katecora92 1 day ago (edited)
Current environmental consultant working in building codes (and former natural resource, wildfire, and habitat field researcher) here whose mother lost her home in the Eaton Fire. Thank you for doing this piece a hell of a lot of justice, PBS.
33 Reply
2 replies

@BreezeCosmos_25 1 day ago
Billions for bombs, NO money for basics.
30 Reply
1 reply

@kimpuppy 2 days ago (edited)
I live in San Diego and watched the live feeds coming out of L.A. during those fires. The message is clear but few will hear the message and that is the sad part.

Love PBS..
Read more
29 Reply
3 replies

@Cruiser-tb5zc 1 day ago
I watched a show years ago that talked about how forests actually need what they called "flash fires" every so many years. Apparently it does several things: it helps with the pH of the soil, gets rid of the fuel on the ground, opens the pine cones allowing the seeds to come out and then takes out the lower branches of the big trees allowing ..
Read more
16 Reply
4 replies

@Shaun-b4i 1 day ago
First, I would like to start off by saying, I'm a homeless guy who was living in the Palisades and I was there the day it started. I got wind of it via Am/Fm radio around 11am that morning. Miss it dearly and YES, it was absolutely scary. Feeling the heat. Hearing ALL the explosions. Watching people driving or running in some cases for thei..
Read more
31 Reply
1 reply

@ivytanblair 2 days ago
This was an exceptionally clear education on how the fires work, from climate to infrastructure to personal cost - presented with compassion and care. I'm giving this link to everyone! And may I say, thank you Moogega Cooper for wearing an n95 mask i..
Read more
121 Reply
3 replies

@lolololol7573 1 day ago
I don't understand why they didn't take it in consideration with new builds. I understand the lack of resources and understanding with older buildings, but the fact they didn't really apply this new knowledge into new development is mind blowing. And I use 'they' losely because I understand it's trick who is responsible and who blocks this kind of ..
Read more
12 Reply

@Nick-Lab 21 hours ago (edited)
I think that if LA had invested in prevention by doing controlled burns, removing dead brush and digging fire stops over the years the experts have been warning, this may not have been so bad.
5 Reply

@kevinc-727 2 days ago
Fire insurance rates should reflect the fire readiness of each building. This will encourage everyone to spend the money on mitigation to get a discount on fire insurance, and this mitigation will save the insurance companies money
106 Reply
12 replies

@tomshady3530 4 hours ago (edited)
I was a fire jumper for a national forrest. When the wind is 40+ mph, hills, nothing can stop a fire. Rural homes in pines, homes on hills are a bad idea.
5 Reply
1 reply

Transcript

Search in video

0:23 but the LA firestorm is just the latest in a string of fires causing unprecedented destruction

0:29 in the modern era.

0:38 These fires are suddenly unstoppable. And there's one simple variable that explains the change - speed.

0:46 I'm Maiava Mya, the host of Weathered.

English

Show chat replay



Pink Floyd - The Dark Side Of Th...
Pink Floyd
29M views • 1 yea...
42:56

Is the Gaza Genocide the...
Palestine Deep Dive
56K views • 3 day...
New
19:52

This speech accidentally...
Geopolitical E...
230K views • 1 da...
New
54:11

Elon, Oligarchy, and Tesla: Berni...
Owl Saves America
20K views • 19...
New
33:18

BREAKING: Judge...
Brian Tyler Co...
134K views • 1 ho...
New
15:40

EMERGENCY DEBATE: They...
The Diary Of ...
1.7M views • 2...
New
26:15

How California's First Wildfire...
Aaron Witt
178K views • 3...
24:08

Declassified JFK Assassination...
Democracy N...
255K views • 1 da...
New
14:21

Bill Burr On The Problem With...
Breakfast Clu...
1.3M views • 8...
54:14

Puerto Rico Is Dying: Here's...
Cogito
653K views • 2...
42:55

Top U.S. & World Headlines — ...
Democracy N...
234K views • 1 da...
New

Is The San Andreas Fault O...
Spark
130K views • 2...
New

Washington Week with The...
Washington ...
93K views • 18...
New

BYD's Game-Changing 30,51...
The Electric Vi...
49K views • 16...
New

Rep. Jamie Raskin: Trump's...
Democracy N...
333K views • 5...
New

Drone swarms inside the U.S....
60 Minutes
1M views • 5 days...
New

Democrats Need to Face Why...
The Ezra Klein Show
461K views • 4...
New

Murphy: Six Weeks In, This...
Senator Chris ...
3.8M views • 2...

We don't need the CIA - The...
The Real New...
1.5M views • 2...

Who's Really Calling the Shot...
More Perfect ...
61K views • 1 day...
New

OJAI PLAYHOUSE
VISIT OJAIPLAYHOUSE.COM OR CLICK HERE FOR FILM SCHEDULE AND TICKETS

How the Thomas Fire compares to the 1985 Wheeler Fire

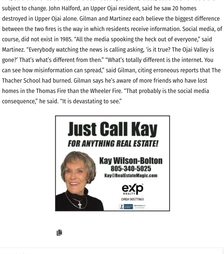
Ojai Valley News Dec 7, 2017 0

Listen to this article now
Powered by Trinity Audio
00:00 03:37



120717 ab thomasfire 4243

Ojai Valley News photo by Andra Belknap **The sun tries to shine through the smoke and ash created by the fire Dec. 5. Andra Belknap**, *Ojai Valley News reporter* For many longtime Ojai residents, the Thomas Fire brought back memories of the last major wildfire that threatened the city of Ojai: the Wheeler Fire of 1985. The Wheeler Fire began July 1, 1985 above Wheeler Hot Springs and is believed to be the work of an arsonist, though no arrests were ever made. The fire burned 119,000 acres, mostly in the southwestern edge of the Los Padres National Forest. More than 1,000 firefighters were assigned to the Wheeler Fire, that was extinguished 18 days after it began. The fire threatened neighborhoods in the city of Ojai the night of July 3, 1985. Many locals were readying themselves for Independence Day festivities, but plans quickly changed. Andy Gilman, who now resides on Goldenwest Avenue, lived on Fulton Street in 1985. He recalls passing the night of July 3 on his roof with a garden hose, working to save his home from falling embers.



120717 td thomas fire 120557 0076

Ojai Valley News photo by Tim Dewar **Traffic moves through town under a smoke-filled sky Dec. 5, the morning after the fire began.**

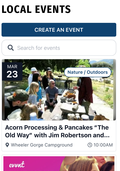
George Martinez, a longtime Ojai resident, was ordered to evacuate his Sunset Place home in 1985, but decided to stay behind with a handful of his neighbors. "The embers were coming down from the foothills down to the Mountain View Avenue area," he recalled. "We were out with our garden hoses extinguishing embers around the neighborhood." As of press time Dec. 7, Martinez was working to extinguish spot fires on McNell Road, where some homes were lost, he said. "The heartbreak is just the same," Martinez said. Just as the during the Thomas Fire, Nordhoff High School served as a refuge for Wheeler Fire evacuees 32 years ago. And just as the Thomas Fire, the winds played a critical role in the Wheeler Fire. Fire officials were reportedly considering evacuating the entire city of Ojai July 3, 1985, when all of the sudden, the winds changed and helped drive the fire back onto itself. One memory of the Wheeler Fire remains at Ojai's "Y" intersection, in the form of a small park dedicated to the firefighters who battled the blaze. A large boulder in the park holds a plaque that pays thanks to the "gallant men and women ... who by extraordinary effort and fortitude, averted catastrophe. We can never forget you." The Thomas Fire, as of press time Dec. 7, has engulfed 96,000 acres in Ventura County and has destroyed structures in the Ojai Valley, Ventura and Santa Paula. The California Department of Forestry and Fire Protection (Cal Fire) said that 73 residences have been destroyed in the blaze, but those numbers are subject to change. John Halford, an Upper Ojai resident, said he saw 20 homes destroyed in Upper Ojai alone. Gilman and Martinez each believe the biggest difference between the two fires is the way in which residents receive information. Social media, of course, did not exist in 1985. "All the media spooking the heck out of everyone," said Martinez. "Everybody watching the news is calling asking, 'Is it true? The Ojai Valley is gone?' That's what's different from then." "What's totally different is the internet. You can see how misinformation can spread," said Gilman, citing erroneous reports that The Thacher School had burned. Gilman says he's aware of more friends who have lost homes in the Thomas Fire than the Wheeler Fire. "That probably is the social media consequence," he said. "It is devastating to see."

Thank you for reading!
Please log in, or sign up for a new account and purchase a subscription to read or post comments.
Sign Up | Log In

Ads
Featured Local Savings
Food 4 Less
Valid Mar 18 - Mar 25
4 Days Left
NEXT



REAL ESTATE WEEKLY



E-EDITION OVN



Ojai Valley News
Click to view our latest print and archive editions.

LOCAL EVENTS

CREATE AN EVENT

Search for events

MAR 23 — Nature / Outdoors
Acorn Processing & Pancakes "The Old Way" with Jim Robertson and...
Wheeler Gorge Campground — 10:00AM

MAR 23 — Theatre
Anastasia The Musical
Conejo Players Theatre — 2:00PM

MORE EVENTS

powered by evvnt

OJAI MAGAZINE ISSUES

Winter 2024 | Fall 2024 | Summer 2024

Spring 2024 | Winter 2023 | Fall 2023

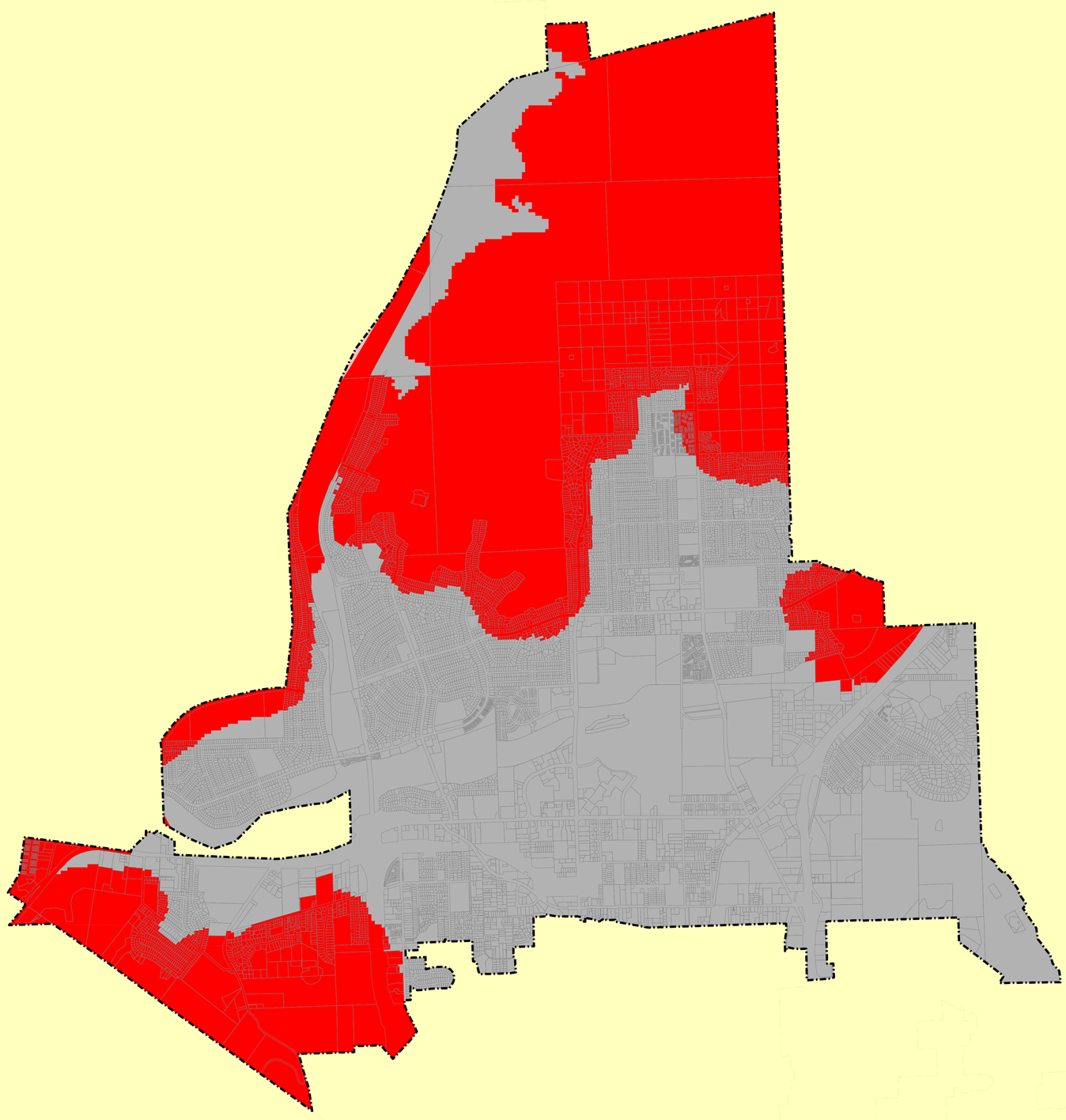
See More

© 2024 OJAI MEDIA LLC. | Terms of Use | Privacy Policy

Fire and Resource Assessment Program
California Department of Forestry and Fire Protection

Santee

Very High Fire Hazard Severity Zones in LRA
As Recommended by CAL FIRE



Fire Hazard Severity Zones

Local Responsibility Area	State or Federal Responsibility Areas
VHFHSZ	VHFHSZ
Non-VHFHSZ	Non-VHFHSZ

City Boundary
Parcels
County Boundary

Government Code 51175-89 directs the California Department of Forestry and Fire Protection (CAL FIRE) to identify areas of very high fire hazard severity zones within Local Responsibility Areas (LRA). Mapping of the areas, referred to as Very High Fire Hazard Severity Zones (VHFHSZ), is based on data and models of, **potential** fuels over a 30-50 year time horizon and their associated expected fire behavior, and expected burn probabilities to quantify the likelihood and nature of vegetation fire exposure (including firebrands) to buildings. Details on the project and specific modeling methodology can be found at http://frap.cdf.ca.gov/projects/hazard/methods.htm. Local Responsibility Area VHFHSZ maps were initially developed in the mid-1990s and are now being updated based on improved science, mapping techniques, and data.

In late 2005 to be effective in 2008, the California Building Commission adopted California Building Code Chapter 7A requiring new buildings in VH FHSZs to use ignition resistant construction methods and materials. These new codes include provisions to improve the ignition resistance of buildings, especially from firebrands. The updated very high fire hazard severity zones will be used by building officials for new building permits in LRA. The updated zones will also be used to identify property whose owners must comply with natural hazards disclosure requirements at time of property sale and 100 foot defensible space clearance. It is likely that the fire hazard severity zones will be used for updates to the safety element of general plans.

This specific map is based on a geographic information system dataset that depicts final CAL FIRE recommendations for Very High FHSZs within the local jurisdiction. The process of finalizing these boundaries involved an extensive local review process, the details of which are available at http://frap.cdf.ca.gov/projects/hazard/btnet/ (click on "Continue as guest without logging in"). Local government has 120 days to designate, by ordinance, very high fire hazard severity zones within its jurisdiction after receiving the recommendation. Local government can add additional VHFHSZs. There is no requirement for local government to report their final action to CAL FIRE when the recommended zones are adopted. Consequently, users are directed to the appropriate local entity (county, city, fire department, or Fire Protection District) to determine the status of the local fire hazard severity zone ordinance.

This map was developed using data products such as parcel and city boundaries provided by local government agencies. In certain cases, this includes copyrighted geographic information. The maps are for display purposes only - questions and requests related to parcel or city boundary data should be directed to the appropriate local government entity.

N
W E
S

0 2 Miles
0 3 Kilometers

Projection Albers, NAD 1983
Scale 1: 20,000
at 36" x 36"
June 11, 2009

The State of California and the Department of Forestry and Fire Protection make no representations or warranties regarding the accuracy of data or maps. Neither the State nor the Department shall be liable under any circumstances for any direct, special, incidental, or consequential damages with respect to any claim by any user or third party on account of, or arising from, the use of data or maps.

Obtain FRAP maps, data, metadata and publications on the Internet at http://frap.cdf.ca.gov
For more information, contact CAL FIRE-FRAP, PO Box 944246, Sacramento, CA 94244-2460, (916) 327-3939.

Arnold Schwarzenegger, Governor,
State of California
Mike Chrisman, Secretary for Resources,
The Natural Resources Agency
Del Walters, Director,
Department of Forestry and Fire Protection

MAP ID: FHSZL_c37_Santee

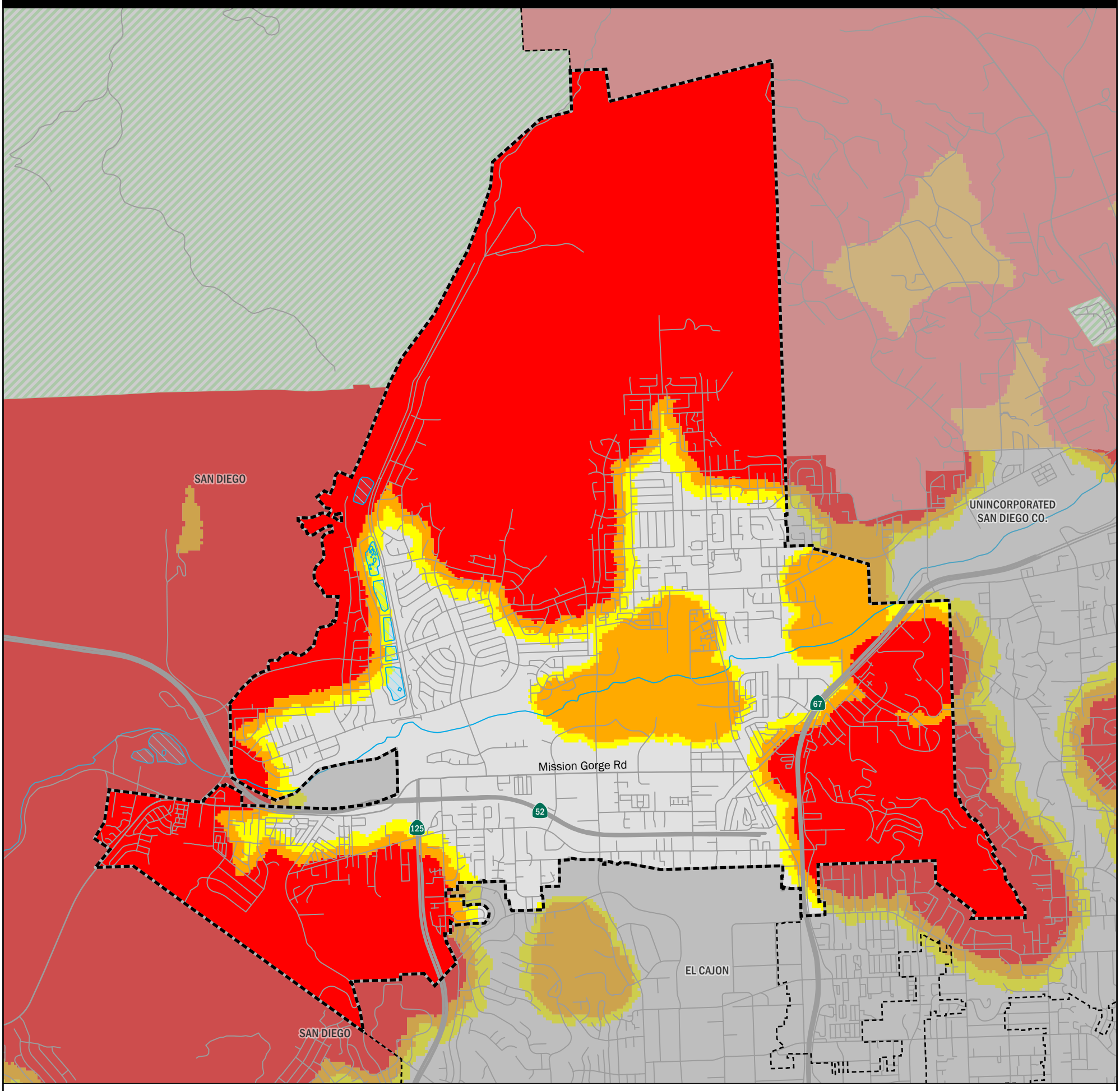
DATA SOURCES
CAL FIRE Fire Hazard Severity Zones (FHSZL06_3)

CITY OF SANTEE – SAN DIEGO COUNTY

Local Responsibility Area Fire Hazard Severity Zones

As Identified by the State Fire Marshal

March 24, 2025





Fire Hazard Severity Zones (FHSZ) in Local Responsibility Area (LRA), as Identified by the State Fire Marshal

Very High High Moderate

Fire Hazard Severity Zones in State Responsibility Area (SRA), Effective April 1, 2024

Very High High

Mi 0 1 2

Km 0 1 2 3

Projection: NAD 83 California Teale Albers
Scale: 1:43,000 at 11" x 17"

Incorporated City Waterbody

Unzoned LRA Federal Responsibility Area (FRA)

Government Code section 51178 requires the State Fire Marshal to identify areas in the state as moderate, high, and very high fire hazard severity zones based on consistent statewide criteria and based on the severity of fire hazard that is expected to prevail in those areas. Moderate, high, and very high fire hazard severity zones shall be based on fuel loading, slope, fire weather, and other relevant factors including areas where winds have been identified by the Office of the State Fire Marshal as a major cause of wildfire spread.

The State of California and the Department of Forestry and Fire Protection make no representations or warranties regarding the accuracy of data or maps. Neither the State nor the Department shall be liable under any circumstances for any direct, special, incidental, or consequential damages with respect to any claim by any user or third party on account of, or arising from, the use of data or maps.

Gavin Newsom, Governor, State of California

Wade Crowfoot, Secretary for Natural Resources, CA Natural Resources Agency

Joe Tyler, Director/Fire Chief, CA Department of Forestry and Fire Protection

Daniel Berlant, State Fire Marshal, CA Department of Forestry and Fire Protection

Data Sources:

CAL FIRE Fire Hazard Severity Zones (FHSZSRA23_3, FHSZLRA_25_1)

CAL FIRE State Responsibility Areas (SRA25_1)

City and County boundaries as of 10/22/24 (CA Board of Equalization)

DJIA 41350.93 -0.20% ↓ S&P 500 5599.30 0.49% ↑ Nasdaq 17648.45 1.22% ↑ VIX 24.23 -9.99% ↓ U.S

IN ONE CHART

This age group owns 79% of stocks and equity funds. Why that's good for bonds.

Bonds should do well in the years ahead, as age demographics are set to play in their favor

By Joy Wiltermuth Follow

Last Updated: Nov. 20, 2024 at 5:11 a.m. ET

First Published: Nov. 19, 2024 at 3:22 p.m. ET



It's a bullish backdrop for bonds that older adults — those age 55 and above — now own the bulk of all U.S. stocks and housing wealth, say Deutsche Bank researchers.

PHOTO: AFP VIA GETTY IMAGES

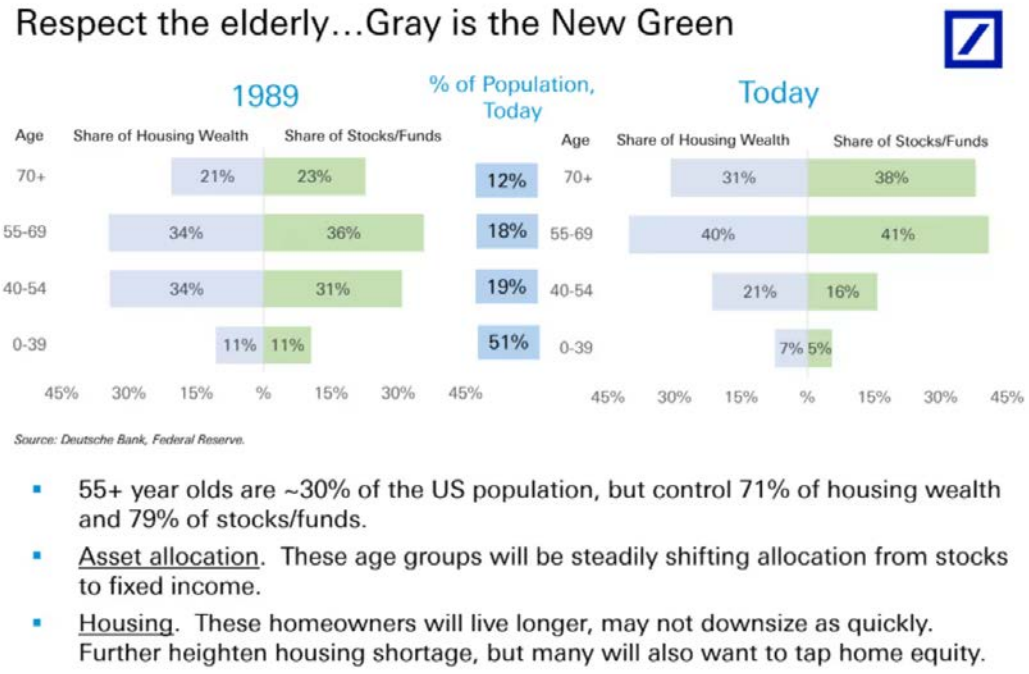
Referenced Symbols

Referenced Symbols

↑ SPX +0.49% TMUBMUSD10Y 4.315% ↓ DJIA -0.20% ↑ COMP +1.22%

Asset wealth in the U.S. has become increasingly concentrated in the hands of older adults since the late 1980s, according to Deutsche Bank researchers.

Only about 30% of the U.S. population belongs to the 55-years-and-older age group, but that group has come to own roughly 79% of stocks and equity funds, as well as also about 71% of housing wealth, the researchers said in an outlook for the year ahead.



Only 30% of the U.S. population owns the bulk of all stock-market and housing wealth, according to Deutsche Bank Research

PHOTO: DEUTSCHE BANK, FEDERAL RESERVE

That's a notable shift from a quarter-century ago, when younger generations shared in a greater slice of asset wealth. The youngest age bracket, from birth to 39 years of age, now owns only 7% of housing wealth and 5% of stocks and equity funds, according to the above chart — down from 11% in 1989.

Related: America's economy looks strong. So why is Wall Street worrying about renters and younger borrowers?

After touching a string of fresh records, stocks are set for another banner year of gains. The S&P 500 index ↑ **SPX +0.49%** was up 24.1% on the year through Tuesday, according to FactSet data. To put that in perspective, there have been only five times in the past 25 years when the S&P 500 has gained more than 24%, according to Dow Jones Market

Data.

Still, bonds should do well in the years ahead from a demand perspective, given that older adults will be "steadily shifting allocation from stocks to fixed income," Deutsche Bank's securitized-products research team, led by Edward Reardon, wrote in its outlook.

The 10-year Treasury yield **TMUBMUSD10Y 4.315%** has climbed sharply higher in the wake of the Federal Reserve's pivot to interest-rate cuts in September. It was at 4.38% on Tuesday, up nearly 80 basis points from its one-year low in mid-September.

The Dow Jones Industrial Average ↓ **DJIA -0.20%** was lower Tuesday, but still up 14.9% on the year so far, while the Nasdaq Composite index ↑ **COMP +1.22%** was 26.3% higher in 2024, according to FactSet.

See: 'Golden Girls' no more: How America's concept of old age became outdated

About the Author



Joy Wiltermuth Follow

Joy Wiltermuth is a news editor and senior markets reporter based in New York.

What to Read Next



Why the White House may be trying to engineer a recession, this analyst says

Continue To Article



LinkedIn co-founder says Americans don't understand this about Elon Musk

Continue To Article

My parents left me $250K, but gave my 'irrational and neurotic' sister $1 million. Would you sever all ties?

Continue To Article

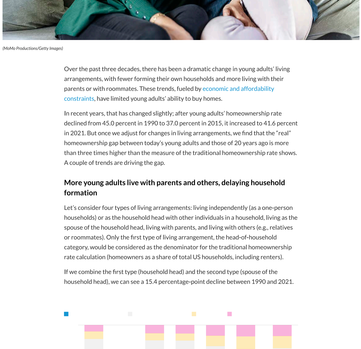
Support research that powers smarter, more effective, and more just policies. DONATE

URBAN WIRE

The "Real" Homeownership Gap between Today's Young Adults and Past Generations Is Much Larger Than You Think

Laurie Goodman, Jung Hyun Choi, Jun Zhu

April 17 2023



(MoMo Productions/Getty Images)

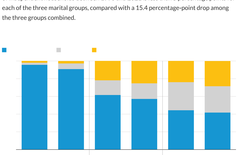
Over the past three decades, there has been a dramatic change in young adults' living arrangements, with fewer forming their own households and more living with their parents or with roommates. These trends, fueled by economic and affordability constraints, have limited young adults' ability to buy homes.

In recent years, that has changed slightly; after young adults' homeownership rate declined from 45.0 percent in 1990 to 37.0 percent in 2015, it increased to 41.6 percent in 2021. But once we adjust for changes in living arrangements, we find that the "real" homeownership gap between today's young adults and those of 20 years ago is more than three times higher than the measure of the traditional homeownership rate shows. A couple of trends are driving the gap.

More young adults live with parents and others, delaying household formation

Let's consider four types of living arrangements: living independently (as a one-person households) or as the household head with other individuals in a household, living as the spouse of the household head, living with parents, and living with others (e.g., relatives or roommates). Only the first type of living arrangement, the head-of-household category, would be considered as the denominator for the traditional homeownership rate calculation (homeowners as a share of total US households, including renters).

If we combine the first type (household head) and the second type (spouse of the household head), we can see a 15.4 percentage-point decline between 1990 and 2021.

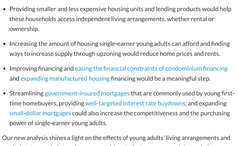


This difference stems largely from increases in the share of young adults living with parents (from 12.5 percent to 20.2 percent) and those living with others (from 10.7 percent to 18.3 percent). Additionally, although the current homeownership rate is similar to that of 2010 and well above the 2015 lows, the share of 25-to-34-year-olds living independently has barely budged since 2015.

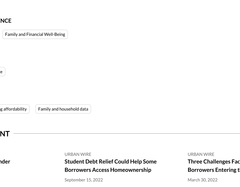
Lower marriage rates and fewer independent young adults are limiting new household formation

The failure to form households within the census's definition also correlates with the large decline in the married population share. The share of married young adults has declined from 59.4 percent in 1990 to 38.6 percent in 2021. The census data do not distinguish between nonmarried partners, friends, and visitors. If all those people are added to the married population, providing a considerable overestimate, the pattern is the same: the share would decline from 64 percent to 49 percent. The never-married share has increased from 29 percent in 1990 to 56.1 percent in 2021.

Controlling for marital status, we also find that young adults' homeownership rates are slightly higher now compared with 1990. This suggests that if today's young adults had a marriage rate similar to those of prior generations, their homeownership rate would be substantially higher than the current rate.



Young adults' living arrangements are different today than in 1990. Controlling for marital status (married; divorced, separated, or widowed; or never married), today's young adults are more likely to live with their parents or live with others than form independent households as head or spouse of the head. But the difference in the share of independent households between 1990 and 2021 is less than 5 percentage points for each of the three marital groups, compared with a 15.4 percentage-point drop among the three groups combined.



It is possible that the rise of cohabitation without marriage is distorting these numbers, but the distortion is likely small; the share of the never-married category that is living with others increased from 24 percent in 1990 to 28.4 percent in 2021. Though the 4.4 percentage-point increase does not have a large effect on our results, and not all the growth among those living with others is attributable to cohabitation in lieu of marriage, the growing share of this population warrants future research on how cohabitation affects housing choices.

What is the real young adult homeownership rate, and how much has it changed?

If we calculate the homeownership rate at the individual level instead of the household level (we call this the "real" homeownership rate), the picture would be very different.

The individual-level homeownership rate calculation allows us to incorporate changes in household formation. Let's compare the household-based traditional homeownership rate with the individual-based real homeownership rate. We found 41.5 percent of young adults were homeowners as heads or spouses. This share dropped to 29.3 percent in 2021. During this period, the traditional homeownership rate, measured at the household level, dropped from 45.0 percent to 41.6 percent. This means the decline in the real homeownership rate is 12.2 percentage points, compared with a 3.4 percentage-point drop in the traditional homeownership rate.

If we isolate the effects of delayed household formation proxied by changes in marital composition (i.e., we assume the marriage rate was the same as in 1990), we find the hypothetical real homeownership rate would have been 39.1 percent, 9.8 percentage points higher than current levels. As of 2021, there are 44 million young adults ages 25 to 34, meaning there would be 4.3 million additional homeowners.

Forward-looking policies can help meet young generations' housing needs

Our research shows that those who buy their homes earlier in life, on average, have substantially higher housing wealth as they near retirement. Our previous research suggests that those ages 25 to 34 who live with their parents are significantly less likely to form independent households and become homeowners, compared with those who moved out earlier and either rented or owned. A significant decline in the real homeownership rate means more of today's young adults won't be able to build wealth through housing equity the way older generations did.

But the increase in this less independent younger generation who face unique barriers to homebuying underscores the need for targeted solutions, such as the following:

- Providing smaller and less expensive housing units and lending products would help these households access independent living arrangements, whether rental or ownership.
- Increasing the amount of housing single-earner young adults can afford and finding ways to increase supply through upzoning would reduce home prices and rents.
- Improving financing and easing the financial constraints of condominium financing and expanding manufactured housing financing would be a meaningful step.
- Streamlining government-insured mortgages that are commonly used by young first-time homebuyers, providing well-targeted interest rate buydowns, and expanding small-dollar mortgages could also increase the competitiveness and the purchasing power of single-earner young adults.

Our new analysis shines a light on the effects of young adults' living arrangements and marital status on their true homeownership rate, but more research is needed to understand why young adults today are making different choices from past generations and what supports they need to access such a large wealth-building opportunity.

Let's build a future where everyone, everywhere has the opportunity and power to thrive

Urban is more determined than ever to partner with changemakers to unlock opportunities that give people across the country a fair shot at reaching their fullest potential. Invest in Urban to power this type of work.

DONATE

RESEARCH AND EVIDENCE

Housing and Communities | Family and Financial Well-Being

EXPERTISE

Families | Housing Finance

TAGS

Homeownership | Housing affordability | Family and household data

RELATED CONTENT

URBAN WIRE
Unmasking the Real Gender Homeownership Gap
March 28, 2023

URBAN WIRE
Student Debt Relief Could Help Some Borrowers Access Homeownership
September 15, 2022

URBAN WIRE
Three Challenges Facing Single Female Borrowers Entering the Mortgage Market
March 30, 2022

 Copyright © Urban Institute

Physical and behavioural factors that influence evacuation times of elderly people: a systematic literature review

Sarah Daniels[1], Bridie Bailey[1], Rosie Wainwright[1], and Gary Daniels[1]

[1]Affiliation not available

July 15, 2024

Posted on 15 Jul 2024 — CC-BY 4.0 — https://doi.org/10.36227/techrxiv.172107460.02342717/v1 — e-Prints posted on TechRxiv are preliminary reports that are not peer reviewed. They should not b...

Abstract

Objective

We conducted a systematic review to investigate the factors influencing the safe evacuation of elderly people.

Background

As populations age, the functional capability of building occupants to evacuate may be impacted as higher percentages of the population require additional assistance. Current fire engineering guidance and codes of practice are based on outdated literature.

Method

This review was conducted according to the PRISMA framework. The electronic databases Web of Science, APA PsycINFO, Embase, MEDLINE and IEEE Xplore were comprehensively searched between November 2023 and December 2023.

Results

We systematically identified 11 studies published between 1995 and 2021. Key findings are as follows: Pre-movement time: Influenced by physical abilities and staff responsiveness. Non-assisted elderly residents have quicker pre-movement times, and faster staff responses shorten pre-movement periods regardless of building structure. Movement speeds: Horizontal movement speeds for elderly range from 0.3 to 0.6 m/s; on stairs, 0.31 to 0.56 m/s for elderly and 0.96 to 1.13 m/s for younger people. Assisted or evacuation chair speeds decrease to 0.14 to 0.29 m/s. Key behaviours: Include seeking information, waiting for others, and collecting belongings, along with reliance on staff for guidance. Role of staff: Staff play a crucial role, especially for those with limitations. Outcomes can be enhanced by proper training, effective task assignment and prioritising residents by mobility.

Conclusion

The studies emphasise the importance of staff responsiveness and effective training in evacuating elderly residents.

Application

This review presents recent research findings on the evacuation of elderly populations, emphasising the necessity to update guidance.

Introduction

The UK, like many other nations, faces a growing aging population. Mid-2022 estimates from the Office for National Statistics indicate that 18.8% of the UK's population is over 65 years old (Office for National Statistics, 2024). Aging is associated with physical, mental, and neurological declines. For instance, walking speed decreases with age, and faster walking speeds may increase the risk of falls in older adults (Kang & Dingwell, 2008; Pavol et al., 1999). As people age, their gait changes, often resulting in shorter steps and strides, which contribute to slower walking speeds (Ostrosky et al., 1994). Muscle strength loss, particularly

in those over 60, is a key factor in reduced gait performance (Pirker & Katzenschlager, 2017). Cognitive decline, including dementia, further impacts walking pace due to deteriorating neurological functions that control gait, such as motor and sensory activities (Quan et al., 2017). Consequently, age-related limitations, including health conditions, cognitive impairments, and sensory deficits, can significantly affect evacuation speeds during emergencies. This demographic shift has important implications for evacuation processes, such as an increased number of elderly individuals in mixed occupancy buildings, necessitating assessments of building egress facilities (Fahy, 2015). A higher proportion of the population with mobility impairments leads to growing social pressure on fellow evacuees and potentially even neighbours / bystanders to assist during emergencies, affecting evacuation performance (Boyce, 2017). Safe evacuation relies heavily on both building design and management, but it's crucial to consider that occupants have varying abilities. Common UK fire engineering codes and guidance documents (British Standard Institution, 2017, 2019b) often do not incorporate the latest research because relevant findings are scattered across diverse fields such as medicine, psychology, and kinesiology. This can result in design assumptions being overly simplified or based on standard norms, limiting fire engineers' ability to tailor designs to specific risks. The Required Safe Egress Time (RSET) is a tool used by fire engineers to evaluate building safety (Cooper, 1983). Currently, RSET calculations rely on fixed values that do not account for physical disabilities or human behaviour, which could significantly influence evacuation times, especially among older occupants. More comprehensive analysis is needed to understand how age, health, and other physiological and psychological factors affect evacuation behaviour, including pre-movement time, decision-making, and travel speeds. Collecting movement data from older occupants, both with and without mobility impairments, will enable engineers to calculate RSET more inclusively, accommodating the evacuation needs of all occupant types (Kuligowski, Peacock, Wiess, et al., 2015). This study adopts an interdisciplinary approach, combining expertise in fire protection engineering and public health science, to identify the factors affecting evacuation times for older adults. We aimed to investigate how aging affects evacuation times in nursing homes by focusing on physical ability, movement speed, human behaviour, and staff response. Our primary research questions are:

What are the average evacuation times and movement speeds for elderly individuals, and how do they compare to those of younger people?

Which behavioural and physical factors impact evacuation times in the elderly population?

Our secondary question is:

What impact, if any, does staff behaviour and training have on evacuation times in the elderly population?

Methods

To identify relevant research within emergency evacuation of elderly people, this paper adapts the PRISMA (Transparent Reporting of Systematic Reviews and Meta-Analyses) framework (Page et al., 2021).

Structuring the research question

Based on our research question, this review focussed on studies reporting movement times and behaviours for evacuating elderly people from buildings. To be included in this review, studies must have reported one or more of the following: a) pre-movement times and movement times (including walking speeds and flow rates) e.g. from observed drills or modelling data; b) views/perspectives on capability for elderly people to exit a building safely e.g. qualitative viewpoints from elderly people or staff assisting in their evacuation, or behaviours reported by researchers from observed drills. Definitions for the pre-movement times and movement times were taken from the CFPA-Europe guidance for key phases 2 and 3 of RSET (Confederation of Fire Protection Associations Europe, 2009):

Pre-movement times: The time between the warning of fire, being given by an alarm or by direct sight of smoke or fire, and the first move being made towards an exit. This phase involves the perception of the

Posted on 15 Jul 2024 — CC-BY 4.0 — https://doi.org/10.36227/techrxiv.172107460.02342717/v1 — e-Prints posted on TechRxiv are preliminary reports that are not peer reviewed. They should not b...

alarm, the interpretation of the alarm, and the decision-making on how to proceed. It is defined as the time to recognise the alarm and stop the activities they are engaged in, and the time to respond by taking action to evacuate. Quantification of pre-movement time is given by time elapsed from the communication of an alarm to the first movement of an occupant.

Movement time: The time occupants take to move from where they are to a safer location. Movement time is the interval between the time when the occupants make the first move and the time when all of them can reach a place of safety. Movement time depends on three components: walking speed, time to queue and flow time through the exits.

The research questions were formulated based on the Population, Exposure and Outcome (PEO) framework (Moola et al., 2015):**Population** : We defined older adults as those who are 60 years and older, or who were referred to in the references as "older adults", "elderly", "elders". We excluded studies focused on children, young or middle-aged people, and populations with an age <60 years. We also excluded studies on populations that were not considered representative of the general elderly population such as those with existing injuries or acute illness that can impair movement speeds e.g. fractures or viral illnesses and amputees. Elderly populations with chronic health conditions or sensory impairment were included (e.g. diabetes, CAD, visual or hearing impairment).**Exposure of interest (independent variable)** : We included all studies that investigated elderly people exiting a building (egress). Emergency evacuations were of particular interest. We excluded studies that reported evacuation strategies for other elements of the built environment (e.g., outdoor spaces, underground structures, vehicles, travel hubs and airports).**Outcome or response (dependent variable)** : Quantitative data was extracted for movement speeds and/or evacuation times or distances of elderly people. Qualitative data was extracted to understand the evacuation behaviour from a social sciences perspective, to get the views/experiences of elderly people or those assisting them to evacuate. In addition, any reported barriers and/or facilitators to safe evacuation times in the elderly were extracted. We excluded outcomes related to qualitative and quantitative measurements taken before or after an evacuation/exiting a building. We were only interested in movement speeds and/or times. Thus, movement outcomes related to gait were excluded. Types of studies included were as follows a) observational studies e.g. cross-sectional survey studies to explore evacuation decision-making, b) experimental studies e.g. evacuation drills to observe movement speeds and evacuation times, c) modelling and simulation studies, d) interventional studies e.g. evaluation of tools that could aid evacuation of the elderly and improve movement speed, e) case study or case series, f) qualitative studies that explore views/perspectives on capability for elderly people to exit a building safely, g) mixed methods studies have applied a combination of methods mentioned above. The literature was limited to original, peer-reviewed, journal articles and conference proceedings that have been written in English. There was no restriction to publication date and geographic location. We excluded expert opinion, commentaries and review articles, including systematic reviews and meta-analyses. Relevant review articles were identified for hand searching of suitable studies for inclusion.

Search strategy

To find potentially relevant studies for inclusion, the following bibliographic databases were comprehensively searched between November 2023 and December 2023: Web of Science, APA PsycInfo, Embase, MEDLINE and IEEE Xplore. We carried out preliminary searches on different databases testing a variety of search strategies. Our final search strategy used terms and associated words for 'elderly' AND 'movement speed' AND 'evacuation'. Search terms used for elderly evacuees included 'elderly, 'older adult', 'older person*' and 'aged'. Terms for movement speed included 'movement speed', 'travel speed', and 'walking speed'. Search terms for evacuation included 'evacuation', 'stair', 'egress' and 'escape' (see Supplementary Material 1 for an example of our search strategy). Hand searches of the reference list of relevant studies were conducted.

Posted on 15 Jul 2024 — CC-BY 4.0 — https://doi.org/10.36227/techrxiv.172107460.02342717/v1 — e-Prints posted on TechRxiv are preliminary reports that are not peer reviewed. They should not b...

Study selection

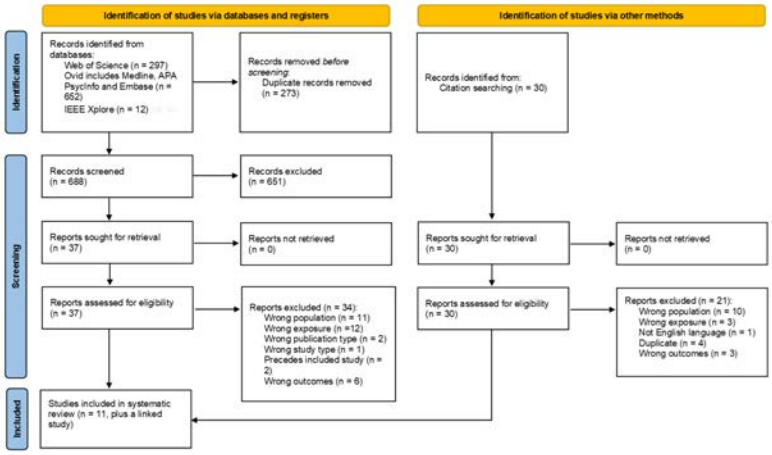
The search results were deduplicated in Endnote 20 and exported to the Rayyan software tool for screening. Two reviewers independently screened a random sample of 20% of the abstracts/titles. Any discrepancies were resolved through discussion or, if needed, by a third reviewer. One reviewer screened the remaining 80%. If the initial reviewer faced difficulty, two reviewers independently screened the record, and any disagreements were resolved through discussion or by involving a third reviewer. A random sample of 20% of the full texts was independently screened by two reviewers. Any discrepancies were resolved through discussion or, if necessary, by a third reviewer. One reviewer screened the remaining 80% of the records. If the reviewer was uncertain, two reviewers independently screened the full text, and any disagreements were resolved through discussion or by involving a third reviewer.

Data extraction and synthesis

Information from the included studies was captured in a Microsoft Excel spreadsheet using a pre-designed form. The information extracted included four domains: (1) study characteristics and settings (article title, first author, study country, year of publication, study type, study aim, description of population, building type; (2) quantitative data for pre-movement times and movement speeds (m/s), including a description of the evacuation scenario and type of evacuee(s), type of egress (horizontal or vertical) and method of data collection (e.g. video recordings, modelling simulation); (3) qualitative data of views and perspectives of elderly and staff evacuation behaviours (self-reported or researcher observations from scheduled drills). A draft of the summarised findings was discussed by all the authors, and necessary amendments were applied until reaching an agreement on the draft.

Results

Search results



Our initial electronic search yielded 688 records after deduplication, with an additional 30 records identified through reference list searches. After title and abstract screening, 67 studies were taken to full text review. Of these, 12 studies were selected for data extraction (Abd Razak et al., 2021; Chen et al., 2020; Folk et al., 2020; Huang et al., 2021; Kholshevnikov et al., 2012; Kuligowski, Peacock, Reneke, et al., 2015; Kuligowski, Peacock, Wiess, et al., 2015; Lim et al., 2023; Pichler & Gales, 2015; Proulx et al., 1995; Rahouti et al.,

Posted on 15 Jul 2024 — CC-BY 4.0 — https://doi.org/10.36227/techrxiv.172107460.02342717/v1 — e-Prints posted on TechRxiv are preliminary reports that are not peer reviewed. They should not b...

2021; Ren et al., 2022). Notably, two of these studies were linked and treated as a single study (Kuligowski, Peacock, Reneke, et al., 2015; Kuligowski, Peacock, Wiess, et al., 2015), bringing the total to 11 studies included in this review. See Figure 1 for a PRISMA flow diagram of the process and reasons for exclusion.

Figure 1: PRISMA flow diagram of included studies

Study characteristics

Of the 11 included studies, four were simulation modelling studies (Abd Razak et al., 2021; Chen et al., 2020; Lim et al., 2023; Ren et al., 2022), five observational field studies of announced or unannounced fire drills (Folk et al., 2020; Kholshevnikov et al., 2012; Kuligowski, Peacock, Reneke, et al., 2015; Kuligowski, Peacock, Wiess, et al., 2015; Proulx et al., 1995; Rahouti et al., 2021). One study was a observational field experiment of a occupants through a smoke-filled corridor (Huang et al., 2021), and one study was mixed methods (Pichler & Gales, 2015) (Table 1). Study locations were China (Chen et al., 2020; Huang et al., 2021; Ren et al., 2022), Canada (Folk et al., 2020; Pichler & Gales, 2015; Proulx et al., 1995), Russia (Kholshevnikov et al., 2012), Republic of Korea (Lim et al., 2023), US (Kuligowski, Peacock, Reneke, et al., 2015; Kuligowski, Peacock, Wiess, et al., 2015), New Zealand (Rahouti et al., 2021) and Malaysia (Abd Razak et al., 2021). The study populations included elderly who could walk independently and those who needed mobility aids or assistance (Chen et al., 2020; Kholshevnikov et al., 2012; Kuligowski, Peacock, Reneke, et al., 2015; Kuligowski, Peacock, Wiess, et al., 2015; Lim et al., 2023; Rahouti et al., 2021), and included elderly with cognitive impairments (Folk et al., 2020; Pichler & Gales, 2015). One study included an elderly population with no disabilities (Huang et al., 2021), one study observed a population of mixed ages including 65+ years with mixed abilities (Proulx et al., 1995) and two studies did not report the physical status of their elderly population (Abd Razak et al., 2021; Ren et al., 2022). Included studies focused on nursing homes and residential facilities for elderly and/or disabled people (Chen et al., 2020; Folk et al., 2020; Kholshevnikov et al., 2012; Kuligowski, Peacock, Reneke, et al., 2015; Kuligowski, Peacock, Wiess, et al., 2015; Lim et al., 2023; Pichler & Gales, 2015; Rahouti et al., 2021), multi- and one-storey buildings (Abd Razak et al., 2021; Proulx et al., 1995; Ren et al., 2022), and a linear corridor (Huang et al., 2021).

Table 1: Study Characteristics

Study
Chen et al. (Chen et al., 2020)
Folk et al. (Folk et al., 2020)
Huang et al. (Huang et al., 2021)
Kholshevnikov et al. (Kholshevnikov et al., 2012)
Kuligowski et al. (Kuligowski, Peacock, Wiess, et al., 2015) and Kuligowski et al. (Kuligowski, Peacock, Reneke, et al., 201
Lim et al. (Lim et al., 2023)
Pichler et al. (Pichler & Gales, 2015)
Proulx et al. (Proulx et al., 1995)
Rahouti et al. (Rahouti et al., 2021)
Abd Razak et al. (Abd Razak et al., 2021)
Ren et al. (Ren et al., 2022)

Abbreviations: LTC: Long-term care

Pre-movement times

The studies observed various pre-movement times for elderly residents under different conditions (Table 2). Rahouti et al. (Rahouti et al., 2021) found that in an unannounced drill at a New Zealand retirement facility, the pre-movement delay ranged from 48 seconds to 3 minutes and 39 seconds. Kuligowski et al. (Kuligowski, Peacock, Reneke, et al., 2015) observed significantly longer pre-movement times in the USA,

Posted on 15 Jul 2024 — CC-BY 4.0 — https://doi.org/10.36227/techrxiv.172107460.02342717/v1 — e-Prints posted on TechRxiv are preliminary reports that are not peer reviewed. They should not b...

with delays from 6 minutes 38 seconds to 28 minutes and 28 seconds during announced drills in 6- and 13-story buildings. Similarly, Folk et al. (Folk et al., 2020) observed significantly longer pre-movement times for assisted and non-assisted residents in Canadian long-term care and retirement homes, with averages ranging from 2 minutes and 2 seconds to 6 minutes and 53 seconds during five scheduled drills. Kuligowski et al. (Kuligowski, Peacock, Reneke, et al., 2015) highlighted a notable difference in pre-movement times, with elderly residents taking significantly longer (14 minutes and 10 seconds) compared to able-bodied occupants of office and residential buildings (2 minutes and 40 seconds).

Rahouti et al. (Rahouti et al., 2021) discovered that pre-movement times for residents are heavily influenced by their physical abilities and the reaction times of home staff. For residents who did not require assistance, times ranged from 10 seconds to 2 minutes and 20 seconds, while for a mixed group of assisted and unassisted residents, times ranged from 48 seconds to 3 minutes and 39 seconds. The study also emphasised that quicker staff responses lead to faster evacuations, regardless of the building's structure.

Table 2: Pre-movement times

Study	**Scenario**
Folk et al. (Folk et al., 2020)	Occupants evacuating LTCs and retirement homes during fi
Kuligowski et al. (Kuligowski, Peacock, Reneke, et al., 2015)	6-storey building: Flooding in basement making elevators in
	12 different types of multi-story building including offices an
Rahouti et al. (Rahouti et al., 2021)	Residents evacuate from a communal area during a unannou
	Residents evacuate from independent living apartments conn

*Number of elderly occupants who participated in evacuation drill. Abbreviations: SD: standard deviation; LTC: Long-term care

Movement speeds

Table 3 summarises the average movement speeds of elderly evacuees as reported in six out of the 11 included studies (Folk et al., 2020; Huang et al., 2021; Kholshevnikov et al., 2012; Kuligowski, Peacock, Wiess, et al., 2015; Proulx et al., 1995; Rahouti et al., 2021).

In 1995, the National Research Council of Canada and Canada Mortgage and Housing Corporation jointly conducted a research project to study evacuation drills in high-rise apartment buildings with occupants of varying abilities and ages (Proulx et al., 1995). The findings revealed that seniors (65+ years) took significantly longer to start their evacuation and exit the building compared to other age groups, with an average speed of 0.56 m/s per floor.

In 2015, the National Institute of Standards and Technology (NIST) studied the movement speeds of occupants with various mobility impairments during evacuations at two residential facilities for disabled and older adults (Kuligowski, Peacock, Wiess, et al., 2015). The average speed of evacuees in these buildings was 0.31 m/s, ranging from 0.07 to 0.91 m/s. Those requiring assistance or using a cane moved at speeds between 0.14 and 0.23 m/s, while those without visible disabilities moved faster at an average speed of 0.40 $\pm$ 0.17 m/s. In comparison, the movement speed for able-bodied people evacuating from offices and residential multi-story buildings is 0.45 $\pm$ 0.18 m/s (Kuligowski, Peacock, Reneke, et al., 2015).

A study on movement speeds of elderly residents in retirement homes found that those using one mobility aid moved faster upstairs (0.29 m/s) than downstairs (0.20 m/s), likely due to a fear of falling from a height given their fragile conditions. Measurements for elderly individuals using two mobility aids were limited, as their horizontal travel speed was approximately 0.1 m/s, and they had minimal ability to navigate stairs. Additionally, these individuals could typically travel only 10-15 meters before needing to rest.

Kholshevnikov et al. observed that elderly individuals in wheelchairs can only navigate routes where horizontal paths and entrance ramps have slopes of 8-10%. Even then, due to age-related loss of strength,

Posted on 15 Jul 2024 — CC-BY 4.0 — https://doi.org/10.36227/techrxiv.172107460.02342717/v1 — e-Prints posted on TechRxiv are preliminary reports that are not peer reviewed. They should not b...

the majority of wheelchair bound individuals still required staff assistance to traverse 8-10% sloped ramps (Kholshevnikov et al., 2012).

Individuals with significant loss of mobility rely on long-term care (LTC) staff, other evacuees, attending first responders, including firefighters, or descending devices (e.g. evacuation chairs). Those assisted by firefighters had significantly slower evacuation speeds (0.14 ± 0.05 m/s) compared to others assisted by staff or fellow evacuees (0.23 ± 0.13 m/s) (Kuligowski, Peacock, Wiess, et al., 2015). Kuligowski et al. suggested multiple reasons for this, including congestion with other evacuees, naturally slow pace, or unique circumstances like the setup and handling of assistance devices by firefighters (Kuligowski, Peacock, Wiess, et al., 2015).

The average speed using evacuation chairs in both 6-storey and 13-storey residential facilities was 0.21 ± 0.04 m/s (Kuligowski, Peacock, Wiess, et al., 2015). There was no standardised technique employed by participating fire department companies to operate the evacuation chairs; however, the primary method involved positioning one firefighter in front to guide the chair and another in the back to push it. Kuligowski et al. suggest that this method may be the most efficient for evacuating a building, as it minimises the number of firefighters needed to assist a resident while maintaining a comparable speed to other movement data collected (Kuligowski, Peacock, Wiess, et al., 2015).

A simulation study measured movement speeds of 150 evacuees with varying ratios of elderly to adults in a straight corridor (Ren et al., 2022). The fastest speed recorded was 0.61 m/s when 90% of the pedestrians were adults, while the slowest speed was 0.46 m/s with 100% elderly pedestrians. The evacuation time increased most noticeably when the ratio of elderly increased from 0% to 30%. From 60% to 100%, the evacuation time also showed a significant increase. However, when the elderly ratio ranged from 30% to 60%, the total evacuation time remained relatively stable. This indicates that population heterogeneity increases evacuation time.

Rahouti et al. (Rahouti et al., 2021) investigated the evacuation behaviour of elderly evacuees and caretaking staff during two announced and one unannounced evacuation in retirement facilities. They estimated the local density in corridors and its impact on movement speed and specific flow in one facility, finding a local density range of 0.00 to 0.83 persons/m^2, walking speeds from 0.13 to 1.55 m/s, and specific flow from 0.00 to 0.33 persons/s/m of effective width. Notably, their findings revealed a significant discrepancy between the data in this study and the Society of Fire Protection Engineers (SFPE) design curves for buildings, as the SFPE curves do not explicitly account for adults with mobility impairments.

Huang et al. (Huang et al., 2021) studied how visual acuity affects the walking speed of non-assisted elderly individuals in a smoke-filled building environment. In thin smoke density, their walking speed is nearly the same as in a smoke-free environment, with only a slight reduction. As the extinction coefficient increases by 1 m^{-1} in intermediate smoke density, the walking speed decreases by 0.31 m/s, influenced by their visual acuity and smoke density. In thick smoke density, the walking speed drops to 0.27 m/s. As smoke density increases, the influence of other factors such as height, age, and gender on walking speed diminishes, making visual acuity the dominant factor. This indicates that while occupant demographics significantly impact walking speed in smoke-free environments, they become less relevant in smoke-filled and disturbing conditions where visual acuity plays a leading role. These findings emphasise the importance of considering visual acuity and varying smoke conditions in evacuation planning of elderly individuals.

Computer simulation work by Abd Razak et al. (Abd Razak et al., 2021) compared the maximum evacuation times for elderly and adult evacuees based on the placement of elderly occupants in a multistorey building. Results showed that placing elderly evacuees on lower floors significantly reduced their evacuation times compared to random placement, where they took almost as long as adults. On the other hand, the evacuation times for adults remained nearly the same regardless of whether elderly occupants were placed randomly or on lower floors. This suggests that housing elderly occupants on lower floors can improve their evacuation times without impacting the evacuation efficiency of younger individuals.

Another simulation study by Chen et al. (Chen et al., 2020) reported that the random distribution of elderly residents leads to significant congestion. Specifically, the random placement of elderly individuals requiring

Posted on 15 Jul 2024 — CC-BY 4.0 — https://doi.org/10.36227/techrxiv.172107460.02342717/v1 — e-Prints posted on TechRxiv are preliminary reports that are not peer reviewed. They should not b...

assistance results in prolonged waiting times for those on higher floors. Thus, by categorising elderly residents based on their physical conditions and strategically assigning them to different floors can optimise evacuation efficiency. Elderly individuals with better physical conditions should be placed on higher floors, while those with poorer conditions should be situated on lower floors to minimise overall evacuation time.

The findings from Ren et al. (Ren et al., 2022) highlight several critical aspects of evacuation dynamics in mixed-age groups. The study reveals that where obstacles along the escape route are near the exit, overall evacuation efficiency declines due to increased congestion. Placing obstacles, such as chairs, more than 5 meters from the exit can mitigate these effects. Additionally, a crowd composed entirely of elderly individuals' experiences significantly longer evacuation times and tends to form denser congestion areas in front of obstacles. These insights emphasise the importance of strategic obstacle placement and the need to account for the unique movement characteristics of the elderly in evacuation planning to enhance safety and efficiency for all age groups.

A simulation study assessed evacuation times using both elevators and staircases in a high-rise nursing home (Chen et al., 2020). The research demonstrated that utilising a combination of elevators and stairs is markedly more effective for evacuation than relying on either method alone. Specifically, increasing both the number and speed of elevators significantly reduces evacuation time.

Table 3: Movement speeds

Study	**Scenario**
Folk et al. (Folk et al., 2020)	Occupants evacuating LTCs and retirement homes during nin
Huang et al. (Huang et al., 2021)	Time taken by the elderly to cross the corridor and the lengt
Kholshevnikov et al. (Kholshevnikov et al., 2012)	Experiments conducted in five senior citizen healthcare buildi
Kuligowski et al. (Kuligowski, Peacock, Wiess, et al., 2015)	6-storey building: Flooding in basement making elevators ino
Proulx et al. (Proulx et al., 1995)	Occupants evacuate from three high rise buildings of 12 to 14
Rahouti et al. (Rahouti et al., 2021)	Residents evacuate from apartment building - walking throug

Posted on 15 Jul 2024 — CC-BY 4.0 — https://doi.org/10.36227/techrxiv.172107460.02342717/v1 — e-Prints posted on TechRxiv are preliminary reports that are not peer reviewed. They should not b...

Abbreviations: CAD: Computer-aided design; LTC: Long-term care; NR: not reported; SD: standard deviation; SDe: smoke density; Vis: visibility

Elderly evacuation behaviours

Two studies investigated the pre-movement behaviours of elderly occupants (Folk et al., 2020; Rahouti et al., 2021). Folk et al. (Folk et al., 2020) noted that residents often sought information by standing at their doors before evacuating, waited for other residents (such as couples), finished tasks (like showering), brought belongings (like tea), or hid. Interestingly, some residents who left their rooms independently or with prompting remained in the hallway until guided to safety by staff. This behaviour affects pre-movement time measurements, as elderly people, despite leaving their rooms, may wait for staff to prompt them further. Similarly, Rahouti et al. (Rahouti et al., 2021) observed that many residents who didn't need daily assistance stayed in their apartments until alerted by staff or another resident knocking on their door. Both studies indicate that truly independent behaviour among elderly populations may be difficult to identify and should be considered in evacuation data.

Other behaviours observed included seeking more information to confirm the situation, talking with staff and other residents, standing in corridors, entering another apartment, returning to their apartment to close the door, collecting walking aids before evacuating, and waiting for assistance due to physical limitations such as walking disabilities (Rahouti et al., 2021). Affiliative behaviours were also noted, such as warning or caring for others and evacuating in groups (Rahouti et al., 2021). Some residents were unable to open fire doors and waited for staff assistance, underscoring the crucial role of staff during the evacuation process (Rahouti et al., 2021).

Staff response

The literature highlights several instances of inadequate staff training and a lack of urgency during emergency drills (Folk et al., 2020; Pichler & Gales, 2015; Rahouti et al., 2021). Pichler et al. (Pichler & Gales, 2015) noted that 15 nursing staff responded to the alarm, but most stood near or behind the exit doors, periodically opening them. Each resident room door had a tab indicating whether the room had been checked for occupancy. However, the task of checking the rooms and flipping the tabs was poorly assigned, leading to increased drill times and creating potential life-threatening scenarios. Reopening a room containing a fire due to uncertainty could release more smoke into the facility's halls impacting the ability of the first responder's ability to evacuate.

Rahouti et al. (Rahouti et al., 2021) observed that having multiple staff members in one area of a residential facility created role confusion, causing some to wait in corners or behind doors for further instructions from the fire warden or chief nurse. Folk et al. (Folk et al., 2020) noted that staff frequently sought information from each other during drills. Despite this, Rahouti et al. (Rahouti et al., 2021) reported positive behaviours such as 1) sweeping fire compartments to alert residents, 2) opening apartment doors to check on unresponsive residents, 3) providing evacuation orders, 4) directing residents to safety, and 5) assisting them to reach a secure area. However, only behaviours 3–5 were observed in communal areas with many staff, likely due to the confusion about their roles in the evacuation.

Folk et al. (Folk et al., 2020) highlighted the significant role of the staff-to-resident ratio in ensuring the safe egress of elderly occupants. Their findings indicate that evacuation times are longest when there are fewer staff members and a higher proportion of residents. This suggests that the timing of staff assistance or prompts is crucial for a safe evacuation.

A simulation modelling study demonstrated that having the elderly occupants designated by the staff and prioritised according to their walking status for evacuation was found to have a positive impact on evacuation time (Lim et al., 2023). These occupants evacuate faster than when staff randomly choose who to assist during an evacuation.

Posted on 15 Jul 2024 — CC-BY 4.0 — https://doi.org/10.36227/techrxiv.172107460.02342717/v1 — e-Prints posted on TechRxiv are preliminary reports that are not peer reviewed. They should not b...

A simulation study revealed that placing elderly residents needing assistance on the top floor increased delays and congestion, reducing overall evacuation efficiency (Chen et al., 2020). Random distribution of residents further worsened congestion, particularly for those with poorer physical conditions. When elderly individuals were placed on middle floors, congestion intensified as assisting personnel had to prioritise evacuating upper floors first, causing blockages and extended evacuation times. Conversely, positioning elderly residents requiring assistance on lower floors reduced delays and congestion. This was because the time required for assisting personnel to reach the ground floor was minimised, enabling them to swiftly navigate the stairs and facilitate an orderly and efficient evacuation for more able elderly residents from upper levels.

Studies have indicated that announced drills are not reflective of real emergency scenarios and consequently affect staff response behaviour (Folk et al., 2020; Pichler & Gales, 2015). Folk et al. (Folk et al., 2020) noted that while it was mandatory to evacuate residents willing to participate in the drill, staff either chose not to disturb them or were unaware they needed to evacuate them. Similarly, Pichler et al. (Pichler & Gales, 2015) observed that only three out of 193 residents took part in their drill, all of whom were ambulatory and did not receive any assistance from staff during the evacuation. Other unrealistic behaviours observed included evacuating residents to a single safe zone regardless of their proximity to other safe zones, having more staff participate than would be typical for the time of day, and using staff stand-ins for residents with greater evacuation difficulties, such as those with reduced mobility or uncooperative behaviour (Folk et al., 2020). Although these adjustments were made for convenience during the drill, they do not accurately represent how residents would be evacuated in a real fire. Additionally, fire marshals and drill coordinators were reported to interact with or prompt participating staff members (Folk et al., 2020).

Discussion

Question 1: What are the average evacuation times and movement speeds for elderly individuals, and how do they compare to those of younger people?

This scoping review addressed the first research question by examining literature on average pre-movement times and movement speeds for elderly individuals. Pre-movement time starts when occupants perceive fire cues and ends when they begin evacuating. The limited studies reveal key factors influencing pre-movement times for elderly residents, including physical abilities and the responsiveness of home care staff (Folk, 2020; Kuligowski, 2015; Rahouti, 2021). Findings indicate that residents who do not require assistance have quicker pre-movement times compared to those needing help. Additionally, faster staff response times are consistently associated with shorter pre-movement periods, regardless of the building's structure.

The studies show average movement speeds for mixed elderly populations descending stairs, ranging from 0.31 m/s to 0.56 m/s (Kholshevnikov et al., 2012; Kuligowski, Peacock, Wiess, et al., 2015; Proulx et al., 1995). This compares to 0.96 m/s to 1.13 for younger people (Proulx et al., 1995). Descending speeds from literature in this review are slower than speeds identified in a controlled study measuring stair descent in 18 elderly people where it ranged from 0.46 m/s and 0.80 m/s (Fujiyama & Tyler, 2004). This demonstrates that when evaluating the average speeds of elderly individuals during an evacuation, the specific evacuation environment must be considered.

For elderly needing assistance or using evacuation chairs, the speed reduces to a range of 0.14 to 0.29 m/s (Kholshevnikov et al., 2012; Kuligowski, Peacock, Wiess, et al., 2015). Kuligowski et al. (Kuligowski, Peacock, Wiess, et al., 2015) reported a significantly different mean vertical evacuation speed using evacuation chairs compared to a study that evaluated the performance of evacuation chairs in a 14-floor university hospital using staff volunteers (Adams & Galea, 2011). The reported speeds were 0.21 m/s and 0.81 m/s, respectively. This further illustrates that evacuation speeds can vary based on the population being studied and the specific setting.

Literature demonstrates that assisted movement speeds are significantly slower than those of unassisted individuals. Elderly individuals in wheelchairs face specific challenges, such as navigating ramps with a slope of 8-10%, often requiring staff assistance (Kholshevnikov et al., 2012). Those with significant loss of

Posted on 15 Jul 2024 — CC-BY 4.0 — https://doi.org/10.36227/techrxiv.172107460.02342717/v1 — e-Prints posted on TechRxiv are preliminary reports that are not peer reviewed. They should not b...

mobility rely on firefighters, staff, or other occupants for evacuation, with firefighter-assisted speeds being the slowest (Kuligowski, Peacock, Wiess, et al., 2015).

The current BSI PD7974-6 (British Standard Institution, 2019a) guidance for mobility-impaired individuals cites literature published before 2000, which generally reports much higher travel speeds. Additionally, the referenced literature does not focus on elderly individuals and is derived from studies conducted in hotels, offices, theatres, and residential apartments.

Question 2: Which behavioural and physical factors impact evacuation times in the elderly population?

In addressing the second research question, the findings emphasise the complexity of pre-movement behaviours among elderly occupants during evacuations (Folk et al., 2020; Rahouti et al., 2021). Behaviours such as seeking information, waiting for others, and collecting belongings, as well as the reliance on staff for guidance, significantly affect pre-movement times and overall evacuation efficiency.

Early-stage fire movement is often characterised by investigation rather than immediate escape. As people age, they tend to use more condition-based judgment and consideration to assess the situation before acting. This principle also applies to pre-movement time (Liu et al., 2020). The ability to decide or plan evacuation activities is significantly influenced by the severity of cognitive impairment (Passini et al., 1995). A study on evacuation performance in vulnerable groups, such as the elderly and those with visual, hearing, or cognitive impairments, found that individuals with cognitive or intellectual disabilities took the longest time to make evacuation decisions. However, their response time (movement) was the shortest compared to people with other forms of disability due to their increased mobility (Choi et al., 2020). Work by Sime (Sime, 1991) revealed that two-thirds of the evacuation time in two theatres—from the alarm to exiting—was spent on the 'time to start' phase (from the onset of the alarm to the initiation of movement). Therefore, reaction time is just as crucial as the time it takes to reach an exit.

The observations underscore the difficulty in classifying truly independent behaviour in elderly populations, highlighting the need to account for these behaviours in evacuation planning. Additionally, the critical role of staff in assisting and guiding elderly residents, especially those with physical limitations, is evident. These insights stress the importance of tailored evacuation strategies that consider the unique pre-movement behaviours and dependencies of elderly individuals to ensure their safety and efficient evacuation.

Question 3: What impact does staff behaviour and training have on evacuation times in the elderly population?

Several included studies highlight the crucial role of staff response in reducing risk behaviours that delay evacuation times. Our primary recommendation is to complement traditional emergency alarms with face-to-face guidance from staff to enhance response times. The findings demonstrate the necessity for thorough staff training and clear assignment of emergency roles to ensure efficient and safe evacuations (Folk et al., 2020; Pichler & Gales, 2015; Rahouti et al., 2021).

Simulation studies suggest that prioritising residents based on their mobility status can enhance evacuation outcomes (Chen et al., 2020; Lim et al., 2023). However, the literature reveals significant gaps in staff training and preparedness during emergency drills in residential facilities (Folk et al., 2020; Pichler & Gales, 2015; Rahouti et al., 2021). The observed lack of urgency and role confusion among staff members can lead to inefficiencies and potential life-threatening situations during real emergencies. Also, the discrepancies between announced drills and actual emergency scenarios underscore the need for more realistic training approaches to better equip staff for real crises (Folk et al., 2020; Pichler & Gales, 2015). Ultimately, improving emergency preparedness through comprehensive staff training and realistic drills will enhance the safety and well-being of all occupants.

Similar results could occur in non-residential buildings where staff are not properly prepared or trained to assist elderly occupants. Properly assigning and executing tasks, such as checking rooms for occupancy, is critical to reducing drill times and ensuring safety. Positive behaviours, like providing evacuation orders and assisting residents to safety, highlight the potential for improving staff performance through targeted training.

Posted on 15 Jul 2024 — CC-BY 4.0 — https://doi.org/10.36227/techrxiv.172107460.02342717/v1 — e-Prints posted on TechRxiv are preliminary reports that are not peer reviewed. They should not b...

The staff-to-resident ratio also plays a crucial role in evacuation efficiency, with timely staff assistance being key to a safe evacuation (Folk et al., 2020).

To improve evacuation procedures, it is crucial to simulate more realistic scenarios, ensure all staff understand their responsibilities, and involve residents in ways that reflect real-life emergencies. This strategy will better prepare staff to manage genuine crises, thereby enhancing the safety and well-being of all residents.

Conclusion

This review highlights the necessity of addressing the unique evacuation challenges faced by elderly residents, especially those with mobility impairments. Elderly persons can exhibit behavioural differences and altered responses to those typically expected for the general population groups. The impact of this should be considered when assessing behavioural and response time components of pre-movement times. Performance based designs for buildings where a higher than average elderly population may be expected should factor the reduced vertical and horizontal movement speeds, identified in elderly specific research studies, in place of using the conventional averages found in codes of practice. The research highlights the critical role of staff response and comprehensive training in emergency preparedness. Complementing traditional alarms with face-to-face guidance can enhance response times. Clear emergency role assignments and thorough training are essential for minimising confusion. Improved coordination and role clarity will lead to more effective emergency responses, safeguarding the well-being of all occupants. Ultimately, focusing on realistic simulations and rigorous training will enhance the emergency response capabilities of residential facilities, ensuring the safety and well-being of all residents.

Key Points

- Pre-movement time is influenced by physical abilities and staff responsiveness. Elderly residents who do not require assistance typically have quicker pre-movement times. Faster staff responses lead to shorter pre-movement periods regardless of building structure.
- The movement Speeds for mixed ability elderly populations, horizontal movement speeds range from 0.3 to 0.6 m/s. Elderly individuals descending stairs move at speeds between 0.31 m/s and 0.56 m/s, compared to 0.96 m/s to 1.13 m/s for younger individuals. Those needing assistance or using evacuation chairs have reduced speeds of 0.14 to 0.29 m/s.
- Key behaviours such as seeking information, waiting for others, collecting belongings, and reliance on staff for guidance significantly impact pre-movement times and overall evacuation efficiency.
- Staff play a critical role in assisting and guiding elderly residents, particularly those with physical limitations. Findings highlight the necessity for thorough staff training and clear assignment of emergency roles to ensure efficient and safe evacuations. Effective task assignment, such as checking rooms for occupancy, is critical to reducing drill times and ensuring safety. Positive behaviours like providing evacuation orders and assisting residents to safety demonstrate the potential for improving staff performance through targeted training.
- Staff-to-Resident Ratio is a crucial factor for evacuation efficiency, with timely staff assistance being key to a safe evacuation. Simulation studies suggest that prioritising residents based on mobility can improve evacuation outcomes.
- To enhance evacuation procedures, the literature emphasises the need for realistic scenario simulations, clear staff responsibilities, and active resident involvement to reflect actual emergencies.
- This review presents recent research findings on the evacuation of elderly populations, emphasising the necessity to update guidance accordingly.

Posted on 15 Jul 2024 — CC-BY 4.0 — https://doi.org/10.36227/techrxiv.172107460.02342717/v1 — e-Prints posted on TechRxiv are preliminary reports that are not peer reviewed. They should not b...

References

https://doi.org/https://doi.org/10.1016/j.firesaf.2017.05.004 https://doi.org/https://doi.org/10.1155/2020/5365126 https://cfpa-e.eu/app/uploads/2022/05/CFPA_E_Guideline_No_19_2023-F.pdf https://doi.org/https://doi.org/10.1016/0379-7112(83)90006-1 https://doi.org/https://doi.org/10.1002/fam.2300 https://doi.org/10.1002/fam.2820 https://doi.org/10.1016/j.ssci.2020.105075 https://doi.org/10.1016/j.gaitpost.2007.07.009 https://doi.org/10.1002/fam.2247 https://doi.org/https://doi.org/10.1016/j.ssci.2020.104785 https://journals.lww.com/ijebh/fulltext/2015/09000/conducting_systematic_reviews_of_association.8.aspx https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/ https://doi.org/10.1093/ptj/74.7.637 https://doi.org/10.1136/bmj.n71 https://doi.org/10.1080/01688639508402431 https://doi.org/10.1093/gerona/54.11.m583 https://doi.org/10.1007/s00508-016-1096-4 https://doi.org/10.1093/gerona/glw121 https://doi.org/10.1007/s10694-020-01058-x https://doi.org/https://doi.org/10.1016/j.physa.2022.127833 https://nfcc.org.uk/wp-content/uploads/2023/10/Publication-2_91-Human-Behaviour-in-Fires.pdf Abd Razak, A., Hanapi, N., Ahmad, S., & Ibrahim, N. (2021). Location of elderly evacuees and its effect on evacuation time and distance in multi-storey housing. *Malaysian Construction Research Journal* ,*12* , 90-100. Adams, A. P. M., & Galea, E. R. (2011, 2011//). An Experimental Evaluation of Movement Devices Used to Assist People with Reduced Mobility in High-Rise Building Evacuations. Pedestrian and Evacuation Dynamics, Boston, MA.Boyce, K. (2017). Safe evacuation for all - Fact or Fantasy? Past experiences, current understanding and future challenges. *Fire Safety Journal* , *91* , 28-40. British Standard Institution. (2017). *BS 9999: Fire safety in the design, management and use of buildings - Code of practice* . BSI Standards LimitedBritish Standard Institution. (2019a). *Application of fire safety engineering principles to the design of buildings - Human factors. Life safety strategies. Occupant evacuation, behaviour and condition (Sub-system 6)* . BSI Standards LimitedBritish Standard Institution. (2019b). *BS 7974: Application of fire safety engineering principles to the design of buildings. Code of practice* . BSI Standards Limited Chen, Y., Wang, C., Yap, J. B. H., Li, H., Hu, H. S., Chen, C.-C., & Lai, K.-K. (2020). Fire Evacuation Process Using Both Elevators and Staircases for Aging People: Simulation Case Study on Personnel Distribution in High-Rise Nursing Home. *Discrete Dynamics in Nature and Society* , *2020* (1), 5365126. Choi, M., Lee, S., Hwang, S., Park, M., & Lee, H.-S. (2020). Comparison of Emergency Response Abilities and Evacuation Performance Involving Vulnerable Occupants in Building Fire Situations. *Sustainability* ,*12* (1). Confederation of Fire Protection Associations Europe. (2009). *Fire safety engineering concerning evacuation from buildings* . Guidelines Commission. Cooper, L. Y. (1983). A concept for estimating available safe egress time in fires. *Fire Safety Journal* , *5* (2), 135-144. Fahy, R. (2015). Panel: life safety options for people with disabilities – how far have we come? *Fire and Materials* , *39* (4), 475-485. Folk, L., Gonzales, K., Gales, J., Kinsey, M., Carattin, E., & Young, T. (2020). Emergency egress for the elderly in care home fire situations. *Fire and Materials* ,*44* (4), 585-606. Fujiyama, T., & Tyler, N. (2004). An explicit study on walking speeds of pedestrians on stairs. *Fujiyama, T. and Tyler, N. (2004) An explicit study on walking speeds of pedestrians on stairs. In: 10th International Conference on Mobility and Transport for Elderly and Disabled People, 23-26 May 2004, Hamamatsu, Japan.* Huang, L. D., Luo, K. Z., Xu, J. J., Xu, X. X., & Dong, Z. L. (2021). Experimental study on the elderly's walking speed considering smoke density and visual acuity in buildings. *Safety Science* ,*134* , Article 105075. Kang, H. G., & Dingwell, J. B. (2008). Separating the effects of age and walking speed on gait variability.*Gait Posture* , *27* (4), 572-577. Kholshevnikov, V., Samoshin, D., & Istratov, R. (2012, 19-21 September 2012). The problems of elderly people safe evacuation from senior citizen health care buildings in case of fire. 5th International Symposium "Human Behaviour in Fire", Cambridge, UK.Kuligowski, E., Peacock, R., Reneke, P., Wiess, E., Hagwood, C., Overholt, K., Elkin, R., Averill, J., Ronchi, E., Hoskins, B., & Spearpoint, M. (2015). *Movement on Stairs During Building Evacuations* (NIST Technical Note 1839). Kuligowski, E., Peacock, R., Wiess, E., & Hoskins, B. (2015). Stair evacuation of people with mobility impairments. *Fire and Materials* ,*39* (4), 371-384. Lim, H., Lee, H., & Hwang, J.-H. (2023). Multi-Agent Simulation on Staff Evacuation Behavior in Elderly Nursing Home Fire Emergencies. *Buildings* , *13* (2). Liu, Y., Zhang, Z., & Mao, Z. (2020). Analysis of influencing factors in pre-evacuation time using Interpretive Structural Modeling. *Safety Science* ,*128* , 104785. Moola, S.,

Posted on 15 Jul 2024 — CC-BY 4.0 — https://doi.org/10.36227/techrxiv.172107460.02342717/v1 — e-Prints posted on TechRxiv are preliminary reports that are not peer reviewed. They should not b...

Munn, Z., Sears, K., Sfetcu, R., Currie, M., Lisy, K., Tufanaru, C., Qureshi, R., Mattis, P., & Mu, P. (2015). Conducting systematic reviews of association (etiology): The Joanna Briggs Institute's approach. *JBI Evidence Implementation* ,*13* (3). Office for National Statistics. (2024). *Estimates of the population for the UK, England, Wales, Scotland, and Northern Ireland* . Retrieved 19 April 2024 from Ostrosky, K. M., VanSwearingen, J. M., Burdett, R. G., & Gee, Z. (1994). A comparison of gait characteristics in young and old subjects. *Phys Ther* ,*74* (7), 637-644; discussion 644-636. Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., . . . Moher, D. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews.*BMJ* , *372* , n71. Passini, R., Rainville, C., Marchand, N., & Joanette, Y. (1995). Wayfinding in dementia of the Alzheimer type: Planning abilities. *Journal of Clinical and Experimental Neuropsychology* , *17* (6), 820-832. Pavol, M. J., Owings, T. M., Foley, K. T., & Grabiner, M. D. (1999). Gait characteristics as risk factors for falling from trips induced in older adults. *J Gerontol A Biol Sci Med Sci* , *54* (11), M583-590. Pichler, J., & Gales, J. (2015, September 2015). *Architectural Considerations for Egress in Nursing and Long Term Care Homes* Human Behaviour in Fire: Sixth International Symposium, Cambridge, UK. Pirker, W., & Katzenschlager, R. (2017). Gait disorders in adults and the elderly : A clinical guide.*Wien Klin Wochenschr* , *129* (3-4), 81-95. Proulx, G., Latour, J. C., MacLaurin, J. W., Pineau, J., Hoffman, L. E., & Laroche, C. (1995). *Housing evacuation of mixed abilities occupants in highrise buildings* (Internal Report (National Research Council of Canada. Institute for Research in Construction); no. IRC-IR-706, Issue. Quan, M., Xun, P., Chen, C., Wen, J., Wang, Y., Wang, R., Chen, P., & He, K. (2017). Walking Pace and the Risk of Cognitive Decline and Dementia in Elderly Populations: A Meta-analysis of Prospective Cohort Studies. *J Gerontol A Biol Sci Med Sci* , *72* (2), 266-270. Rahouti, A., Lovreglio, R., Nilsson, D., Kuligowski, E., Jackson, P., & Rothas, F. (2021). Investigating Evacuation Behaviour in Retirement Facilities: Case Studies from New Zealand. *Fire Technology* ,*57* (3), 1015-1039. Ren, X., Hu, Y., Li, H., Zhang, J., Song, W., & Xu, H. (2022). Simulation of building evacuation with different ratios of the elderly considering the influence of obstacle position.*Physica A: Statistical Mechanics and its Applications* ,*604* , 127833. Sime, J. D. (1991). *Human Behaviour in Fires* . London Retrieved from

Biographies

Sarah Daniels: Sarah is a Research Associate working in the Centre for Environmental and Occupational Health at The University of Manchester. Her work focuses on the relationship between the environment and human health, with reference to occupation and other environmental factors. Her main research projects include the impact of algorithmic management on the gig worker health, return to work for people with long covid and the relationship between air pollution and cognitive development in children. In 2019, she completed her PhD in Cardiovascular Sciences at Manchester Metropolitan University. Her research focused on platelet biology and the activatory and inhibitory signalling mechanisms involved in platelet responses in thrombosis and haemostasis. **Gary Daniels:** Senior Associate Director with Jacobs, Gary is a chartered engineer, registered with the Institute of Fire Engineers (IFE), with over 24 years' experience as a fire engineering consultant. Specialising in the built environment, Gary is a committee member of the British Standard Institute committee FSH/14 and involved in development of several British Standards (BS 9991, BS 9994, BS 9996, BS 9792 and BS 7974-2) as well as industry guides (SCA 'Guidance on Smoke Control to Common Escape Routes in Apartment Buildings' and CIBSE Guide E). He is a committee member of the IFE Registrants Group and a former Board Trustee as well as former President and Secretary of the UK Chapter of the SFPE. **Bridie Bailey:** Bridie is a Fire Engineer at Jacobs Engineering Limited UK. Her main role focuses on the write up of fire strategy reports, against applicable codes and standards in order to assess the built environment from a fire safety perspective. In 2017, she completed her MSc in Mechanical Engineering Design at the University of Manchester. Her thesis, 'Finite Element Analysis of the Human Forearm Complex' determined in-vivo mechanics of the human forearm complex, with a focus on Colle's

Posted on 15 Jul 2024 — CC-BY 4.0 — https://doi.org/10.36227/techrxiv.172107460.02342717/v1 — e-Prints posted on TechRxiv are preliminary reports that are not peer reviewed. They should not b...

fracture and the two groups considered most at risk, women of a postmenopausal age and elderly adults, due to possessing a lower than normal bone mineral density. **Rosie Wainwright:** Rosie graduated with her first-class honour's degree in physics with astrophysics in the Summer of 2023. Rosie is now a key member of the Jacobs Fire Safety Engineering team working as a Graduate Fire Safety Engineer. Since graduating, her technical fire safety knowledge has developed rapidly. She currently produces fire strategies and similar deliverables resolving bespoke challenges for projects including the River Thames Barrier, multiple battery energy storage system (BESS) sites and high-rise residential blocks of flats.

Supplementary Materials

Supplementary material 1

Search strategy applied for APA PsycInfo (1806 to October Week 5 2023), Embase (1974 to 2023 November 09), Ovid MEDLINE(R) and Epub Ahead of Print, In-Process, In-Data-Review & Other Non-Indexed Citations, Daily and Versions (1946 to November 09, 2023) 1 (walking speed* or cadence or movement speed* or travel speed*).mp. 2 (evacuat* or stair* or descend* or descent or egress or escap* or exit*).mp. 3 exp elderly/ 4 1 and 2 and 3 5 remove duplicates from 4

Posted on 15 Jul 2024 — CC-BY 4.0 — https://doi.org/10.36227/techrxiv.172107460.02342717/v1 — e-Prints posted on TechRxiv are preliminary reports that are not peer reviewed. They should not b...

Seniors – Prepare Now for an Emergency

Release Date: Apr 9, 2021

When a disaster strikes, the senior population is one of the most vulnerable, especially for those who live alone. There are measures older Americans can take to start preparing for emergencies before they happen. For example, if it is difficult to get around on your own or you need assistance to shelter at home or evacuate, you need to know ahead of time who will help.

Older adults face many more obstacles during an emergency than most people: isolation, limited mobility, medical needs, and distrust. Sometimes, seniors rely on a single relative as their main caregiver. But emergencies can happen at any time, and that usual person may not be there. It is important to have a list of other people you can call on and know how to get hold of them.

Make a List of People Who Can Help

- Create a chain of contacts. Assign who will contact who during an emergency. Enlist family, friends, and neighbors, if necessary, but do not leave it all to one person. If the one person on the list is injured or incapacitated, you may be left stranded. Keep your list of helpers in your emergency kit.
- There are many communication apps available. Choose one or two, then ask the family and friends on your emergency contact list to download these same apps. They can be used to communicate with each other when phone lines or internet service is down.

Be Sure Your Medical Information is Available

If you have a medical condition, you may choose to wear a medical alert bracelet or pendant. This could save your life, especially if you are a diabetic or allergic to specific medications, etc. Any of the medical alert jewelry that is available today could help first responders treat you properly in case you are unable to give or tell them your medical history.

There are Things You Need to Take with You if You Leave Your Home

- Before an emergency arises, write down a list of everything it takes for you to stay healthy. Include your doctor's and pharmacy name and contact information, a list of medications any medical devices and medications. Then let the people on your contact list know where the list will be in case you need it.
- A **kit**. One thing you will need is a kit with all the items you need to survive for a minimum of 72 hours. For a comprehensive list, visit Build A Kit | Ready.gov. The American Red Cross can also help you with information on recommended items.
- **Cash**. The general rule of thumb is to have at least enough cash to pay for 30 days of essential living expenses. The amount depends on how much your critical expenses are. This usually includes a mortgage, electricity bill, phone bill, water bill, gas bill, etc. A better idea is to have your bills on auto-pay - then you may not have to worry about this issue unless there is a widespread power outage in your part of the country. Be sure you have at least some of your cash in small bills and some coins in case you need it for toll booths or for buying groceries and supplies.

Everyone can take steps to prepare for the kinds of emergencies that are the most likely where they live. In Louisiana those include hurricanes, flooding, fires and more. Sometimes the danger is known well ahead of time, and you have time to prepare. Other times, you must react now. When that happens, you need to know who to call for help.

For more information on being ready, see Preparing Makes Sense for Older Americans - YouTube.

For the latest information on Hurricane Laura, visit Louisiana Hurricane Laura (DR-4559-LA). For the latest information on Hurricane Delta, visit Louisiana Hurricane Delta (DR-4570-LA). For more information on Hurricane Zeta, visit Louisiana Hurricane Zeta (DR-4577-LA). For more information on the Winter Storms, visit Louisiana Severe Winter Storms (DR-4590-LA) Or, follow the FEMA Region 6 Twitter account at FEMA Region 6 (@FEMARegion6) / Twitter.

Fire Safety Journal 127 (2022) 103509



Contents lists available at ScienceDirect

Fire Safety Journal

journal homepage: www.elsevier.com/locate/firesaf





Perspectives on egressibility of older people with functional limitations

Erik Smedberg [a,*], Gunilla Carlsson [b], Giedre Gefenaite [b], Björn Slaug [b], Steven M. Schmidt [b], Enrico Ronchi [a]

[a] Division of Fire Safety Engineering, Lund University, Sweden
[b] Department of Health Science, Lund University, Sweden

ARTICLE INFO

Keywords:
Evacuation
Ageing
Disability
Thematic analysis
Qualitative analysis
Functional limitations

ABSTRACT

Older people and people with functional limitations are recognized as vulnerable groups when it comes to evacuation. Previous studies have focused mostly on the quantitative aspects of their physical characteristics, such as movement speeds. This study explores the perspectives on egressibility of older people with functional limitations. This was achieved by reflexive thematic analysis of semi-structured interviews with 28 older people with functional limitations. Participants were recruited based on voluntary participation mainly from senior citizen organizations. Inspired by The International Classification of Functioning, Disability and Health, a questionnaire was developed to characterize the sample in terms of presence of functional limitations. The sample consisted of people with a wide variety of functional limitations. The findings are presented in the form of three themes constructed from the transcripts: *Other people's difficulties in understanding, Strategies to cope with the limitation*, and *Uncertainty of evacuation*. The findings highlight that older people may perceive a lack of reliance on the physical environment and other people's support in evacuation situations. Instead, they considered relying primarily on their own ability to mitigate issues caused by functional limitations. The findings may be used to inform future in-depth studies aimed at achieving an equal evacuation safety for all.

1. Introduction

Many countries today see a rapid increase in the proportion of older citizens in the population, and this trend is anticipated to continue [1]. The ageing process is often connected to a decline in physiological and psychological functions, lowering the functional capacity of individuals [2]. This decline in functional capacity is often referred to as 'functional limitations', defined as restrictions in performing fundamental physical and mental actions used in daily life [2]. Functional limitations have been shown to be a significant risk factor concerning fire safety [3]. Despite this decline in functional capacity, a larger portion of the population is able to enjoy the public environment through recent efforts in research, policy, and technical advances in the area of accessibility to public buildings [4]. In this study, 'public environment' refers to the built, social, and organizational environment made available to the public, whereas 'public building' refers to the public built environment. While providing equal opportunities to access a building, similar provisions should be made for exiting from a building in case of emergency, i.e. providing accessibility during evacuation (as recognized by regulatory authorities, e.g. Refs. [5,6]). The latter can be described using the term egressibility.

Accessibility and egressibility are closely connected concepts, and they share many characteristics. Accessibility can be defined using a three-step definition: the personal component (reflecting functional capacity of the individual), the environmental component (barriers in the environment) and an analysis integrating the two components [7]. The main difference between accessibility and egressibility is the dynamic nature of evacuation, and of utmost importance is efficient and timely actions [8]. Accessibility and egressibility concern not only persons with permanent impairments, but are relevant concepts for others as well, such as individuals with temporary and situational impairments. It is also evident that the needs of people with functional limitations differ depending on the specific type of functional limitation. A person with a visual impairment may benefit from additional auditory emergency information for example, which is of little use for a person who is deaf. In the present study, the definition of accessibility is used as a basis for understanding issues of egressibility.

In the context of fire safety research, the impact of specific functional limitations has been investigated for several purposes. For example, to provide data for modelling studies (e.g. movement speeds) [9], to design

* Corresponding author.
E-mail address: erik.smedberg@brand.lth.se (E. Smedberg).

https://doi.org/10.1016/j.firesaf.2021.103509
Received 24 June 2021; Received in revised form 12 November 2021; Accepted 9 December 2021
Available online 13 December 2021
0379-7112/© 2021 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/).

alarm and notification systems [10,11], and to understand the influence of heterogeneous populations on evacuation [12–14]. Although the main focus of this paper is the fire threat, many of the concepts related to egressibility discussed here are applicable to other types of threats. A recent literature review shed new light on issues/barriers related to egressibility and older people by examining existing evidence on the role of functional limitations in the chain of evacuation activities from alarm detection to exiting the building [15]. As previous research has shown, efforts to increase fire safety for people with functional limitations have been insufficient [16,17]. This can partly be explained through the inability to fully understand and consider the needs and preferences of people with functional limitations while designing fire safety systems. In this paper, we take a step back from the design stage and investigate the perspective of these individuals: how they try to cope with functional limitations and how they consider potential issues in evacuation situations. The purpose is to better understand how the design of fire safety systems challenge or could support the egressibility of older people with functional limitations.

Experiencing a limitation in one or more body functions often means that you compensate with other functions [18]. However, it is hard to predict how this is achieved and how the public environment can be designed to facilitate such coping strategies. For this reason, the thoughts and experiences of people with a variety of functional limitations are important to enable efficient design interventions aimed towards improving evacuation design for all.

Similar efforts have been made in the specific domain of design of refuge areas [16] as well as other means of evacuation [17] considering mobility impaired occupants, and in historical buildings considering a wide variety of functional limitations [19]. These studies have focused primarily on functional limitations and not explicitly on ageing. Old age presents an increase in multimorbidity, and hence a number of functional limitations [20]. As such, functional limitations in old age are often complex and multi-faceted [21]. More than the functional limitation as such, culture and other social factors also influence the experience. For example, in the U.S. it has been found that older people with functional limitations perceive less interpersonal and institutional discrimination than younger equivalents [22]. Social factors include for example the perceived "right" to the public environment and the respect for older people in particular.

The aim of this study was to explore how older people with functional limitations reason about egressibility from public buildings such as movie theatres, concert halls, shopping malls, etc. It was anticipated that most potential participants (and the population in general) had limited experience of real evacuations. In addition, among those that had experienced an evacuation, they may have not done so in their current functional capacity. Therefore, this study focuses on egressibility rather than evacuation, incorporating aspects of accessibility and interactions with the public environment in general, while the analysis sets this in relation to evacuation. It is also argued that egressibility, which is the scope of this study, concerns accessible exit from buildings in general and thereby is not strictly relevant only to evacuation. As a result, we explored the following research questions:

1. How do older people with functional limitations consider egressibility when they are in public buildings?
2. How do the interactions between older people with functional limitations and the public environment cause issues relevant to egressibility, and how do they mitigate those situations?

2. Methods & sample

To best capture the thoughts, perceptions and experiences of older people with functional limitations, a qualitative study was deemed appropriate. Qualitative research focuses on categorizing, structuring and giving meaning to non-numerical data gathered from participants [23]. The perspective of older individuals with functional limitations on egressibility was studied using semi-structured interviews performed remotely. To characterize the sample, a self-assessment questionnaire on functional limitations was developed and used. After an initial contact between the researcher and the participant was established by phone and/or e-mail, the participant received the self-assessment questionnaire and was asked to fill it in. When returned, a time for the interview was booked.

2.1. Sampling procedure

This study was conducted within the scope of a larger project concerning the egressibility issues of the ageing population in Sweden. Participants were recruited through non-probability convenience sampling [24]. Information was sent to organizations, such as senior citizen organizations and interest organizations for people with functional limitations in Sweden, and people interested in participating could ask for more information. There were three inclusion criteria: participants should be older (60+ years old was chosen as criterion considering availability of participants and prevalence of functional limitations. Additionally, 60+ years old is often used to characterize older people for example by the World Health Organization [25]), have one or more self-reported functional limitations, and be able to speak and understand Swedish. People confined to a bed and people experiencing severe cognitive limitations, defined as people who are not able to express their thoughts in an understandable way through oral communication, were excluded from the study. Efforts were made to recruit a sample that was as diverse as possible when it came to functional limitations. The variation in the types of functional limitations in the population was ensured by contacting organizations with different interests (e.g. organizations linked to people with certain functional limitations, e.g., people with visual impairments, etc.) rather than selecting participants within the people who applied. No effort was made to recruit people with previous experience of evacuations. The reason for this was to keep the sample as representative as possible in relation to the research questions posed. The research revolved around thoughts and concerns rather than actual experiences. As the research focused on public buildings and elderly people retired from work, no screening was made for living arrangements and/or work arrangements. The recruitment of participants and the contacting of organizations were performed in parallel to conducting the interviews. The researchers contacted people who had reported interest to participate in the order in which they had done so. It was during this first contact that the researcher determined whether the person met the inclusion or exclusion criteria. As such, participants were included in the study solely based on the time by which they reported their interest, and whether or not they met the criteria specified above. In some instances, participants decided not to participate in an interview after the researcher had registered their interest and checked for eligibility.

The concept of saturation was used to determine the sample size. Although the concept of saturation in qualitative research has been the object of some debates [26,27], the definition of saturation in this study was that new data does not lead to the construction of new themes. In other words, the constructed themes were iteratively compared with the research questions in relation to the scope of the analysis. Once the research questions were satisfactorily addressed, the recruitment of participants was discontinued. This definition was established prior to initiating the interviews to allow for systematic evaluation of saturation. The resulting sample size was 28 participants. Comparing this to a mean of 31 participants from 560 previous studies [28], our sample size seems reasonable for this type of study. Based on these premises, the results obtained in this study are deemed not to have been impeded by the number of participants. Nevertheless, readers should consider this approach when considering generalizability of findings to the population.

2.2. Self-assessment questionnaire

To characterize the sample based on functional limitations, the participants were asked to fill in a study-specific self-assessment questionnaire (see appendix 1), describing their functional limitations. As an overall framework, the International Classification of Functioning, Disability and Health (ICF) [29] was used to describe the functioning, health, and disability of individuals, irrespective of underlying causes or health conditions. ICF is a biopsychosocial model of functioning and disability, integrating the social and medical model of disability. The questionnaire was developed by the authors based on the personal component of the Housing Enabler (HE) instrument [30], thus including impairments as well as some activity limitations in the concept of functional limitations. Since the HE is developed for accessibility applications, the questionnaire used in this study was complemented to better reflect functions relevant to evacuation (e.g. the ability to smell smoke). Some components from the HE were also excluded because of the scope of this study (e.g., components related to cognitive limitations). To achieve content validity, the questionnaire was discussed and reviewed through multiple iterations with intermittent research group meetings. The research group were deemed apt to evaluate the content validity of the self-assessment questionnaire due to the expertise found within the research group. The questionnaire was developed in Swedish, but the categories are presented here in English.

The questionnaire consisted of 22 items, covering a wide variety of functional limitations and the response alternatives were given on a 7-point scale from *no limitation* to *extensive limitation*. The answers were then categorised in four different categories: *None* (0), *Low* (1–2), *Moderate* (2–4), *Severe* (5–6). The 22 items covered 12 categories of functional limitations, presented in Table 1. Certain functional limitations had more than one item to capture their complexity and variation. This was a necessary step in order to better characterize the sample, as some categories could not be captured by a single item. The self-assessment questionnaire is provided in appendix 1.

In cases where the participants had trouble answering certain questions, missed answering a question, or simply were unable to fill in the form due to their functional limitation, the researcher helped them complete the questionnaire prior to the interview. This was performed on an as-needed basis answering any questions the participants had about filling in the questionnaire.

2.3. Participants' characteristics

The age of the participants ranged from 61 to 88 years old (Median = 78). Forty-three percent of the participants identified as men, 54% identified as women, and 4% identified themselves with another gender not specified. All but one participant were retired.

The distribution of categories of functional limitations among the participants is visualised in Fig. 1.

Table 1
Categories of functional limitations covered by the self-assessment questionnaire.

Category	Number of items covering the category
Seeing	3
Hearing	3
Mobility – Head	1
Mobility – Spinal column and/or lower extremities	3
Dependency on mobility aids	2
Dependency on wheelchair	2
Balance	1
Stamina	2
Coordination	1
Mobility – Upper extremities	2
Fine hand use	1
Smell	1

The most frequent functional limitation in the study sample was balance limitations, where 50% (n = 14) of the participants stated that they had moderate to severe difficulties. The least frequent was smell, where only 18% (n = 5) stated that they had moderate to severe difficulties in recognizing the smell of smoke. The number of functional limitations where the participants stated they had moderate to severe limitations is presented in Fig. 2. Sixty-four percent of the participants (n = 18) stated that they had moderate to severe limitations in more than one functional limitation category, and 32% (n = 9) stated that they had moderate to severe limitations in more than three functional limitation categories. It is anticipated that, as a person experiences more than one functional limitation, their interactions with the environment during egress and other activities are made more complex.

Participants were also asked about their dependence on mobility aids. Twenty-one percent (n = 6) of the participants stated that they were dependent (fully or partially) on some mobility aid other than wheelchair indoors (outdoors; 36%, n = 10), and 7% (n = 2) stated that they were dependent (fully or partially) on the use of a wheelchair indoors (outdoors; 11%, n = 3). While 29% of the participants stated that they used some mobility aid indoors (outdoors; 46%, n = 13), slightly more participants stated that they had moderate to severe limitations in lower body or spine column mobility (50%, n = 14). It is possible that the participants in this study chose not to use a mobility aid even though they had limitations, but this was not investigated to a greater extent in this study.

2.4. Semi-structured interviews

The interviews were performed remotely due to the Covid-19 pandemic in 2020. The interviews were conducted in Swedish by phone between May 2020 and October 2020. The first five interviews were conducted jointly with two researchers present representing different disciplinary backgrounds (engineering and health science) to establish a consistent manner of conducting the interviews ensuring important aspects of egressibility and functional limitations were captured. The rest were conducted only by the first author. Interviews were audio recorded with permission from the interviewees and later transcribed verbatim. The interviews lasted between 25 and 90 min. One of the interviews was conducted via email as the participant had a hearing limitation (self-rated as four on the 7-point scale) which made an oral interview inaccessible for him/her.

An interview guide was developed based on a previous literature review [15] and professional expertise of the authors. The guide covered aspects related to egressibility and functional limitations and contained prompting questions to initiate the conversation, followed by probing questions to deepen the content. However, the interview was conversational and organic in nature rather than fixed. The interview guide was designed to encourage reflections on specific subjects, and not to gather quantitative data. In other words, the analysis relies on how the participants argued and formulated their perspectives, rather than if they answered yes or no to specific questions. This method of analysis conducted in this work allows to reflect upon how the participants formulated themselves, and the sole purpose of the questions has been to motivate the participants to reflect on the topic. This is in line with the reflexive approach adopted in this study. The topics under consideration and associated prompting questions in use are presented below (here translated from Swedish to English):

- **The public environment:** About the participants' use and perception of the public environment in everyday life. E.g. *Could you please tell me which places you normally visit during weekdays and weekends?; Are there some places that you visit less often?*
- **The functional limitations:** About the participants' experience and perception of his/her own functional limitation(s). E.g. *Which aspects of your functional limitation affect you the most when you are in a public*

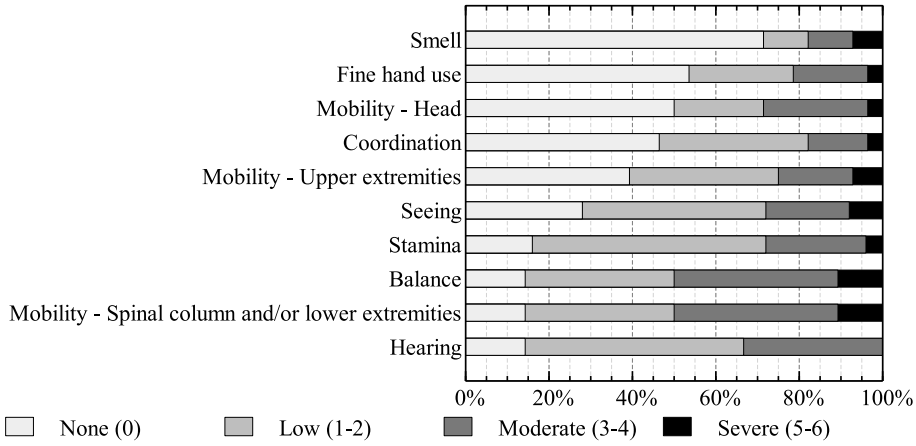


Fig. 1. Frequency of participants with different levels and categories of functional limitations (N = 28).

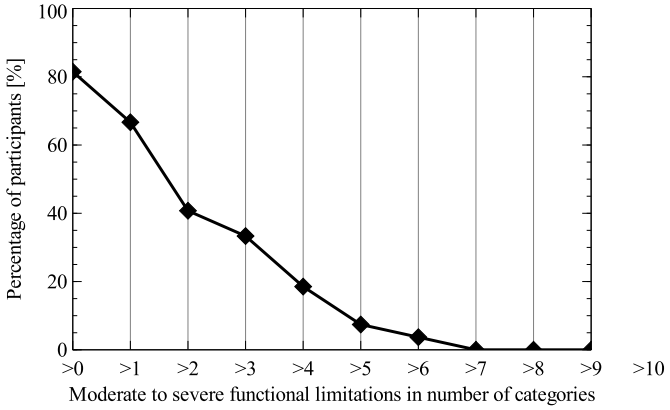


Fig. 2. Number of moderate to severe functional limitations.

environment?; Do you think you have any advantages because of your functional limitation when you are in a public environment or during an eventual evacuation?

- **Evacuation:** The participants' experience, thoughts and concerns about evacuation. E.g. *Have you experienced a real evacuation? If so, please tell me what happened; How do you experience situations that resemble evacuation, such as leaving a concert, lecture, sports event, train station or similar?; Are you in any way worried about being in an evacuation situation?; How would you describe your own ability to evacuate?; Do you use any precautionary measures to compensate for your functional ability?*
- **The built environment:** Specific aspects of the built environment experienced to be of particular help, or to cause problems, in relation to egressibility. E.g. *Are there aspects of the built environment that you think are especially useful for you when it comes to evacuation?; Are there aspects of the built environment that you think are more difficult to interact with when it comes to evacuation?*
- **About others:** The participants' experience, thoughts and concerns about others with regards to evacuation. E.g. *Which group of people with a specific functional limitation do you consider to be the most vulnerable when it comes to evacuation?; Do you think you would receive help from others during an evacuation?*

2.5. Qualitative data-analysis

There are numerous methods available to analyse qualitative data. As there is limited knowledge in the area of egressibility in relation to older people with functional limitations, inductive reflexive thematic analysis [31] was deemed most appropriate in this study, given its exploratory nature and focus on participants' perspectives. Thematic analysis can be described using six phases, and is here used as a structure to describe this study:

1. Familiarizing yourself with the data

After the interviews were completed, the first author listened to them again before proceeding with transcribing them. To facilitate data analysis, the transcribed interviews were imported into the software NVivo 12 [32]. The first author read through the transcripts before starting the analysis. This was performed to become familiar with the data.

2. Generating initial codes

The first author coded the transcripts. Codes are used to label parts of the data in a meaningful way in relation to the aim of the study. A pre-constructed coding book was not used in this study due to the inductive approach. Instead, the coding was a dynamic process. This dynamic process also led to the decision to not include multiple coders, but instead discuss the coding process intermittingly within the research group. The transcripts were coded using the technique of descriptive or semantic coding [31]. Because inter-rater reliability is not compatible with reflexive thematic analysis [33], it was not evaluated as part of this study.

3 Searching for themes

After the transcripts had been coded once, the first author started searching for themes in the data. A theme is described by Braun and Clarke [34] as capturing "something important about the data in relation to the research question, and represents some level of patterned response or meaning within the data set". Codes that were similar or shared a common pattern were constructed into sub-themes. These sub-themes were themselves also constructed into themes at a higher level of abstraction. After conducting nine interviews, a preliminary analysis was undertaken, and sub-themes and themes were formulated. By doing this, the analysis of the forthcoming interviews was conducted more efficiently as this first cycle of coding informed the authors on what seemed to be recurrent and relevant to the research questions. However, the authors were still open for new findings and patterns to be constructed. For further information concerning the process of constructing themes, please refer to Braun and Clarke [34].

4 Reviewing potential themes

This phase consisted of an iterative discussion where all authors

reviewed the primary themes and related sub-themes and codes proposed by the first author. Most of the themes were altered to some extent at this phase. As changes were proposed by the other authors, the first author went back to the transcripts and the codes generated to see if the theme could be reformulated or reworked. This phase deals largely with improving the reliability and validity of the analysis.

5 Defining and naming themes

The naming of themes is essential in thematic analysis. This phase consisted of careful considerations involving all authors. Theme names should be clear, focused and unique. Themes and theme names should convey a patterned meaning or response and should not be merely a summary of everything that was said related to a specific topic.

6 Producing the report

This final phase is writing the actual report. In qualitative analysis such as this, the analysis is largely interconnected with the process of writing up the results. Therefore, this manuscript has been a working document since before the first interview was conducted.

Important for all scientific studies is that the results presented should be trustworthy. Two of the more established criteria for trustworthiness of qualitative research are credibility and transferability [35–37]. Credibility in qualitative research resembles what is known as internal validity in quantitative research, meaning that the findings presented are plausible interpretations of the original data, i.e. the transcripts. Interpretation by just one person may be biased, so to strengthen credibility in this study, the interpretation of the data by the first author, i.e. the codes generated and applied to the data and the themes generated from those, was iteratively discussed and reviewed by all authors until the final coding and theme construction was agreed upon. The plausibility that the resulting codes credibly represent the content of the interviews should be evident to the reader from the presented excerpts in section 3.

Transferability on the other hand resembles what is known as external validity or generalizability in quantitative research. Transferability is facilitated by a "thick description of the participants and the research process" [36]. To support transferability of results of the current study, such descriptions have been presented previously in this section. This description enables the reader to decide if the findings presented here are transferable to other contexts.

2.6. Ethical considerations

This study followed the principles outlined in the Declaration of Helsinki [38], and an ethical approval was given by the Swedish Ethical Review Authority prior to initiating the study (application number 2019–06334). All participants were informed of the purpose of the study and the amount of time required for participation. Informed consent was sent to the participants through regular post, along with the self-assessment questionnaire. Both were completed prior to the semi-structured interview. Participants were assured that their personal information and interview responses would remain confidential, and they could withdraw from the study at any time without giving any explanation. All participants were offered compensation equivalent of 100 SEK (approx. 10 EUR).

3. Results

The participants were asked what public buildings they frequently visit. Examples of answers to those questions are: shopping malls, grocery stores, libraries, gyms, churches, communication centres, etc. This information provides some context to the excerpts provided in this section.

While conducting the interviews, it was noted that the participant often drew parallels to accessibility rather than discussing evacuation. As anticipated, many participants stated that they could not recall that they had ever experienced a real evacuation, and only a few stated that they recalled having taken part in an evacuation drill. Additionally, these experiences were often from a long time ago, when the participants did not experience the functional limitations they experienced at the time of the interview. However, the participants gladly shared their thoughts on related topics, such as accessibility, crowding, availability of information, etc. When asked with specific questions about evacuation, the answer was typically in the form of "I don't know how I/others would behave". This indicates that evacuation is something very unfamiliar to most people, and that it is therefore a hard topic to discuss and relate to own experiences. The results presented here are related to egressibility, but less so to first-hand experiences of evacuation.

The analysis of the interviews resulted in the construction of three themes and thirteen sub-themes, as shown in Table 2.

The following sections aim to visualize and describe the constructed themes presented in Table 2. Note that since some participants decided not to participate in the interview study after being registered by the

Table 2
Themes and sub themes constructed from the perspectives of older people with functional limitations, as well as examples of codes.

Theme	Sub-theme	Code example
Other people's difficulties in understanding	People find it difficult to understand my problems	Others have a hard time knowing how limited I am
		Hard to make people understand that I cannot hear
	People do not know how to help me	Others harm instead of help
		Those who try to help become vulnerable
	Limitations that are more clearly visible are shown more consideration	People show more consideration when they see that I am in a wheelchair
		If people see that I have problems, maybe I'll get help
Strategies to cope with the limitation	Adjusting behaviour	I must look around more due to vision loss
		I try to ensure that I have enough time available to compensate for my limitation
	Avoiding inaccessible environments	I don't visit places with stairs
		I avoid rush-hour
	Using others to compensate for functional limitation	If I can't hear, I can ask
		I ask others when I cannot see what it [e.g. the sign] says
	Using the other senses	I can see instead of hearing
		I use smells to help with orientation
	Accepting my limitation	I have to accept my limitations and take the same route as everyone else
		Sometimes I forget about my limitation
	Pushing through	I can push through if it is needed
		I would use the escalator if I had to
Uncertainty of evacuation	I do not know how I would react or behave in an evacuation	Difficult to know how I would react in an evacuation
		My reaction would be dependent on the situation
	I do not think that I can rely on help from other people in an emergency	Difficult to know if other people would help me
		People only care about themselves in an emergency
	I can rely on help from other people in everyday situations	People are helpful in everyday situations
		People are happy to help
	I do not worry about evacuation	I don't worry about evacuation situations
		I don't avoid environments due to evacuation safety

researcher, one participant is being referred to as participant 31A despite the sample size being 28.

3.1. Other people's difficulties in understanding

Being able to understand struggles faced by individuals with a different ability than oneself might be difficult because of the lack of personal experience and inability to put oneself in someone else's position. Therefore, helping or communicating with someone with different needs than one's own may also be problematic, as explained by one of the participants experiencing a hearing difficulty:

> Participant 5A: Yes, for example that you have problems with the social and … when you meet a lot of people and such and … if I meet more than two or three persons then you are put aside and such when we are discussing. So like that … It's to get people to … to really understand it, what problems you have. So you avoid initiating certain conversations and such.

The fact that people do not understand the struggles one is facing does not only lead to a feeling of exclusion, as highlighted in the above excerpt. It may also lead to issues when someone else is trying to be nice and tries to help. It could be that the good intention from others instead leads to more issues, as explained by one participant sitting in a wheelchair when asked which group of individuals is most vulnerable when it comes to evacuation:

> Participant 7A: The most vulnerable group is others who have to evacuate at the same time and try to show consideration, and then run away, want to run away but in fact run in the way. […] strangers can cause problems, but … I do not know how to … You cannot educate other people to be perfect …
>
> Interviewer If I understand you correctly, do you mean that they have an intention to help but it will be that they are in the way instead?
>
> Participant 7A: Yes, that's what I mean. It has happened on a few occasions, I was going to open a gate, and then there was a man who thought that the gate might not be fully open and ran back and would correct the gate but in fact stood in the way when I arrived. But it was the good will and stuff.

In a similar way, people that do not understand one's limitation or struggles may also be reluctant to help. This was explained by one participant with total loss of sight.

> Participant 10A: Ignorance too. I think that maybe sighted people would need to practice a bit too actually. And, how to help someone who needs help getting out. 'Cause that's what I think, if I grab someone, that someone in a panic can feel, "My God, how can I help her, she can't do anything basically. She is blind". There are some people who react in the same way in other situations. And do not understand that there may be certain things you can say, or in some ways you can help, and then it can work. Even pretty good. It is very important what words you use to give information to someone who does not see. And I notice a huge difference in how people manage to explain if I ask in the city, for example, that, "now I have lost myself, where am I?" There is a huge difference in how people say what they want to say. And some information is straight … Yes, to no use at all or even confusing. While other may consider more what they need to say.
>
> Interviewer: It is probably situation-dependent as well, but can you give an example of good or bad communication then that you can get when you ask for help or so?
>
> Participant 10A: Yes, a very … It is if someone says that "it's over there".
>
> Interviewer: Yeah, it is a common reflex many people have maybe, just to say that.
>
> Participant 10A: Yes, and point or so. Or "to the right". That is also difficult when you don't see anything. And it is of course impossible for another human being to understand how much or how little a visually impaired person sees. And if he or she sees at all …

It was often reported by the participants that they perceived others to be helpful and kind, but a pattern emerged depending on the visibility of the limitation. Some limitations are clearly visible to others, such as the use of mobility aid, while others are more hidden, such as hearing or balance difficulties. This was explained most vividly by a participant who had progressed from using no mobility aid, to using a cane, and later also a mobility scooter:

> Participant 7A: But, two examples. When I started walking with a cane, I noticed that it was much easier to get out into the traffic, cars and cyclists [showed] a consideration I had never received before. When I started riding a scooter it was the same step with greater consideration.

Of course, being old (or looking old) also led to more consideration from others, as explained by the following participant experiencing a non-visible limitation in shoulder movement:

> Interviewer: I wonder … how do you think yourself … when you go up a flight of stairs; do you think that others see that you need to use the handrail?
>
> Participant 9A: No, not always. I am quite light and free in the body and so that … it is not visible because it is a shoulder so … I am quite unobstructed in the legs even though I am not as strong as when I was younger so. I do not think it is visible, but they see that I'm a little older. So that's probably what makes them move away easily.

In many evacuation situations, one is more or less dependent on the help from others, irrespective of functional ability. The awareness by others that someone needs help, and that they also have the skills or ability to provide the appropriate help, is therefore of importance.

3.2. Strategies to cope with the limitation

Experiencing a limitation means that it is part of everyday life, and that one needs to cope with it somehow. Understanding the different coping strategies used is necessary in order to make sense of and predict their actions in emergencies. The participants mentioned a variety of ways in which they try to cope with their limitation. For example, behavioural changes were often mentioned as one type of strategy, as can be seen in the following excerpt:

> Interviewer: Do you think that you think more about how you could get out of a building, compared to a person who has no functional limitations?
>
> Participant 12A: Oh yes, I think so. Both to get in and out, I'm probably much more observant. I notice that among my friends. Most of my friends are walking and are mobile, so when I say, "what does it look like for me?", "Yes we did not think of that", they say. They do not, because they do not have to.

Here, the participant highlighted that there is a lot more planning required for her because some environments are inaccessible for her. This uncertainty could also lead to a reluctance to try to access unfamiliar environments.

> Participant 12A: […] I do not travel as much at all, and I hardly go to Denmark anymore. So … no I think I limit … I no longer expose myself in the same way. I am much more at home and move around in the local environment and so on. And that's probably because I do

not want to expose myself simply. I cannot take it. It's probably more than I can bear.

Relating to evacuation, one does not expect to be asked to evacuate when visiting a public building, and it is not possible to avoid such a situation if it were to occur. This means that this strategy has limited applicability to evacuation, and a person may be forced to do something is not comfortable with. This is one of the main differences between accessibility and egressibility. If encountered with an accessibility issue, a person may, in some cases, decide not to participate. This is not always a viable option when it comes to evacuation. Instead, people are forced to use other strategies to cope. One such strategy is by using the other senses, as expressed by this participant experiencing a loss of hearing:

Interviewer: Would you say that there are environments that you avoid because of that you would feel worried about your own safety if it were to be … or connected to evacuation?

Participant 6A: uh … hard to say. I have my vision, so if there was an evacuation, I would see what everyone else did. Then I would do the same thing I guess, even if you did not hear that they sounded the alarm for example.

For evacuation design, it is important to acknowledge these kinds of strategies in order to facilitate them. These strategies were mostly mentioned in relation to seeing and hearing but could of course be relevant for other functional limitations as well. As can be seen in the excerpt, an alternative stimulus could be the actions of others. In cases where this is impossible, another visual stimulus, such as light beacons, could be used. In some instances, participants stated that they simply had to accept their own limitation by ignoring it.

Interviewer: Can you come up with a situation where you think you would need help?

Participant 9A: Yes, it can be to open doors. It can be going down stairs. Yes … I try to think of the places where I usually am … I often feel that it is very nice if most people go out, so I can get out at my own pace. But it does not always work that you can adapt. You have to follow the flow. I don't really know …

This sense that one cannot always adapt the situation to one's own needs could also lead to other coping strategies being required. In some instances, a person may be forced to go beyond his/her own ability. This was acknowledged by some participants, and some also stated that they had a potential to "push through" in such situations. This means that they perceived themselves to have an increased capability in case of emergency.

Participant 19A: […] and should it be in a situation where you have to rush out and cannot bring the crutches with you, you must try to cope with that bit also, if it is not too far. It's kind of like imagining a candle, before it goes out it burns up properly and lights up before it goes out. And it is the same, if you were in such a situation, you would have to take all your strength to cope, if it becomes such a serious situation. And I think that … In general, humans can do much much more than they think they can.

This ability to push through could be seen as some sort of last resort when everything else fails. It is nevertheless interesting to note that some participants, including participant 19A in the excerpt above, would be comfortable in doing so. There is however a risk that this strategy is relied upon too heavily, and that the decline in functional capacity would not be considered carefully enough. This could mean that people, unconsciously, put themselves in situations which they cannot handle.

3.3. Uncertainty of evacuation

Evacuation is an issue people in general do not deal with on a regular basis, and most participants stated that they had never experienced a real evacuation. This lack of experience means that there is a lot of uncertainty surrounding evacuation situations. One issue is the uncertainty in one's own behaviour as explained by a participant with multiple moderate functional limitations:

Interviewer: Would you say that you are in any way worried about how you could affect other people in an evacuation situation? I then think of situations where there are a lot of people and so on.[…]

14A: I do not think I can answer that question because how I behave in such an extreme situation, depends on like my … yes, my attitude and so on … If there are a lot of people who are young around me, it may not be necessary for me to intervene. Should there be someone sitting in a wheelchair or whatever, I can hope I would help.

It is difficult to know why this participant did not think about having full control over her own actions in an evacuation situation. It is clear that her wish is to be of help, but that she is uncertain about her actions. It should also be noted that she had no clear explanation of what her actions would depend upon, but that it may have something to do with her attitude. This kind of uncertainty was not only found in discussions about one's own behaviour, but also regarding the actions of others in such situations.

Interviewer: […] I also thought in connection to evacuation situation and the like, and other people then. Do you think you would get help from other people in an evacuation situation if you needed it?

Participant 31A: [sighs] It's probably not so much up to me actually as the people around me, what their attitude is maybe. How … how much you interpret so to speak "here it is a matter of saving yourself" huh. So that … but in a … so … in general, I probably think that people are quite accommodating and so. And helpful with most things. But, I think like you have … I have … if we ignore the medical conditions themselves and things like that, so just that you have become a little older, there are quite a few who give space for you at the bus, and then in the beginning you almost got pissed and thought "I'm not that old" [laughs]. Now I accept it with joy, so it's all right. But … No, I mean … I actually still experience most of the people around me as friendly and helpful. And if they can maintain that kindness and helpfulness in a stressful situation, I cannot answer that.

In this excerpt, the participant explicitly mentions that people are considerate and helpful in other situations, but it is uncertain if that would be the case in an evacuation. However, this pattern was not found among all participants. Some participants stated that they thought others would help in emergencies, but the uncertainty was still there. Interestingly, most participants perceived others to be helpful in everyday situations, even though the opinions differed when it came to emergencies. This excerpt is from another participant where the discussion was about help in everyday situations.

Interviewer: How do you think people in general are when it comes to showing consideration?

Participant 12A: Well, I think people are good at that. I think most people do. But there I think the situation can change quickly if there is … yes fire or evacuation and so on. But in ordinary everyday life, people show consideration, I think.

The participant makes a clear distinction between the actions of others in normal everyday situations, and those anticipated in an emergency. The element of uncertainty is also present in this excerpt. As exemplified in the excerpts, uncertainty about evacuation is common.

However, this uncertainty seems not to be dealt with by the participants. Most participants stated that they did not worry about evacuation.

> Interviewer: yes or if you think that other people may not think as much about how to get out, or how they can get out, compared to how much you think about it?
>
> Participant 10A: I have not thought about it too much, so I think it … It's probably the same as for many others I think. It may have more to do with attitude. If you are anxious or if you … I think if I would have been in an evacuation situation like this before, then of course I would have considered, or found out more, I think. Made myself more aware.

As can be seen in the excerpt, for the participants, worrying seems to be related more to individual attitudes and experience, and not so much related to being vulnerable or experiencing functional limitations. This was reported by numerous participants, i.e., being not the worrying kind, they would not worry about evacuation either. This should be read in context with that many participants, albeit not all, reported that they saw themselves as more vulnerable when it came to evacuation.

4. Discussion

The aim of this study was to explore the perspectives on egressibility of older people experiencing a wide variety of functional limitations. The aim was achieved using the qualitative analysis method of inductive reflexive thematic analysis on a set of 28 transcripts of semi-structured interviews, resulting in three themes: *Other people's difficulties in understanding, Strategies to cope with the limitation*, and *Uncertainty of evacuation*. The use of a qualitative approach - compared to quantitative approaches investigating physiological characteristics such as walking speed etc. [9] - allows for a nuanced and complex understanding of the perspectives and concerns related to egressibility of older people with functional limitations. The results highlight aspects such as perceived risk and vulnerability, coping strategies, uncertainties about evacuation, etc. which may benefit from more in-depth studies. Main findings are that the themes and sub-themes largely reflect uncertainties or a lack of reliance on the physical environment and other people to be supportive in evacuation situations. To mitigate evacuation situations the participants were instead mostly considering changing their own behaviour, using other senses to compensate for functional limitations or avoiding visiting buildings where issues may occur. It should be noted that these findings are based on the responses of the participants in this study and hence do not present a comprehensive view on the issue of egressibility, but rather the views of a relevant group (a sample of 60+ years old people with functional limitations from Sweden). Furthermore, we argue that measuring the physiological abilities of people with functional limitations is not sufficient to guide the community in increasing the fire safety for this increasing portion of the population. Therefore, the research presented here provides valuable guidance in doing so.

4.1. Other people's difficulties in understanding

The theme *Other people's difficulties in understanding* covers aspects such as issues in making others understand the limitation and henceforth barriers. Communication and feelings of exclusion are central in this theme. It was noted that visible limitations (such as the use of mobility aid) were perceived given more considerations from others, and that issues occurred when others tried to help but not knowing how. This link between the visibility of the limitation and level of consideration can be linked to the representativeness heuristic [39]. We use this heuristic to infer how likely it is that something or someone is part of a "class", in this case people with disabilities. If people see someone using a mobility aid or similar, according to the heuristic, they are more likely to see this person as disabled since they more closely represent our "mental model" of a disabled person. This might then lead to showing more consideration to this person and highlights that society's attitudes and overall understanding of disability has importance also for evacuation.

This theme relates largely to the experience of others in interacting with people with functional limitations. The theme highlights that the perspectives of the participants in this study were that experiences in helping people with functional limitations are to a large part lacking. This issue has been investigated only in certain specific contexts (e.g. Refs. [40,41]) and deserves further research. This may in turn affect an evacuation situation. The lack of experience of others and how it causes worry for people with functional limitations regarding evacuation has been highlighted in a previous study investigating the use of emergency stair travel devices [17]. In their study, the participants expressed concerns about having to leave their mobility aid behind, risk of physical injury, and the need for assistance and training, which corresponds well with the findings from this study. It should be noted that this theme reflects the perspectives of the participants in this study and hence, the perspectives from the "others" mentioned in the theme name may be different. Therefore, the issues brought forward by this theme needs to be highlighted from other perspectives as well to comprehensively address this aspect.

4.2. Strategies to cope with the limitation

The second theme identified in the analysis was *strategies to cope with the limitation*. The sub-themes consist of different strategies deployed, such as changes in behaviour, getting help from others, using other senses to compensate for their functional limitations, pushing through, etc. Considering the interactions with the built environment as a person-environment fit, these strategies mainly address the personal component, i.e. enhancing the ability to overcome barriers. Recognizing these different strategies allows for enhancing egressibility for older people by facilitating their adoption. For example, recognizing that people tend to make use of other unimpaired senses highlights the importance of offering different kinds of stimuli to become aware of a potentially dangerous situation, such as complementing auditory alarms with visual alarms.

One suggestion brought up by the participants was the use of directional sound for the visually impaired to aid orientation. This issue has been investigated before in the fire safety domain mainly with the scope of studying human behaviour in smoke-filled conditions [42,43]. The studies concerning the use of directional sounds showed a reduction in evacuation times even in perfect visibility and without the presence of visual impairments. Even the use of conventional loudspeakers has been shown to have some effect on improving orientation in a smoke-filled environment [44]. In the same experiment, the evacuating occupants also preferred to sense their way forward by keeping a hand on the wall in order to get better orientation when the smoke blocked visual information. Hence, it is deemed that auditory systems for wayfinding could be of value for the visually impaired, and others alike. This also underscores that designing for the permanently impaired is not only beneficial for the aforementioned, but that during an evacuation situation, we may all become impaired due to situational circumstances (such as smoke) and might benefit from such design considerations. Similarly, solutions could be adopted for people with other kinds of functional limitations (e.g. alternative fire alarms for people with hearing impairments [45]).

The strategy to use other senses was most evident when it came to seeing and hearing, but some participants also mentioned that they may ask for help (i.e. using speech) if they were not able to negotiate the environment due to physical constraints. Participants who were blind reported that they used both memory, smell and sound to orient themselves in both familiar and unfamiliar environments. It should be noted that some of these strategies, i.e. accepting the limitation and pushing through, might lead to adverse outcomes when it comes to evacuation. Participants stating that they would have the ability to push through did so while recognizing that it may lead to increased discomfort. This

relates to a common bias when it comes to decision-making under uncertainty, namely *Illusion of control* [46,47] stating that people tend to think that they can influence or control situations out of their control. In other words, this sub-theme should not be seen as a support for a systematic "pushing through" approach to address the needs of people with functional limitations. The effect of "pushing through" is indeed difficult to quantify and unreliable.

4.3. Uncertainty of evacuation

As anticipated, evacuation had not been experienced to a large extent in the study sample. This is also reflected in the theme *Uncertainty of evacuation*. This theme incorporates uncertainties in the behaviour of others, as well as one's own behaviour. It also incorporates how participants stated that they generally did not worry about evacuation. It is not concluded whether or not "not worrying" about evacuation is connected to experiencing functional limitations, or if it is a general issue. Indeed, evacuations from public buildings are rare events and the experience of such events is therefore limited in the general population. When asked if they worried about evacuation, most participants stated that they did not, and that they were not the kind of person who was worried, indicating that worrying about evacuation was seen as something more connected to the proneness of worrying in general. This theme is closely connected to risk perception. A previous study conducted in the residential setting showed that risk perception was low among the older participants, and that they felt confident in their ability to act in such a situation [48]. Similar findings emerged in this study related to the themes *Strategies to cope with the limitation* and *Uncertainty of evacuation*.

It should be noted that some participants stated that they perceived that the risk of experiencing adverse effects in an emergency was higher for them than for others not experiencing functional limitations, indicating a higher perceived vulnerability [49]. This together with the fact that participants stated that they generally did not worry about evacuation, indicates that anchoring bias (that people tend to rely too much on previous experiences) [46] has some influence. It has been shown in previous investigations that experience and preparedness is a success factor when it comes to evacuation [49,50]. Whether or not they would receive help in emergencies was illustrated with many uncertainties. Many participants stated that they perceived others to be helpful in everyday life, but they were uncertain if that would be the case in an emergency. This was frequently attributed to the concept of panic, and a belief that people who panic do not think of anyone other than themselves and exhibit some kind of anti-social behaviour. It should be noted that the need to investigate such complicated and rare phenomena is of limited scientific interest, since even large groups of people usually move in a quite orderly and cooperative manner [51] (and buildings are generally designed to avoid extremely congested scenarios).

As previous research has shown [52,53], panic is a concept surrounded by a lot of misconceptions, and these misconceptions were found in this data set as well. The idea that people in such situations exhibit anti-social behaviour is one such misconception [54,55]. The participants frequently stated that they would help others in an emergency if they could. Some participants stated that this was because they had a greater understanding of the different functional limitations people might experience, and they therefore knew that they might be vulnerable.

It is interesting to note that much of the discussions regarding evacuation revolved around the actions of others. This is also why it is a large part of the results from this interview study. It reflects the fact that the participants in this study perceived evacuation very much as a social and collective phenomenon that is dependent on the actions of others. If this view on evacuation is specific for people with functional limitations cannot be concluded as the study sample was homogenous in this sense.

4.4. Limitations of the study

In this study, most participants had not experienced a real evacuation. Of those who had, even fewer had done so in their current functional capacity. In one way, this is a disadvantage, as they did not have first-hand experience. On the other hand, it likely means that our participants more closely resemble the general population of older people of not having experienced a real evacuation. However, this lack of experience was anticipated (as described in section 1) and the study was therefore designed to not rely on the participants' first-hand experience, i.e. the scope of this study was on egressibility (which is closely connected to accessibility) and not on evacuation or fire safety experiences per se for this group of people.

To characterize the sample in terms of their functional limitations, a self-assessment questionnaire was used. To ensure the questionnaire validly captures perceived functional limitations, it was developed through an extensive process of multiple iterations by all the co-authors. The responses to the questionnaire provided a nuanced picture of the functional limitations experienced by the individuals and demonstrated that a diversity of functional limitations was represented in the participants. It should be noted though, we have not tested the reliability of the self-assessment questionnaire, and a test-retest study would be recommended to support further use. It should be noted though that the self-assessment questionnaire is largely based on both the International Classification of Functioning, Disability and Health [29], as well as the Housing Enabler [30]. Those are widely used and established methods in their respective field and have been used to develop the questionnaire used in this study. While its further testing and analysis would be beneficial, this questionnaire still represents an accurate method for self-reporting functional limitations. A potential direction for future research is the systematic development and testing of a self-assessment questionnaire of functional limitations specific to the context of egress and egressibility. This could include the identification of more specific anchor points in the questionnaire that relate to the activities required during egress.

During the interviews, many of the participants were reluctant to admit that the activity limitations and participant restrictions they experienced were connected to their functional limitations as such. In contrast, they saw their activity limitations and participant restrictions as something to be expected when you reached a certain age. How to best address this issue should be investigated in future studies.

An effort was made to recruit a diverse sample in terms of functional limitations. However, due to the qualitative nature of the current study it is not possible to compare the prevalence of the functional limitations in our sample to that found in other older population-based studies or population statistics. The way in which functional limitations are defined may differ across studies, depending on the ways of assessment (e.g. self-report versus professional assessment) as well as measurement instruments (i.e., types of questions or questionnaires) used. Nevertheless, functional limitations related to hearing were frequent in our sample, and are frequent in the Swedish population as a whole [56]. Based on Statistics Sweden [56], it is also indicated that visual impairments, mobility impairments and multiple functional limitations were more frequent in our sample than in the Swedish population of older adults.

The participants included in this study lived in Sweden. Previous research has suggested that culture affects the evacuation behaviour of people [57]. Therefore, a further generalization of the findings would require performing the study with a wide variety of populations from different cultures. One key aspect of culture that is thought to have a large influence is the view of older people and people with disability in the society [58]. One of the findings was that others tended to respect the needs of people that could easily be identified as vulnerable. In a society where there is more or less respect for the vulnerable, the findings may therefore have been different. Future research in the area of egressibility relating to older citizens should investigate the role of

cultural and social factors. Considering the definition adopted for egressibility [7], it becomes evident that the built environment influences egressibility to a large extent. It is therefore important to note that the findings from this kind of study may be different if it is conducted in a setting with the built environment being generally different. This includes for example a significantly higher proportion of high-rise buildings, the provision of refuge areas, the design of wayfinding systems, etc.

4.5. Implications of the study

This exploratory study aimed to highlight the perspectives of the participants with various functional limitations in relation to egressibility. The context of the discussions were wide, involving different environments and actions related to evacuation. This is in contrast to previous qualitative studies in the area, looking specifically at participants' perspectives on evacuation methods for mobility impaired [16,17] or investigating evacuation issues in the specific context of historical buildings [19]. Compared to studies of historical buildings [19], the participants in the current study did not emphasize the importance of organizational aspects to a large extent. This may stem from the fact that public environments are different, and that in some, organization plays a bigger role in evacuation safety. Another possible explanation is that in the present study the participants did not emphasize their experience with fire drills or real fire scenarios. Future studies should investigate the relationship between experience with evacuation and perceived impact of staff.

The results from this paper should be seen as informative for identifying a set of key issues that may benefit from more in-depth studies. One indication is that the participants generally had limited experience of evacuation, and that they therefore had issues imagining such a situation. However, the participants are familiar with issues of accessibility encountered in everyday life and could easily draw parallels to other situations. Utilizing another method for data collection, such as ethnographic go-alongs [59] where the participants are provided a fictitious evacuation scenario, may help in addressing these issues. Similarly, quantitative experiments (e.g. through the use of virtual reality [60]) investigating the relation between degree of visibility of functional limitation versus proneness of others to help might conclude more general statements related to this.

5. Conclusions

A set of 28 semi-structured interviews with a population of older adults with a wide variation of functional limitations allowed the identification of three key themes concerning participants' perspectives on egressibility: *Other people's difficulties in understanding, Strategies to cope with the limitation*, and *Uncertainty of evacuation*. These themes together highlight the perspective of people with functional limitations concerning egressibility and related aspects of accessibility. The qualitative approach used in this study was fruitful, as it proved to be a useful complement to quantitative studies given its wider perspective. Furthermore, a self-assessment questionnaire was designed to capture a range and severity of different functional limitations. This instrument proved to be useful to characterize the population in this type of study. The findings from the present study highlight the perceived uncertainties and lack of reliance on the physical environment and others to be supportive in evacuation situations that older people may feel, instead perceiving to be reliant on their own ability to mitigate issues caused by functional limitations. These findings could be used as a starting point for studies delving deeper into the specific needs of older people with functional limitations with regard to evacuation situations. By incorporating the qualitative aspects of egressibility, design interventions aimed at equal evacuation safety for all are deemed to be more effective.

Author statement

Erik Smedberg: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Data curation, Writing – Original Draft, Writing – Review & Editing, Visualization, Gunilla Carlsson: Conceptualization, Methodology, Validation, Investigation, Writing – Review & Editing, Giedre Gefenaite: Conceptualization, Methodology, Validation, Writing – Review & Editing, Björn Slaug: Conceptualization, Methodology, Validation, Writing – Review & Editing, Steven M. Schmidt: Conceptualization, Methodology, Validation, Writing – Review & Editing, Enrico Ronchi: Conceptualization, Methodology, Validation, Writing – Review & Editing, Supervision, Project administration, Funding acquisition.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

The authors would like to thank the participants of this study for sharing their unique and most important perspectives on egressibility and related aspects. Funding was provided by Svenska Forskningsrådet Formas (Grant 2018–00575). This study was conducted within the context of the Centre for Ageing and Supportive Environments (CASE) at Lund University.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.firesaf.2021.103509.

References

[1] United Nations, Department of Economic, Social Affairs, Population Division, World Population Ageing 2019, ST/ESA/SER.A/444, New York, 2020.
[2] L.M. Verbrugge, A.M. Jette, The disablement process, Soc. Sci. Med. 38 (1) (1994) 1–14.
[3] M. Ahrens, Physical Disability as a Factor in Home Fire Deaths, " National Fire Protection Association, 2014.
[4] M. Vaughan, M.P. LaValley, R. AlHeresh, J.J. Keysor, Which features of the environment impact community participation of older adults? A systematic review and meta-analysis, J. Aging Health 28 (6) (2016) 957–978, https://doi.org/10.1177/0898264315614008. Sep.
[5] Boverket, Frångänglighet, 2020. *https://www.boverket.se/sv/PBL-kunskapsbanken/regler-om-byggande/boverkets-byggregler/brandskydd/franganglighet/*.
[6] National Fire Protection Association, NFPA 101, Life Safety Code, 2018.
[7] S. Iwarsson, A. Ståhl, Accessibility, usability and universal design—positioning and definition of concepts describing person-environment relationships, Disabil. Rehabil. 25 (2) (2003) 57–66, https://doi.org/10.1080/dre.25.2.57.66. Jan.
[8] G. Proulx, Movement of People: the Evacuation Timing," in *SFPE Handbook of Fire Protection Engineering*, third ed., National Fire Protection Association, Quincy, MA (USA), 2002, pp. 3–341, 3-366 (Chapter 3–13).
[9] P. Geoerg, F. Berchtold, S. Gwynne, K. Boyce, S. Holl, A. Hofmann, Engineering egress data considering pedestrians with reduced mobility, fam, Fire Mater. 2736 (2019), https://doi.org/10.1002/fam.2736. Aug.
[10] S.M.V. Gwynne, D.L. Boswell, G. Proulx, Understanding the effectiveness of notification technologies in assisting vulnerable populations, J. Fire Protect. Eng. 19 (1) (2009) 31–49, https://doi.org/10.1177/1042391508095094. Feb.
[11] M.A. Hersh, M.A. Johnson (Eds.), "Alarm and Alerting Systems for Hearing-Impaired and Deaf People," in *Assistive Technology For the Hearing-Impaired, Deaf and Deafblind*, Springer-Verlag, London, 2003, pp. 215–255, https://doi.org/10.1007/1-85233-855-5_7.
[12] P. Geoerg, J. Schumann, M. Boltes, S. Holl, A. Hofmann, in: The Influence of Physical and Mental Constraints to a Stream of People through a Bottleneck," Presented at the 9th International Conference on Pedestrian and Evacuation Dynamics, Lund, Sweden, 2018.
[13] P. Geoerg, J. Schumann, S. Holl, M. Boltes, A. Hofmann, The influence of individual impairments in crowd dynamics, fam, Fire Mater. 2789 (2020), https://doi.org/10.1002/fam.2789. Feb.
[14] M. Spearpoint, H.A. MacLennan, The effect of an ageing and less fit population on the ability of people to egress buildings, Saf. Sci. 50 (8) (2012) 1675–1684, https://doi.org/10.1016/j.ssci.2011.12.019. Oct.

[15] O. Bukvic, G. Carlsson, G. Gefenaite, B. Slaug, S.M. Schmidt, E. Ronchi, A Review on the Role of Functional Limitations on Evacuation Performance Using the International Classification of Functioning, Disability and Health, Sep, *Fire Technol*, 2020, https://doi.org/10.1007/s10694-020-01034-5.

[16] N.C. McConnell, K.E. Boyce, Refuge areas and vertical evacuation of multistorey buildings: the end users' perspectives: refuge areas and vertical evacuation OF multistorey buildings, Fire Mater. 39 (4) (2015) 396–406, https://doi.org/10.1002/fam.2205. Jun.

[17] K. Butler, E. Kuligowski, S. Furman, R. Peacock, Perspectives of occupants with mobility impairments on evacuation methods for use during fire emergencies, Fire Saf. J. 91 (2017) 955–963, https://doi.org/10.1016/j.firesaf.2017.04.025. Jul.

[18] L.-O. Persson, A. Rydén, Themes of effective coping in physical disability: an interview study of 26 persons who have learnt to live with their disability, Scand. J. Caring Sci. 20 (3) (2006) 355–363, https://doi.org/10.1111/j.1471-6712.2006.00418.x.

[19] L. Kecklund, K. Andrée, S. Bengtson, S. Willander, E. Siré, How do people with disabilities consider fire safety and evacuation possibilities in historical buildings?—a Swedish case study, Fire Technol. 48 (1) (2012) 27–41, https://doi.org/10.1007/s10694-010-0199-0. Jan.

[20] K. Jindai, Multimorbidity and functional limitations among adults 65 or older, NHANES 2005–2012, Prev. Chronic Dis. 13 (2016), https://doi.org/10.5888/pcd13.160174.

[21] B. Slaug, O. Schilling, S. Iwarsson, G. Carlsson, Defining profiles of functional limitations in groups of older persons: how and why? J. Aging Health 23 (3) (2011) 578–604, https://doi.org/10.1177/0898264310390681. Apr.

[22] E.H. Namkung, D. Carr, Perceived interpersonal and institutional discrimination among persons with disability in the U.S.: do patterns differ by age? Soc. Sci. Med. 239 (2019) 112521, https://doi.org/10.1016/j.socscimed.2019.112521. Oct.

[23] U. Flick, The SAGE Handbook of Qualitative Data Analysis. 1 Oliver's Yard, 55 City Road, SAGE Publications Ltd, London EC1Y 1SP United Kingdom, 2014, https://doi.org/10.4135/9781446282243.

[24] K. Säfsten, M. Gustavsson, Research Methodology - for Engineers and Other Problem-Solvers, first ed., Studentlitteratur Ab, Lund, Sweden, 2020.

[25] WHO, Decade of Healthy Ageing: Baseline Report, " World Health Organization, Geneva, Switzerland, 2020.

[26] V. Braun, V. Clarke, "To Saturate or Not to Saturate? Questioning Data Saturation as a Useful Concept for Thematic Analysis and Sample-Size Rationales, *Qualitative Research in Sport, Exercise and Health*, 2019, pp. 1–16, https://doi.org/10.1080/2159676X.2019.1704846. Dec.

[27] B. Saunders, et al., Saturation in qualitative research: exploring its conceptualization and operationalization, Qual. Quantity 52 (4) (2018) 1893–1907, https://doi.org/10.1007/s11135-017-0574-8.

[28] M. Mason, Sample size and saturation in PhD studies using qualitative interviews, Forum Qual. Soc. Res. 11 (3) (2011), https://doi.org/10.17169/fqs-11.3.1428.

[29] World Health Organization, International Classification of Functioning, Disability and Health : ICF, World Health Organization, 2001.

[30] S. Iwarsson, B. Slaug, Housing Enabler — A Method for Rating/screening and Analysing Accessibility Problems in Housing. Manual for the Complete Instrument and Screening Tool, Veten & Skapen HB & Slaug Data Management., 2010.

[31] V. Braun, V. Clarke, Thematic analysis.," in *APA Handbook of Research Methods in Psychology* vol. 2, American Psychological Association, Washington, DC, US, 2012, pp. 57–71, https://doi.org/10.1037/13620-004. Research designs: Quantitative, qualitative, neuropsychological, and biological.

[32] QSR International Pty Ltd, *NVivo*, [Online]. Available, https://www.qsrinternational.com/nvivo-qualitative-data-analysis-software/home, 2018.

[33] V. Braun, V. Clarke, One size fits all? What counts as quality practice in (reflexive) thematic analysis? Qual. Res. Psychol. (2020) 1–25, https://doi.org/10.1080/14780887.2020.1769238. Aug.

[34] V. Braun, V. Clarke, Using thematic analysis in psychology, Qual. Res. Psychol. 3 (2) (2006) 77–101.

[35] A. Bryman, S. Becker, J. Sempik, Quality criteria for quantitative, qualitative and mixed methods research: a view from social policy, Int. J. Soc. Res. Methodol. 11 (4) (2008) 261–276, https://doi.org/10.1080/13645570701401644. Oct.

[36] I. Korstjens, A. Moser, 1, Series: Practical Guidance to Qualitative Research. Part 4, vol. 24, Trustworthiness and publishing," null, 2018, pp. 120–124, https://doi.org/10.1080/13814788.2017.1375092. Jan.

[37] Y.S. Lincoln, E.G. Guba, Naturalistic Inquiry, SAGE Publications Ltd, 1985.

[38] World Medical Association, World medical association declaration of Helsinki: ethical principles for medical research involving human subjects, J. Am. Med. Assoc. 310 (20) (2013) 2191–2194, https://doi.org/10.1001/jama.2013.281053. Nov.

[39] D. Kahneman, A. Tversky, Subjective probability: a judgement of representativeness, Cognit. Psychol. 3 (1972) 430–454, https://doi.org/10.1016/0010-0285(72)90016-3.

[40] M.W. Boyce, J. Al-Awar Smither, D.O. Fisher, P.A. Hancock, Design of instructions for evacuating disabled adults, Appl. Ergon. 58 (2017) 48–58, https://doi.org/10.1016/j.apergo.2016.05.010. Jan.

[41] S.A. Lavender, J.P. Mehta, G.E. Hedman, S. Park, P.A. Reichelt, K.M. Conrad, Evaluating the physical demands when using sled-type stair descent devices to evacuate mobility-limited occupants from high-rise buildings, Appl. Ergon. 50 (2015) 87–97, https://doi.org/10.1016/j.apergo.2015.02.008. Sep.

[42] L.C. Boer, S.J. van Wijngaarden, Directional Sound Evacuation from Smoke-Filled Tunnels, " *Safe & Reliable Tunnels. Innovative European Achievements*, Prague, Czech Republic, 2004.

[43] D. Withington, M. Lunch, Directional Sound Evacuation . An Improved System for Way Guidance from Open Spaces and Exit Routes on Ships, 2003, p. 6. London, Mar.

[44] E. Ronchi, K. Fridolf, H. Frantzich, D. Nilsson, A.L. Walter, H. Modig, A tunnel evacuation experiment on movement speed and exit choice in smoke, Fire Saf. J. 97 (2018) 126–136, https://doi.org/10.1016/j.firesaf.2017.06.002. Apr.

[45] E. Smedberg, E. Ronchi, Review of Alarm Technologies for Deaf and Hard of Hearing Populations, Fire Protection Research Foundation, Quincy, MA (USA), 2021. FPRF-2021-09, Aug.

[46] D. Kahneman, S.P. Slovic, P. Slovic, A. Tversky, C.U. Press, Judgment under Uncertainty: Heuristics and Biases, Cambridge University Press, 1982.

[47] M.J. Kinsey, S.M.V. Gwynne, E.D. Kuligowski, M. Kinateder, Cognitive biases within decision making during fire evacuations, Fire Technol. 55 (2) (2019) 465–485, https://doi.org/10.1007/s10694-018-0708-0. Mar.

[48] M. Karemaker, G.A. ten Hoor, R.R. Hagen, C.H.M. van Schie, K. Boersma, R.A. C. Ruiter, Elderly about home fire safety: a qualitative study into home fire safety knowledge and behaviour, Fire Saf. J. 124 (2021) 103391, https://doi.org/10.1016/j.firesaf.2021.103391. Sep.

[49] M.T. Kinateder, E.D. Kuligowski, P.K. Reneke, R.D. Peacock, A Review of Risk Perception in Building Fire Evacuation, NIST TN 1840, Sep, " National Institute of Standards and Technology, 2014. Feb. 18, 2015. [Online]. Available, http://nvlpubs.nist.gov/nistpubs/TechnicalNotes/NIST.TN.1840.pdf.

[50] T.J. Shields, K.E. Boyce, N. McConnell, The behaviour and evacuation experiences of WTC 9/11 evacuees with self-designated mobility impairments, Fire Saf. J. 44 (6) (2009) 881–893, https://doi.org/10.1016/j.firesaf.2009.04.004. Aug.

[51] A. Sieben, J. Schumann, A. Seyfried, Collective phenomena in crowds—where pedestrian dynamics need social psychology, PLoS One 12 (6) (2017), https://doi.org/10.1371/journal.pone.0177328. Jun.

[52] R.F. Fahy, G. Proulx, L. Aiman, Panic or not in fire: clarifying the misconception, Fire Mater. 36 (5–6) (2012) 328–338, https://doi.org/10.1002/fam.1083. Aug.

[53] M. Haghani, E. Cristiani, N.W.F. Bode, M. Boltes, A. Corbetta, Panic, irrationality, and herding: three ambiguous terms in crowd dynamics research, J. Adv. Transport. (Aug. 2019) 1–58, https://doi.org/10.1155/2019/9267643, 2019.

[54] J. Drury, C. Cocking, S. Reicher, Everyone for themselves? A comparative study of crowd solidarity among emergency survivors, Br. J. Soc. Psychol. 48 (3) (2009) 487–506, https://doi.org/10.1348/014466608X357893.

[55] E.L. Quarantelli, Conventional beliefs and counterintuitive realities, Soc. Res. 75 (3) (2008) 873–904.

[56] SCB, Undersökningarna Av Levnadsförhållanden (ULF/SILC) År 2018-2019, " Statistiska Centralbyrån, 2020.

[57] E.R. Galea, M. Sauter, S.J. Deere, L. Filippidis, Investigating the impact of culture on evacuation response behaviour, in: " In *Proceedings of the 6th International Symposium on Human Behaviour in Fire*, London, 2015, pp. 351–360.

[58] B. Ingstad, S.R. Whyte, Disability and Culture, University of California Press, 1995.

[59] M. Kusenbach, Street phenomenology. The go-along as ethnographic research tool, Ethnography 4 (3) (2003) 455–485.

[60] S. Arias, J. Wahlqvist, D. Nilsson, E. Ronchi, H. Frantzich, Pursuing behavioral realism in Virtual Reality for fire evacuation research, Fire Mater. 1 (11) (2020), https://doi.org/10.1002/fam.2922.

An official website of the United States government Here's how you know

U.S. Department of Health & Human Services (HHS)
National Institutes of Health (NIH)

Share:

Disaster Preparedness and Recovery for Older Adults



While everyone is at risk during a natural weather-related disaster or similar emergency, older adults can be especially vulnerable during these challenging times. Being prepared in advance can literally mean the difference between survival and death, particularly for those who may have special medical or mobility needs. Read on to learn more about safety planning steps to consider now, whether you plan to remain at home or be evacuated in the event of an emergency.

NIA-funded research on older

adults and disasters

Weather and climate disasters are on the rise. In 2021, there were 20 extreme weather and climate events in the United States, triple the average number of events 15 years earlier. These extreme events include droughts, heat waves, wildfires, floods, tornadoes, and hurricanes. Research suggests that older adults are particularly vulnerable to the health effects of these disasters. As a part of a **broader NIH-wide initiative**, NIA supports research that explores the effects of extreme weather and natural disasters on older adults, with the ultimate aim of improving the well-being of people who experience these events. Learn more in ***Protecting older adults from the effects of natural disasters and extreme weather.***

Evaluate and plan

The first step is to learn about what kinds of disasters are most likely to affect you and your family based on where you live. For example, while flooding can happen anywhere, communities near water may be more likely to experience floods. And people who live close to a forest may be more likely to experience wildfires. Thinking about what your community is most likely to encounter will help you understand what you might need to include in your plan. For more information on preparing for various disasters and emergency situations, visit www.ready.gov/be-informed.

Next, develop a plan that includes possible evacuation routes and locations of shelters. State, county, and local governments will often set up emergency shelters or evacuation centers for people affected by disasters. These may include air-conditioned facilities for extreme heat waves or shelters at higher ground in the event of flooding. Search for open shelters in your area by texting SHELTER and your ZIP code to 43362 or by visiting www.ready.gov/shelter or www.disasterassistance.gov.

Discuss your plan and needs with friends, family, caregivers, and neighbors. Identify specific people you trust and who would be willing to help in a crisis. Fill out an emergency communications plan. Include backup communication measures for how to keep in touch, and have a fallback plan in the likely event of power and internet outages. Be sure to keep cell phones and similar electronics charged regularly.

Another part of planning is protecting important documents and records. These include:

- Identification, Social Security cards, passports, birth certificates
- Health and dental insurance
- Medical records
- Property insurance policies
- Family or other emergency contact information

For a full list of documents to consider, visit Safeguard Critical Documents and Valuables from the Federal Emergency Management

Agency (FEMA).

Store important documents in a fireproof and waterproof container and save a digital copy. Also consider reviewing and updating your home insurance policy, if needed. For example, many insurance policies do not include flood coverage.

An official website of the United States government Here's how you know

U.S. Department of Health & Human Services (HHS)
National Institutes of Health (NIH)

Share:

Protecting older adults from the effects of natural disasters and extreme weather

RESEARCH HIGHLIGHTS

October 18, 2022

Mental & Emotional Health Health Disparities Behavioral & Social Research

On this page:

- Disasters disrupt regular health care for older adults
- Some medications may make older adults more sensitive to heat
- Certain older adults are more resilient than others
- Neighbors can buffer the adverse impact of disaster
- Shaping research to inform disaster recovery practices
- What's next?

Weather and climate disasters are on the rise. In 2021, there were 20 extreme weather and climate events in the United States, triple the average number of events 15 years before. These extreme events included droughts, heat waves, wildfires, floods, tornadoes, and hurricanes. Research suggests that older adults are particularly vulnerable to the health effects of these disasters, but the specific reasons behind this susceptibility are still being explored.

As a part of a broader NIH-wide initiative, NIA funds research that explores the effects of extreme weather and natural disasters on older adults, with the ultimate aim of improving the well-being of people who experience these events.



“Older adults are particularly vulnerable during weather and climate disasters,” said Emerald Nguyen, Ph.D., an NIA program official. “There is a pressing need to explore their experiences and health outcomes during these events. NIA supports a wide range of research that aims to better understand how we might support older adults’ resilience, preparedness, and recovery from disasters.”

Disasters disrupt regular health care for older adults

While you may think that disaster response health care is all about treating burns, broken limbs, hypothermia, and other pressing medical emergencies, that’s only part of the story. When a community is affected by a disaster, the regular health care services that the community offers are affected, too. Sue Anne Bell, Ph.D., assistant professor at the University of Michigan School of Nursing, leads a team that studies how communities and health care systems can better support older adults through the phases of a disaster.

Bell, a nurse practitioner by training, regularly deploys to disasters across the country as a part of a federal disaster response team. She has extensive experience providing support in many different types of disaster, from hurricanes in Puerto Rico to California wildfires to the COVID-19 response.

> ***“When communities are disrupted, so are the supports for those who live there. The loss of basic infrastructure — such as loss of power or transportation — may cause serious health care interruptions, which can have long-lasting health impacts.”***
>
> — Sue Anne Bell, Ph.D., University of Michigan School of Nursing

In Bell’s experience, most of the care provided in the days and weeks after a disaster is basic primary care and

management of chronic health conditions, such as diabetes, high blood pressure, cancer, and kidney disease. According to a report from the Centers for Disease Control and Prevention (CDC), approximately 85% of U.S. adults over age 65 have one or more chronic diseases. People with these conditions need, and benefit from, regular access to health care. When a disaster makes it difficult or impossible to get health care services, older adults with chronic diseases are affected more than others.

Using large sources of data, such as Medicare claims records and the National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) Program, Bell's team discovered that disruption of basic health care has serious consequences. In an NIA-funded study, Bell and her colleagues found that people with breast cancer who lived through Hurricane Katrina in 2005 experienced interrupted care and were more likely to die within 10 years than those not exposed to the disaster. Bell's research has also demonstrated that living through disasters, when regular health care services and access to treatment may be limited, increases the likelihood that older adults will be hospitalized. Moreover, older adults living in poverty and those with certain chronic conditions are more likely to be hospitalized during or immediately after a disaster compared to all older adults.

Bell and her team are investigating strategies to promote healthy aging in communities affected by disasters, including improving home-based care before and after a disaster. Home-based care describes health care services that are provided by a professional caregiver in a person's home — the modern-day equivalent of a house call. Most older adults in the U.S. are aging in their own homes, rather than living in nursing homes or other care facilities. Preliminary findings from the NIA-funded study suggest that increasing access to home-based care could help fill the gaps in care that occur for older adults living at home during a disaster.

Additionally, NIA funds research into how large-scale organizational changes to primary care access could help meet the health needs of older adults during disasters. One study that began early in 2022 aims to identify which models of physician organization (such as federally funded health centers or independent medical groups) best meet people's health care needs during Puerto Rico's ongoing recovery from Hurricane Maria in 2017. Findings from the study may suggest how to prioritize the expansion of specific services that most directly improve the lives of older patients and their caregivers.

Some medications may make older adults more sensitive to heat

Many older adults take prescription drugs to manage chronic diseases and other health conditions. According to a report by the CDC, 83% of U.S. adults in their 60s and 70s had used at least one prescription drug in the previous 30 days and about one-third used five or more prescription drugs. Some medications increase heat sensitivity by interfering with body temperature regulation, suppressing thirst, or disrupting fluid balance. So, older adults who take medications to treat chronic diseases may be especially vulnerable to our changing climate, particularly extreme heat and heat waves.

Soko Setoguchi, M.D., Dr.PH., a professor of medicine and epidemiology at Rutgers Biomedical and Health Sciences, has been researching the health effects of climate change for more than 10 years. Her research examines the relationship between extreme heat and medication use in older adults. She has not only a professional interest, but also a personal one. "As a mother who cares about the future of the planet and the children, I believe we need to work harder

toward understanding and mitigating the effects of climate change on health," said Setoguchi.



During heat waves, older adults with certain chronic conditions are more likely to be hospitalized with heat-related conditions such as heat stroke and dehydration. Setoguchi's research team examined whether taking certain medications makes older adults more likely to experience health problems during heat waves. The study, funded in part by NIA, examined data from almost 400,000 Medicare beneficiaries over age 65 with chronic conditions such as diabetes; dementia; and heart, lung, or kidney disease. The results showed that several classes of drugs (specifically ACE inhibitors, anticholinergic medications, antipsychotics, and loop diuretics) are associated with higher risk of heat-related hospitalizations for older adults with chronic conditions. The study did not find a meaningful difference between heat waves and other hot summer days.

Understanding how medications interact with heat can help older adults and health care providers make informed decisions to help lower risks. "For example," said Setoguchi, "if we found that patients taking certain medications, such as diuretics, have a significantly higher risk for heat-related hospitalization, clinicians might advise patients to be aware of the risk and potentially adjust the dose of medications when exposure to extreme heat is expected."

Setoguchi notes, however, that the decision to adjust medication is complex and must be made by patients guided by their health care providers. You should always talk to your doctor if you have concerns about medications you are taking.

Certain older adults are more resilient than others

Not all older adults who experience a natural disaster are affected the same way. Scientists are researching why certain older adults are able to cope with the effects of disaster while others are vulnerable. For example, Rachel A. Pruchno, Ph.D., director of research at the New Jersey Institute for Successful Aging, studies how disasters worsen the daily functioning of some older adults but not others.

Pruchno's research was not originally disaster related. Her team started collecting data in 2006 as a part of the Ongoing Research on Aging in New Jersey: Bettering Opportunities for Wellness in Life (ORANJ BOWL) study. They were interested in factors that contribute to healthy aging generally, outside of the context of disaster. Six years later, Hurricane Sandy struck.

"Happenstance led me to become a disaster researcher," said Pruchno.

When Hurricane Sandy hit the state, her staff had already collected three waves of data from more than 3,000

ORANJ BOWL participants. Pruchno felt that she had to switch her research focus, as she had been given a unique opportunity to understand how a hurricane affects the physical and mental health of older adults.

In an NIA-funded study, Pruchno's team analyzed the data with particular attention to tasks of daily living, including walking up steps, kneeling, grasping small objects, and carrying heavy items. Pruchno and her colleagues compared older adults whose daily functioning worsened in the six years after the hurricane with older adults whose daily functioning was not affected. Overall, the data revealed that older adults with low incomes, low levels of social support, poor mental health, and poor physical health before the hurricane were the most likely to experience limitations in daily functioning after the disaster. These findings highlight the need to direct disaster preparedness and response resources to these groups.

Pruchno and her colleagues also found that having certain experiences during the disaster affected older adults' daily functioning years later. Those who experienced traumatic stress during a storm, such as a difficult evacuation, were more likely to have limited daily functioning six years later. Pruchno's team found this association for several specific skills, including walking up a flight of stairs, carrying a heavy bag of groceries, and standing for two hours without resting. According to Pruchno, focusing immediately after a disaster on helping older people who experienced traumatic stress may help alleviate these limitations before they develop. Additionally, understanding that not everyone who lives through a disaster has the same experiences may help researchers find meaningful associations between particular types of disaster exposure and health outcomes.

Neighbors can buffer the adverse impact of disaster

Having close social connections can help buffer the mental and emotional tolls of disasters. Ichiro Kawachi, Ph.D., professor of social epidemiology at Harvard T.H. Chan School of Public Health, leads a team that studies how relationships with family, friends, and neighbors can help older adults during a disaster.



In the NIA-funded Iwanuma Study, Kawachi and his team examined data from older survivors of the 2011 earthquake and tsunami in northeastern Japan. The study started as a collaboration between Kawachi and colleagues in Japan who had established a nationwide cohort to study the factors that contribute to healthy aging. As with ORANJ BOWL, the study was not originally intended to study the effects of disaster.

"About seven months after we finished establishing the baseline surveys, the Great East Japan earthquake happened. It was pure chance," said Kawachi. He soon realized that one of the field sites of the nationwide study was in the town of Iwanuma, about 50 miles west of the earthquake's epicenter. Kawachi's team had already collected data about older adults' social relationships before the earthquake. Now they could examine how these connections

influenced the impact of this disaster.

Kawachi and his colleagues studied more than 3,000 older adults who were profoundly affected by the disaster, defined as anyone who lost a loved one, had housing damage, lost a job or other source of economic stability, or had their medical care interrupted. The researchers found that those who were affected by the disaster in these ways experienced steeper cognitive decline and increased rates of post-traumatic stress disorder (PTSD) than those who were not affected by the disaster. The older adults who experienced the most severe consequences were those who lost their homes and were moved to temporary shelters, separating them from their friends, family, and neighbors. The researchers found that older adults who were able to maintain social connections, such as informal socializing with neighbors and family, were protected from some negative effects, such as symptoms of depression.

Based on Kawachi's data, keeping social groups together during relocation may protect older adults from future health issues. When whole neighborhoods were relocated together (instead of as single households), older adults in those communities had lower rates of cognitive impairment and mental illness. Based on these findings, avoiding relocation to temporary shelters and trying to keep social units together may protect the health of older adults exposed to disaster.

> ***"It is essential for older adults to maintain social connections as a part of disaster preparedness. Being prepared is not only stockpiling resources like food and medicines and water. You also need to pay attention to the social connections."***
>
> — Ichiro Kawachi, Ph.D., Harvard T.H. Chan School of Public Health

Kawachi's research with earthquake and tsunami survivors paves the way for the study of social connectedness as a protective factor in other types of disasters, such as the COVID-19 pandemic. Since the pandemic emerged in early 2020, it has disrupted social connectedness on an unprecedented scale throughout the world. Kawachi's research suggests that this puts a lot of people at risk, especially older adults, and emphasizes the need to

increase our understanding of how social connections influence health. In the future, Kawachi aims to find out "how we can recruit the strength of the community in order to meet these new challenges."

Shaping research to inform disaster recovery practices

Insights from scientific research can be used to help federal and state governments respond more effectively to disasters. For example, these insights could lead to the development of new tools and programs to help older adults who experience disasters. Elizabeth Frankenberg, Ph.D., director of the Carolina Center for Population Aging and Health and distinguished professor of sociology at the University of North Carolina, Chapel Hill, leads a team that is investigating the aftermath of the 2004 Indian Ocean tsunami, a large-scale, unanticipated natural disaster. The NIA-funded Study of the Tsunami Aftermath and Recovery (STAR) study has followed more than 25,000 individuals since before the tsunami, collecting detailed data on exposures, recovery, health, and economic status. They have completed at least one post-tsunami interview with 98% of surviving original respondents, making it one of the largest datasets in the field.



In an analysis of STAR data from more than 12,000 adults over age 40, Frankenberg's team examined the effectiveness of a post-tsunami housing reconstruction program. In the aftermath of the tsunami, billions of dollars were committed to the reconstruction of housing in damaged areas. Frankenberg and her colleagues found that for older adults, having permanent housing after a disaster lowered the chance of developing symptoms of PTSD. The team also discovered that those who moved into permanent housing after the tsunami had lower mortality rates in the decade following the disaster, when compared to people who moved into temporary housing. Frankenberg notes that these findings underscore the need for studies that examine not only the immediate but also the long-term effects of disasters.

In recent years, assistance agencies have become increasingly aware of the potential vulnerability of older adults during and after disasters. However, according to Frankenberg, "There's not a consistent set of policies designed around the needs of older individuals, particularly with respect to the recovery phase."

Before scientific findings can influence policy, researchers must establish a broad foundation of knowledge. "It would be premature for policies to flow directly from one study," says Frankenberg. "It typically takes similar findings from multiple studies, and then perhaps a pilot program or demonstration project might be implemented, or an existing program strengthened or adapted."

According to Frankenberg, research that identifies how different population subgroups are affected by a disaster, and the factors that underlie successful recovery, is critical for the design of effective policies and programs.

What's next?

Researchers will continue to explore the effects of natural disasters and extreme weather on older adults and how different factors interact with each other. "An older adult with limited financial resources may also live in a rural area, be isolated from friends and family, take several medications, and have chronic illnesses that require regular medical care," said NIA's Nguyen. By understanding what makes older adults more vulnerable, researchers can identify ways to better support them. "Exploring how these factors influence each other will be essential to crafting effective interventions to improve the health and well-being of older adults who experience disaster," Nguyen said.

Return to top

Newsletters

Sign up to receive updates and resources delivered to your inbox.

Sign up

nia.nih.gov
An official website of the National Institutes of Health

Advertisement

Commentary | Article | January 17, 2025

Wildfire Evacuations Spell Difficulties for Disabled, Elderly Residents

Author(s): Julia Bonavitacola

Listen 00:00 05:57

With emergency evacuation orders requiring swift action, less mobile individuals, such as those with disabilities or the elderly, are often left behind.

The wildfires that have spread throughout Los Angeles have, thus far, affected more than 20,000 structures and have forced approximately 180,000 people to evacuate from their homes. However, evacuation is often a struggle for those who are physically incapable or have significant struggles with moving easily. This gap in health

care could spell issues as natural disasters continue to ravage different parts of the country.

Advertisement

During natural disasters, evacuation orders and warnings are often a means of protecting people from severe injury or death due to the unpredictable weather. The Los Angeles Fire Department had given out evacuation orders as early as January 7 to help give residents as much time as possible to flee to safety from the, at the time, uncontrolled fires.[1] However, for people with disabilities or with limited mobility, these evacuation orders are hard to abide by.

According to NBC News,[2] most of the 25 residents who were confirmed to have died during the fire were either aged 65 years or older or had a physical disability that made evacuation near impossible. There were 2 victims of the fires who were diagnosed with cerebral palsy and 1 with a leg amputation that were not able to evacuate without emergency assistance. These victims are a sign of

a lack of planning and assistance for those who are most vulnerable.



The quick development of wildfires can make it hard for vulnerable populations to get the help that they need when evacuating | Image credit: MyPhotoBuddy - stock.adobe.com

Preparing to address the needs of disabled people during a national emergency can require multiple steps and preparation that some people do not have time or access to accomplish. FEMA's guide for people with disabilities preparing for evacuation[3] includes recommendations to stay informed, consider transportation, include others in the plans, and building an emergency kit. However, in the cases of those with disabilities, planning for medical needs can be more involved than simply grabbing a prescription bottle from a nightstand. Assistive technologies, such as oxygen masks or hospital beds, are harder to transport for those who require those technologies to live.

Response and preparedness may not be up to the needs of people with disabilities during natural disasters and emergencies, according to the CDC.[4] Access barriers to effectively communicating with people with disabilities or helping them can include a lack of effective communication through either visual aids or hearing aids, transportation being limited, shelters not being accessible to those with disabilities, or environments in general not being accessible, such as assistance technologies relying on electricity.

With these potential areas of oversight for those who are already vulnerable, it is imperative to think of means by which to close the gaps. Emergency managers in California emphasized the need for social resources to give comprehensive training for all residents so that they understand the information and are able to act accordingly.[5] This could also help to foster community engagement in making sure that everyone in the community is protected. However, they

> also acknowledged that addressing transportation inadequacies to help those in all areas would require more institutional support and strengthening of infrastructure to improve existing networks of transportation.
>
> Solutions, the emergency managers said, could be driven through the use of technological tools that improve resource allocation through creating specific evacuation zones for each neighborhood or enlisting the community to check in on those who are vulnerable in the area to make sure that they've been evacuated safely. Although the infrastructure around evacuating vulnerable populations is still lacking, this community effort could provide a temporary solution to ensuring the safety of those who need help in the neighborhood.
>
> More reliable solutions to helping vulnerable populations during emergencies, whether it be through evacuation or providing resources to keep them healthy, is imperative in the future, despite temporary solutions like

community support. The victims of the California wildfires speak to a particular susceptibility of disabled and elderly people to natural disaster, whether it be from a lack of understanding of the risk or the inability to get the care that they need to evacuate. Funding for infrastructure improvements, including improved communication of evacuations and more easily accessible evacuation methods, should be the forefront of policymakers' priorities as the country thinks about natural disaster response.

References

1. Palisades fire. Los Angeles Fire Department. Updated January 16, 2025. Accessed January 16, 2025. https://lafd.org/news/palisades-fire-0
2. Burke M, Kreutz L. What we know about the victims killed in the California wildfires. Updated January 16, 2025. Accessed January 16, 2025. https://www.nbcnews.com/news/us-news/california-wildfires-

victims-rcna186989
3. 6 ways people with disabilities can prepare for evacuations. FEMA. July 22, 2022. Accessed January 16, 2025. https://www.fema.gov/blog/6-ways-people-disabilities-can-prepare-evacuations
4. Emergency preparedness and disability inclusion. CDC. 2024. Accessed January 16, 2025. https://www.cdc.gov/disability-emergency-preparedness/about/index.html
5. Ermagun A, Thompson D, Vahedifard F, Silver RC. Emergency managers' challenges with wildfires and related cascading hazards in California. *J Environ Manage*. 2025;374:124008. doi:10.1016/j.jenvman.2024.124008

Related Videos



Gene Editing for Safer CAR T-Cell Therapy in Large B-Cell Lymphoma

Related Content



March 17th 2025

Updated MIRASOL Data Confirms Efficacy of Mirvetuximab Soravtansine for FRα+ Platinum-Resistant Ovarian Cancer

Brooke McCormick

The final data analysis confirmed that mirvetuximab soravtansine-

gynx (Elahere; AbbVie) significantly improves progression-free survival, overall survival, and objective response in patients with folate receptor alpha-positive (FRα+) platinum-resistant ovarian cancer.



February 25th 2025

Navigating Sport-Related Neurospine Injuries, Surgery, and Managed Care

Pearl Steinzor

Arthur L. Jenkins III, MD, FACS

On this episode of Managed Care Cast, we speak with Arthur L. Jenkins III, MD, FACS, CEO of Jenkins

NeuroSpine, to explore the intersection of advanced surgical care for sport-related neurospine injuries and managed care systems.



March 17th 2025

Community, Connection, and Sharing the Science at CROI 2025

Maggie L. Shaw Annie Antar, MD, PhD Lynae Darbes, PhD Katrina Ortblad, ScD, MPH Bridgette J. Picou, LVN, ACLPN Priscilla Tsondai, MD, MPH

Experts share here what they take away from the Conference on Retroviruses and

Opportunistic Infections (CROI) each year and why this meeting is so important in this space.



February 18th 2025

Varied Access: The Pharmacogenetic Testing Coverage Divide

Brooke McCormick

Jai N. Patel, PharmD

On this episode of Managed Care Cast, we speak with the author of a study published in the February 2025 issue of The American Journal of Managed Care® to uncover significant differences in coverage decisions for pharmacogenetic tests across major US health insurers.



March 17th 2025

Cancer Labels on Alcohol? Ireland, Where Pubs

Still Rule, Will Have Them by Next Year

Mary Caffrey

As St. Patrick's Day brings global celebrations involving alcohol, Ireland looks forward to rethinking excess consumption with a new tool set to arrive next year: the world's most comprehensive alcohol warning label.



March 15th 2025

FDA Approves Expanded Indication of Eculizumab for Pediatric Generalized Myasthenia Gravis

Luke Halpern

The FDA first approved eculizumab for use in adult

use in adult patients with generalized myasthenia gravis in 2017, before expanding the indication to include pediatric patients who are 6 years or older and positive for antiacetylcholine receptor antibodies.

---

2 Commerce Drive
Suite 100
Cranbury, NJ
08512

© 2025 MJH Life Sciences®
and AJMC®.
All rights reserved.

ResearchGate

See discussions, stats, and author profiles for this publication at: https://www.researchgate.net/publication/286103547

Study on the relation between age and evacuation in case of undergroud evacuation

Article *in* Contemporary Engineering Sciences · January 2014

DOI: 10.12988/ces.2014.49131

CITATIONS
8

READS
357

4 authors, including:



Gyu-Yeob Jeon
Jeju National University
24 PUBLICATIONS **447** CITATIONS

SEE PROFILE



Won-Hwa Hong
Kyungpook National University
221 PUBLICATIONS **2,587** CITATIONS

SEE PROFILE

All content following this page was uploaded by Gyu-Yeob Jeon on 27 March 2018.

The user has requested enhancement of the downloaded file.

Contemporary Engineering Sciences, Vol. 7, 2014, no. 21, 1045 - 1052
HIKARI Ltd, www.m-hikari.com
http://dx.doi.org/10.12988/ces.2014.49131

Study on the Relation between Age and Evacuation in Case of Undergroud Evacuation

Gyu-Yeob Jeon

Jeju National University
102 Jejudaehakno, Jeju, South Korea

Jun-Ho Choi

Pukyong National University
45 Yongso-ro, Namgu, Busan, South Korea
* Corresponding author

Won-hwa Hong

Kyungpook National University
80 Deahakro, Bukgu, Deagu, South Korea

Jong-ha Kim

Dongyang University
145 Dongyangdearo, Yeongju, South Korea

Copyright © 2014 Gyu-Yeob Jeon et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Abstract

Many codes and standards regarding fire safety are designed and established based on healthy adults in general. Human represent many different properties in various aspects depending upon age. The study tried to identify the relation between age and evacuation depending on visibility. Correlation analysis and linear regression analysis were conducted to identify the correlation between the subject's age and evacuation speed. As the visual impairment became stronger, the correlation between age and speed became smaller.

Keywords: Evacuation, Fire drill, Visibility, Age, Fire safety

1 Introduction

Many codes and standards regarding fire safety are designed and established based on healthy adults in general. Occupants can experience evacuation safety in a building mostly used by children or senior who have poor physical ability or decision ability. As of 2012, children below 14 old age accounted for 15.1% while those aged 65 or older 11.8% of the entire population in Korea and the percentage of the elderly is expected to increase. Human represent many different properties in various aspects depending upon age. Particularly, the exercise ability is reached a peak in twenties and then, gradually declined. This decline is getting more drastic after fifties. In sixties, the exercise ability is about 70~80% of adults in twenties. Differences in exercise ability are normally reflected into evacuation behaviors hence representing various evacuating characteristics. It is critical to have accurate data regarding behavioral characteristics of evacuation according to age for Performance Based Design as well as reliable evacuation simulation result.

The study aimed to identify correlation between age and evacuation. Evacuation experiments were performed to analyze evacuation time and speed according to age. Visibility was reduced as an environmental constraint over evacuation. It was also analyzed how the evacuation changes depending on age as well as the visibility. Quantitative data on correlation between age and evacuation were discussed through the analysis in this study.

2 Experiment summary

The evacuation experiments were conducted in subway stations which have four underground stories, located in Daegu, South Korea. Subjects of the evacuation experiment started from the center of subway platforms in the fourth underground story and evacuated to the exit on the ground level. Subjects evacuated one by one at regular intervals and then a questionnaire about the experiment was surveyed after the completion of evacuation. Evacuation routes, time, behavioral factors were recorded by a recorder who was following the subject throughout the evacuating experiments.

Three evacuation experiments with three different visibility conditions were conducted. The three visibility conditions applied to the experiments are summarized in the table 1. In the condition of Test 1, all indoor lights and equipment were normally operational while all indoor lights were turned off except for exit signs and several billboards in Test 2 and 3. In particular, the Test 3 in impaired visibility condition simulated the evacuation drill in the event of fire with smoke. Subjects of Test 3 have the reduced visibility as well as visual impairment due to the smoke in hindrance condition as shown Fig 2. In order to make condition, meaning impaired visibility, the subjects put on the opaque eye-patch which allows transmission of about 27% visible light in average. With the opaque eye-patch, the visibility of subject becomes approximately 5~10 meters which can be converted to

0.13~0.26 m-1 as the smoke density value. Under the smoke density of 0.13~0.26 m-1, the fire alarms in building may be activated and occupants who are unfamiliar with building path take difficulties for the evacuation.

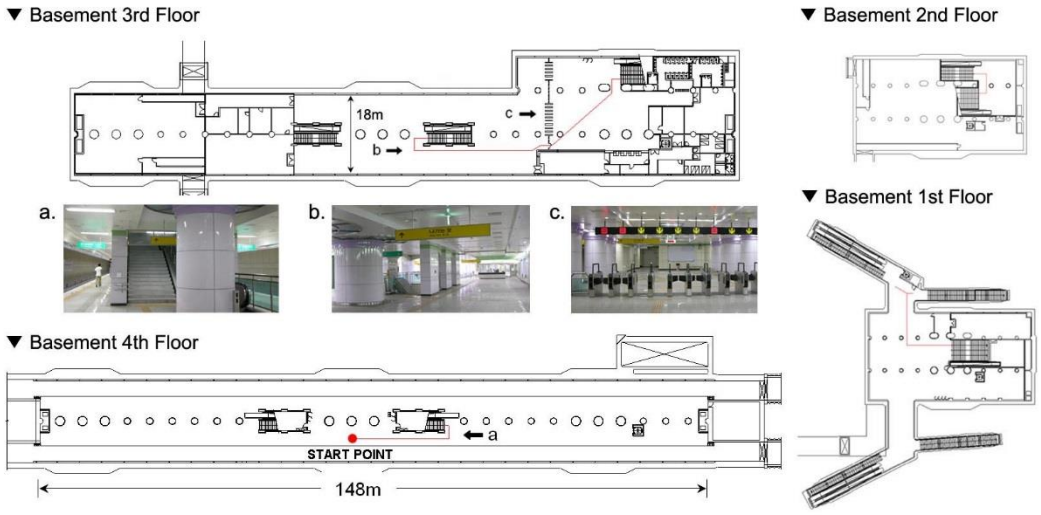


Fig. 1. Subway station. The fourth underground story was being used for subway platforms while the third underground story was being used for tickets and waiting rooms.

Table. 1. Experiment scenario and condition

Index	Visibility condition	Indoor lights	Opaque eye-patch
Test 1	normality	work	-
Test 2	light-off	-	-
Test 3	hindrance by smoke	-	put on



Fig. 2. Visibility before (left) and after (right) putting on the eye-patch

In this study, subjects were classified into three age groups based upon the human life cycle. The subjects below 20 were Group A, those between 20 and 50 were Group B and those aged 50 and older were Group C and all the subjects were recruited from ordinary citizens. A total of 103 subjects with a wide range of age were involved in experiment. As shown Fig 3, the average age and height of subjects were 27.7 years old and 167.7cm, respectively. The youngest subject was 9 years old while the oldest was 67 years old.

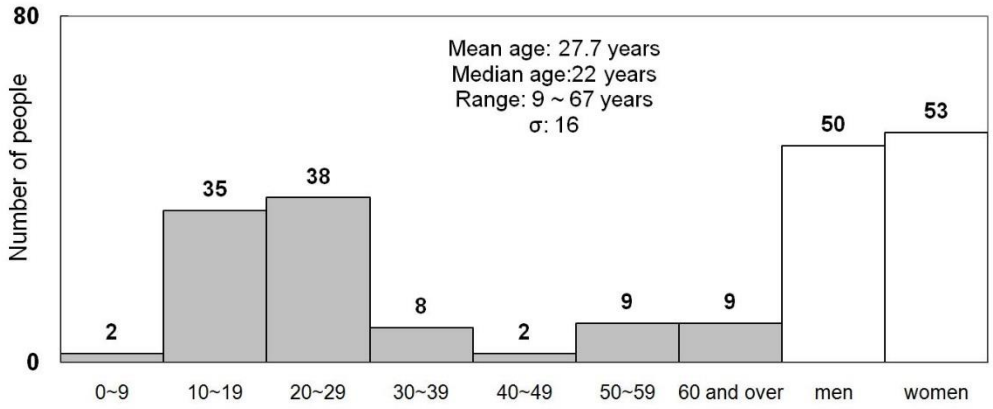


Fig. 3. Personal information of subjects

3 Evacuation experiment result

There were significant differences in evacuation time per each test as shown in the Fig 4. In the test 1, the mean evacuation time was 112.1 seconds which is the shortest while it was found to be 425.5 seconds in the test 3. Test 3 recorded a greater deviation of evacuation completion time than Test 1 and 2. The evacuation time of the test 3 exceed over 1 minute of evacuation time which is allowed by NFPA 130 code in the USA.

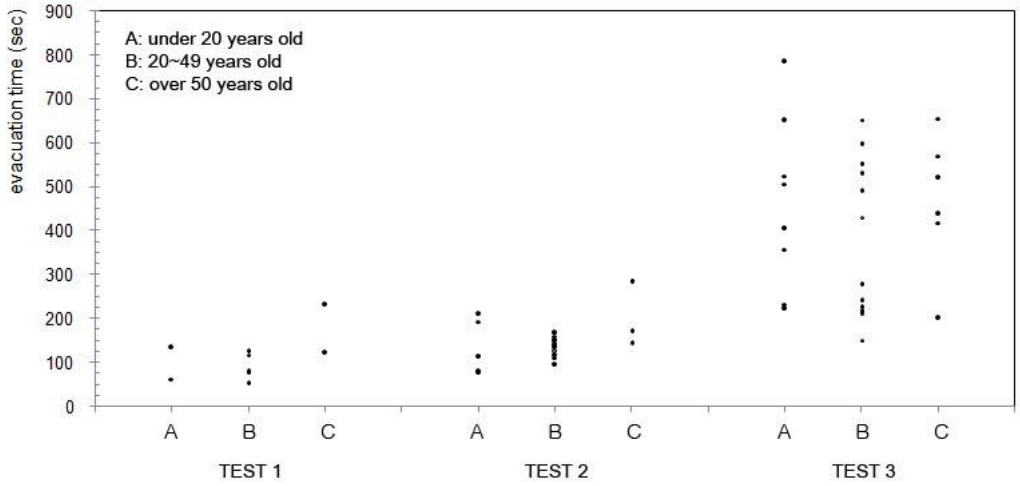


Fig. 4. Distribution of evacuation time

With the condition of impaired visibility, due to power failure and smoke, the evacuation time was significantly increased differently according to the age as well as evacuation space. As the table 2 shows, Group B in the Test 1, Group A in the Test 2 and Group B in the Test 3 took the shortest time to evacuate while Group C, the oldest, took the longest time for evacuation at all tests. At all age groups, Test 1 with the best visibility recorded the shortest time to evacuate and Test 3 with the

worst visibility showed the opposite. In the meantime, Group A, the youngest, showed the greatest difference of evacuation time under the condition of different visibility. In the test 2, without indoor lights, Group A and Group B showed the similar evacuation time. With impaired visibility due to smoke, Group A and Group C were similar in time took for evacuation in the test 3. On the other hand, a slightly different pattern was found in evacuation time depending upon the evacuation space. In test 2&3, Group A showed the shortest evacuation time in staircase whilst it was longest in the Group C.

Table 2. Evacuation time depending on age classification

Exp. index	**Age classification**			
	A (0-19)	B (20-49)	C (50 and over)	All age
Test 1	99.2	90.9	178.1	112.1
Test 2	134.6	138.4	221.5	154.1
Test 3	460.3	381.3	467.2	425.5

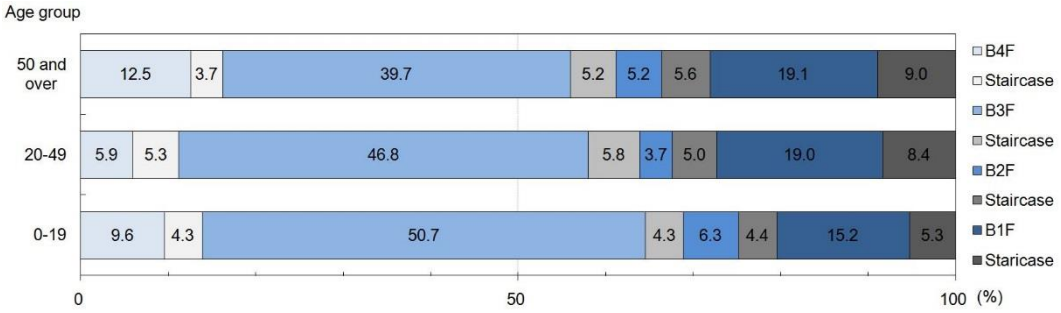


Fig. 5. Evacuation time ratio in Test 3

4 Relation analysis and discuss

The evacuation speed which is calculated using the evacuation time and moving distance was shown in the Fig 5. Although the difference was smaller than the evacuation time, there was a clear difference in the evacuation speed. As the figure 6 shows, the evacuation became slower when the visibility grew worse in general. It was 2.33m/s at Test 1, 1.70m/s at Test 2 and 0.89m/s at Test 3 on average. However, Group C recorded the fastest evacuation at Test 2, which had the medium visibility constraint, without following the pattern. Though Group C, the oldest, was the slowest to evacuate typically, their evacuation time depending on constraint conditions was the least different.

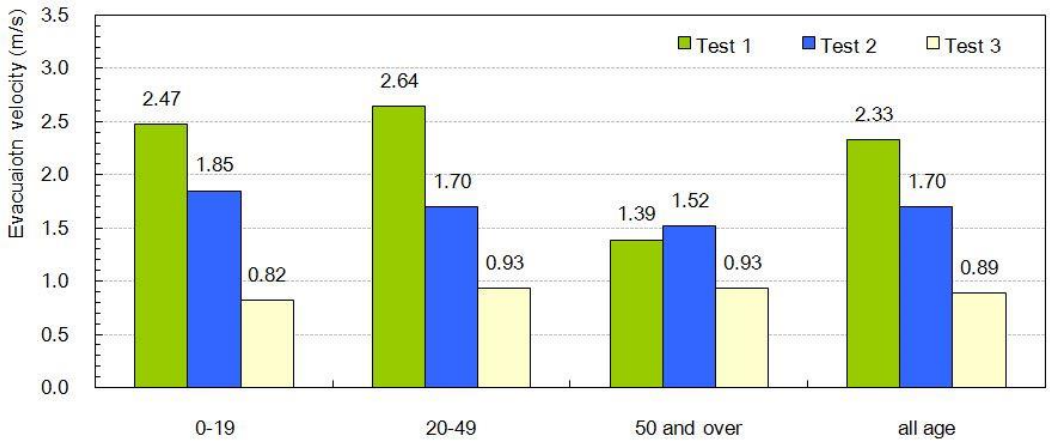


Fig. 6. Evacuation speed comparison

If the evacuation speed of Test 1 that has no visual hindrance is assumed default value as "1", the speed of Test 2 slows to 0.73. Test 3 speed also slows to 0.38, less than half Test 1. Such difference also varied depending on the age group shown in Table 3.

Table 3. Relative comparison of the evacuation speed

	Test2/Test1	**Test3/Test2**	**Test3/Test1**
0-19	0.75	0.44	0.33
20-49	0.64	0.55	0.35
50 and over	1.10	0.61	0.67
All age	0.73	0.52	0.38

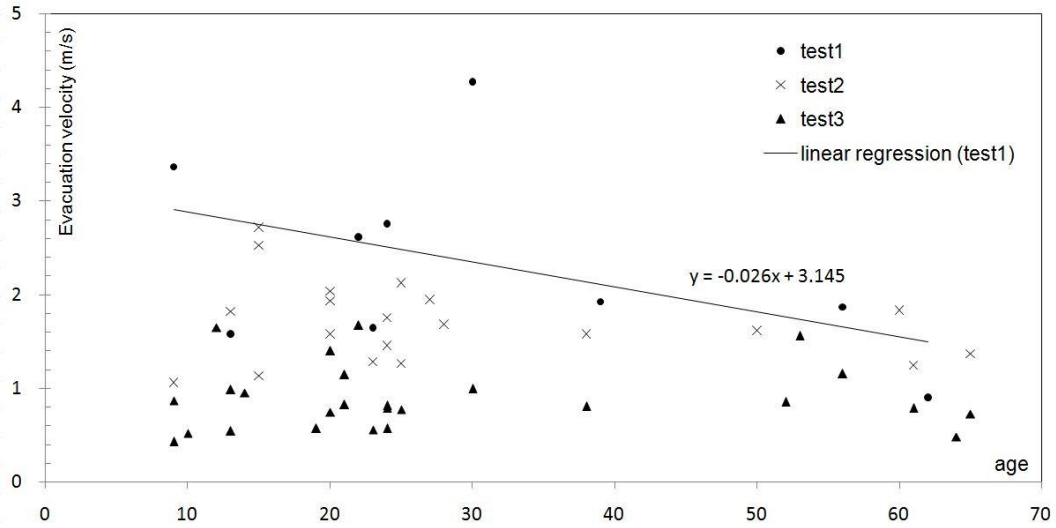


Fig. 7. Linear regression analysis between age and evacuation speed

Correlation analysis and linear regression analysis were conducted to identify the correlation between the subject's age and evacuation speed. Test 1 without vi-

sibility constraint recorded relatively higher correlation rather than other tests. As the visual impairment became stronger, the correlation between age and speed became smaller. However, all tests did not show significant correlation between age and speed.

5 Conclusion

The study focused on the relation between age and evacuation depending on visibility. Subjects between 20 and 49 evacuated, Group B in this study, fastest in general. The impaired visibility slowed down the evacuation speed and cause wide interindividual variability in evacuation results. When the indoor lights were off, the speed was 73% of the normal condition. When visibility reduced by smoke, the speed stood at 38% of the normal condition. In case of the participants aged 50 and older, the variability of evacuation speed depending on visibility was the least. The correlation between age and speed the study analyzed was not significant though it grew bigger when the visibility constraint was weaker.

Acknowledgements. This research was supported by the Next Generation Fire Protection & Safety Core Technology Development Program funded by the National Emergency Management Agency of Korea
(2014-NEMA14-033-00000000-2014)

References

[1] D.A. Cunnigham, C. Morrison, C.L. Rice, C. Cooke, Aging and isokinetic plantar flexion, *European Journal of Applied Physiology*, 56 (1987), 9 - 24.

[2] J.H. Kim, *Rehabilitative medicine*, Samhwa Press, Seoul, 1994.

[3] G.Y. Jeon, W.H Hong, An Experimental study on how phosphorescent guidance equipment influences on evacuation in impaired visibility, *Journal of Loss Prevention in the Process Industries*, 22 (2009), 934 - 942.

[4] G.Y. Jeon, J.Y. Kim, W.H. Hong, G. Augenbroe, Evacuation performance of individuals in different visibility conditions, *Building and Environment*, 46 (2011), 1094 - 1103

[5] G.H. Chang, S.H. Lee, G.Y. Jeon, W.H. Hong, A Study on visual information acquisition based on spatial cognition, *INFORMATION-An International Interdisciplinary Journal*, 17 (2014), 3169 – 3174

[6] Y.J Lee, *Disaster prevention in architecture*, Kimoondang Press, Seoul, 2002.

[7] NFPA, *Life safety code*, National Fire Protection Association, Quincy, MA, 2006.

[8] L.T. Wong, K.C. Lo, Experimental study on visibility of exit signs in buildings, *Building and Environment*, 42 (2007), 1836 - 1843

[9] T. Jin, T. Yamada, Experimental study on human emotional instability in smoke filled corridor: Part 2, *Journal of Fire Science*, 8 (1990), 124 - 134

[10] M.M. Rahman, M.I. Abdullah and M.S. Hossain, Level Based Path Selection Technique in Large WSN for Hierarchical Architecture, *International Journal of Advanced Science and Technology*, 32 (2011), 33 - 44

Received: August 3, 2014

View publication stats

Advertisement

News | Article | January 28, 2025

Q&A: Dr Michael Ashley Stein Speaks on How Natural Disasters Can Affect Disabled Individuals

Listen 00:00 06:46

Advertisement

Key Takeaways

- Disabled individuals are disproportionately affected by natural disasters due to systemic planning failures and lack of accessible emergency alerts and shelters.
- There is a significant overlap between disability and age-related vulnerabilities, with societal marginalization exacerbating risks for these groups.

SHOW MORE

Michael Ashley Stein, PhD, JD, speaks about how disabled individuals are at a disadvantage when it comes to preparing for natural disasters, specifically during wildfires.

Michael Ashley Stein, PhD, JD, professor of law at Harvard Law School, spoke with *The American Journal of Managed Care®* (*AJMC®*) about the response for disabled individuals during natural disasters, especially wildfires, discussing the ways in which they are vulnerable and how these vulnerabilities could be closed in the future.

Recent Content


Long COVID Disparities Revealed in New Study From England


Solving the Transition Conundrum as More Children With Muscular Dystrophy Live to Adulthood


For Neuromuscular Disease Community, an Era of Opportunities and Threats


Updated MIRASOL Data Confirm Efficacy of Mirvetuximab Soravtansine for FRα+ Platinum-Resistant Ovarian Cancer

View More Recent Content→

This Q&A has been lightly edited for clarity.

***AJMC*:** With the recent climate disaster in California, we have learned that at least 3 of the victims were in some way disabled, be it from cerebral palsy or a leg amputation. How are people who are in some way disabled more vulnerable to serious injury and death in a natural disaster?

Stein: Persons with disabilities, empirically, are more vulnerable to natural disasters. We know that from the study of Australia over 15 years, wherein something like 90% of the victims of wildfires were people with 1 or more disabilities. We know that from British Columbia, which came up with the same numbers. We know that people with psychosocial disabilities are 2 to 4 times more likely to die during heat waves and other natural disasters. That's the empirical evidence.

As to why they are more vulnerable, it

> is not because people with disabilities are inherently vulnerable, but because we put them in positions of vulnerability. So you know, in many parts of the world, including parts of the United States, we don't have accessible emergency alerts. Of course, finding out that a hurricane is hitting three days after it hits does no good. The evacuation shelters are infrequently accessible to people with different types of disabilities. People with disabilities can be separated from their medication, from assistive devices, from caregivers and others who help support them, and that's true, by the way, of people who are elders, either with or without disabilities as well. So we render them vulnerable by not planning ahead of time and thinking about how to create the means by which to escape and by which to survive natural disasters and other climate change induced stressors.
>
> ***AJMC*:** Are there overlaps in how to address the needs of older adults and people with disabilities amid natural

disasters, whether it be through communication or transportation?

Stein: Epidemiologically, we know that the incidence of disability increases dramatically as one ages. If you are lucky enough to live to old age, you will have 1 or more forms of disability, and we know that in this country, at least by 2040, we will double the number of adults over the age of 65 [years]. So there is an empirical overlap there. It's a Venn diagram that significantly overlaps. And there are commonalities as to why older adults and why people with disabilities tend to be put into situations of risk and not come through well. Some of those areas of overlap include accessible communication, transportation, evacuation, access to medication and supports. But the underlying reasons why we don't have those those provisions laid out is that as a society, we unfortunately tend to marginalize individuals that we view as less productive and more vulnerable and less valuable.

That may sound harsh, but one only

has to look at what happened during [the] COVID-19 [pandemic]. The numbers of individuals with disabilities and the numbers of individuals who were older adults who died in nursing homes or who were left without vaccination, without support, are dramatic. 20% of all deaths during COVID were people in nursing homes. That's not a coincidence. It's a reflection of what our society apparently values and apparently doesn't value. And now that we are in the second Trump administration, those of us who are concerned about policy and about threats to Medicaid blocks and threats to home- and community-based services and threats to the idea that people ought to age with supports in their homes, are thinking a lot and being very concerned about what's down the road.

***AJMC*:** What are some areas where gaps are most noticeable when it comes to response for natural

disasters, especially wildfires?

Michael Ashley Stein | Image credit: Harvard Law School

Stein: Well, Having plans set out ahead of time that are designed to ensure that no one is left behind. The people who respond to natural disasters, including wildfires, are amazingly brave and giving and put themselves in the way of harm. And it's not a reflection on them, but they're following the plans that are laid out. We have, as a country, advanced somewhat in those areas. Before hurricanes Rita and Katrina, President George W. Bush actually ordered, by executive order, that evacuation plans be developed by all states and local municipalities. They did not do so, and we saw the result of that, which was people with psychiatric disabilities being left locked up without their medication, either suffering because of that, or even drowning and having secondary disabilities.

We should have learned from that. We didn't really, as is evidenced by New York City having been sued by

disability rights advocates because of their lack of accessible alert responses in advance of Hurricane Sandy and other endeavors. The Obama administration made some great headway by appointing the disability point person to try to integrate FEMA responses to natural disasters and other situations of risk. There was a pause during the first Trump administration. There was renewed vigor during the Biden administration, and it remains to be seen, what will occur now during the second Trump administration. So we've progressed overall, and our planning has improved and our inclusion has improved, but it's still a work in progress.

***AJMC*:** What are some things that policymakers, emergency workers, scientists, and even the community can do to help close those gaps?

Stein: Most of us who work on disability inclusion, from either a legal or a policy point of view, would argue that including people with disabilities in the initial design and then the

implementation of natural disaster planning, responses to climate change more generally, would help improve it, because we always say that nobody knows their needs and priorities better than the stakeholders themselves. In this case, people with disabilities. So co-design, highlighting of priorities, highlighting of best practices, and perhaps some clever responses to natural disasters and other climate change would be useful as a knowledge sharing.

***AJMC*:** What should be the biggest takeaway about accounting for disabled people during natural disasters?

Stein: Climate change is not going away. We're at a critical existential tipping point, and 1 of the first enactments of the Trump administration was to withdraw from the Paris Agreement. So one has to be concerned, given that we're now having wildfires in the middle of winter in addition to summer. Now that we're having hurricanes and other natural

disasters increasingly affecting the Southeast United States, tornadoes in the Midwest, that rather than pulling back, we need to advance and think about how to how to do a better job of ensuring that our vulnerable populations rendered vulnerable because of our policy neglects are protected and included.

Related Videos



Gene Editing for Safer CAR T-Cell Therapy in Large B-Cell Lymphoma

Related Content



March 17th 2025

Long COVID Disparities

National Library of Medicine
National Center for Biotechnology Information
Search
Log in
PubMed Central®
Search PMC Full-Text Archive
Search in PMC
Journal List
User Guide
Export to PMC
ACTIONS
Cite
Collections
Permalink
RESOURCES
Similar articles
Cited by other articles
Links to NCBI Databases
On This Page
Short abstract
Abstract
Summary
Background: Older Adults and Disasters
Purpose and Methods
Findings
Implications for Stakeholders
Note
References

J Gerontol Soc Sci. 2019 May 2;74(3):S.

Improving Disaster Preparedness Among Older Adults: Findings from a Multi-Stakeholder Investigation and Agenda for Future Efforts

Barbara Resnick, Lisa Gwyther, Keith Fernsler, Jennifer Hoffman, Jane Mahoney, Sandra Simpson, Kristy Gonzales

Author notes ▸ Copyright and License information

PMCID: PMC6499951 PMID: 29659742

Short abstract

This study uses interview data from public health departments and aging-in-place efforts to explore how to improve disaster preparedness for older adults. Findings can help older adults and elderly assembly programming purposes or other communities.

Abstract

Keywords: Community Resilience, Community Readiness, The Elderly, Emergency Preparedness, National Disaster, Public Health

Summary

- The increasing frequency and intensity of weather-related and other disaster events is combined with the growing proportion of older adults who are vulnerable to the effects of public health preparedness and problems can impact older adults.
- Preparedness programs conducted by public health departments are designed to reduce the impact of disasters on community residents, but little is known about how well they are addressing the needs of older adults or the broader factors that may help or hinder this success.
- Interviews with stakeholders revealed that most age-friendly communities (AFCs) and senior villages did not have a high priority on promoting disaster preparedness. While AFCs and senior villages have the potential to leverage existing resources and social connections and activities, they were not necessarily tailored to older adults.
- AFCs and senior villages interviewed lacked older adults' challenges with communication and transportation during disasters. Older adults with cognitive impairments, mobility limitations, and chronic conditions may require additional assistance to evacuate and benefit from their commitments to provide services to help them communicate for better prepared.
- Current aging-in-place efforts can be harnessed to strengthen the disaster resilience of older adults. Existing programs and new collaborations between public health departments and aging-in-place organizations have potential for improving disaster resilience for older populations.
- The needs of public health departments and aging-in-place efforts to complementary leveraging the everyday engagement of older adults in disaster preparedness, neighborhood connections, support volunteerism and operation preparedness needs of older adults in disaster preparedness, and more sensitive to the needs of older adults to engage with others and learn skills needed to remain safely living at home in disasters.
- Engaging and coordinating public health department current preparedness activities to include aging-in-place efforts and greater training of existing preparedness activities to be more sensitive to the needs of older adults can improve disaster preparedness for older adults.

Summary

Interviews with stakeholders revealed that most age-friendly communities (AFCs) and senior villages did not have a high priority on promoting disaster preparedness. While AFCs and senior villages have the potential to leverage existing resources and social connections and activities, they were not necessarily tailored to older adults.

AFCs and senior villages interviewed lacked older adults' challenges with communication and transportation during disasters. Older adults with cognitive impairments, mobility limitations, and chronic conditions may require additional assistance to evacuate and benefit from their commitments to provide services to help them communicate for better prepared.

Current aging-in-place efforts can be harnessed to strengthen the disaster resilience of older adults. Existing programs and new collaborations between public health departments and aging-in-place organizations have potential for improving disaster resilience for older populations.

The needs of public health departments and aging-in-place efforts to complementary leveraging the everyday engagement of older adults in disaster preparedness, neighborhood connections, support volunteerism and operation preparedness needs of older adults in disaster preparedness, and more sensitive to the needs of older adults to engage with others and learn skills needed to remain safely living at home in disasters.

Engaging and coordinating public health department current preparedness activities to include aging-in-place efforts and greater training of existing preparedness activities to be more sensitive to the needs of older adults can improve disaster preparedness for older adults.

Background: Older Adults and Disasters

Extreme storms and other emergencies have become more frequent and severe in recent years—in part, because of climate change (National Oceanic and Atmospheric Administration, 2017). Hurricanes Katrina (2005), Sandy (2012), and Harvey (2017), and the California Camp Fire, Hurricane Irma and Hurricane Maria (2017) are examples of disasters that resulted in huge human and economic costs. A disaster is a hazardous event that causes a lot of harm, such as injury or death, damage to property, and/or damage to the environment (Merriam-Webster, 2019). A hazard is an event that may or may not occur, but if it occurs, it will cause harm (Merriam-Webster, 2019). Public health departments are the government agencies responsible for protecting the health of residents in the event of a disaster. Public health departments are focused on the entire community and even their efforts and programs may be limited to individuals with functional needs (Kailes & Enders, 2007). Older adults are at risk for many disaster-related problems, including injury, death, and psychological distress (Centers for Disease Control and Prevention, 2018). Older adults are also at risk for poor outcomes after a disaster, including increased mortality (Adams et al., 2013; Brown et al., 2012; Kilbane et al., 2014; Lowe et al., 2013; Sharma et al., 2015). Older adults are more likely than others in a community to be socially isolated and have multiple chronic conditions and functional limitations (Cornwell & Waite, 2009; Resnick et al., 2017). Stress and disruption from disasters can disrupt their medical care and medication regimens (Aldrich & Benson, 2008). A number of studies report that

Gaps in Preparedness Activities

We explored ATC, village, and public health department views of how well their preparedness activities aligned with the greatest needs that older adults face. All acknowledged ongoing gaps in this alignment.

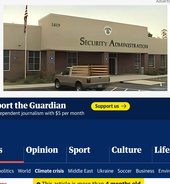
ATCs

ATCs acknowledged gaps between the greatest needs of older adults and the available services or support for preparedness. ATC representatives identified several areas of preparedness that they felt were lacking, including help with pet care (n=3), transportation assistance, self-fulfilled prophecies (e.g. lack of transportation paired with transportation assistance), medication management, lack of transportation, and medical needs.

Most ATC respondents suggested that certain needs are more common among older adults than others. For example, ATC respondents described that transportation needs, pet care needs, and, if left unaddressed, can prevent older adults from following a shelter-in-place directive. Providing or obtaining transportation for people with functional limitations, for example, can be challenging. Pet care needs can also be challenging, as many older adults have pets that they consider to be family members and will not evacuate or supplies (such as supplemental oxygen) rely on home care services, or need medications to maintain health can disrupt these routines due to a lack of awareness of services, or inability to get to an open pharmacy. This could create a serious situation that compounds with other preparedness needs. Finally, a lack of awareness of preparedness activities where older adults need planning for them—can also be a challenge, with public awareness, and first responders—is an area of gap.

The ability of municipalities or first responders to reach vulnerable and in-isolated individuals was also a concern for ATC respondents. Many ATC respondents described that older adults may not have access to the news, but they trust information shared in posting people signed up for these registries and maintaining them is a way that would be useful. Others (n=3)

Advertisement



Social Security Recipients Under $2,384/Mo Now Entitled To 12 "Kickbacks" In March (Tap for List)

Super Saving Circles

Wildfires

This article is more than 4 months old

Smoke pollution from wildfires may be killing an extra 12,000 people a year, new research suggests

Global heating particularly increasing risk of death from smoke inhalation in Australia, South America, Europe and parts of Asia

Graham Readfearn
Environment and climate correspondent
Mon 21 Oct 2024 11.00 EDT

Share



Hundreds of people died from the effects of smoke inhalation caused by Australia's 2019-20 black summer bushfires, according to Prof Hilary Bambrick. Photograph: Joel Carrett/AAP

Global heating is causing more of the planet to be burned from wildfires and probably killing an extra 12,000 people a year from breathing in smoke, new research has found.

Global heating was particularly increasing the risk of death from wildfire smoke in Australia, South America, Europe and the boreal forests of Asia, one modelling study found.

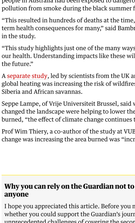
A separate study said between 2003 and 2019 global heating had increased the area of the planet being burned almost 16% but other human actions, including clearing forests and savannahs for roads or agriculture, had lowered the total burned area by 19%.

Both studies, published in the journal Nature Climate Change, teased apart the effect that adding greenhouse gas emissions to the atmosphere was having on wildfires, compared with other human actions such as land clearing.

The study - led by Dr Chae Yeon Park of Japan's National Institute for Environmental Studies - estimated that in the 2010s that almost 100,000 people died each year from breathing smoke from fires that contain tiny particles, known as PM2.5, that can penetrate the lungs and bloodstream.

How global heating is contributing to these deaths has been difficult to understand because, while hotter temperatures and lower humidity increase the risk of fires, other direct human interventions - such as the fragmenting of forests and savannahs - reduce the area that can burn or suppress the spread of fire.

Advertisement



To overcome the problem, the researchers looked at three models of global vegetation and fire under today's climate conditions and compared them to a model where modern-day climate change effects were removed.

While the results varied, the authors from eight countries, including the UK, the US, Germany and China, found that in all cases global heating was causing a rising number of deaths from people breathing PM2.5 from wildfires.

In some regions temperature increases were the main factor for increasing fire risk while in others, it was lower humidity.



Wildfires rage across Portugal – video

The authors said the health effects from wildfires could be underestimated because the "scarcity of particles originating from fire" were more severe than from other sources.

Prof Hilary Bambrick, director of the National Centre for Epidemiology and Population Health at the Australian National University, said millions of people in Australia had been exposed to dangerous and prolonged levels of pollution from smoke during the black summer fires in 2019 and 2020.

"This resulted in hundreds of deaths at the time, and will likely have long-term health consequences for many," said Bambrick, who was not involved in the study.

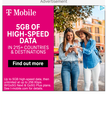
"This study highlights just one of the many ways climate change is bad for our health. Understanding impacts like these will help us to better plan for the future."

A separate study, led by scientists from the UK and Belgium, found that global heating was increasing the risk of wildfires, in particular in Australia, Siberia and African savannas.

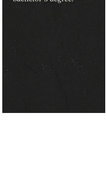
Seppe Lampe, of Vrije Universiteit Brussel, said while human activities that changed the landscape were helping to lower the area of the planet being burned, "the effect of climate change continues to grow".

Prof Wim Thiery, a co-author of the study at VUB, said the rate that climate change was increasing the area burned was "increasing every year".

Advertisement



Advertisement



Most viewed

The honeymoon is over for Trump, whose every unwitting misstep brings chaos and strife
Simon Tisdall

Trump sharpens attacks on US media and says their actions are illegal


Trump administration mulling new travel restrictions on citizens from dozens of countries

How Pete Hegseth is pushing his beliefs on US agency 'nothing to prepare forces'

Swollen eyeballs, baby-like skin, and the overview effect: how astronauts feel when they return to earth

Humanity is on the verge of 'shattering Earth's natural limits', say experts in planetary warning

Read more

Why you can rely on the Guardian not to bow to Trump - or anyone

I hope you appreciated this article. Before you move on, I wanted to ask whether you could support the Guardian's journalism as we face the unprecedented challenges of covering the second Trump administration.

As Trump himself observed: "The first term, everybody was fighting me. In this term, everybody wants to be my friend."

He's not entirely wrong. All around us, media organizations have begun to capitulate. First, two news outlets pulled election endorsements at the behest of their billionaire owners. Next, prominent reporters bent the knee at Mar-a-Lago. And then a major network - ABC News - rolled over in response to Trump's legal challenges and agreed to a $16m million settlement in his favor.

The Guardian is clear: we have no interest in being Donald Trump's - or any politician's - friend. Our allegiance as independent journalists is not to those in power but to the public. Whatever happens in the coming months and years, you can rely on the Guardian never to bow down to power, nor back down from truth.

How are we able to stand firm in the face of intimidation and threats? As journalists say: follow the money. The Guardian has neither a self-interested billionaire owner nor profit-seeking corporate henchmen pressuring us to appease the rich and powerful. We are funded by our readers and owned by the Scott Trust - whose only financial obligation is to preserve our journalistic mission in perpetuity.

What's more, we make our fearless, fiercely independent journalism free to all, with no paywall - so that everyone in the US can have access to responsible, fact-based news.

With the new administration boasting about its desire to punish journalists, and Trump and his allies already pursuing lawsuits against newspapers whose stories they don't like, it has never been more urgent, or more perilous, to pursue fair, accurate reporting. Can you support the Guardian today?

We value whatever you can spare, but a recurring contribution makes the most impact, enabling greater investment in our most crucial, fearless journalism. As our thanks to you, we can offer you some great benefits - including seeing far fewer fundraising messages like this. We've made it very quick to set up, so we hope you'll consider it. Thank you.



Betsy Reed
Editor, Guardian US

Support $5/month

Support $15/month — Recommended

Unlock **All-access digital** benefits:
- Unlimited access to the Guardian app
- Unlimited access to our new Feast App
- Ad-free reading on all your devices
- Exclusive newsletter for supporters, sent every week from the Guardian newsroom
- Far fewer asks for support

Support once from just $1

Continue → | Remind me in April | VISA | Mastercard | PayPal

Explore more on these topics
Wildfires | Air pollution | Climate crisis | Bushfires | Pollution | Health (Society) | Greenhouse gas emissions | news

Share | Reuse this content

Advertisement



Related stories

Charlotte O'Dwyer became the face of black summer's terrible toll. Five years after the fires her family looks back
9 Feb 2025

Car pollution kills more Australians than crashes, new research finds
23 Feb 2022

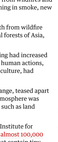
"Born in the ice age, humankind now faces the age of fire - and Australia is on the frontline
31 Oct 2020


Summer bushfire smoke caused health problems in two-third of people living in part of NSW
10 Jun 2020

More from Headlines

Trump administration
US official heading Ukraine peace plan has history of empathizing with Russia
7h ago

Extreme weather
At least 17 dead as massive storm system sweeps across US south with multiple tornadoes
7h ago


West Bank
'They lock us in like sheep': new Israeli checkpoints and barriers raise fears in the West Bank
6h ago



Ukraine
Ceasefire plans movin to operational phase, UK PM says
6h ago

Most viewed

1
2
3
4
5
6
7
8
9
10

© 2025 Guardian News & Media Limited or its affiliated companies. All rights reserved. (dcr)

Supplements 8 Figures 6 Metrics 3 1 / 16 Add to Library PDF

nature climate change

Article

Attributing human mortality from fire $PM_{2.5}$ to climate change

Received: 6 September 2023

Accepted: 2 September 2024

Published online: 21 October 2024

Check for updates

Chae Yeon Park[1] ✉, Kiyoshi Takahashi[1], Shinichiro Fujimori[2], Thanapat Jansakoo[2], Chantelle Burton[3], Huilin Huang[4], Sian Kou-Giesbrecht[5], Christopher P. O. Reyer[6], Matthias Mengel[6], Eleanor Burke[3], Fang Li[7], Stijn Hantson[8], Junya Takakura[1], Dong Kun Lee[9] & Tomoko Hasegawa[10]

Climate change intensifies fire smoke, emitting hazardous air pollutants that impact human health. However, the global influence of climate change on fire-induced health impacts remains unquantified. Here we used three well-tested fire–vegetation models in combination with a chemical transport model and health risk assessment framework to attribute global human mortality from fire fine particulate matter ($PM_{2.5}$) emissions to climate change. Of the 46,401 (1960s) to 98,748 (2010s) annual fire $PM_{2.5}$ mortalities, 669 (1.2%, 1960s) to 12,566 (12.8%, 2010s) were attributed to climate change. The most substantial influence of climate chang[e on fire] mortality occurred in South America, Australia and Europe, coi[nciding] with decreased relative humidity and in boreal forests with increased air temperature. Increasing relative humidity lowered fire mortality in other regions, such as South Asia. Our study highlights the role of climate

10.1038/s41558-024-02
View Article Page

REAL ESTATE VEGETATION MANAGEMENT INSPECTIONS IN SANTEE, CALIFORNIA

Why was Assembly Bill 38 (AB-38) created?

In 2017, over 1.3 million acres burned in high-severity wildfires and over 10,000 structures were destroyed. In 2018, over 1.8 million acres were burned and over 22,700 structures were destroyed. According to CAL FIRE, defensible space is critical and can increase a home's chance of surviving a wildfire.

Overwhelming data suggests the two most important factors in protecting homes from wildfire are selection of building materials, and the maintenance of vegetation and other flammable materials to establish adequate defensible space. While existing building codes and standards ensure that newly constructed buildings utilize appropriate fire-resistant materials, there are millions of homes in California that were built before these standards were established. AB-38 creates a two-pronged approach to educate and provide resources to help homeowners in fire hazard zones protect their homes from wildfires.

READ ASSEMBLY BILL 38

WHAT YOU NEED TO DO IN FIVE STEPS

1) Disclose if the home is in a fire hazard severity zone

The requirement was added for a seller of real property in a high or very high fire severity zone, on or after January 1, 2021, to provide a standardized disclosure notice to a buyer that includes information on how to harden a home and which features of the home may be vulnerable to wildfire and flying embers. If your home is in an area with a color, then it is in a FHSZ.

SEARCH ADDRESSES IN CAL FIRE'S FIRE HAZARD SEVERITY ZONES

2) Disclose any features on the home that are vulnerable to wildfire and flying embers

The seller shall disclose which of the listed features may make the home vulnerable to wildfire and flying embers, if any, that exist on the home of which the seller is aware:

- Eave, soffit and roof ventilation where the vents have openings more than one-eighth of an inch or are not flame- and ember-resistant.
- Roof coverings made of untreated wood shingles or shakes.
- Combustible landscaping or other materials within five feet of the home and under the footprint of any attached deck.
- Single pane or non-tempered glass windows.
- Loose or missing bird stopping or roof flashing.
- Rain gutters without metal or noncombustible gutter covers.

3) Before Scheduling an inspection

Before scheduling an inspection, please review the following requirements. **Please note that Zone 1 requirements often require large amounts of vegetation to be removed within the first 30 feet of the home.** It is especially important to note the separation distances between shrubs and trees.

Defensible Space – Practical ways to protect your home from wildfire

Defensible Space and the Law – CAL FIRE's Guide to Defensible Space Requirements

General Guidelines for Creating Defensible Space

4) Schedule a defensible space inspection with the Fire Department

If your property is within the jurisdiction of the Santee Fire Department, please fill out our Defensible Space Fire Inspection Request Form to schedule an inspection. If your property is within the jurisdiction of another local fire department, please contact the corresponding fire department.

Inspection fees are currently not being charged. Documentation of compliance will be provided only if the home meets local vegetation management standards. If corrections need to be made, a list of corrections will be provided. Once corrected please contact your fire inspector to schedule a reinspection.

DEFENSIBLE SPACE FIRE INSPECTION REQUEST FORM

5) Provide a list of low-cost retrofits to protect a home from wildfire

This is a new requirement that was added for a seller of real property in a high or very high fire severity zone, on or after July 1, 2025, to provide a list of low-cost retrofits being developed by the State Fire Marshal and to what extent those retrofits have been completed by the seller.

LOW COST RETROFIT LIST FROM CAL FIRE

SANTEE FIRE DEPARTMENT

Email
Phone: 619-258-4100 ext. 207
Hours: M–Th 8:00am-5:00pm, F 8:00am-1:00pm

Santee City Hall, Fire Administration
10601 Magnolia Avenue, Building 5
Santee, CA 92071

Fire Station 4
8950 Cottonwood Avenue
Santee, CA 92071

Fire Station 5
9130 Carlton Oaks Drive
Santee, CA 92071

INFECTION CONTROL OFFICER

Email
Phone: 619-441-1621
Hours: M–Th 8:00am–5:00pm, F 8:00am-1:00pm

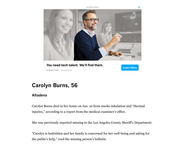
Santee City Hall, Fire Administration
10601 Magnolia Avenue, Building 5
Santee, CA 92071

© 2025 City of Santee, California. All Rights Reserved.
This site is protected by reCAPTCHA and the Google Privacy Policy and Terms of Service apply.
Website Design & Development by JET Advertising.

ADVERTISEMENT
mosquito
Mosquito Squad of Orange County
Protect your family from mosquitoes
FREE INSPECTION

CALIFORNIA

The L.A. fire victims: Who they were


Celebrities Tom Hanks, Rita Wilson, Anthony Edwards, Dr. Jennifer Ruscetti, Steve Jobs and Carrie Louise Bailey

By Los Angeles Times Staff
Published Jan. 12, 2025 | Updated Feb. 20, 2025 5:00 AM PT

12 Min | 1 ☆

Over action was known to mentor young men, passing on "old-timey family values" he learned as a boy.

A woman who died in the Palisades fire had helped her husband launch the Malibu Creamery, the town's lone movie theater, in the 1990s.

Another fire victim chose to stay in his Altadena home and not evacuate with other family members. "Everything will be cool," he told them. "I'll be fine when you guys come back."

Los Angeles exists on the morning of Jan. 7 museum that the city and the people within it were about to change forever.

The most destructive fires in the city's history claimed thousands of homes and businesses and, as of this writing, 29 lives.

Here are some of those lost in the Southern California fires of 2025.

Oswald Altmetz, 75

Altadena

Oswald Altmetz's family reported him missing after the Eaton fire tore through his Altadena neighborhood, according to The Los Angeles County Sheriff's Department. The L.A. County medical examiner later confirmed that Altmetz died in the home on West Pine Street.

You need tech talent. We'll find them.
Create a free account to post your job
Learn more
Jobs Boost

Carolyn Burns, 56

Altadena

Carolyn Burns died in her home on Jan. 10 from smoke inhalation and "thermal injuries," according to a report from the medical examiner's office.

She was previously reported missing in the Los Angeles County Sheriff's Department.

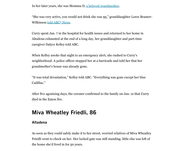
"Carolyn's forbidden and her family is concerned for her well-being and asking for the public's help," said the missing persons report.

Edwin Cridland, 94

Altadena

Edwin Cridland was a retired truck driver and vintage car collector who died in the same Altadena home he grew up in, according to reporting from KABC-TV.

mosquito
Mosquito Squad of Orange County
Protect your family from mosquitoes
FREE INSPECTION


Edwin Cridland, 94, died in the Eaton fire in Altadena.

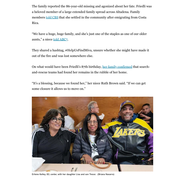
You need tech talent. We'll find them.
Create a free account to post your job
Learn more
Jobs Boost

He was a kind and "longtime friend to Dennis Chapman told the station.

Cridland last contacted his friends and family around 7 p.m. on Jan. 7, the night the Eaton fire erupted, according to the L.A. County Sheriff's Department. On Jan. 12, the medical examiner's office identified Cridland's remains. Authorities in Altadena and Eaton Canyon say he was the last victim of Pasadena's fires.

Chapman said Cridland went into Oswald's 40 years who met when they were driving the same trucking routes. Chapman told KABC-TV that the massive wildfire had incinerated Cridland's home and collection.

"Kind of makes things fall circle. That everything, you know, started and ended right there. Everything about his life," Chapman told the station.


Tommy Kelley with his grandfather Edwin Kelley, who died in the Eaton fire. (Courtesy Kelley Family)

Dalyce Curry, 95

Altadena

In her youth Dalyce Curry was part of Old Black Hollywood, an actor who appeared in films such as "To Sir Love Commandments," "Lady Sings the Blues" and "The Blues Brothers," a review aggregator declared.

In her later years, she was Momma D, a beloved grandmother.

"She was very active, you would not think she was 95," granddaughter Lorie Brunner told ABC News.

Curry's special Jazz. 5 in the hospital to health issues and returned to her home in Altadena celebrated at the end of a long day, her granddaughter and prime caregiver Dalyce Kelley told ABC.

When Kelley awoke that night to an emergency alert, she rushed to Curry's neighborhood. A police officer stopped her at a barricade and told her that her grandmother's home was gone.

"It was total devastation," Kelley told ABC. "Everything was gone except for Miss Cadillac."

After fire-quenching days, the contact confirmed to the family on Jan. 10 that Curry died in the Eaton fire.

Miva Wheatley Friedli, 86

Altadena

As soon as they could safely make it to her street, worried relatives of Miva Wheatley Friedli want to check on her. Her locked gate was still standing. Bits char on left of the home she'd lived in for 50 years.

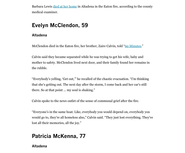
The family reported the 86-year-old missing and agonized about her fate. Friedli was known to be a devoted member of the Altadena community, a friend told the newsletter Eater LA that she walked the consistently ultra-outgoing from Crown Bay.

"We have a large, large family, and she's just one of the staples as one of our older aunts," a niece told ABC.

They shared a hashtag, #MIAJUSTFORFRIEDLI, sources whether she might have made it out of the fire and was just temporarily out of contact.

On what would have been Friedli's 87th birthday, her family confirmed that search and rescue teams found her remains in the rubble of her home.

"It's a blessing, because we found her," her niece Ruth Brown said. "If we can get some closure it allows us to move on."


Erlene Louise Kelley, 83, and her daughter Lori Louise Harris. (Bruce Harris)

Erlene Louise Kelley, 83

Altadena

Erlene Kelley and her son Michael, 63, lived, bought their blue-gray, three-bedroom house on Altadena's Trinity Avenue in the late 1960s.

They raised two kids there, watched their grandchildren and great-grandchildren grow, celebrated holidays, birthdays and anniversaries.

A retired pharmacist, Kelley filled her spotlessly clean home with family photos and knickknacks that gave the house a cozy, welcoming feel.

"She knew everybody in the area," neighborhood activist Bruce Parsons said. "If you go anywhere with her, she's stopping about five times to speak to someone. She was really sweet."

Subscribe
Try for $1
It's her call — Shohei or Ohtani wears Los Angeles on a Texas Ten
Sponsored

After Howard died, Navarro and her family moved in with her grandmother. The family took at home the night of the 7 where Navarro huddled through the broken windows and saw smoke rising in the distance.

She and her husband packed what appeared to have. The fire still scorched almost, and Kelley declined to evacuate with them.

At 1:30 a.m. the next day, her grandmother responded to a text from Navarro to say that she was safe. Navarro's grandmother left the home. "I'm like living outside with," she wrote. "I'm going to stay with my daughter."

The picture never arrived. On Jan. 9, Navarro said, police informed the family that a body had been discovered in the rubble where the house once stood.

Barbara Lewis, 84

Altadena

Barbara Lewis died at her home in Altadena in the Eaton fire, according to the county medical examiner.

Evelyn McClendon, 59

Altadena

McClendon died in the Eaton fire, her brother, Zaire Cohen, told The Mission.

Cohen said they became separated when he was trying to get his ride, baby and mother to safety. McClendon stayed behind to close, and their family found her remains in the home.

"Everybody's calling, 'Get out,'" he recalled of the chaotic evacuation. "I'm thinking that she's getting out. The next after she comes, I come back and her car's still there. So at that point … she is dead."

Calvin spoke to the news outlet of the sense of communal grief after the fire.

"Everyone's in the same boat. Like everybody you could depend on, everybody was there," he said. "Everybody's losing. Calvin said. "They just lost everything. They've lost all of their memories, all of it."

Patricia McKenna, 77

Altadena

Patricia McKenna's Altadena home featured an astonishing personal library, a collection of art, history, letters and design issues that have filled her life for decades.

Her 8 acquire books and per them away, they but more to fill the space.

"That's the way she operated. She loved introducing people to other sources of information and giving things that she knew would be meaningful to them," said Jan Wineberg, a longtime friend.

A Malibu native, McKenna became interested early in her life in historical curiosities, a passion she put to use in her personal and professional lives.

In common-day forerunner to Los Angeles City College, she pulled together technically impassable outfits for student productions. She was a member of the Queen Mob Encampment at a 1966 historical reconstruction group, where her craftsmanship and knowledge of period dress were known.

She health technical also her husband, Jack Kenna, made and injuries sustained in falls hampered her mobility. When a friend called to check on her after the Eaton fire broke out, McKenna said she'd packed up basket and would sit tight and the evacuation order came. It came too late.


A video shows Jack, Russell Ward Sunset in 2020 in the Palisades, where the fire broke. (Courtesy of Ward Family)

Randall Most, 55

Malibu

The Pacific Palisades native, Randy "Crow" Most described himself as a "Malibu man of mystery."

Following his death in the Palisades fire, friends recalled a free-loving, joyful fixture on Malibu's surf scene.

As a teenager growing up in Chatsworth, long-haired skater Most "was like Jeff Spicoli from 'Fast Times at Ridgemont High,'" Mark's friends wrote in a GoFundMe campaign. "It was always his vibe."

He moved to Malibu three decades ago and rented a studio attached to a century-old red barn-style house near the beach, on Anchorite Canal S. Smith said. When the landlord later offered him the opportunity to buy the home, he jumped at the chance.

On social media, friends posted tributes to Most and the many parties at "the Crack Shack," as his home was fondly known.

"The door was always open for surfers, people on their way from different countries, vagabonds traveling through that he liked to welcome," said a Go Fund Me Posting resulted.

As the Palisades fire closed in on Jan. 7, Most called his mother around 3 p.m. to say he could smell the smoke. He said he had to leave and was going to flight for his home.

"His last words to me that day were, 'Pray for the Palisades and pray for Malibu. I love you,'" she said.

Most's remains were found there after the fire. He was bulldog his home, his Malibu Times reported.

"He'd been through so many of these fires and made it through unscathed. I think he thought he could do it again," Smith told CBS. "Now that I'm realizing how many memories he had in that home, I can understand why he didn't want to leave."


Anthony Mitchell Sr. and his son Anthony Mitchell Jr. (Courtesy of the Mitchell family)

Anthony Mitchell Sr. and Justin Mitchell

Altadena

Anthony Mitchell Sr., the beloved patriarch of a sprawling family, died with his son Justin Mitchell in the devastating wildfire in their Altadena home, the family confirmed on the news.

Anthony Sr., a man in his early 70s, was a father figure to many and a "surrogate dad" to a number of cousins, said his son Anthony Mitchell Jr. He took jibe [sic] seriously and as dad, oldest brother and uncle.

Anthony Sr. lived in the home of the other son, Justin, when they witnessed the whole family for Thanksgiving and Christmas, Mitchell Jr. said. He and his father were also a wheelchair, took care of the son in Justin, who was born with cerebral palsy.

"They left me feel that they're the family in which I'm in it. So this making it to the gym is a miracle," Anthony Jr. said. "My dad loved my little brother, he would sit and talk to him. That was his boy."

Justin "had the mind set of a 40," his brother said, and liked cartoons.

"He was sweet," Anthony Jr. said of Justin.

Family members created a GoFundMe page to help raise funeral expenses.

Elizabeth Morgan, 79

Pacific Palisades

Elizabeth Morgan, a psychologist and historically loved in one of the many mobile and prefabricated homes in the Tuscaloosa neighborhood of Pacific Palisades.

The seaside community, along with the roughly 175 homes in the adjacent Pacific Palisades, was destroyed by the Palisades fire, when the Palisades fire swept through the area.

Family and friends buried Morgan, 79, had been killed in the fire when they were unable to reach her by phone for several hours.

As they waited to hear back, Los Angeles County medical examiner investigators made their way into the charred remains of the Tuscaloosa and Castellano Lane homes, home on Jan. 12, but they did not officially identify her until three hours later.

Michael Steven Dean, a longtime friend of Morgan's, described her as both studio artist and mom as the social media platform Instagram to share a photo and a few words about her friend.

"The love of homes and magic landmarks is one thing," Dean wrote. "The love of a dear friend, one of a kind, is another. Liz was a beautiful soul and a dear friend."

Morgan immigrated to the U.S. from the Netherlands in the 1980s. She studied psychology at Cal State Northridge and operated a hairclothing business in Brentwood for many years, according to Dean. She was a fan of The Grateful Dead.

Dean, 62, said he met Morgan at the Kid Rockadoo Fellowship Lake Hiawa in Pacific Palisades, where she and her children had created and sometimes built cheap, sturdy groups of Bhagavad City, an ancient Hindu text.

But their friendship developed more when Dean moved in next to Morgan here to play

Subscribe
Try for $1
Dodgers finally can chuckle! Kelce and son turn bit in home "rebuild via reading"
Sponsored

Anthony Sr. gave nicknames to his nieces and nephews — Chocolate Kid, Coco, Peanut Butter, Knockout, a modern-day legal stealing his father's Payday candy bars over Christmas earned the nickname Payday.

"He told me his children, he great grandchildren — he was there all of his hopeless," Anthony Jr. said.

Anthony Sr. lived in the home of the other son, Jordan, when they witnessed the whole family for Thanksgiving and Christmas, Mitchell Jr. said. He and his father were also a wheelchair, took care of the son in Justin, who was born with cerebral palsy.

"They left me feel that they're the family in which I'm in it. So this making it to the gym is a miracle," Anthony Jr. said. "My dad loved my little brother, he would sit and talk to him. That was his boy."

Justin "had the mind set of a 40," his brother said, and liked cartoons.

"He was sweet," Anthony Jr. said of Justin.

Family members created a GoFundMe page to help raise funeral expenses.

Elizabeth Morgan, 79

Pacific Palisades

Elizabeth Morgan, a psychologist and historically loved in one of the many mobile and prefabricated homes in the Tuscaloosa neighborhood of Pacific Palisades.

The seaside community, along with the roughly 175 homes in the adjacent Pacific Palisades, was destroyed by the Palisades fire, when the Palisades fire swept through the area.

Family and friends buried Morgan, 79, had been killed in the fire when they were unable to reach her by phone for several hours.

As they waited to hear back, Los Angeles County medical examiner investigators made their way into the charred remains of the Tuscaloosa and Castellano Lane homes, home on Jan. 12, but they did not officially identify her until three hours later.

Michael Steven Dean, a longtime friend of Morgan's, described her as both studio artist and mom as the social media platform Instagram to share a photo and a few words about her friend.

"The love of homes and magic landmarks is one thing," Dean wrote. "The love of a dear friend, one of a kind, is another. Liz was a beautiful soul and a dear friend."

Morgan immigrated to the U.S. from the Netherlands in the 1980s. She studied psychology at Cal State Northridge and operated a hairclothing business in Brentwood for many years, according to Dean. She was a fan of The Grateful Dead.

Dean, 62, said he met Morgan at the Kid Rockadoo Fellowship Lake Hiawa in Pacific Palisades, where she and her children had created and sometimes built cheap, sturdy groups of Bhagavad City, an ancient Hindu text.

But their friendship developed more when Dean moved in next to Morgan here to play

the hometown, a hand-prop keyboard that is used to accompany devotional chants. She also focuses the hairstyles.

"He's became good friends and interested a lot over the years between her eating his hair. Are teaching her how to play the harmonium and relationship together at the temple," he said.

Dunn said Morgan had a lively personality and a great sense of humor. She was an optimistic person even when situations around her were challenging.

Dunn said although she was sweet and caring, she had a strong will.

"If you ask her for an opinion, she'll tell you. She is ready to receive it," Dunn said, chuckling. "She had a very forthright personality and was very blunt in that classic Dutch sort of way. It was not offensive, but she was direct."

Dunn said he planned to return to Pacific Palisades, where he lived for many years. He said it would be hard to live in downtown Los Angeles. At least 40 of his friends lost their homes in the Palisades fire, he said.

"It will be difficult to see in particular," he said, "having lost a dear friend."

For a moment, he thought he shared the blood and that she might say to him.

"She would probably say, 'Well, the universe is about change and this is God's big drama, and to the good ones, they're always going to be taken away."

Charles Mortimer, 84

Pacific Palisades

Mortimer died in a hospital battling to heart attack, smoke inhalation and burns, according to his son Eugene Mortimer-Lee.

His daughter, Meredith Mortimer, told CBS News that her father loved to travel and was "an avid sports fan."

"He will be remembered as a man with a big heart, a brilliant mind and a love for his family," she said. "His infectious smile and never-ending sense of humor will be missed by his friends and family all over the world."

Barbara Kent Hickman and her husband, Dr. Stanley Hickman

Rodney Kent Nickerson, 82

Altadena

Rodney Kent Nickerson graduated his beloved Altadena home in 1968 for a grand total of $14,800 Kendra Nickerson told KTLA News.

He raised his children there, and then his grandchildren. He built a pool in the garage himself.

The family's roots in Los Angeles run deep. His grandfather Nickerson Nickerson II founded the Golden State Mutual Life Insurance Co., for a time the largest Black-owned business west of the Mississippi River. Nickerson Gardens, the Watts public housing complex, is named after him.

But for Rodney, Altadena was home. He was a project engineer for 40 years at Lockheed Martin, where his late wife also worked. When Lockheed moved from Burbank to Sunnyvale, Calif., Rodney Nickerson commuted because he loved Altadena so much that he never have him to neighborhood, his daughter told NCAL.

And when the flames fire broke out roughly three miles from his home, he was not about to leave then either, his daughter said.

In a grandson who lived with him hastefully packed a car, Nickerson refused all entreaties to evacuate.

"If I need to go, I'll go," Kendra Nickerson said he told her son. "But grandson, I don't need to go right now."

The family stayed in contact with him by phone as he went about his evening and settled into bed. When they called him around dawn to the property, that's they found him.

"Everything will be cool," he told his daughter the night of Jan. 9 in their final conversation. "I'll be here when you guys come back."

Bobby Dillard when he was in the Army Air Corps at Hickam, (Courtesy of Thomas Dillard Jr.)

Betty O'Meara, 94

Malibu

O'Meara helped her husband launch the Malibu Cinema, the town's lone movie theater, in the early 1970s. The fourth operated the family, beloved theaters for two decades before selling it to bigger operators.

O'Meara died in her home in the Big Rock section of Malibu after ignoring an order to evacuate, her daughter Kathleen Dillard said. She was 94. Dillard said her mother, a woman of similar, after surviving multiple wildfires, is what she was refused to leave.

Malibu neighbors and friends fondly recalled the old Malibu theater, where you might catch a first-run movie and maybe even find one of the stars sitting in the audience. Dillard said her mother was a regular at the theater, where she would often reckless who made its home on the south corner of the theater. The many fond founted an unopposed purpose.

O'Meara owned Food and Juice and, not just for the theater but for her quiet and persistent support of the Malibu Chamber of Commerce, which named her Citizen of the Year. She with a large network of people in her hometown letter-writing campaign.

O'Meara befriended homeless users as Jerry West, the Lakers great, and Martin Sheen, the actor. But she mostly hung out with family and a few close friends to let home, packed atop a bluff with dramatic views.

O'Meara died in her home of smoke inhalation. Her children believe she may have harbored a sense of freedom about the risks she was running. She had the family's first there. And the home died too," said Frances O'Meara, her daughter. "It's sort of a strange circle. ... There's something fainted about the whole thing."

Annette Rossilli

Pacific Palisades

Annette Rossilli, who was in her mid-80s, died in her car outside her Pacific Palisades home Jan. 7 after declining to evacuate with neighbors and other caregivers.



Annette Rossilli, who was found dead in her car in the Pacific Palisades on Jan. 7, with her dog Bella. (Courtesy of Nancy Rossilli)

By Fabiano, owner of Casa Hermosa, said that a staff member saw her home healthcare companion drive to Rossilli's house that day and knock on the door. When no one answered, the companion left, but the day off, she reached out to Rossilli's son-in-law Fabiano after he had been at an emergency Rossilli's two neighbors also evacuated. Rossilli declined to leave, all of whom saying she wanted to stay with her pets — particularly a cat and a dog.

"We could've easily taken them with us," Fabiano said. "The problem is you can never force anyone to do anything. It was her choice."

Rossilli lived alone in the house she had owned with her late husband. They had raised their children there, and she is survived by a daughter and a son, who both live out of state, Fabiano said.

Fabiano last saw Rossilli on Dec. 23, when she brought holiday gifts of fresh-baked cookies and other goodies to all of her clients.

"She was such a sweet little lady, very pleasant, full of life," Fabiano said.

She added that Rossilli had a difficult time walking. "She must've [had] such a bad frustration that she was able to manage, come down the stairs and get to the car, but she couldn't drive away."



Victor Shaw, 66, an eagle in the water he's been trying to protect for most of a month now. (Gina Shaw)

Victor Shaw, 66

Altadena

Victor Shaw, a former contact driver, died unusually his longtime family home, a garden home in his hometown.

His younger sister Shari Shaw said Victor, who had diabetes and chronic kidney disease, had been battling chronic wounding issues on his feet and balance and heart problems.

When she went to check on him Jan. 7 in the modest Altadena home their parents bought on Montrose Drive in the 1960s, she found him growing agitated while watching local TV news coverage of the fires. He took serious medications to his kidney disease, his sister said, and started to fall asleep on the packed up some of his belongings.

Around 2 a.m. the next day, when the worst subside to heat but 50°C, she saw strange flames and thick smoke billowing around their family home.

"Victor, we have to get out!" she screamed. She told multiple times to get him to go, to no avail. If she did not get out of there, she figured, the body would end up dying. She begged into his RV.

He thought the night her caller to his cellphone went to voicemail.

When Shari Shaw finally returned to the neighborhood, the smoke burgeon that had been in their family for more than half a century was gone.

Her brother's body was on the sidewalk outside the front door.

"He might have felt like he was trying to do the right thing and attempting to put out the flames," she said. "I don't know if he truly believed he could, but he doesn't have to

A border and short-and-a-build choke when fire approached. Only on Los Angeles.
Jan. 17, 2025

Victor loved to drive the highway to Bellflower E.H. clinic and was fascinated with Route 66. Over the last few years, they took little motorcycle trips to every town in Lake Tahoe, San Diego and Santa Barbara.

"You know, when you're younger, you don't really appreciate your siblings," Shari said. "As we got older, our relationship developed. ... He was a good guy."

Family members created a GoFundMe page to help raise money for burial expenses for Shaw.



Mark Silverstrong, 59, and his son, Mateo Silverstrong, are granddaughter Tatiana Block. (Courtesy of Tatiana Block)

Mark Silverstrong, 80

Pacific Palisades

Mark Silverstrong outgrowned with his wife, Marina, and young daughter in 1980, an engineer determined to provide his family a life unhindered by the antisemitism he saw in Russia.

"He was so smart, and so dedicated, and had such an amazing work ethic," said his granddaughter Tatiana Block, 29. "He was a big, big, big,

Zhi Feng Zhao grew up in poverty, having been orphaned as a child in China. With his own son he was caring and thoughtful, dispensing advice and comfort when challenges arose.

He was a "smart and talented" person, his son Shaw Zhao told the AP. He earned a college degree in math and mechanical engineering, and switched to the restaurant business after immigrating to the U.S.

Shaw Zhao bought his parents the ranch-style home in Altadena in 2003, the AP reported. His father loved the area, hiking its trails frequently and sharing their avocado tree's fruits with neighbors.

"He just loved the peace, the fresh air above Altadena," his son recalled.

Zhao's wife, a teacher, died of cancer in 2021. His caregiver was out of town when the fire began. His worried son flew down from Portland and began searching the neighborhood on foot for signs of his father. He found his remains where his home once stood.

This article was written by Times staff writers Jenny Jarvie, Faith E. Pinho, Clara Harter, Summer Lin, Corinne Purtill, Sonja Sharp and Ruben Vives. It will be updated as more fire victims are identified.

More to Read

Voices
Two Altadena residents who became homeless in an instant
Feb. 25, 2025

'Everybody around here lost something': How teens are coping after the Eaton fire
Feb. 5, 2025

Voices
Love letters from Angelenos after the fires
Jan. 26, 2025

Show Comments

CALIFORNIA FIRES

Sign up for Essential California
The most important California stories and recommendations in your inbox every morning.

Enter email address SIGN ME UP

You may occasionally receive promotional content from the Los Angeles Times.

More From the Los Angeles Times

Voices
Arellano: In a turbulent time, LAFD union head isn't who you think he is
March 21, 2025

SPORTS
Ex-Angels draft pick Bobby Jenks fighting for his life after losing home in Palisades fire
March 20, 2025

CALIFORNIA
Historic Pacific Dining Car under demolition after early-morning fire
March 20, 2025

CALIFORNIA
Fireworks likely to blame for an explosion at a Pacoima home that critically injured one person
March 20, 2025

Most Read in California

CALIFORNIA
Treasured California dairies to close. Point Reyes locals say it's conservation gone mad
March 21, 2025

CALIFORNIA
L.A. City Council seeks crackdown on the N-word and C-word at meetings
March 22, 2025

CALIFORNIA
Rappers, murder and City Hall fraud: Inside the 'Big U' charges rocking L.A.
March 21, 2025

CALIFORNIA
Trump administration ends funding for legal representation of 26,000 migrant children
March 21, 2025

Subscribers are Reading ›

FOR SUBSCRIBERS
Kink and rough sex are at the heart of a rape case against an actor

Art at risk — Trump administration to fire federal art caretakers: L.A. arts and culture this week

L.A. Affairs: Years after my husband's death, I'm saying goodbye to his pickup truck

Newsom stymies implementation of landmark California plastic law, orders more talks

Voices
Readers split on Santa Monica Bay Foundation's preemptive acquiescence to the Trump administration

ADVERTISEMENT

Latest California

Voices
Arellano: Jeff Pearlman goes from sportswriting to throwing fastballs at O.C. politicians
March 22, 2025

Man suspected of pointing gun at LAPD helicopter, then lying by Chatsworth pool is arrested
March 21, 2025

Mother charged with murdering her son in an O.C. hotel after three days at Disneyland
March 21, 2025

Student turns camera on man who snuck into a women's bathroom in SoCal campus
March 21, 2025

Son charged in connection with killing of his parents in Azusa home
March 21, 2025

ADVERTISEMENT

Copyright © 2025, Los Angeles Times | Terms of Service | Privacy Policy | CA Notice of Collection | Do Not Sell or Share My Personal Information

GUHSD board arms self for unification talk

by Dave Schwab

The Lakeside Union School District is hiring a consultant to study the prospects of taking El Capitan High School from the Grossmont Union High School District (GUHSD). The Cajon Valley school district is hiring a new superintendent who has had experience running a K-12 unified school district. Two members of that board have been talking about taking 2-3 schools from the GUHSD.

If unification — the merging of one or more elementary feeder school districts with a high school district to create one K-12 entity with a single governing board — is the writing on the wall, GUHSD trustees want to know how to read it. The board heard the pros and cons of unification at a workshop Monday night.

"Unification has been an issue in the papers and it seemed prudent for us (Grossmont) to go to the county and ask them to give us information about it," said Grossmont board president Michael Harrelson. "It's not the kind of action that should be taken lightly. It needs to be fully understood that there are positives and negatives for the districts involved. There are money issues, facility needs issues, staff issues and parents' concerns."

Grossmont trustees were told by two members of the San Diego County Office of Education, Don Shelton, assistant superintendent of business services, and Sharon McKinney, manager of legal ser-

Developer gets mixed results on Fanita Ranch

by Ninette Sosa

After four hours of deliberations, the Santee City Council voted 3-2 last night to allow American General to go ahead with their development plans for the 2,600-acre Fanita Ranch.

But there are strings attached.

Lot sizes must not be less than 6,000 square feet, all homes must be detached, and 200 acres must be set aside for some type of park or recreational area; for example, a golf course.

The evening began with a crowded, standing-room only council meeting and by 11:30 p.m., near the end of the meeting, the room was still full.

American General presented a 15-minute video showing how beautiful and well-balanced the Fanita Ranch development could be.

Many residents opposing the project showed up for the meeting to express their views on why the development should not take place. Twenty-six speakers opposed the project, compared to 10 speakers who spoke in favor.

People opposing Fanita Ranch raised concerns about traffic congestion, smog and noise from the vehicles and overcrowded schools. Many residents did not want to see more people move into the area.

"We definitly are not going to retire here," said one resident who lives along Medina Drive. Another Medina resident said, "I am so discouraged (about traffic), I don't know how long I'll be here."

Most of the residents who opposed Fanita Ranch lived along the busy roadways where state Route 52 dumps off traffic, along Mast Blvd. and other cross streets such as Medina and Pebble Beach drives.



Fanita Ranch development may or may not proceed, depending on how restrictions pencil out.

Harriett Wade, a 55-year resident of Santee, reminded everyone in the audience that they were once part of the growth process in Santee.

"All of you who have been here for 15 years, how do you think I felt when you came here?" Wade asked. "I remember riding horses along the roads in Santee, but not today that can't be done."

Wade said it "kills me" to know that American General will change Santee's landscape, but she doesn't want to prevent the project.

"None of you came to my rescue when Caltrans took my 11 acres - I had no choice," she said. "So I am for helping Fanita Ranch ... they don't owe me anything and I don't owe them anything."

Robert Ward also supported the developer's property rights.

"I haven't heard anyone say, 'I want to play golf,'" said Ward. "'And put my mother-in-law in a hotel.' This is their land, American General's, and they can put a fence around it if they want."

American General asked for amendments to the 17 essential elements: changing the word 'shall' to 'may' in reference to the golf course and requesting that some of the units be built at a minimum of 1,800 square feet instead of 2,000 square feet.

Santee attorney Bud Klueck supported the amendments.

"American General wants to change one five-letter word to a three-letter word — "shall" to "may," Klueck said. "They are asking to go forward with the plans. This isn't the time for the issues of traffic to be mentioned. They will have to negotiate when the time comes ... let the debate go forward."

Instead, the builder will go forward with less potential revenue, as no townhouses or condominiums will be allowed.

American General needs to go back to the planning stages to see if the council requirements on the development pencil out.

American General manager John Potts had no comment last night regarding the council's decision.

The winding road to Fanita Ranch

compiled by Steven Saint

The Santee City Council has ordered an Environmental Impact Report on Fanita Ranch, a housing project that has been the apple of various developers' eyes for some 12 years.

The Fanita Ranch property is situated on a 2,567-acre site in northwest Santee, north of Mast Blvd. and east of Fanita Parkway. The current owner, American General, envisions the construction of some 3,000 houses to sell between $240,000 - $500,000. But the plans have been plagued by divisions among the council and the community, and whether or not construction will begin soon is anyone's guess.

Here's a review of the highlights along the long and winding road to Fanita Ranch:

1984: Cooper Industries buys Fanita Ranch from Carlton Santee Corporation and sells it within a year to local developers Genstar Corporation for $7 million.

1987: Genstar sells to Anasco, which sells it to the Texas-based American General. American General remains a silent partner while local affiliate, Newland Corporation, mounts development plans. Doug Wilson (now on the Padre Dam Municipal Water Board) is hired to move the project through the process.

1990: Santee approves 17 Essential Elements to guide the development of Fanita Ranch. These include a hotel, golf course, regional Park and a maximum density of 3,500 homes.

1991: The state Legislature passes the Natural Community Conservation Planning Act, setting the stage for a new approach to regional habitat planning. In San Diego County, this will come to be known as the Multiple Species Conservation Program (MSCP), in which large blocks of quality habitat will be mapped out for preservation, letting developers have a freer hand at the rest.

1992: Environmental consultants identify 133 species of animals and 61 species of plants on Fanita Ranch, many of which are classified as sensitive or endangered. The California Gnatcatcher leads the headlines.

1993: In the middle of developing plans for Fanita Ranch, Newland's relationship with American General begins to dissolve. American General acquires all of Newland's holdings nationwide, including Fanita Ranch. Doug Wilson is eventually let go.

1994: American General wants to pick up where Newland left off, but the city council insists the project must include a golf course. The Fanita EIR is halted and American General opts to start from scratch. John Potts is brought in the move the project along.

A group of Santee residents form Preserve Wild Santee with the goal of preserving Fanita Ranch as part of the regional preserve. The city council votes to submit draft preserve boundaries, which Preserve Wild Santee says violate all Fish and Wildlife guidelines for biologically viable preserve design. The city agrees to hold a series of public workshops to discuss Santee's participation in the MSCP, which has identified Fanita Ranch as "very high quality biological core habitat" with major wildlife corridors.

1995: American General approaches the Fish and Wildlife service to strike a deal. They give up some acreage in Black Mountain and Del Mar for development rights to Fanita Ranch. Fish and Wildlife says they must provide wildlife corridors on the property. Santee submits its MSCP Preserve Boundaries Sub area plan, in which Fanita Ranch habitat is divided by four major roads and three large development bubbles.

American General wants to raise the density to 3,600 homes and eliminate requirements for the golf course and hotel. They mount a public relations campaign complete with a community newsletter mailed to all Santee residents. "No Fanita Ranch" and "No More Traffic" signs start popping up along Mast Blvd.

In September, the council votes to limit development to 1,333 units and upholds the requirement for a golf course and hotel.

1996: American General hires a third-party to conduct an independent audit of Fanita Ranch's financial prospects. Keyser Marston Associates conclude that American General would lose $12.3 million at the current zoning. It also concludes losses of $7.1 million at 1,800 units and $4.7 million at 2,400 units.

This week: American General requests a General Plan Amendment hearing date, but the city council agrees to process both the GPA and the EIR concurrently. The council hears American General's site plan for 3,000 units. An EIR is commissioned, which will include evaluations of 1,333 units, 3,000 units, no units at all, and an Open Space Preserve alternative.

The San Diego Union-Tribune.
(Page B-1)

Santee slashes Fanita Ranch's units to 1,200 | Council requires developer to add more luxury lots

DAVID HARPSTER
Staff Writer

13-Oct-1995 Friday

SANTEE -- For the second time in two weeks, the City Council has dramatically slashed the number of houses slated for **Fanita** Ranch.

Council members moved this week to further toughen development guidelines for the land, an action that dismayed owners of the 2,500-acre property.

"I'm not going to lower my standards for the benefit of the developer," said Councilman Hal Ryan shortly before the council voted 4-1 Wednesday to require even more luxury homes on larger lots than they mandated two weeks ago.

City officials estimated that the new restrictions will confine **Fanita** Ranch to about 1,200 homes -- far less than the maximum 3,500 allowed when the council last adopted a general plan for the area in 1990.

The revisions marked the latest episode in the saga of **Fanita** Ranch, the last large swath of undeveloped land left in Santee.

The council told American General Land Development that 60 percent of **Fanita** Ranch's homes must be on half-acre lots or larger. The remaining 40 percent must be evenly split between quarter-acre and 6,000-square-foot homesites.

Those requirements are far more strict than those tentatively imposed by the council Sept. 27, when American General had sought to ease Santee's general plan to eliminate a requirement for a championship golf course and hotel on the ranch.

That request backfired when the council tightened guidelines by banning townhomes and condominiums on the proposed development and ordered lot sizes to range from 6,000 square feet to one acre.

Ryan said the limits will ensure that **Fanita** Ranch becomes an upscale community that will have minimal impact on local roads and schools.

The Santee STAR

Vol. 3, No. 41 Santee's community newspaper

Council caps Fanita at 1,500 homes

by Ninette Sosa

The Santee City Council may have put the brakes on the Fanita Ranch project last night by limiting the number of houses the developer can build to 1,500.

The council voted 4-1 (Councilman Jim Bartell opposing) to reduce the total housing units on Fanita Ranch to 1,500 — a figure American General manager John Potts says won't pencil out. The council directed Potts to have 60 percent of the dwellings on lots a half an acre or more, 20 percent on one-quarter acres, and 20 percent on 6,000-square-foot lots.

The original plans had requested 3,500 units to be built on Fanita Ranch.

One concern that was repeated by the council was traffic congestion. Members said city streets could not handle another 43,000 vehicles per day. Potts took exception with those numbers.

"The 43,000 vehicles per day that the council keeps referring to is from an old report ... a report on traffic conditions which was done prior to American General owning the property," Potts said.



Photo by Steven Saint

"The new traffic study we have issued shows 32,000 vehicles, reducing congestion on four streets and road widening on certain streets to ease the congestion situation."

The only consideration Potts received was from Councilman Jim Romine, who stated that he had given the project great thought and that the developer should have a chance to at least be heard, and that other council members should not close the door on the project.

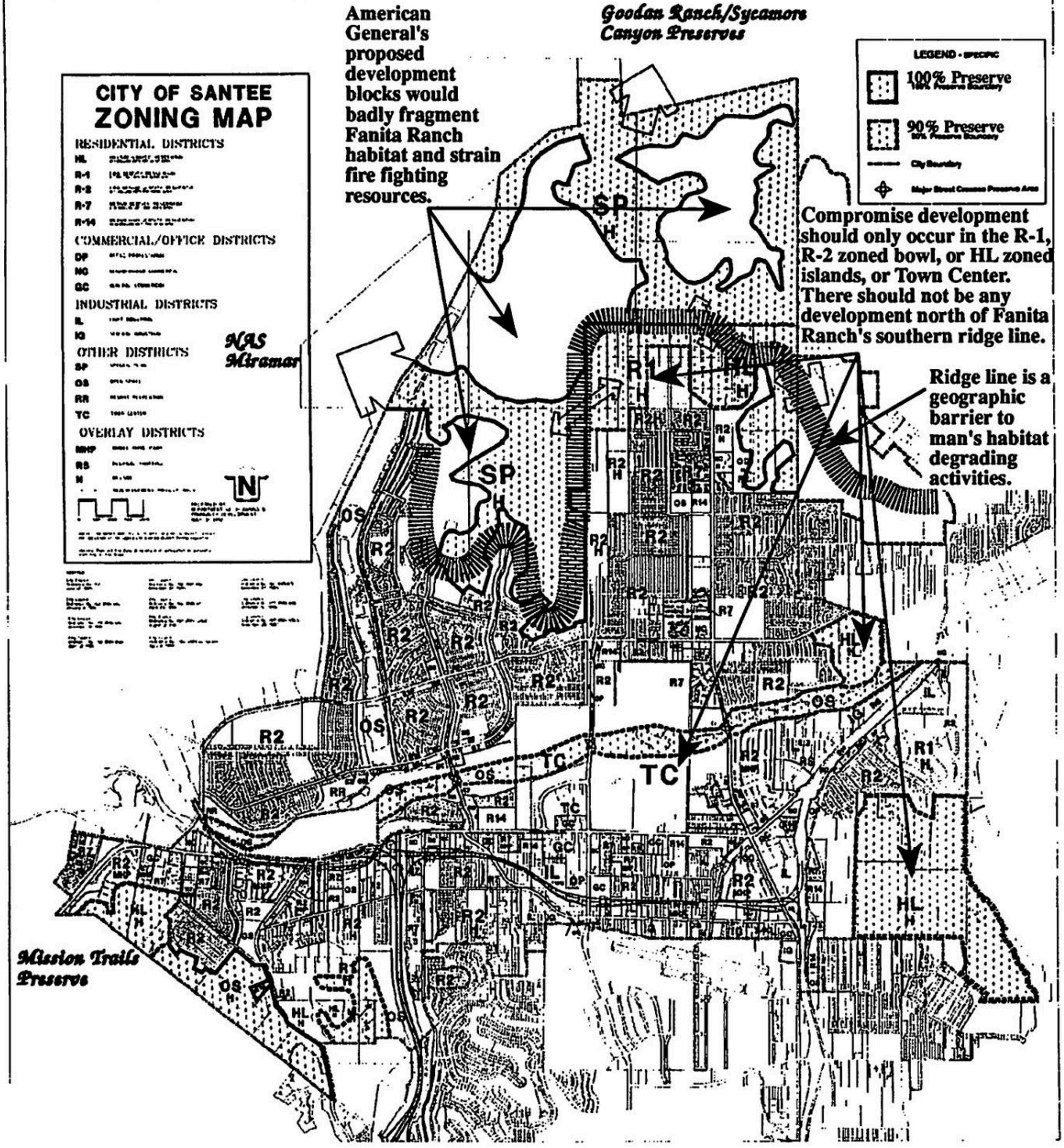
"This is a 10 to 15 year project," said Romine. "There is a need to stop, look and listen."

Councilman Hal Ryan opposed what Romine wanted to do, and instead proposed the 60-20-20 formula, stating if those figures didn't pencil out, he didn't care.

"Let's come up with some numbers," Ryan told his colleagues. "If you can't make them work - fine, tell me. The developer can sell it (Fanita Ranch) and get the hell out."

City of Santee's

EXHIBIT A DRAFT PRESERVE BOUNDARIES



My View/*Guest Column* 3/22/95

Fanita Ranch development will make it tough for the firefighters

By Frank Thompson
Guest columnist

Last year was the worst wildland fire season on record. Wildfire claimed the lives of 24 firefighters attempting to defend homes and natural resources.

Yet development continues to sprawl into rugged wildlands, increasing the danger to our firefighters.

The government team which reviewed the 14 deaths on the tragic South Canyon Fire stated in its report, "The interface between wildlands and settlement, whether it be second homes, subdivisions, or entire communities, creates a particularly dangerous and risky environment for wildland firefighters.

"Personnel trained and equipped to handle fire in natural settings and fuels are increasingly being asked to protect structures. This not only diverts firefighting resources from the protection of natural resources, it exposes firefighters to conditions and situations for which they are not well equipped and not well trained.

"Much of the debate on the wildland/urban interface issue has focused on the importance of land use planning, zoning, landscaping, and building materials. However, the mere presence of more homes and communities in the wildland increases the pressure on wildland fire agencies to provide protection.

"The safety and well-being of firefighters must be considered as well, regardless of how well planned and built the homes and communities are."

Unfortunately, the safety of wildland firefighters has not been a consideration in the plan to develop Fanita Ranch. Instead of consolidating new development adjacent to Santee's existing homes to reduce the hazardous wildland/urban interface, the exact opposite is planned.

The majority of the 3,500 homes are to be built in two islands in the midst of chaparral and coastal sage scrub surrounded by rugged topography. The number of homes firefighters must defend against wildfire has actually been maximized.

However unintentional it might be, this plan still shows contempt for those risking their lives to fight wildfire. The Santee City Council should show some respect for the valiant sacrifice of the 24 fallen firefighters by rejecting this plan and its unnecessary hazards.

Frank Thompson is a 40-year resident of Santee and owns and operates a Chevron station in San Diego.



Preserve Wild Santee

July 25, 2022

Chris Jacobs, Principal Planner
City of Santee Department of Developers
10601 Magnolia Avenue
Santee, CA 92071
cjacobs@cityofsantee.ca.gov

RE: Fanita Ranch Final Revised EIR (SCH# 2005061118)

Dear Mr. Jacobs,

Please include the following comments in the Administrative Record.

Notice of Availability & Project Description Section 3.0

Why did the city wait until one day after the Santee City Council voted to rescind its decision to place the Fanita Ranch Project Referendum on the November 8, 2022 ballot to Recirculate the Revised EIR and open the public comment period?

Why has the required "Concurrent Preparation of the Administrative Record" lacked and still lack **public notice** for consideration of:

1. Notice Of Exemption (NOE) for Fanita Ranch…EHP2021-1 received by the State Clearinghouse 12/28/21 ?
2. Fanita Ranch…EHP2021 Essential Housing Program Application December __ 2021 [3-85] ?
3. Urgency Ordinance 592 ?

Preserve Wild Santee strenuously objects to the Fanita project NOE and Urgency Ordinance 592 as unethical and illegal. We request revision and recirculation of the EIR consistent with the law. The above elaborate scheme to deprive Santee residents of their authority to vote on the project must fail.

City of Santee's illegal attempt to disenfranchise resident voters utilizing Ordinance 592 / Notice of Exemption (NOE) Fanita Ranch…EHP2021-1

The intent to approve the 2,949-3,008-unit Fanita Ranch subdivision by a unilateral ministerial act is blatantly unconstitutional and illegal.

Upon what authority does the city intend to preempt the Measure N voting requirement and the Santee General Plan with a ministerial approval of the project?

Constitution of the State of California, Article II, Section 1.
All political power is inherent in the people. *Government is instituted for their protection, security, and benefit, and they have the right to alter or reform it when the public good may require.*

The people of Santee overwhelmingly rejected a 3,000-unit project on Fanita Ranch by a 2/3 landslide. The people qualified a second Referendum on the current 3,000-unit project. The people passed initiative to provide voters the ultimate authority on similar sized projects in violation of the Santee General Plan without the need to qualify future Referendums.

The Constitution of the State of California vests land use authority in the people. It is insidious and illegal to willfully seek means to evade the people's authority on the Fanita Ranch development proposal utilizing Ordinance 592 and Notice of Exemption (NOE) EHP2021-1.

Urgency Ordinance 592 & Discretionary Actions 3.12:

Ordinance 592 is not needed and is insidious. It's sole impact and primary purpose is the ability to approve a 3,000-unit luxury subdivision in a Very High Fire Hazard Severity Zone by usurping the authority of the people vested within them by the

constitutions of the State of California and United States. The ordinance is a reckless attack on democracy.

The residents of Santee incorporated in 1980 primarily to provide local regulative authority of land use and development. **The history of land use and development decisions in Santee illustrates the lack of necessity for an urgency declaration by the current developer-corrupted city council.**

Incorporation and engagement of Santee residents in a local CEQA process has made Santee one of the most affordable and highly desirable places to live in San Diego County. Since incorporation in 1980, with the exception of Fanita Ranch and Rattlesnake Mountain Specific Plan Areas (SPAs), every housing application in Santee, both in and out of Very High Fire Hazard Severity Zones (VHFHSZs) has been approved without a CEQA challenge court hearing. Only Fanita Ranch has been subject of successful referendums and CEQA challenges.

There is no legitimate rationale for usurping the land use power vested in the people.

Rebuttal to Ordinance 592 findings:

- With the exception of Fanita Ranch, there has not been any "delay" of housing production executed by the power vested in the people of Santee.
- City housing is diverse and among the most affordable and desirable of jurisdictions within San Diego County. [Table 17: Medium Home Sales Prices 2015 and 2020, Santee Housing Element 2021-2029, p. 24]
- "Cost burdens" are ubiquitous nationwide and are locally undefined by the Ordinance in Santee. Nationwide marginalization of living wages exacerbated by corrupted and inflationary monetary policies are the true sources of household "cost burden." Approval of a massive luxury subdivision does not address the needs of marginalized citizens. The "urgency" argument diverts from and exacerbates those citizens plight by further eroding democratic process and institutional trust.
- Housing prices rise inordinately due to the over production and concentration of luxury housing which in itself perpetuates higher prices. Developers and

home owners will charge as much as the market will pay for their product/ property regardless of any subsidies that may reduce their costs.

- All housing requires reinvestment and maintenance as governed by the laws of physics/thermodynamics. Stripping citizens of their authority to defend their quality-of-life from significant adverse environmental impacts removes citizen incentive to maintain and reinvest in existing housing stock. Age of housing is not consequential in a homes adequacy.
- Building new housing does not generate maintenance improvements to existing housing. The two classes are distinct. A homeowners newfound ability to abandon existing housing can actually discourage reinvestment in their existing homes/neighborhoods.
- Santee civil servants are paid well enough to locate in more expensive locations outside of Santee if they so choose and many have done so. Santee is one of the most affordable jurisdictions in San Diego County. [Table 17] Numerous subdivisions were built over the past two decades and more are currently under construction.
- City bureaucracy has become addicted to short-term infusions of developer fees despite the cost burden of providing essential services to residential units over the long-term. It is commercial development that provides revenue stability to a General Fund.

Rational for adoption of Ordinance 592 is inadequately supported. Evidence contradicts 592 as being political theater.

Ordinance 592 **falsely cites a Regional Housing Needs Assessment (RHNA) assignment of 3,660-units.** The Santee Housing Element correctly contradicts Ordinance 592 in Table 34: RHNA Housing Needs for 2021-2029, p. 65, with an RHNA allocation of only 1,219 units. “Affordable” Low Income categories total 603 of those 1,219-units and would not be built by the luxury Fanita Ranch subdivision. [Table 35: RHNA Credits and Remaining Need]

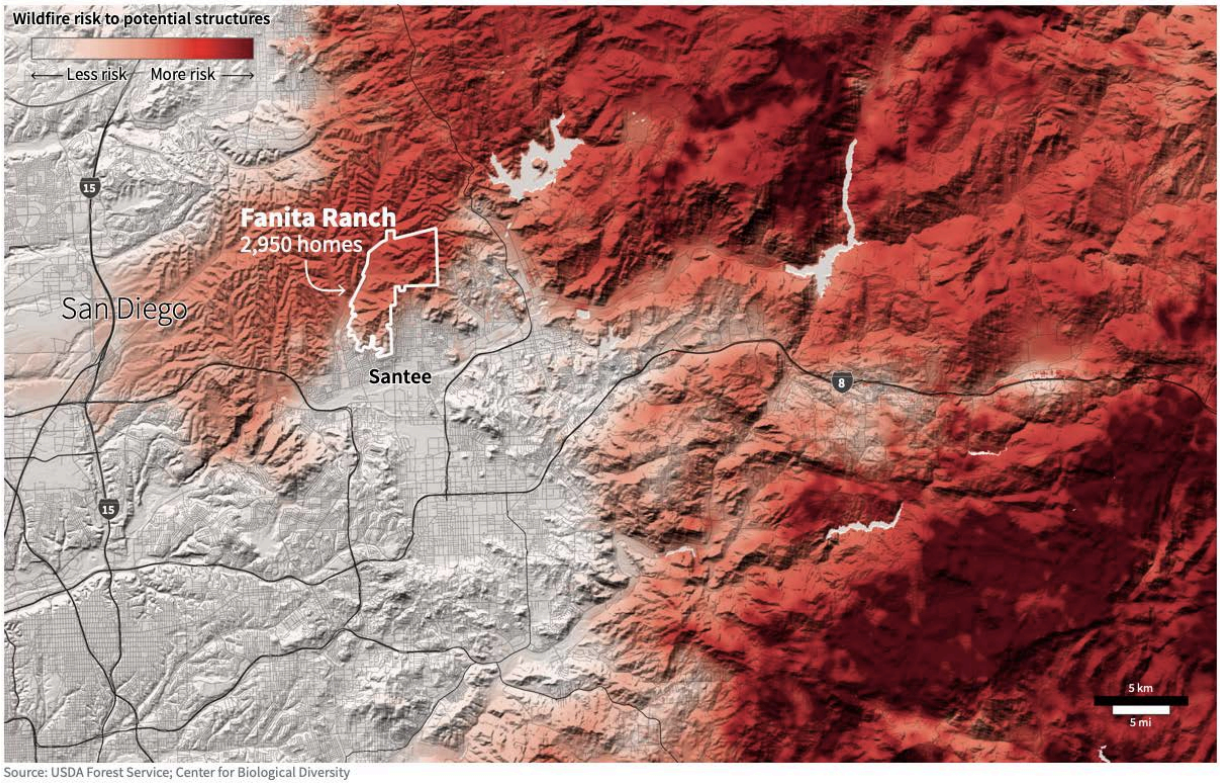
The Santee fair share of regional housing need has fallen - not risen - directly contradicting the false flag arguments of Ordinance 592 used to justify usurping the people’s land use authority.

The City was aware of the correct RHNA calculation when the Ordinance was drafted, yet chose to utilize an outdated higher regional needs allocation to weakly support its unconstitutional Ordinance 592 and Fanita Ranch NOE **EHP2021-1.**

The Final REIR fails to, but must, disclose the Fanita project's inconsistencies with the Land Use Element of the Santee General Plan. The REIR must fully disclose all approvals required for the project including the voting requirement of Measure N.

Considering the voting requirement of Measure N, why does the Project Description, p. 3-82 anticipate beginning construction in 2023? How is a 2023 construction date substantiated?

Construction of luxury housing in a severe fire hazard zone is not essential nor urgent. Public safety and respect for land use law is essential. Section 3.12 Discretionary Actions must be revised to meet legal standards.

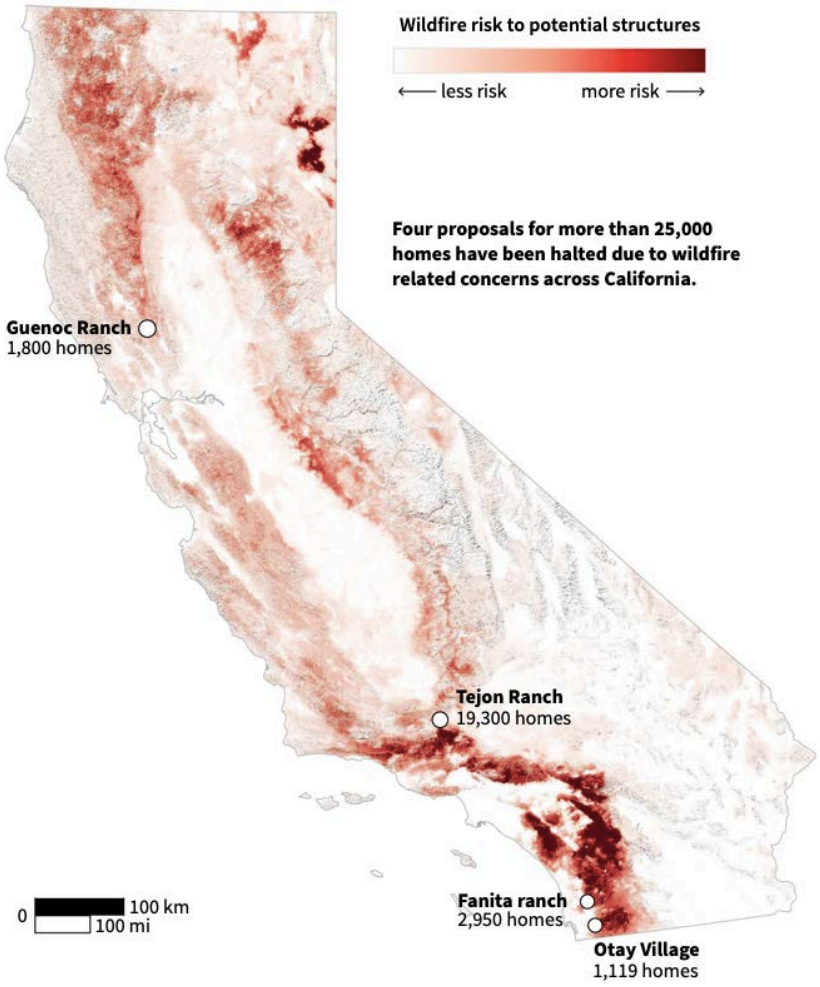


Source: USDA Forest Service; Center for Biological Diversity

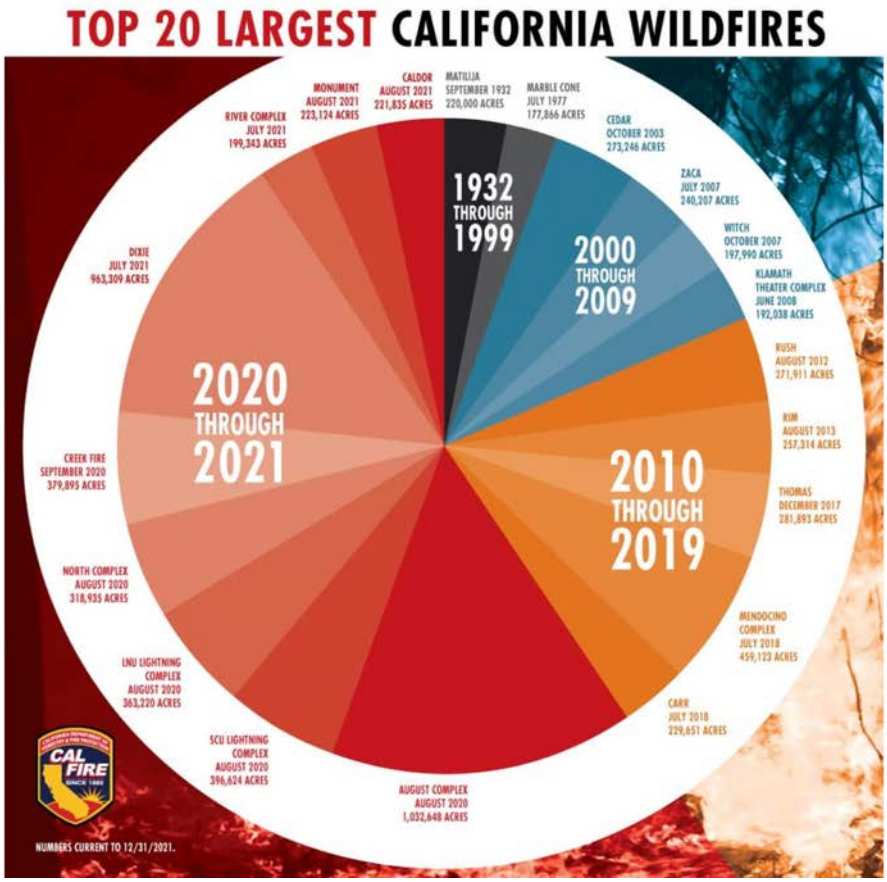
4.18 Wildfire

"Since 2016, more than 50,000 structures in California have been destroyed by wildfire…Eighteen of the 20 largest wildfires in California history have happened since the turn of the millennium - 12 of them since 2016." https://www.theatlantic.com/science/archive/2022/03/wildfire-insurance-california-fair-plan/627065/

The facts quoted and their impact upon potential retention of fire insurance coverage in California are not disclosed in the development-slanted REIR.



The REIR is deficient because it omits relevant disclosures and because it fails to remedy the deficiencies identified by the court.



REIR 4.8-2. "Extreme conditions, used in worst-case fire modeling for the project site, include 92ºF temperatures…"
Fanita project fire modeling underestimates worst-case temperatures, winds and humidity levels.

Temperatures in Santee now exceed 92ºF during any season, commonly exceed 100ºF and approach 120ºF during extreme heat waves.

The last seven years have been the warmest years on record worldwide. All indications are for continued temperature rise due to global dependence upon fossil fuel consumption that disrupts atmospheric energy circulation and energy release back into space.

Project fire modeling and planning should reflect the reality of increasing temperatures and resulting insurance company coverage withdrawals from severe hazard zone homes, but the REIR ignores the issue and fails to disclose, avoid, or mitigate for the significant impacts to future project residents.

Local Regulatory Ordinance

Defensible Space Inspections are conducted primarily to prevent transition of fire from vegetation to structures and/or from structures to adjacent vegetation during average weather conditions. California PRC 4291 and more restrictive County of San Diego Defensible Space Ordinance are the primary code sources of authority.

A secondary and usually undiscussed purpose of inspections is to assist homeowners to adapt to a "new normal" of extreme fire behavior experienced with increasing frequency due to continued economic dependence upon burning fossil fuels.

REIR 4.18.2.2 discusses agencies responsible for Defensible Space Inspection and enforcement. Notably absent from the discussion is the City of Santee where properties on the WUI and elsewhere would fail inspections if they were conducted.

The REIR further states:

"If violations of the program requirements are noted, inspectors list the required corrective measures and provide a reasonable time frame in which to complete the task. If violations still exist upon re-inspection, the local fire inspector will forward a complaint to the County for further enforcement action." [4.18-7]

Since I posses substantial experience performing Defensible Space Inspections as assigned to the Cal Fire Prevention / County of San Diego Community Risk Reduction Units, I am aware of flaws the REIR statement relies upon.

While Cal Fire / County Fire will respond to public complaints, the complaint response is secondary to progress prioritized for annual inspection plan areas. Because engine crews, which may be absent on strike team assignments, etc. are relied upon for a substantial percentage of annual inspections and because the crew

of DSI inspectors is insufficient for the vast number of parcels in the county, annual inspection plans are regularly not completed.

Furthermore, failing secondary inspections, when completed, may not result in an actual citation or forced abatement. There are very few citations issued for failing homeowners both county and statewide, with those few citations focused upon worst offenders and no current program for abatement in existence.

Inspections conducted by an HOA or third party on Fanita Ranch are likely to have similar limitations.

Since Santee does not conduct Defensible Space Inspections and notice violations, Fanita Ranch cannot rely upon a non-existent program within its jurisdiction or rely upon partially completed programs in other jurisdictions to prevent transfer of structure fires to open space during periods of extreme fire weather.

Reliance upon fire inspection and suppression departments in other jurisdictions as partial rationale for locating residents within a severe fire hazard zone is inappropriate.

REIR 4.18-2 acknowledges Santa Ana winds are not limited to Fall seasons. Santa Ana winds are also occurring in late Spring and have potential wind "speeds of up to 50 miles per hour or higher." However, the REIR underestimates potential high temperatures, relative humidity, fuel moisture levels. Temperatures above 115 F and Relative Humidity under 10 percent have occurred outside of Fall and are likely to continue to occur with greater frequency.

What are the levels of service for SR-52, SR-67, Mast Boulevard, Cuyamaca Street, Fanita Parkway and Magnolia avenue during morning and afternoon commute hours?

What are the differences in evacuation times during commute hours for existing residents north of Mast Boulevard (residents between Mast Boulevard and the project site) and proposed residents during significant evacuation scenarios and a worst case scenario?

REIR 4.18-8 "…the Community Emergency Response Team, which educates community members about disaster preparedness and trains them in basic response skills, such as fire safety, light search and rescue, and disaster medical operations. The City is 1 of 20 jurisdictions that support and participate in the team."

I am unaware of the existence of or opportunity to participate in any such training in Santee as either a resident or fire professional.

REIR 4.18-8 significantly over-estimates the capability of the San Diego County Emergency Operations Center. The EOC cannot "ensure an effective, coordinated evacuation." Evacuations in San Diego County have been chaotic and deadly, despite outstanding work by the professional resources activated.

REIR 4.18-8. The utility of safety grid maps is over stated when evacuation required is immediate or imminent. Grids are relatively large and may contain substantial population densities. Population within a grid can easily gridlock ingress/egress at the project and/or adjacent infrastructure.

REIR 4.18-10
4.18.3 Thresholds of Significance
The project would significantly exceed thresholds 2, 3, 4, 6, 8 and requires avoidance, additional mitigation or full disclosure with a statement of overriding considerations.

REIR 4-18-12 cites an incorrect address for Fire Station 5 which may alter the anticipated response time estimate calculation.

REIR 4.18-13 "50-feet of modified fuel areas along both sides of the road." 50-feet of fuel modifications are insufficient for gridlocked traffic experiencing an over burn adjacent to mature chaparral capable of flame generation exceeding 100 feet.

What are the flame lengths estimated on either side of the unmanaged areas these routes traverse?

How many residential streets within the project site are oriented north, northeast

and east forcing potential driving toward the fire without an alternative? What are the distances for each of these street segments?

REIR 4.18-13 over-states the utility of the Fanita Ranch Wildland Fire Evacuation Plan by calling it a "sophisticated evacuation modeling approach" without providing substantial data to support the claim.

REIR 4.18-13 makes a false assurance that "Wildfire evacuations from the site would be focused on early relocation from the project site long before a fire would threaten the project or its access routes." Since data documents the opposite, the REIR does not provide data to support the false claim the project can be evacuated prior to wind driven wildfires. This is a fatal flaw in the REIR.

REIR 4.18-13 inappropriately places heavy reliance upon utilization of Temporary Refuge Areas (TRAs). TRAs are survival measures to be used by over-extended firefighters when an escape route to an appropriately sized safety zone has been compromised. TRAs are not appropriate for civilians to rely upon as dependable evacuation tools. Survival in a TRA may not be tenable as fire behavior intensifies. As conditions deteriorate at a TRA, a secondary action is required to prevent injury or death. The ability to asses these changing circumstances is challenging for professional firefighters and would be significantly lacking in the resident population. Furthermore, TRAs are not substitutes for identifying and utilizing viable escape routes and safety zones. [Cal Fire. 2014. Wildland Urban Interface Operating Principles]

Even if new residents were to read and understand the "Ready, Set, Go!" brochure, executing the directions during emergency is tenuous. I have provided Ready, Set, Go! brochures to thousands of residents in San Diego County and discussed the concepts with interested residents. The REIR relies too heavily upon the public's questionable ability to execute evacuation-specific actions during significant wildfires.

REIR 4.18-14. Threshold 2 conclusion of less than significant impacts is not supported.

REIR 4.18.21. The REIR anticipates completion of FMZ vegetation management twice per year. [4.18-29] Zone 2 is proposed to eliminate 70% of native shrub vegetation. The REIR acknowledges disturbance introduces "highly flammable exotic grasses" of greater susceptibility to ignitions, which can then ignite more fire resistant native shrubs [4.18-25]. Leaving just 30% of native vegetation in Zone 2 creates an unrealistic and likely unattainable goal for control of flash fuels in FMZs. The result is likely to be the conversion of natural lands into a more ignition vulnerable landscape, especially over the longer-term.

The REIR misrepresents the potential for multi-directional evacuation on the project site. In fact at least half of the Vineyard Village development island must evacuate into the direction of Santa Ana wind driven fires.

REIR 4.18.21-25
The REIR fails to disclose and discuss the trade-off made by designing high density, close proximity structures inconsistent with the lot space requirements adopted by Land Use Element Fanita Ranch Guiding Principle 3 of the Santee General Plan:

3. The plan shall contain a mix of house sizes on lot sizes distributed as follows:
6,000 sq. ft. lots – 20 percent of total lots
10,000 sq. ft. lots – 20 percent of total lots
20,000 sq. ft. lots – 60 percent of total lots or greater
LAND USE ELEMENT
Santee General Plan
Santee, California - 1-29 - 1-30

Violation of GP3 is a significant un-avoided, inadequately mitigated and undisclosed impact to public safety because design of structures in close proximity within a severe fire hazard zone significantly increases the potential for massive losses from structures to structure direct flame impingement cluster burns.

"The Santa Ana winds with wind gusts of up to 60 mph blowing from northeast/ east pose a significant threat from wind-blown embers to all structures within this project." [Fanita Ranch Fire Protection Plan 2007. p 14. AR 028606]



IIBHS Major Finding: “While homes adjacent to wildland are most vulnerable to wildfires, homes in the interior areas of housing developments that were located less than 15 feet apart, were much more likely to burn in clusters - in other words, multiple homes right next to each other tended to burn…Cluster burning was not witnessed in homes located more than 45 feet apart from each other. [Insurance Institute for Business & Home Safety. Mega Fires: The Case for Mitigation. ES p. 3]

Violation of GP3 is also significant because the project is not capable of being fully evacuated during firestorm event ignitions within 16-miles aligned with the project. Occupied and cluster burning structures have significant potential to become a mass casualty event.

Furthermore, consistency violation of GP3 requires a public vote for project approval subject to Santee General Plan Protection Measure N and other State law.

Will there be a public vote determining approval or disapproval of the Fanita Ranch project? REIR information is contradictory to the statement made by Mayor John Minto to the press after the opening of the REIR public comment period. "Minto… noted that because the project would need an amendment to the city's General Plan it would require a public vote. That was mandated in 2020 when Santee voters passed Measure N, which would put any project that needs an amendment to the existing General Plan on the public ballot for approval."
https://www.eastcountymagazine.org/print/37950?fbclid=IwAR0bu8JR6GGiwGs9n7Qh6zjLuwWInCSOFZwoVhC1rM58dYu96bqQW8uILjQ

What are the range of separation distances between structures?

Where, by distance between structures/proximity range, are those structures arranged on the project's developed site landscape?

What is the minimum distance required to prevent a transfer of a structure fire once ignited to an adjacent structure?

What is the range of inadequate spacing for project structures subjected to structure to structure direct flame impingement?

Furthermore, the need for primary booster pump and backup power sources (subject to failure) to maintain water pressure significantly increases the potential for a cluster burn failure.

"A private booster pump and secondary power source would be installed for approximately 21 single-family residences in Vineyard Village where the area experiences residual pressures of less than 40 pounds per square inch during peak hour demand conditions."
[REIR 4.18.23]

What are the power sources for the pumps and where are the power sources and pumps located?

The REIR fails to disclose and discuss the significant adverse impacts of choosing to locate residential development above steep slopes, chutes and fire chimneys with Fuel Model 4 Chaparral in direct path of the prior Cedar Fire corridor. [II:101:29204-5]

REIR 4.18.37 Ignition Resistant Structures

The REIR attempts an apples to oranges inaccurate comparison of fire activity and structural design in Rancho Santa Fe. My prior comments already in the Administrative Record detail how the wind and fire activity diminished significantly prior to the 2007 Witch Creek fire threatening the Rancho Santa Fe development. Structures built after 2007 continue to be damaged or destroyed in wildfires.

Discussion of significant fires that did not sustain structure loss without disclosing and discussing recent fires with modern structure loss displays pro-development bias and reduces the credibility of the REIR.

What California fires and developments since 2007 have sustained structure losses in wildfires and why?

> *"Almost no one expected it. After all, the homes were brand new. They were surrounded by dozens of other homes. And most importantly, they met the state's building codes for areas at heightened risk of wildfires.*
>
> *"Ventura City Fire Marshal Joe Morelli thinks topography played a role…And even with the fire-resistant construction standards you can still have loss. They're not fireproof standards."*
>
> *"According to Cal Fire data, 80 percent of houses destroyed in the Thomas Fire had fire-resistant exteriors and 90 percent had fire-resistant roofs."*

https://www.kunc.org/2018-12-09/fire-resistant-is-not-fire-proof-california-homeowners-discover

Emily Guerin. 09/24/2018. Why Do We Keep Building Houses In Places That Burn Down? LAist
https://laist.com/news/why-do-we-keep-building-houses-in-places-that-burn-down

So why the determination to build on Fanita despite the hazards? The answer in Santee, documented in my prior letters is mirrored elsewhere and specifically in Orange County. Financial reasons there include:

* $50,000 to incumbent campaigns of the decision makers
* > $1,000,000 annually to the local fire department with the bill for actual fire suppression going to state and federal governments as a subsidy
* $8.25 million local annual property tax revenue
* Substantial $ to the growth machine: Business / real estate / development consultant industries

Appendix P2. Wildfire Evacuation Plan

The "Wildland Fire Evacuation Plan for the Fanita Ranch Community" (plan) is inadequate to mitigate public safety impacts below a level of significance. The plan lacks substantial evidence to support its conclusions and is contradictory.

About 8,000 new residents are proposed to be concentrated on Public Safety Map Grid page 224… in the highest of fire hazard severity zones.

The plan contradicts the Ready, Set, Go!" (RSG) model it proposes for public distribution by directing residents to "make sure to secure your home by locking all doors and windows…"[p.10]

Cal Fire Evacuation Tips and RSG under "Set" directs evacuees to leave doors **unlocked**. This is a significant contradiction and exhibits how if fire planners are confused - significant segments of the the public are likely to be confused when events occur also, significantly compromising safety.

The Directive to lock all doors is alarmingly significant because during events when the project cannot be evacuated prior to the arrival of the fire front, the plan relies upon the availability of "Temporary Refuge Areas" (TRAs). If doors are expected to be open by evacuees or firefighters and they are not, severe injuries could occur.

Furthermore, the Evacuation Plan places inappropriately heavy weight on the public's ability to timely read, understand, remember and then execute during an emergency by utilizing RSG and the 5 additionally listed preparedness reference tools residents might be introduced to.

Without disclosing, supporting and defining the "highest probability wildfire", the Plan makes an outrageously unsupportable assertion; "targeted areas of Fanita Ranch and the existing community can be evacuated within 19 minutes." [p.15].

The plan does not consider the vast majority of residents are unlikely to be in the model state of Ready, Set before they decide to Go! **There will be significant lag times between the fire size-up, the Evacuation Order and actual execution of the order after it is received, even if the directive is heard, understood and acted upon.**

For example, the 2007 Harris Fire ignited at 9:23 am, but it wasn't until 10:30 am until the first Reverse 911 evacuation calls were made. (Sorenson and Vogt, Results of An Investigation of the Effectiveness of Using Reverse Telephone Emergency Warning Systems in the October 2007 San Diego Wildfires, June 2009).

This was a lag of 37 minutes from ignition to public alert experienced even after post 2003 Cedar Fire upgrades to communications. Add additional time for the public to digest the information and act.

Furthermore, the new communications system did not reach all residents targeted. For the 2007 fires, **37% of respondents surveyed indicated they did not receive the evacuation alert.** (Sorenson and Vogt, June 2009).

Significantly, of the survey respondents who acknowledged receipt of evacuation directives, only 41% evacuated. (Sorenson and Vogt, June 2009). If a similar percentage ignores directives on Fanita Ranch, the close proximity of structures with cluster burn vulnerability results in significant mass casualty risk the plan does not analyze or disclose.

“Warnings by themselves do not motivate evacuation, people must perceive risk.” (Dash and Gladwin 2007)

“As we see time and time again, for as much research as has been conducted on the issue of evacuation, our understanding of evacuation is extremely limited. Those expected to evacuate often do not, and those who should not evacuate at least in the estimation of emergency managers often do.” (Dash and Gladwin 2007)

The plan acknowledges, “Many civilian deaths have occurred when residents evacuated late and were exposed to wildfire on unprotected roadways.” [p. 23]

Surviving 2007 fire evacuees surveyed reported obstacles of traffic congestion, smoke impairing visibility, road debris, road closures, vehicle problems and health effects. (Sorenson and Vogt, June 2009).

The plan does not offer any range of time to reflect differences in commute hour traffic flows or (as during the 2003 Cedar Fire) a before sunrise emergency when the public is sleeping and is even more slow to react. It would be difficult to execute the times projected under best case scenarios, but the plan should be evaluating opposite worst case scenarios. Especially since the plan reluctantly admits, “…evacuation…may not be feasible.” [p. 20]

The same undisclosed issues discussed above will significantly impact the 1.5 hour projected evacuation time for all vehicles to exit the project site.

The plan is significantly flawed because it does not consider worst-case scenario rates of spread from close proximity ignition points and compare a few representative scenarios with best and worst-case evacuation times.

Furthermore, the plan asserts there will be the luxury of phased evacuations without considering potential rates of spread from highly probable ignition sources such as SR-67.

An extreme weather fire spreading from SR-67 at 1,966.5 feet/minute (Fanita Ranch Fire Protection Plan BehavePlus calculation) could strike the project in less than 10 minutes.

“The Highway 67 corridor presents a serious threat as a ready source of potential ignitions resulting from vehicle accidents, over-heated vehicles and burning material thrown from vehicles during extreme fire weather conditions brought about by drought and drying seasonal Santa Ana winds. During the October 2003 wildfires, Incident Reports noted wind gusts of up to 75 MPH from the northeast at higher elevations.” Fanita Ranch Fire Protection Plan. 2007, p. 3. AR 018469]

[Vineyard Village]“Rock Point is vulnerable to ignitions at the SR-67 corridor within ten minutes or less under high velocity Santa Ana winds. Evacuation routes are vulnerable to direct flame impingement, radiant heat, and smoke. City reference to ‘safe routes’ for evacuation is unsupported and incorrect.” Cleveland National Forest Supervisor - Retired, Anne S. Fege, Ph.D., M.B.A.

The plan makes distorted assertions about the extent of evacuations, suggesting the project site will not require complete evacuation because “mass evacuations” will no longer occur.

“This type of evacuation, called a mass evacuation, is not used in Santee or San Diego County.” P. [10]

The plan fails to understand or disclose that the Incident Commander (IC) evaluates current and expected fire behavior and then issues evacuation directives based upon what is in the expected fire path. The IC uses Public Safety Grid Maps to identify at risk populations and communicate directives. The size of the evacuation is primarily determined by the expected rate-of-spread from the fires active fronts and flanks during size-up, <u>not by utilizing a planners idea of what may constitute most efficient evacuation phasing.</u>

It is both plausible, and highly likely that evacuation orders could be issued for the entire project site (Public Safety Grid & Evacuation Planning Map Book page 224)





and for offsite populations on adjacent page grids simultaneously during a Santa Ana wind driven firestorm when evacuation needs are immediate or imminent.

Because the bias of the plan is to support development, the plan wishes to relegate ignition points and rate-of-spread to secondary considerations. Planners refused to even calculate basic evacuation timing without a court order.

The plan does not even disclose the existence of Public Safety Grid & Evacuation Planning Map Book page 224 and invents an entirely new phasing proposal that is unlikely to be reviewed or available to emergency responders prior to or during the next wind driven firestorm.

It is also distorted to cite (Sorensen and Vogt) for support, when Fanita planners have resisted our requests to estimate evacuation times and compare those to expected rates of spread. Sorenson and Vogt support the issue we brought to court, "accuracy of evacuation time estimates should be established."

"Our research identified ten major issues in evacuation planning that cut across hazards. Planning for large-scale evacuations requires improvement. **A better understanding of special evacuation planning needs for fast-moving events is needed. Evacuation planning for concurrent hazardous events is lacking.** A better understanding of human behavior in evacuations is desirable. The **accuracy of evacuation time estimates should be established.** Guidelines on reentry after an evacuation should be improved. Special populations planning requires further investigation. Liability for evacuation decisions should be resolved. Uncertainties and problems in evacuation decision-making need greater attention. Adoption and implementation of integrated evacuation plans
should be investigated." (Sorenson and Vogt 1987)

Sorenson confirms the importance of **"evacuation time estimates"** in later research. (Sorenson 2002)

Fanita planners have resisted analysis of the issues Sorenson and Vogt conclude deserve attention and this plan does little to address those issues identified.

Plan section 3.3.1 Evacuation Points and Shelters is generic word soup that does not offer any specific locations on or off of the project site expected to function as evacuation points or shelters. This is a significant deficiency in the plan which fails to establish if suitable evacuation points or shelters exist for the populace during events of magnitude. Specifically, where are these suitable points or shelters and what facts establish them as suitable functionality for large evacuation events?

The plan acknowledges that shelter-in-place is not preferred for residents that would be "directly impacted or in the direct path of a hazard." [p. 22] Yet, all of the project site could be impacted within a short interval of minutes during a wind driven fire with a rapid rate-of-spread or with simultaneous area ignitions. The plan labels structures as "ignition resistant," not ignition proof, which places the resident population in significant danger.

The plan downplays and deflects from the significant risk of shelter-in-place strategy by pointing to three large fires without resident injuries or structure loss, and by failing to disclose the destruction of other large fires with structures built to fire resistant standards.

The 2018 Camp Fire burned 18,804 structures in Paradise. Post fire analysis concluded 56% of the structures built to 2008 Chapter 7A standards were destroyed. https://wildfiretoday.com/2021/10/11/characteristics-of-structures-that-burned-in-the-2018-camp-fire/

Knapp, E.E., Valachovic, Y.S., Quarles, S.L. *et al*. Housing arrangement and vegetation factors associated with single-family home survival in the 2018 Camp Fire, California. *fire ecol* **17,** 25 (2021). https://doi.org/10.1186/s42408-021-00117-0

The plan / Final REIR ignores the Marshal Fire that burned about 1,000 structures within hours on December 30, 2021. The Marshal Fire demonstrates the potential for rapid destruction of fire resistant homes placed in close proximity. Drone video aftermath reveals the destructive potential for homes in close proximity with little adjacent vegetation fuels. Homes became the fuel. Video documents homes that survived had fewer homes in close proximity.

The community impacted by the Marshal Fire had more numerous points of ingress/egress differentiating it from the constrictive congestion of Fanta Ranch dependency upon Mast Boulevard. Shelter-in-place strategy is a recipe for failure in densely configured sites in severely vulnerable topography such as Fanita "Vineyard Village."

Denser development, such as what is proposed for Fanita, built to Chapter 7A standards, may protect the structures from direct flame impingement of a vegetation fire, but density design becomes a detriment once buildings ignite and cluster burn.



The plan fails to disclose destruction of 20 mansions by a 200-acre fire in Laguna Niguel, May 11, 2022. The spring wildfire burned adjacent to the ocean during

onshore flow wind gusts of 20-25 mph. This was not a Santa Ana condition. Homes were immaculate and compliant with PRC Section 4291 defensible space code. Proximity of structures doomed them once the initial home ignited from the downslope generation of firebrands. There is significant similarity in vulnerability from downslope vegetation on Fanita Ranch to close proximity home clusters above.

Fire resistant homes with PRC 4291 compliant defensible space ignited during a spring onshore wind driven fire. Coastal Fire, Laguna Niguel, 05/11/2022. https://www.ocregister.com/2022/05/11/fire-prompts-evacuation-at-laguna-beach-resort/

“With the climate change. The fuel beds are so dry that fire like this is going to be more common place. [Orange County Fire Chief Brian Fennessey, ABC News.]



During unexpected ignition with rapid fire spread, it takes only one absent resident on Fanita who leaves a window open for fresh air to create vulnerability for an entire cluster of homes.

Significant cluster burn risk can be reduced by three modifications:

- **Eliminate all windows and garage doors on the north, northeast, east and southeast sides of structures / require air tight garage door seals**
- **Require a minimum of 50 feet between each structure (keep other structures out of Zone 1)**
- **Limit the number of windows on southern to northwest sides of structures to 1 per room, with an area limit of 9 square feet, constructed in a permanently closed design.**

Evacuation Plan Section 4 - Wildfire Scenarios

Without supporting data analysis and disclosure, the "Wildfire Scenarios" section of the plan attempts to exclude worst-case scenarios from consideration. Scenarios where ignition points are in close proximity to the project with spread rates at a magnitude to impact the developed site during a time period insufficient to evacuate the entire site are not adequately considered.

"If a fire starts in the backcountry (East San Diego County) and is fanned by these fire weather conditions, an early evacuation of the area may occur several or more hours prior to actual threatening conditions. Such an evacuation may include the entire project site." [p. 25.]

I've provided data in prior comment letters documenting large-area/short-time-period scenarios are both plausible and likely. **The plan is significantly deficient because it refuses to do calculated ignition point / rate-of spread analysis with distressed fuels and during extreme weather conditions and then avoiding or mitigating for such a scenario's significant adverse impacts.**

I've asked for this analysis repeatedly and the court acknowledged in its ruling the EIR was inadequate because of the failure to respond adequately to public comments. The plan repeats this failure by the denial bias embedded in this section.

The plan then generally admits:

“If a wildfire ignited close to the Fanita Ranch community during weather that facilitates fire spread (i.e., low humidity and high winds facilitate fire spread), multiple hours would likely not be available for evacuation and a different approach would need to be explored.”

What are the critical distances and time periods during worst case fire spread scenarios?

The plan fails to consider and then avoid or mitigate for these circumstances. Furthermore - under the above scenario, there is not time to explore a “different evacuation approach.” The time for exploration is now while significant deficiencies may still be addressed, not during the event when failures have real life consequences.

The 3 “contingency options” mentioned are to generalized. Please “explore” 1 - 2 - 3 specifics: [p. 25.]
1.
How long would it take to relocate “residents in perimeter homes on the north/west/east edges” to “internal areas of the Fanita Commons Village Center”?
What is the capacity of the Center?
Under what conditions is the Center at risk of significant failure?
What is the contingency for failures at the Center after a partial evacuation there?
Is the Center designed with characteristics of a safety zone under a specified stress point or is the Center sufficient to be a Temporary Refuge Area up to a specified stress point?
Considering the Incident Commander uses a much more generalized Public Safety Grid Map system, specifically, how will evacuation of “residents in perimeter homes on the north/west/east edges” be timely and accurately communicated from the IC to the EOC, then law enforcement and to the targeted residents?
How will confusing messaging permeating through other neighborhoods whose actions could adversely impact the targeted evacuation be avoided?
If the IC chooses to request more specific areas for evacuation orders, what is the average amount of time it takes for the specific order to be prepared by the IC, communicated by the IC to the EOC and then translated digitally and distributed through WEA or AlertSanDiego systems to the public?

2.
Considering the Incident Commander uses a much more generalized Public Safety Grid Map system, specifically, how will evacuation of “certain neighborhoods” be timely and accurately communicated from the IC to the EOC, then law enforcement and to the targeted residents?
How will confusing messaging permeating through other neighborhoods whose actions could adversely impact the targeted evacuation be avoided?
How long will it take to evacuate “certain neighborhoods” to “Lakeside or el Cajon.”
How much delay time will be added to the vacation of a vulnerable existing WUI from the evacuation of “certain neighborhoods”?
In what scenarios would existing Santee neighborhoods north of Mast Boulevard be evacuated prior to “certain neighborhoods” on the Fanita ranch project site?
If the IC chooses to request more specific areas for evacuation orders, what is the average amount of time it takes for the specific order to be prepared by the IC, communicated by the IC to the EOC and then translated digitally and distributed through WEA or AlertSanDiego systems to the public?
3.
What are the contingency options if/when structures fail and begin to cluster burn?
What are the thresholds and contingencies when firefighters cannot remain outside to perform structure protection functions?
Specifically, where are firefighter safety zones and for fires of what specific threshold would the safety zones remain sufficient?
What are the contingency options when residential doors are locked and radiant heat precludes outside operations and/or direct flame impingement from cluster burning structures precludes indoor shelter?
What are the contingency options when residential vehicles and/or fire engines begin to melt?

The plan exaggerates the utility of the internal road network. Significant numbers of residents would be forced to evacuate in the direction of a Santa Ana firestorm before connecting to the Fanita/Cuyamaca horseshoe connection to an overburdened Mast Boulevard.

The plan acknowledges reliance upon emergency responders to control intersections and traffic flow, but does not disclose that responders required may be limited or absent due to concurrent incidents.

The plan overstates EOC capability and over relies upon it. "Fire and law enforcement officials **will** identify evacuation points before evacuation routes are announced to the public." [p. 27]

There are scenarios where the EOC will not be able to accomplish the above, including scenarios when phone lines and cell towers may not function. It is also unknown if it will be feasible to monitor traffic conditions which "**must** be monitored along evacuation routes…"

Evacuation Plan Section 5 - Fanita Ranch Resident Fire/Evacuation Awareness

"There are aspects of fire safety and evacuation that **require** a significant level of awareness by the residents and emergency services to reduce/or avoid problems with an effective evacuation." [p29]
Ready, Set, Go! (RSG) brochures/procedures are useful tools, however their utility is overstated.

I have distributed RSG brochures to thousands of residents in San Diego County while performing Defensible Space Inspections. Without engaging in question/ answer discussions during and after distribution of RSG, an assessment of residents comprehension of RSG and their ability to execute upon it or fulfill the **"required"** "significant level of awareness" is absent.

Experience has demonstrated to me that redundancy of concept and repeated exercise of it (practice) is necessary to achieve a "significant level of awareness." There is not any evidence the Fanita plan will achieve either.

The redundancy of concept measures described in the plan are infrequent, voluntary and inadequate to achieve a "significant level of awareness" for the bulk of the resident population.

Registration for the "AlertSanDiego" emergency notification is a primary talking point during my public contact inspections. Out of thousands of public contacts, many have stated they would register, but a relative few requested or accepted offers to be walked through the short registration process (Most people can register in two to three minutes). Therefore, it is unknown how much redundancy is required to gain registration action from a public contact. Especially since much of the public in San Diego County remains unregistered.

Furthermore, existing Santee residents are unaware of or participating in the type of educational activities promised for future Fanita Ranch residents, which puts in question the feasibility of those promises in the plan.

Evacuation Plan Section 6 - Fanita Ranch Evacuation Procedures

Conclusions about plan effectiveness are optimistic and negated by development sited on inappropriate topography within a severe hazard zone.

What are the trigger points that constitute a "conservative threshold" for evacuation of Fanita Ranch?

The plan's conclusion regarding Fanita Ranch non-consideration as a "vulnerable community" is errant. Close proximity between structures and the inclusion of windows/vents leaves the development vulnerable to cluster burns.

6.1 Fanita Ranch Evacuation Summary

"…it is **imperative** that each household develop a plan that is clearly understood by all family members and **participates** in the educational and training programs sponsored by the Fanita Ranch HOA and the SFD. In addition, it is **imperative** that the "READY! SET! GO!" information be **reviewed on a routine basis** along with the accompanying maps illustrating evacuation routes, temporary evacuation points and pre-identified safety zones. It **must** be kept in mind that conditions may arise that will dictate a different evacuation route than the roads used on a daily basis." [p. 32]

It is more imperative that decision-makers understand the 6.1 introductory paragraph is unrealistic and there are significant real world safety impacts associated with these unreal expectations.

The significant adverse impacts to public safety have not been disclosed, avoided or adequately mitigated.

6.2 Fanita Ranch Road Evacuation Capacity Analysis

"In an actual emergency, unified command…**will** consider…**will** issue specific evacuation or shelter-in-place directives…"

The language above creates a false narrative that in itself is a significant impact to public safety.

There can be no guarantee that there WILL be enough trained/experienced personal or enough time to effectively consider "numerous factors including wind speeds and direction, humidity, topography, fuel loading, emergency access routes, evacuation routes, shelter-in-place options, time needed to evacuate, and other variables."

Note the Cedar Fire rate of spread was underestimated by law enforcement and experienced fire officials in both premiere wildand firefighting agencies.

"Fire and law enforcement personnel underestimated the potential size and rate of spread of the Cedar Fire."
[2003 San Diego County Fire Siege Fire Safety Review, p. 15]
https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5297020.pdf

Underestimation should be expected because of the human brain's inability to comprehend exponential growth/fire spread. Yet, the plan inappropriately forecasts expert precision.

"…exponential growth is beyond our natural intuition and comprehension. That's why any phenomenon involving exponential growth is potentially dangerous, why mathematics provides the only tool we have to handle it, and why leaders and societies can do themselves and us possibly irreparable harm…if they ignore what the math tells them."
https://www.mathvalues.org/masterblog/can-we-really-understand-exponential-growth

Leading the public to believe and **rely upon** a false narrative of reliably accurate dispersal of directives has been deadly and can be again in high risk settings as the frequency of extreme weather events increase.

For example, during the 2018 Camp Fire, a mother and daughter had divergent positions on the issue of waiting for official direction. The mother chose to wait for specific directive and without any, chose to shelter-in-place until getting direction. The daughter felt uncomfortable, but lost time trying to persuade her mother to evacuate with her. The mother perished in her home waiting for direction that never came. The daughter survived a harrowing evacuation, where others did not.

"Christina and her mother argued on whether to evacuate and ultimately her mother decided to stay put because she had not heard evacuation orders from officials."
https://theorion.com/77084/news/chico-state-student-loses-mother-and-paradise-home-during-the-camp-fire/

"They argued about the neighbor, showering, paying the phone bill, packing the safe, talking to a woman named Mary, the bumper-to-bumper traffic outside, the severity of the fire and God. They argued over evacuating."
https://www.mercurynews.com/2018/12/19/i-want-my-mom-back-camp-fire-survivor-recounts-final-moments-with-mother/
https://www.cbc.ca/news/world/california-paradise-wildfires-1.4915372

Furthermore, as residents experience the dynamics of one or more fires, the basic experience can lead to a false sense of security that disarms residents to

more serious dynamics in subsequent events. Emergency fatigue is an unconsidered significant adverse impact.

“"She didn't expect it to be that bad. She expected someone would be calling, or something, if it got bad. But they didn’t."
https://www.nbcnews.com/news/us-news/paradise-fire-survivors-say-warnings-were-too-little-too-late-n935846

Note that law enforcement reported mass alerts were sent: “5,227 by email, 25,643 via phone (to both land lines and cellular devices) and 5,445 by text message… Like other counties, Butte has a system that allows residents to sign up for “reverse 911” telephone alerts in times of emergency.”
https://www.nbcnews.com/news/us-news/paradise-fire-survivors-say-warnings-were-too-little-too-late-n935846

Law enforcement after the fact statements support the significance of emergency fatigue upon the population and public safety officials themselves.

"You have to keep in mind that this was an extraordinarily chaotic and rapidly moving situation. The fire started in a remote area. It takes awhile for our fire resources to get there and from that point, trying to determine the path of travel and whether or not that’s going to effect populated areas, that takes time," Honea said.

He added that it's possible some people were warned and didn't immediately act to get out of harm's way. "We were trying to move tens of thousands of people out of an area very rapidly with the fire coming very rapidly. And no matter what your plan is to do that, no plan will ever work 100 percent when you are dealing with that much chaos."

Honea, who took office four years ago, also suggested that emergency officials have to be concerned not to over-burden people with excessive or unneeded evacuation orders. He said the region had already lived through evacuations from earlier fires and last year’s threatened collapse of the Oroville Dam, which caused nearly 200,000 people to flee.

"So that takes a toll on people," Honea said. "I don't want to ever get into situation where people begin to stop paying attention because they feel like we are ordering evacuations for no cause or for very little cause."
https://www.nbcnews.com/news/us-news/paradise-fire-survivors-say-warnings-were-too-little-too-late-n935846

As a seasoned wildland firefighter and currently as a Cal Fire Defensible Space Inspector performing public outreach, when I discuss emergency alerts with the public and request registration with the AlertSanDiego system, I let individuals know that an alert may not be issued. And when an alert is issued, they will only receive the alert if they have service at their present location at that time. It is up to individuals to grasp the vulnerabilities of their physical location, preplan evacuation routes and safety zones with representative scenarios, maintain situational awareness and act upon their own judgement if required by circumstances. Official alerts/directions are to be taken seriously to guide actions if issued and received. **The difficulty of evaluating physical settings in dynamic circumstances for both officials and residents is why it is gross negligence for land use officials to intentionally site new residents into increasingly severe hazard zones.**

The plan's false narrative of guaranteed expert direction from public safety agencies is a significant adverse impact to public safety.

For residents already residing in tenuous locations, LCES is not just for firefighters. LCES (Lookouts, Communications, Escape Routes, Safety Zones) should be practiced by the public. However, even firefighters have difficulty implementing the concept. Hence, firefighter injuries and deaths continue to occur in the effort to defend poorly sited people and properties.

Technical Memorandum Appendix D suggests: "Existing Land Uses" north of Mast Boulevard can be evacuated in 78 minutes. Partial evacuations can be accomplished in scenarios ranging from 19 minutes to 78 minutes. Full Project evacuation is estimated to take 53 - 92 minutes depending upon construction of the Magnolia Avenue escape route. A Full Project evacuation including Existing Land Uses is estimated to take 117 minutes. [p. 18] These estimates do not account for

various degrees of readiness and mobilization by the public or lags in distribution of communications.

Without substantiating evidence, the plan labels the 19 minute scenario as the "Most Probable Evacuation." The label is misleading because the need for a full project evacuation may be just as probable as the "most probable" perimeter only evacuation scenario suggested as a 19 minute end point.

This "Most Probable" scenario should be re-designated as a "Priority Phase 1 Perimeter Evacuation" Scenario.

However, the "Most Probable" scenario does not reflect the reality of the San Diego County Evacuation Planning Map Book Public Safety Grid Index system most likely to be utilized for evacuation directives (Orders and Warnings) when the need for evacuation is immediate or imminent. The grids cover much larger areas than the meandering perimeters desired in "Most Probable." Half of the project or more exists on a single grid. For example, the bulk of the project, both "Orchard Village" and "Vineyard Village" exist on Grid 3333 of page 224.

During a major Santa Ana wind driven event, even if an experienced Incident Commander is available, the IC is still unlikely to have time to be any more specific than to identify the Public Safety Grid numbers subject to a directive when the need for evacuation is immediate or imminent. Elaborate specific directives are unlikely to be effectively communicated.

If the IC chooses to request more specific areas for evacuation orders, what is the average amount of time it takes for the specific order to be prepared by the IC, communicated by the IC to the EOC and then translated digitally and distributed through WEA or AlertSanDiego systems to the public?

For instance, even if contemplated, a description of the "Most Probable" perimeter evacuation would require identification of four different grids and is complicated enough that it is unlikely to be completely understood and translated for implementation. This reality means that significantly larger populations are likely to be simultaneously evacuated than the Evacuation Plan alleges (without

providing substantial evidence in support). The entire grids identified are most likely to be evacuated rather than elaborate subsets of those grids. The same issue exists for all of the partial evacuation scenarios the plan relies upon.

Hence, if the plan's other data input calculations are reliable, a more realistic evacuation time is a minimum of 120 minutes (two hours) plus additional time for readiness/mobilization variations, plus time for neighborhoods adjacent to Fanita outside of Santee, plus time from when the ignition report to when a size-up with an action plan is communicated to dispatch. These additional realities could require another 60-minutes or more.

A project evacuation time of two hour or more has a significant divergence from the FEMA guideline to be able to evacuate a community in 1.5 hours or better. The additional time of 30 minutes or more is a significant adverse impact to public safety.

The plan analysis suggests that a typical Santa Ana wind-driven fire with ignition 16 miles northeast of the project might leave SR-52 westbound "available for a period of time" because of the 14 hours between the reported Cedar Fire ignition and approximate arrival to SR-52. [p. 35]

The period from fire ignition to front arrival referenced does not recognize the 2003 Cedar Fire did not ignite during Santa winds.

The Cedar Fire (reported to dispatch at 1737, October 25, 2003) spread relatively slowly for about 8 hours until early morning when Santa Ana winds over 15 mph then drove the fire rapidly toward the coast. [2003 San Diego County Fire Siege Fire Safety Review, p. 13]
https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5297020.pdf

The period of time before SR-52 is impacted will be heavily dependent upon wind speed and distance. Ignitions within 16 miles of the project site fanned by 40 mph winds or greater, could impact SR-52 and the project site in 2 hours or less preventing evacuation of the site. The plan fails to disclose nor adequately consider the ramifications of ignitions relatively close to the project site. Instead, the plan

largely ignores or downplays the significance of firestorm ignitions near the project rationalizing with a misplaced reliance upon TRAs or shelter-in-place contingencies.

Furthermore, none of the Evacuation Scenarios consider existing populations directly adjacent to Fanita Ranch on Grids 3334 and 3234 of page 224 on Eucalyptus Hills in Lakeside. What are the time impacts associated with evacuation of Eucalyptus Hills, 1/4 mile from Fanita Ranch open space?

Plan analysis conclusion of only 6 minutes difference in evacuation time for residents by building the project are flawed (1.3 versus 1.2 hours). (p. 34) The project would not build new ingress/egress for Santee, nor significant upgrades to Santee's currently congested boulevards. Project evacuation would add 7,042 vehicles to the currently congested road network [p.13 Appendix D]. How does the plan support a 6 minute difference conclusion with an addition of 3,000 homes?

The plan introduces further bias towards development by referencing approval by the County of San Diego Board of Supervisors for subdivisions with 60-120 minute evacuation timeframes. The plan fails to disclose the referenced projects were successfully challenged by either the California Attorney General, environmental organizations and/or successful referendums because of adverse impacts prioritizing fire safety. [p. 35]
https://inewsource.org/2022/06/15/rural-homes-fire-risk/?fbclid=IwAR2uSYjVdR0Fmx8Ofn40qd07ALRRKGonGtuwHxoAjpdYBieJgAV5CE51nXY

What is the current status for all of the subdivision projects referenced on page 35?

The plan wrongly asserts without support, "additional [evacuation] time does not necessarily generate a greater safety risk." Where are the specific TRAs and what are their contingencies? Under what conditions will specific TRAs fail or be insufficient to prevent injury? Without detailed answers to these two questions a plan conclusion that available evacuation time is unnecessary is unsupported.

6.2 Phased vs. Mass Evacuation - Evolution of Wildfire Evacuation Implementation

The plan errantly suggests high risk Red Flag days will occur "fewer than 20 days per year." [p. 35]

The conclusion is unsupported. Extreme weather records are now a common occurrence that will continue as long as the economy remains dependent upon burning large quantities of fossil fuels. Extreme fire behavior is increasingly correlated to human intransigence and ineffectiveness to resolve a destructive fossil fuel addition with transition to cleaner alternatives.

The plan fails to recognize that it is the rate-of-fire-spread and distance from directly aligned populations that determines the size of areas targeted for evacuation directives. Phased evacuations may or may not be an option. Recognition of facts above is what is "most realistic."

The plan recognizes "phased evacuation effort **will** need to be enforced by law enforcement agencies and coordinated with the OA EOC and affected jurisdictions." [p. 36] However, the plan fails to recognized law enforcement does not have the authority to force evacuations or prevent evacuations divergent from a target phase plan that could disrupt the directed evacuation. Nor does the plan adequately address or recognize that law enforcement may be unavailable to perform the required enforcement and coordination.

The plan fails to disclose that a lucky "break in severe winds" was a primary factor in limiting injuries during the 2017 Lilac Fire. [Executive Summary, Lilac Fire After Action Report] By this omission, the plan misrepresents the potential feasibility of future required evacuations.

6.2 Evacuation Modeling: Planning Uses and Limitations

"Emergency responders **will** coordinate the safest possible evacuation based on the dynamic circumstances of the actual event, including the appropriate phasing of

the evacuation, and utilization of the most appropriate ingress and egress routes for area residents and emergency responders." [p. 37]

Once again, the plan inappropriately and significantly overstates the capability and availability of emergency response.

6.4 Civilian and Firefighter Evacuation Contingency

The plan admits that "no community in San Diego County has been directed to shelter in place during a wildland fire." [p. 38] Yet, the plan relies on TRAs and shelter-in-place for aligned firestorm ignitions within 16 mile of the project site. This reliance places people and property in significant risk of injury during a wildland fire.

The plan recommends "concerted pre-planning" to determine when it is safe for civilian populations to "temporary seek refuge than evacuate." [p. 38] Failure to complete this analysis now is a significant impact to public safety by plan deficiency.

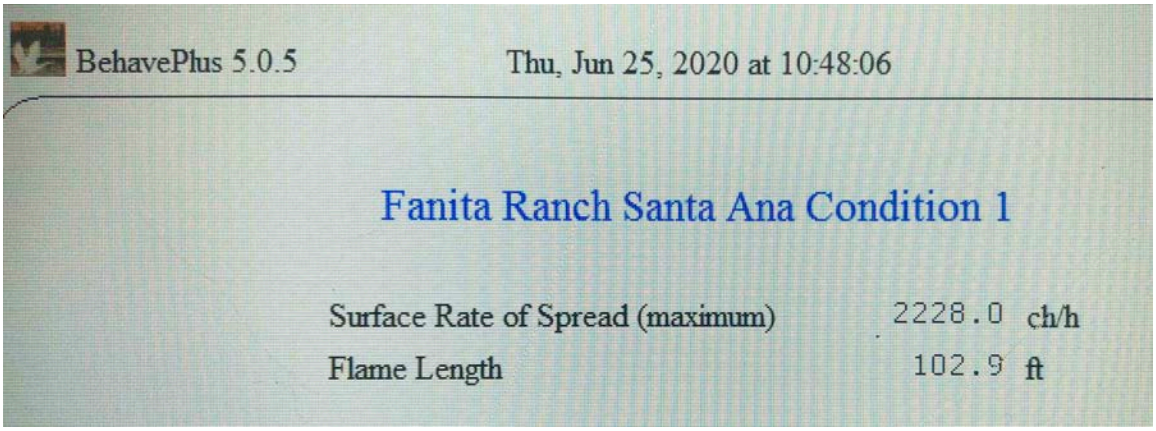
The plan admits evacuations my be disrupted or precluded by factors that include: "Fires that prevent safe passage along planned evacuation routes; inadequate time to safely evacuate; Fire evacuations during peak traffic conditions or when large events are occurring; Blocked traffic due to accidents or fallen tree(s) or power pole(s); The need to move individuals who are unable to evacuate." [p. 38] Yet, the plan fails to disclose the potential consequences of the listed risk factors occurrence. What are those potential consequences?

6.4.1 Safety Zones

Vineyard Village/Rock Point "will eventually be surrounded by southern mixed chaparral vegetation more than six feet in height…best described as Fuel Model 4 (FM-4). An FM-4, chaparral vegetation greater than 6-feet in height, provides the greatest rates of spread and energy release with flame length usually exceeding 100 feet." [Fanita Ranch Fire Protection Plan 2007. 1:192:15843]

The current evacuation plan significantly underestimates potential flame lengths, fire intensity and the size of safety zones required to reduce potential burn injuries.

The Fanita project's own 2007 Fire Protection Plan (prepared by actual firefighters rather than consultants capable of manipulating data inputs to get a desired result) used the BehavePlus model to calculate flame lengths of 100 feet. I confirmed the 2007 FPP, 100 feet flame length calculation using BehavePlus 5.0 calculating a result of **102.9 feet.**



The 34 + underestimation of flame length/fire intensity is significant. Another 136 feet of fuel separation is necessary. The actual safety zone requirement is 400 feet in all directions.

Furthermore, a safety zone of appropriate size for flame length size does not assure protection from convective activity such as fire whorls that may impact the center location point.

"…potentially greater distance if there were site-specific features that would result in more aggressive fire behavior.." [p. 39]

Fanita Ranch has features that would result in more aggressive fire behavior. The project locates development at the top of numerous fire chimneys and chutes. [II:101:29204-5]

The plan suggests "some neighborhood interior roads would provide safety zones" but hedges by stating, "during a fire, the identified safety zones may not be feasible

due to distance, location, fire behavior, etc." [p. 39] The "etc." fails to specifically disclose cluster burn risk for all neighborhoods due to the close proximity of structures relative to each other.

The plan then defers its actual purpose by placing the responsibility upon fire and law enforcement agencies to identify potential safety zones with **required** focused study.

"…safety zones will require additional focused study." [p. 39]

Focused study should have shaped the design of the project to avoid steep topography, chutes, chimneys, saddles and Fuel Model 4 vegetation. [II:101:29204-5]

Failure to design and designate adequate safety zones is a significant adverse impact to public safety that must be disclosed.

6.4.1 Temporary Firefighter Refuge Areas

The plan correctly discloses "TRAs are not a substitute for a safety zone." And "a TRA requires another planned tactical action, i.e., TRAs cannot be considered the final action. [p. 40.]

TRAs are not considered appropriate tactics for civilians because they require expertise and rely upon a series of actions that may be compromised or fail. [Cal Fire. 2014. Wildland Urban Interface Operating Principles]

Yet, without disclosing the project's significant risk of cluster burn, the plan relies upon "interior areas of neighborhoods" to be used as TRAs "For the Fanita Ranch Community."

The plan identifies residences it previously directs to be "locked" as TRAs and touts fire resistant features, including ember resistant vents and a tempered pane of dual pane windows.

Wide FMZs do not stop airborne firebrands. Ember resistant vents aligned with a storm of firebrands can be breached to points of structure ignition.

Windows can be broken by convective action that lifts objects stored outside of a residence allowing ignition.

Windows can be left open for ventilation by residents absent and unaware of fire ignitions or motivated to ventilate by hot weather increasing the probability of fire ignitions.

The plan infers the project may not be able to be evacuated "during a fast moving wind driven fire that ignites off of SR-52 or SR-67" and relies upon TRAs (sometimes appropriate for firefighters - not civilian tactics) without disclosing significant risk of cluster burns or any tactical contingency to deal with cluster burns. [p. 41]

The plan then once agains overstates the capability of fire and law enforcement resources by promising "The decision for evacuation or temporary refuging on site **will** be made by responding law enforcement and/or fire personnel."

Even if law enforcement is available, law enforcement officers are not trained to calculate wildland fire rate-of-spread over various fuel types and topographies in dynamic weather conditions. Nor are they trained to make a series of tactical decisions for civilian use of Temporary Refuge Areas. These tasks would be a challenge for trained veteran firefighters if they are available and not detained by concurrent fire activity elsewhere.

6.5 Social Aspects of Wildfire Evacuation

Fire: Plan consumption is largely limited to planners; Training is largely limited to professionals with redundancy and experience required for successful execution; Education is sparse; Awareness is motivated in the midst of an event.

To reduce the probability for chaos and panic, the plan places too much weight on public exposure to RSG, understanding of RSG, and ability to execute RSG concepts.

The plan once again over promises stating "movement… will occur according to a pre-planned and practiced protocol, reducing the potential for panic." [p. 41]

Who is pre-planning?

Where are examples of these pre-plans in Santee?

What are the protocols referenced?

Who is practicing the protocols referenced?

What documentation exists to demonstrate the protocols referenced have been and will be practiced in Santee?

The plan inadvertently admits there are circumstances when evacuees will <u>not</u> "receive information from credible sources," despite repeated contradictory use of the word "will."

The plan does emphasize a **requirement** for annual training without establishing a mechanism commitment for such essential training.

"The importance of training these personnel cannot be understated and annual education and training regarding fire safety and evacuation events **will** be essential for successful future evacuations." [p. 41]

Evacuation training at fire agencies is limited, if it occurs at all, and is secondary to the primary responsibility of fire suppression. I suspect the same is true for law enforcement where the primary responsibility is law enforcement.

6.6.1 Evacuation of Special Populations

The plan relies upon "Accessible AlertSanDiego, CERT programs, or other" to provide emergency evacuation transportation to special needs individuals anticipated as residents. [p. 42]

The Camp Fire (among others) where a Reverse 911 system was in place demonstrated that reaching all special needs individuals during a firestorm is not feasible. Special needs individuals are also less likely to be willing to leave without simultaneous evacuation of their pets.

Placing special needs individuals in the Fanita Ranch severe fire hazard zone is a significant adverse impact to public safety.

7. Limitations

[My observations bracketed]. Again the plan over promises:

"The Fanita Ranch populace **will** be "Set"…officials **will** implement the plan and mandate [without legal authority to do so] that populations "Go"…evacuation **will** occur based upon conservative decision points…residents **will** be aware of this evacuation plan…educational outreach **would** result in a populace that understands [without any way to measure understanding or compel educational participation] the potential for evacuations and the routes and options that may be presented to them." [p. 46]

The plan correctly lists some of its contradictions, including:

- "…instances when evacuation is not possible"
- "During extreme fire weather conditions, there are no guarantees that a given structure will not burn or that evacuations will be successful…"
- "Fire can compromise procedures through various unpredictable ways"
- "Fire is a dynamic and somewhat unpredictable occurrence, and it is important for anyone living at the wildland-urban interface to educate themselves…"

These admitted limitations and contradictions, despite project mitigation measures, are why a decision to place new residents in harm's way significantly exposes people or structures to a significant risk of loss, injury or death involving wildland fires and requires either avoidance or a statement of overriding considerations for doing so.

The project should be denied. Placing thousands of new residents in a Cal Fire designated "Very High Fire Hazard Severity Zone" while the State is setting more records for climate exacerbated wildfires would be gross negligence.

Santee residents previously defeated a 3,000-unit project by a 2/3 landslide. The effort to force another 3,000-unit project upon Santee residents despite their clear direction reeks of corruption. [Reference Van Collinsworth letters dated 9/21/2020 documenting the flow of funds from Fanita Ranch participants to elect Santee city council members.]

Specific evidence was provided in my prior comment letters as to why cluster burns on this project are of great concern. The specific evidence presented by my comments remain inadequately address by substantial evidence to the contrary. I carry forward my prior public safety objections to the project.

The project is based upon the false assumption that cluster burns will not occur. The site cannot be effectively evacuated so the design wagers heavily that design features will prevent cluster burns with mass fatalities. The REIR distorts reality by making "apple to orange" comparisons for Fanita with projects that survived wildfires, while failing to discuss recent subdivisions that have suffered losses. My previous comments explain in detail why those comparisons fail. I carry those comments forward.

What are the distances between structures and the flame impingement potential from structure-to-structure.

Who is or are the entities to be relied upon for transportation assistance? This should be answered by a project that proposes to place thousands in a severe fire hazard zone.

The project assumes without providing any evidence that law enforcement will be available during Santa Wind driven wildfires when emergency response teams are often overwhelmed by the pace and scale of multiple expanding events. The REIR does not adequately address the potential for gridlock along evacuation routes adjacent to wildland fuels capable of incinerating evacuees.

The REIR assumes incorrectly and without any evidence that a wildfire will not transition into the urban environment with older homes highly vulnerable to embers and that high-intensity urban fires would not impact gridlocked escape routes. The REIR completely ignores recent fire history of urban environments in California and Oregon being wiped from the map by wind driven firestorms.

What is the total amount of wildlan-urban-interface area added by the project? How many miles of wildlland interface currently exist in Santee? What percentage increase does the project represent? How many brush engines and firefighters does Santee currently have to respond to emergencies and how many will be added? What is the percentage change in resource availability versus wildlan-urban-interface?

The project site has had difficulty maintaining existing fire buffers taking well into June to cut tall dead flash fuel grasses. Creating more interface increases the burden of difficulty.

A buffer 4-times flame length rule of thumb to reduce the potential for burn injuries is standard for firefighters. The principle is the same if it is a firefighter deploying a fire shelter or an individual temporarily sheltered in a vehicle. Chaparral is capable of generating flame lengths in excess of 100-feet and the gridlock the inadequate circulation system provides potentially leaves people incinerating in their vehicles.

Fire code requires two access routes with at least 1.38 miles of separation. Cuyamaca Street and Fanita Parkway merge into a single horseshoe configuration

dependent upon Mast Boulevard. The distance between the two roads is only **1.25 miles** at the exits from natural lands. Fire Code D107.2 Remoteness requires a minimum of 1.38 miles of road separation based upon a service area diagonal dimension of 2.75 miles. **The road design is not compliant and both of these routes could be heavily impacted by a firestorm simultaneously.**

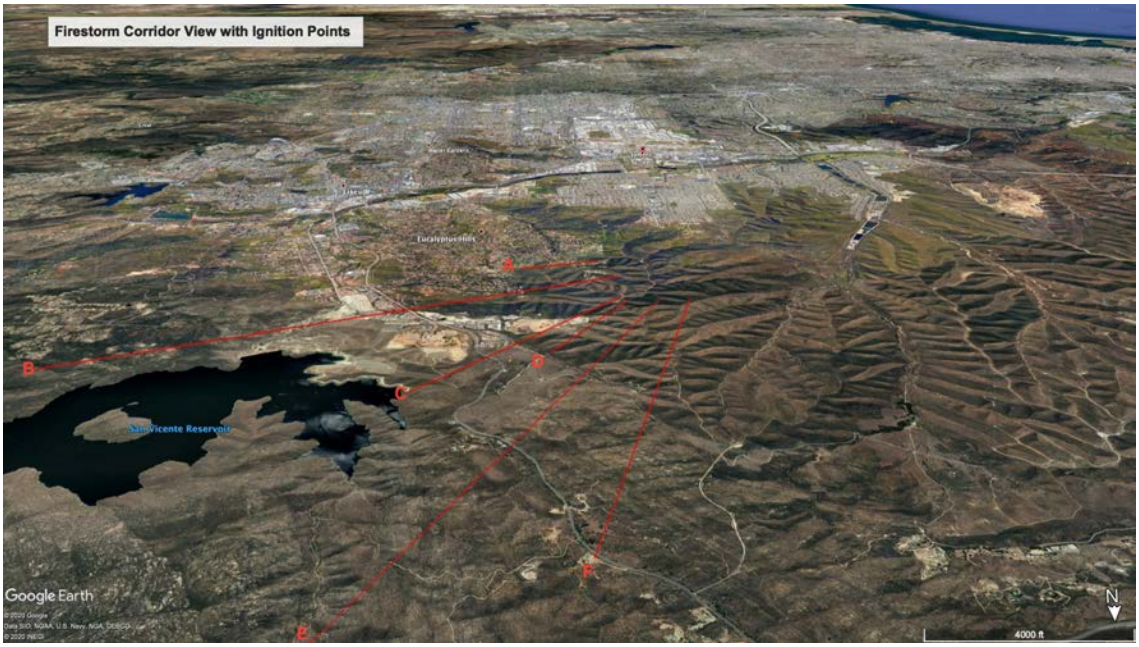
There is a lack of public safety zones within the project site.

Since the project relies upon the school as a Temporary refuge Area, what is the status of potential school construction? What is the impact of losing the school site as a TRA?

Why hasn't the highest risk topography on the northern part of the project site been avoided?

Points A- E are all plausible ignition points and plausible scenarios for Santa Ana wind driven fires, yet the EIR fails to plan for any of them or any other points of ignition. Not one single scenario is evaluated in the document for timing of evacuation or emergency response. The decision is negligent and a callous denial of the trends of growing mega-storm wildfires.

Point A is .6 miles from the project.
Point B is 3.75 miles from the project.
Point C is 1.9 miles from the project.
Point D is 1 mile from the project.
Point E is 3.75 miles from the project.
Point F is 3 miles from the project.
[1 mile = 5,280 feet]



The 2007 FPP disclosed a potential rate of spread at **1,966.5 feet/minute**

Of the requested ignition point analysis, Points B and E are the greatest distance so the fire would impact the project site more rapidly in the other scenarios.

Points B & E = 19,800 feet / 1966.5 feet/minute = **10.06 minutes to the project site**.

Can the project site be evacuated in 10 minutes or less? The answer to this question the EIR refuses to analyze and disclose is that it is absolutely not feasible to evacuate the project site in 10 minutes or less. Under these scenarios with structural failure leading to cluster burns there would be a mass casualty incident.

These calculations reveal a significant adverse impact with an answer of yes to the question: "***Would the project expose people or structures, either directly or indirectly, to a significant risk of loss, injury or death involving wildfires?"***

Again – the EIR does not adequately address this CEQA required significance threshold issue/question.

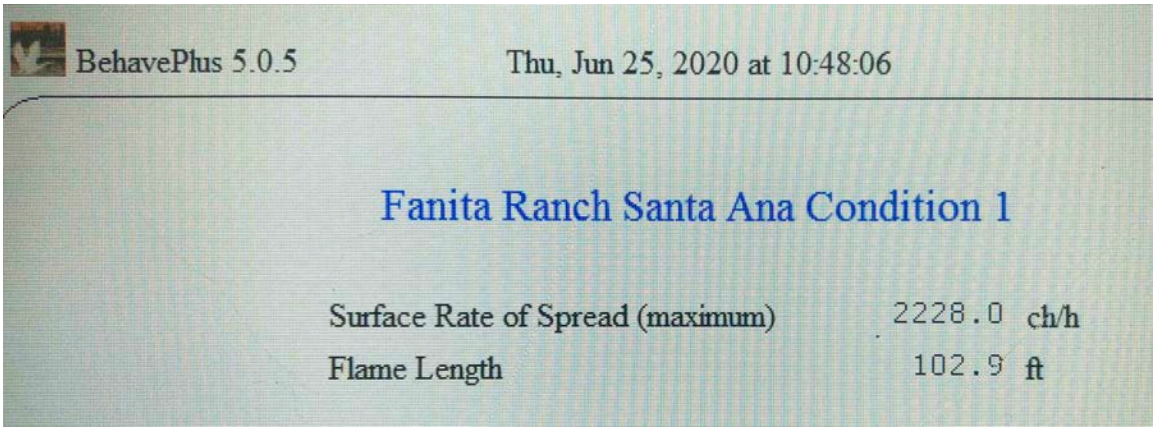
A Santa Ana wind driven fire igniting 17 miles downwind would impact the project site in 45 minutes.

89,760 feet / 1966.5 feet/minute = **45 minutes to the project site.**

In 2007, at hearing, a project consultant estimated at least 1 hour and 45 minutes to evacuate a 1,395-unit project site. If the calculation for the 1,395-unit project is reliable, evacuation of the project site is clearly underestimated and infeasible for a 3,000-unit project.

The project wagers heavily upon shelter-in-place without being honest about the bet or designing a feasible fall back plan if the wager fails.

A project infeasible to evacuate provides incentive for project proponent consultants to diminish former FPP flame length calculations by utilizing different inputs. I have performed a calculation yielding 102.9 ft. flame lengths using reasonable input variables.



The Evacuation Plan is Inadequate

The Evacuation Plan needs to address the additional significant deficiencies.

What data addresses the deficiencies identified below?

An Evacuation Plan summary should be part of a Tactical Suppression plan summary that describes the specific area of coverage by geographic name/s, Public Safety grid map pages / grid numbers & Thomas Guide grid pages.

The tactical suppression summary cover should prepare a Risk Assessment Summary with a Risk Assessment Matrix and Critical Information chart including: Firefighter Safety, Civilian Safety, Air Safety (recognizing MCAS Miramar and Gillespie Field flight paths), Hazmat, Fuels, Topography, Clearance, Construction, Structural Spacing, Access, Water, Communications, Tac Air support.

Critical Information should include response safety including access and communication frequencies.

Briefing Information should include fuels, expected fire behavior, topographic features, access, special hazards, specific safety zones, temporary refuge areas, limits of use for each, water supplies.

Command post, potential participants, staging areas should be identified.
Large fire weather development factors should be addressed.
WUI arrangements should be identified.
All of the items above should encapsulated on the cover page summary.

A second summary page should be developed for a Tactical Plan that includes the Evacuation Plan Summary. The EP summary should include a description of targeted populations, including critical/notable sites and communication methods. Evacuation trigger points should be identified. Temporary assembly sites and safety zones should be identified.
The larger tactical plan summary should include a primary plan, alternate plan, contingency plan, emergency plan and perimeter control plan.
Develop an assessment of population and structures at risk for the planning area that considers structural triage.
Emergency resource needs for the first six hours should be identified, including law enforcement, logistics and other organizational response.

A tactical map should be prepared that includes information from the critical information summary page.
Area map page summaries to clearly portray evacuation routes and other critical data should be included.

Scenario maps should be prepared that include critical ignition points, major paths, and projected arrival times with common and extreme weather variables.
Have the Tactical / Evacuation Plan Summaries described above been prepared similar to what already exists (as described above) for another location in the county?

If not, will they be prepared and when?

The project has significant adverse impacts to public safety and should be denied.

Sincerely,

Van Collinsworth
Geographer/Fire Expert/Director

References & Links:

Cal Fire. 2014. Wildland Urban Interface Operating Principles
https://www.iaff.org/wp-content/uploads/2019/05/CAL-FIRE-Wildland-Urban-Interface-Book.pdf

Emma Marris. 03/15/2022. People Deserve to Know their Houses Are Going to Burn. The Atlantic.
https://www.theatlantic.com/science/archive/2022/03/wildfire-insurance-california-fair-plan/627065/

Camille von Kaenel. 09/03/2021. Insurance Companies Increasingly Drop Homes Throughout San Diego County As Fire Risks Rise. Inewsource.
https://www.kpbs.org/news/2021/sep/03/insurance-companies-increasingly-drop-homes-throug/?fbclid=IwAR0CHygXrpSE8o-7qtDDn9bwXF95gj6k1zl1sFJUQbVrtp5GesNcXVj61TY

Eric E. Knapp, Yana S. Valachovic, Stephen L. Quarles and Nels G. Johnson. 2021. Housing arrangement and vegetation factors associated with single-family home survival in the 2018 Camp Fire, California

James Rainey. 11/14/2018. Paradise Fire survivors say warnings were too little, too late. NBC News
https://www.nbcnews.com/news/us-news/paradise-fire-survivors-say-warnings-were-too-little-too-late-n935846

Briar Stewart. 11/22/2018. 'This is where they must have found her': Woman who refused to flee California fire is one of the dead. CBC News
https://www.cbc.ca/news/world/california-paradise-wildfires-1.4915372

Bianca Quilantan. 12/19/2018. 'I want my mom back': Survivor recounts final moments with mother. San Jose Mercury News https://www.mercurynews.com/2018/12/19/i-want-my-mom-back-camp-fire-survivor-recounts-final-moments-with-mother/

Yaritza Avon. 12/5/2018. Chico State student loses mother and Paradise home during the Camp Fire. The Orion https://theorion.com/77084/news/chico-state-student-loses-mother-and-paradise-home-during-the-camp-fire/

Camille von Kaenel. 06/15/2022. San Diego officials said rural homes were safe from fires. They were listening to developers. inewsource. https://inewsource.org/2022/06/15/rural-homes-fire-risk/?fbclid=IwAR2uSYjVdR0Fmx8Ofn40qd07ALRRKGonGtuwHxoAjpdYBieJgAV5CE51nXY

Travis Hartman & Daniel Trotta, May 2, 2022. California fires threaten unbuilt housing. Reuters. https://graphics.reuters.com/CLIMATE-CHANGE/USA-WILDFIRES/zgvomlymnvd/index.html?fbclid=IwAR1XIf6qPrwGJIrLSnAP6J3e5YUIFn94w1fbK9O2k7klKz4t2Gt73RveLek

Daniel Trotta. May 4, 2022. As California burns, environmentalists find new tactic to halt development. Reuters. https://www.reuters.com/world/us/california-burns-environmentalists-find-new-tactic-halt-development-2022-05-03/?fbclid=IwAR0w1RCG7MAoIPX7dPC_1xxEUOrLIGX2u5ykZ9iJBVIAjra5GDRoNwNDvbI

United States Forest Service, California Department of Forestry & Fire Protection. 2003. The 2003 San Diego County Fire Siege Fire Safety Review https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5297020.pdf

Firefighter Nation Staff. 7/17/2012. Temporary Refuge Area Considerations and Options
https://www.firefighternation.com/firerescue/temporary-refuge-area-considerations-and-options/#gref

Sorenson, J. A. 08/30/2002. Planning Protective Action Decision-Making: Evacuate or Shelter-in-Place. Oak Ridge National Lab. FEMA.
https://www.osti.gov/biblio/814651-planning-protective-action-decision-making-evacuate-shelter-place

County of San Diego. 2017. Lilac Fire After Action Report
https://www.sandiegocounty.gov/dmpr/docs/LilacFireAAR.pdf

Emily Guerin. 12/09/2018. Fire-Resistant Is Not Fire-Proof, California Homeowners Discover. KPCC Southern California Public Radio
https://www.kunc.org/2018-12-09/fire-resistant-is-not-fire-proof-california-homeowners-discover

Emily Guerin. 09/24/2018. Why Do We Keep Building Houses In Places That Burn Down? LAist
https://laist.com/news/why-do-we-keep-building-houses-in-places-that-burn-down

Mike Allen. 06/12/2022. Santee Council Removes Fanita Ranch From November Ballot. East County Magazine.
https://www.eastcountymagazine.org/print/37950?fbclid=IwAR0bu8JR6GGiwGs9n7Qh6zjLuwWInCSOFZwoVhC1rM58dYu96bqQW8uILjQ

Evacuation Checklist / Resources

City of Santee. 2021. Draft Housing Element 2021-2029
https://www.cityofsanteeca.gov/Home/Components/News/News/3890/9

City of Santee Regular Meeting Agenda. June 08, 2022. Item 10 - Resolution Repealing Resolution No. 006-2021

Collinsworth. 6/08/2022. Statement Item 10 - Resolution Repealing Resolution No. 006-2021

Peter J. Broderick. 6/08/2022. Letter Item 10 - Resolution Repealing Resolution No. 006-2021. Center for Biological Diversity

12/28/21 Fanita Ranch Essential Housing Project (EHP2021-1)
https://ceqanet.opr.ca.gov/2021120599

Notice of Exemption
https://www.cityofsanteeca.gov/home/showpublisheddocument/21743/637768993340730000

8/26/2021 Urgency Ordinance adopting an Essential Housing Program
https://ceqanet.opr.ca.gov/2021080506

Recirculated Sections of Final Revised Environmental Impact Report Fanita Ranch Project
https://www.cityofsanteeca.gov/services/project-environmental-review

An official website of the United States government Here's how you know

U.S. Department of Health & Human Services (HHS)
National Institutes of Health (NIH)

Share:

Studying the impact of climate change on older adult health and well-being

April 20, 2022



Emerald NGUYEN,

Division of Behavioral and Social Research (DBSR).

Funding Opportunities Research Scientific Resources

As our nation observes Earth Day this week, NIA recognizes that far too many people continue to struggle due to climate change and related weather conditions. Now more than ever, it's crucial to better understand the s of changing climates and their impact on the health and well-being of older adults. The 2020 report of *The* Countdown on health and climate change identified older adults as a vulnerable population experiencing morbidity and mortality associated with extreme weather, such as alarming heatwaves, widespread wildfires, and violent hurricanes. NIA behavioral and social research program priorities (PDF, 433K) include supporting research to investigate older adults' health outcomes and their preparedness, adaptation, and resilience to climate change and extreme weather conditions.

Privacy - Terms

Expanding research on older adult health affected by climate change

Research on older adult health and well-being affected by climate change builds on NIA's established interest in disaster preparedness, our support for research institutions affected by disasters, and our partnerships with other federal agencies to support older adults in emergencies. NIA recently awarded six grants for projects in response to the Environmental Influences on Aging: Effects of Extreme Weather and Disaster Events on Aging Processes funding opportunity. NIA's expanding interests in this area of research include but are not limited to:

- Impacts of exposure to air pollution, heat, and wildfires, and other extreme weather events on health and well-being in midlife and later life
- The impact of age-related change in affective, social, and cognitive factors on individual responses to extreme weather events
- How individuals initiate and maintain the behavior changes needed for preparedness and adaptation to extreme weather events
- The contribution of extreme weather events and related natural disasters to social structure and social adversity, and their effects on aging processes across the life course in studies of animals in their natural habitats
- Impacts of extreme weather events on individuals with functional limitations or disabilities, persons living with Alzheimer's disease and related dementias, as well as caregivers/care partners
- The preparedness of health care systems and care providers before and after extreme weather events, as well as reducing health care facilities' and systems' contribution to climate change
- The impact of internal migration, displacement, or resettlement from extreme weather events on health in midlife and later life
- Regional and cross-national variation in extreme weather and their disparate health impacts on midlife and older adult populations, particularly vulnerable communities

How to get involved

If you are interested in developing a research project focused on climate change connections to older adult health and well-being, we would be happy to discuss your ideas. Please check out the links in this post, keep an eye on our current funding opportunities, and, if you have questions, please contact me or leave a comment below!

Subscribe to the NIA blog for weekly updates on funding policies and research priorities

*Email Address

Subscribe

Advertiser Disclosure

2025 U.S. wildfire statistics

Written by Natalie Todoroff. Edited by Jesse Casey
Published on January 29, 2026 · 8 min read

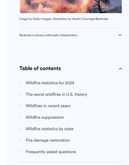


Image by Getty Images. Illustration by Austin Cruz/Bankrate

Bankrate is always editorially independent.

Key takeaways

- A wildfire is an uncontrolled, unpredictable and unplanned burn in an area of naturally ignitable vegetation. While prairies, forests and grasslands are standard wildfire zones, suburban areas backing up to wildlife are frequently impacted.
- Unless otherwise excluded, a typical homeowners policy covers damage from a fire to your dwelling, other structures and personal property. A renters insurance policy will cover losses to your personal property. The amount and type of insurance payout depends on your provider and policy selection.
- Homes in regions with a high risk from wildfires might not qualify for a standard homeowners insurance policy.

Globally, forest fires are now responsible for 16 million more acres of tree cover loss annually compared to the beginning of the 21st century. The United States is no exception to this trend, with 2024 and 2020 standing out as peak years for acreage burned.

In 2024 alone, wildfires caused $1.8 billion in damage nationwide. Having the right homeowners insurance in place can be key to helping offset the cost of wildfire damage. Here, we examine the most recent statistics and data for U.S. wildfires, including how to file a claim if your home is impacted by smoke or fire.

Wildfire statistics for 2024

Bushfire, brushfire, forest fire, rural fire and wildland fire are different terms for wildfire. The region and characteristics of the fire determine the type. According to the World Health Organization (WHO), wildfires are an increasing concern not only due to the loss of property but also their impact on air quality, crops, resources, transportation and the health of animals and people. Most wildfires are caused by human activity, such as unattended campfires and discarded cigarettes, while some are caused by lava and lightning.

The worst wildfires in U.S. history

Triple-I rated the costliest wildland fires in the United States. Based on its data, the top five were all in California, each causing several billions of dollars in insured losses.

- **Camp Fire, 2018:** Total damage from what is currently the costliest U.S. wildfire of all time is estimated at $10 billion, or roughly $11.8 billion in 2022 (when accounting for inflation). The fire burned 18,804 structures and 153,336 acres of woodland.
- **Tubbs Fire, 2017:** The Tubbs Fire incurred $6.7 billion in estimated insured losses, or about $10.5 billion in 2022 value. This electrical fire caused 36,807 acres of woodland and 5,636 structures to burn.
- **Woolsey Fire, 2018:** The Woolsey Fire caused estimated losses of $4.2 billion, nearly $5 billion after accounting for inflation. 1,643 structures and 96,949 acres of woodland were destroyed.
- **Oakland Fire (Tunnel), 1991:** This wildfire in the early '90s caused estimated losses of $1.7 billion, or $3.7 billion in 2022 value. 2,900 structures and 1,600 acres of woodland were damaged.
- **Atlas Fire, 2017:** The Atlas Fire cost about $3 billion in damage, or what would be $3.7 billion in 2022. The fire caused damage to 903 structures and burned 51,624 acres of woodland.

Wildfires in recent years

The NIFC collects year-over-year data on U.S. wildfires, although recordkeeping did not begin until 1983.

U.S. wildfires by year

Wildfire suppression

Fires need fuel, heat and oxygen to burn. Wildfire suppression involves managing, modifying, preventing or extinguishing a wildfire. Several strategies can be used to suppress wildfires, including creating control lines using prescribed burns or natural barriers like rocky slopes or large barren soil areas and removing the fire's fuel source by using hand tools or heavy equipment to remove quick-burning vegetation. National Guard members may also be deployed to support efforts, providing air assistance for mapping the fire and dropping flame retardant and water, as well as offering assistance on the ground to firefighters and EMTs. The area's landscape, plus fire and weather conditions, determine the method used.

The NIFC compiles data on annual suppression costs for U.S. wildfires. The five-year average cost to the Forest Service is over $2 billion, while the cost to Department of Interior bureaus (DOI) agencies was more than $325 million. The total 10-year average is less, at around $1.9 billion, suggesting that the price of suppressing these fires is going up over time.

At nearly $4.4 billion, 2021 was the most expensive year for total fire suppression costs since recordkeeping began in 1985, when the total annual costs topped out at just under $340 million.

Annual wildfire suppression costs

Year	Forest Service	DOI agencies	Total
2023	$2,700,000,000	$466,300,000	$3,166,300,000
2022	$2,300,000,000	$649,000,000	$3,049,000,000
2021	$3,741,000,000	$646,000,000	$4,387,000,000
2020	$1,764,000,000	$510,000,000	$2,274,000,000
2019	$1,130,000,000	$440,000,000	$1,590,000,000
2018	$2,699,256,000	$535,000,000	$3,143,256,000
2017	$2,410,082,000	$538,000,000	$2,948,182,000
2016	$1,603,806,000	$371,739,000	$1,975,545,000
2015	$1,753,000,000	$417,643,000	$2,130,643,000

Wildfire statistics by state

To best understand how wildfires affect different regions of the U.S., this NIFC table shows the number of wildfires by cause and type in 2023.

Wildfires by state

Riskiest states for wildfires

California is by the far most at-risk state for wildfires in the U.S., according to CoreLogic, with nearly four times the number of properties at risk in 2024 as the second-highest state (Colorado). Below are the top at-risk states based on the number of properties at extreme risk.

Rank	State	Number of moderate or greater at-risk properties	Total value of at-risk properties
1.	California	1,218,748	$769,4B
2.	Colorado	321,294	$140.9B
3.	Texas	244,617	$88.4B
4.	Oregon	129,667	$45.3B
5.	Arizona	104,603	$36.2B
6.	Idaho	104,782	$34.9B
7.	New Mexico	100,059	$34.7B
8.	Utah	67,023	$32.3B
9.	Montana	88,102	$31.3B
10.	Washington	59,063	$20.9B
11.	Nevada	22,768	$14.7B
12.	South Dakota	26,697	$8.4B
13.	Wyoming	16,215	$5.7B
14.	Oklahoma	1,624	$4M

California's wildfire risk

If you're a California homeowner, wildfires are probably never far from your mind. Fire season was once contained to just a few months a year here. But, with temperatures rising in the state, lack of rain in Southern California and parched vegetation, fire season is now year-round. Why are California wildfires so dangerous? In part, it has to do with where some homes are built. California has the most homes along urban-wildland interfaces — where spans of dry vegetation border developed areas. When a wildfire sparks here, there's a higher concentration of buildings in the path of the blaze, thus leading to greater insured losses.

Fire damage restoration

The average home insurance policy covers the structure of your home, as well as personal belongings and additional living expenses, should you be affected by a wildfire. Those with renters insurance, condo insurance and manufactured or mobile home insurance should check their policies to ensure adequate coverage in case of a wildfire.

However, if you live in a high-risk area, such as California, you could be denied coverage. In this case, the California FAIR Plan is one option that offers basic coverage for high-risk customers who typically cannot find standard home insurance. After a second year of wildfires in 2018, it was estimated that 350,000 California home and business owners could not purchase adequate property and casualty insurance because of the increased risk that providers were facing. Significant issues were created for homeowners with mortgages who were required to carry home insurance coverage as a condition of their loans.

Many home insurance policies cover damage from wildfires, as well as smoke damage. If your home or property is damaged by smoke, you can file a claim with your insurance company. Most carriers offer several ways to file a claim, including online, over the phone and through a mobile app. Once the claim is filed, an insurance adjuster will be assigned to your case and provide you with next steps. Be aware that the claims process can move slowly when there are numerous structures and vehicles affected. In the meantime, consider taking photos and videos of the damage and retain receipts for any out-of-pocket expenses that might be covered as part of your homeowners claim.

You may wish to call a remediation company that can start the process of repairing your home after smoke or fire damage while you wait for further guidance from your insurer. The remediation company can work with you to save damaged items as evidence to support your claim.

Frequently asked questions

How can you prepare for a wildfire?

When is wildfire season?

How can I stay safe during a wildfire?

Cite us

Share this article



Written by
Natalie Todoroff
Writer & Assistant

Read more from Natalie

Natalie Todoroff is an insurance writer and industry analyst for Bankrate. She is based in San Francisco and holds a personal lines insurance license.

You may also like

BEST LENDERS
Best lenders for low- and no-down payment...
By Erik J. Martin · 8 min read



MORTGAGES
2025 Ohio conforming and FHA loan limits by...
By Bankrate Staff · 1 min read



RETIREMENT
What is the Financial Independence, Retire...
By James Royal, Ph.D. · 8 min read

HOMEOWNERS INSURANCE
U.S. house fire facts and statistics in 2025
By Natalie Todoroff · 8 min read

How we make money
Bankrate.com is an independent, advertising-supported publisher and comparison service. We are compensated in exchange for placement of sponsored products and services, or by you clicking on certain links posted on our site. Therefore, the compensation may impact how, where and in what order products appear within listing categories, except where prohibited by law. For our mortgage, home equity and other home lending products, the compensation we receive and our proprietary website rules and whether a product is offered in your area or at your self-selected credit score range, can also impact how and where products appear on the site. While we strive to provide a wide range of offers, Bankrate does not include information about every financial or credit product or service.

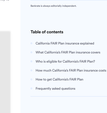
Bankrate, LLC NMLS ID# 1427581 · NMLS Consumer Access
BR Tech Services, Inc. NMLS ID #1715461 · NMLS Consumer Access

We use cookies and similar technologies to understand how you use our services, improve your experiences and serve you personalized content and advertising. To manage your cookies and learn more about our use of cookies click "Cookie Settings". Cookie Settings

Accept

Written by Natalie Todoroff | Edited by Miranda Haines | Reviewed by Mark Friedlander | Expert-verified

Published on February 19, 2025 · 6 min read



Bill Bachi | Getty Images Illustration by Austin Cruse/Bankrate

Bankrate is always editorially independent.

The California FAIR Plan is an insurance program of last resort for homeowners unable to obtain fire coverage in the private insurance market. Contrary to popular belief, the CA FAIR Plan is not a government program. It's a financially supported by California's private insurance companies and is regulated by the California Department of Insurance. As the name of the FAIR Plan overlooked, strained and increasingly expensive. As of December 2024, the CA FAIR Plan has more than 450,000 residential policies in force. But, it's California-like north homes in high-risk wildfire areas, it may be the only way to purchase fire coverage.

Bankrate's team of insurance experts is here to explain what Californians considering a FAIR Plan need to know.



That event could very well be the recent Los Angeles wildfires in January 2025. Los Angeles experienced a series of devastating wildfires, and insured losses are expected to exceed $40 billion — but they were also much higher. One of the major losses, the Palisades Fire, wreaked havoc in the Pacific Palisades, a wealthy community known for celebrity residents. The Palisades Fire destroyed or damaged of the structures destroyed in the Palisades Fire, the other major blaze. In total, the FAIR Plan is looking at a potential payout of $4.77 billion.

California FAIR Plan insurance explained

The California Fair Access to Insurance Requirements, or FAIR, Plan was established in 1968 to provide insurance coverage to homeowners in high-risk areas, whether that means their property is in a fire zone or along an earthquake fault line. The FAIR Plan is offered through a shared market where California insurance companies decide the risk of California insurance companies who do not qualify for voluntary coverage. As of September 2024, the CA FAIR Plan had $498 billion in dwelling coverage exposure — an increase of more than 61 percent since September 2020.



California FAIR Plan insurance is more limited than a standard homeowners insurance policy. But, a FAIR Plan policy can financially protect homeowners from shouldering the full cost of a loss out-of-pocket. Though a FAIR Plan typically covers fewer types of losses and offers fewer policy options than a private home insurance plan, more coverage can be added at an additional cost. Importantly, earthquake coverage is not included and must be added as an endorsement from the California Earthquake Authority.

California's FAIR Plan is a last resort option and is intended to be a temporary solution for homeowners who need insurance in California. The FAIR Plan Association recommends that homeowners should continue to explore private homeowners insurance several times before applying for FAIR Plan coverage. Homeowners may qualify for private insurance even after requirements to qualify for the FAIR Plan.

How will the California Sustainable Insurance Strategy affect the FAIR Plan?

Multiple insurance companies limiting or entirely pausing new home insurance policies in California has sent the market swerving towards chaos. Beginning in March 2024, the CA FAIR Plan began implementing reforms to help the market share better amid the closest to placed heavy limitations on writing new policies in the state. With coverage availability shrinking, many homeowners across California have had no option but to resort to a FAIR Plan policy.

In March 2024 State Farm, the largest home insurance company in California by market share, broke the news that it would nonrenew around 70,000 policies, 30,000 of which are estimated to belong to homeowners. It's expected that many of these non-renewed policies will migrate to the FAIR Plan, putting the FAIR Plan's financial health at risk. Insurance Commissioner Ricardo Lara announced the plan. Remember: The FAIR Plan is financially supported by California insurance companies. If homeowners on the plan incur widespread losses, like those that occur after a wildfire, homeowners with a private policy could potentially see a steep premium increase in order to cover those FAIR Plan losses.

In late 2025, California Insurance Commissioner Ricardo Lara announced the Sustainable Insurance Strategy, a multi-pronged approach to bring stability to the home insurance market and encourage private providers to return to the state. One of the goals named in laundry plan is for the FAIR Plan to start seeking a commitment from private insurers to write 85 percent of new business in historically underserved areas and its modernize the current FAIR Plan to include homeowners associations and affordable housing projects. Homeowners who have a FAIR Plan policy would be the first FAIR Plan to call homeowners and the state's insurance companies — instead of insurance companies alone — if the Plan needs to make a cash call after a catastrophic, residential loss. Essentially, if the FAIR Plan makes an assessment, it would be split among the state's insurance companies and homeowners with a FAIR Plan policy would be the last. With some experts putting losses from the January 2025 fires at $75 billion, an assessment could be on the horizon.

> We would expect insured losses [from the January 2025 wildfires] to run in the billions of dollars given the high value of homes and businesses in the impacted areas. Losses will be shared among standard homeowners insurers, insurers specializing in high-value excess and surplus homeowners policies, and the California FAIR plan. In addition, commercial property losses could be significant.
>
> — Jason Cooper, Bank Rate's Deputy Chief CPA, Mortech Ratings



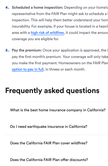
What California's FAIR Plan insurance covers

A California FAIR Plan policy covers much less than a traditional HO-3 does. A standard CA FAIR Plan policy only provides financial protection for your home's dwelling and your personal property if they are damaged from one of four named perils: fire, lightning, internal explosions and smoke. Liability coverage is not available through the California FAIR Plan, and the standard plan only covers what's listed above. To compare, an HO-3 policy includes liability coverage, covers your dwelling and other structures on an open peril basis and offers financial protection for your personal property from 16 different named perils.

A FAIR Plan home insurance policy can be modified with these endorsements, but during as will increase the cost of coverage:

- **Other structures coverage:** Other structures coverage protects against covered damage to detached structures like a garage, porch, shed or fence.
- **Fair rental value coverage:** Available for rental properties, this endorsement covers lost income if the unit is rendered unlivable due to damage sustained from a covered peril.
- **Dwelling replacement cost coverage:** This endorsement changes the dwelling of replacement cost value (RCV) versus actual cash value (ACV).
- **Personal property replacement cost coverage:** Insurance personal belongings at RCV, which replaces items at their current replacement value without depreciation factored in.
- **Ordinance/law coverage:** After a covered loss, this endorsement pays to make structural upgrades to a home as it meets residential building codes.
- **Vandalism and malicious mischief:** Adds financial protection if your home's physical structure and personal belongings are damaged due to vandalism or malicious mischief or both.
- **Debris removal coverage:** Pays to clean up debris on the property after a storm.
- **Inflation guard protection:** This endorsement will automatically raise coverage limits based on inflation, without paying out of pocket for more coverage.
- **Plumbs, shocks and trees coverage:** This endorsement includes up to $500 of coverage for landscaping losses.
- **Outdoor radio and TV equipment, awnings and signs coverage:** This endorsement covers outdoor equipment, signs and awnings from covered perils, with the exception of wind or hail storms.
- **Improvements, alterations and additions coverage:** This coverage is available for condo owners, and covers damage to improvements or alterations in your unit.

Earthquake insurance is not available through the FAIR Plan. Customers can instead purchase a separate earthquake policy through the California Earthquake Authority (CEA).



What is a Difference in Conditions (DIC) policy in California?

Purchasing FAIR Plan home insurance endorsements can offer broader financial protection, but it will not the same as a private insurance policy. Homeowners on the FAIR Plan who are unable to obtain a policy in the private market but want the kind of financial protection offered by an HO-3 can purchase a Difference in Conditions (DIC) policy. It is a supplemental form of insurance meant to fill in the coverage gaps left by a FAIR Plan policy. It's a more comprehensive way for a wider selection of perils, the theft, and can provide liability insurance. A DIC policy also typically offers coverage for landslides, mudflows, earthquakes and floods. Not every insurer in California offers this kind of coverage, but the California Department of Insurance maintains a list of providers that offer it.

Who is eligible for California's FAIR Plan?

California's FAIR Plan offers property insurance for owner- and tenant-occupied buildings, seasonal homes, condos and rental properties (personal property coverage only). To get coverage, property owners must meet certain criteria. FAIR Plan applicants must own a single-family home, townhome, condo or have a rental unit in California, and the home must meet certain building requirements.

Some homeowners do not meet FAIR Plan criteria, even if they are considered part of the pool. The FAIR Plan does not cover vacant homes that are unoccupied for 30 percent of the year, homes with existing damages that have not been repaired and homes that are tied to illegal activity based on state and federal laws.

Most importantly, homeowners seeking to get onto the California FAIR Plan must demonstrate that they have been denied coverage from the private insurance market multiple times. The FAIR Plan was designed as an insurer of last resort, and policies are generally reserved for the most high-risk homes in the state.

How much California's FAIR Plan insurance costs

Like standard home insurance, California FAIR Plan premiums vary based on a number of policy factors. This includes the location, age and condition of the home, proximity to a fire station, the homeowner's claims history, the types and amount of coverage and the deductibles chosen. In a 2022 interview with KCAL, a FAIR Plan spokesperson stated that the average cost of a policy is about $3,000 per year, which is substantially more than the average home insurance policy in California, where the average homeowner pays $1,428 for $300,000 in dwelling coverage as of February 2025. Keep in mind that the FAIR Plan policy covers much less than a typical home insurance policy, and that a homeowner who qualifies for a FAIR Plan policy because they're in a high-risk home can be even more expensive if purchasing additional coverage on the FAIR Plan, such as a difference in conditions, flood or earthquake policy.

How to get California's FAIR Plan

The process of purchasing a California FAIR Plan is pretty simple. However, the process is slightly different than getting a traditional home insurance policy. Here's a brief overview of how to get a California FAIR Plan:

1. **Find a provider:** California FAIR Plan insurance can be purchased through a licensed insurance broker in the state. Homeowners can use the online broker search tool on the FAIR Plan website to find local agents within or near their ZIP code. Brokers do not collect a fee when selling FAIR Plan insurance policies like they do with standard home insurance.
2. **See if you are eligible.** Not every homeowner will be able to qualify for a California FAIR Plan. Your broker will run an extensive search to see if you can get preferred homeowners insurance coverage through the traditional marketplace before you will be allowed to move forward with the FAIR Plan application.
3. **Complete the application:** If you work with a broker, they can help you fill out the application, choose an appropriate amount of coverage and endorsements and calculate the fair market value of your home. Once the application is completed, you will get an instant rate quote. Keep in mind that if you apply for a FAIR Plan without a broker, you cannot get an immediate price estimate.
4. **Scheduled a home inspection:** Depending on your home's location, a representative from the FAIR Plan might be scheduled to schedule an inspection. For example, if your house is located in a heavily wooded area with a high risk of wildfires, it could impact the amount of coverage you are eligible for.
5. **Pay the premium:** Once your application is approved, the last step is to pay the first month's premium. Your coverage will only take effect once you make the first payment. Homeowners on the FAIR Plan have the option to pay in full, or break up payments.

Frequently asked questions

What is the best home insurance company in California?

Do I need earthquake insurance in California?

Does the California FAIR Plan cover wildfires?

Does the California FAIR Plan offer discounts?

Are insurers leaving California due to wildfires?

How much coverage can I get under the California FAIR Plan?

Cite or Share this article

Written by

Natalie Todoroff

Writer II, Insurance

Read more from Natalie

Natalie Todoroff is an insurance writer and industry analyst for Bankrate. She is based in San Francisco and holds a personal lines insurance license.

You may also like



BANKING

How to get financial assistance after a natural...

By Sarah Brenton · 6 min read

REAL ESTATE

What is a preferred lender? Should I take an...

By Erik J. Martin · 5 min read



RELOCATION

North Carolina Solar Cost Tax Credits & Rebates...

By Faith Pustilnik · 5 min read



REAL ESTATE

Selling your home fast in Colorado

By Erik J. Martin · 5 min read

How we make money

Bankrate.com is an independent, advertising-supported publication and comparison service. We are compensated in exchange for placement of sponsored products and services, or by you clicking on certain links posted on our site. Therefore, this compensation may impact how, where and in what order products appear within listing categories, except where prohibited by law. Our compensation may also impact how and where products appear on this site, including where they appear in any rank order. Bankrate does not include all companies or all types of products available in the marketplace. You should consider carefully whether you can afford the payments and whether you understand the associated costs and fees before applying for any product. See all Bankrate's rates.

Bankrate, LLC NMLS ID# 447139 · NMLS Consumer Access
NY Bank Advertising Disclosure · Member FDIC

We use cookies and similar technologies to understand how you use our services, improve your experience and serve personalized content, ads and recommendations. To change your cookie settings at any time, click "Cookie Settings" in the footer of our website. Learn more

Cookie Settings

Sponsored Ad
Wal-Mart Car Insurance $199/mo
GET QUOTE

MONEYWATCH

After wildfires, hundreds of thousands of Californians can't get insurance

MONEY WATCH
By Aimee Picchi
August 28, 2018, 12:00 AM EDT / MoneyWatch

Next Story

The Selling Storage of California's waste

Paul Ryan, Annie Glyn

Angelo Bellomo Video building a Cabin

How mortgage rates in Canada Could Affect Your Home

- An estimated 350,000 California home and business owners are unable to get property and casualty insurance after last year's devastating wildfire
- As the threat of mega-fires grows across the state, California's insurance commissioner predicts the situation will get worse.
- Consumer advocates say insurers are "holding us hostage," noting that people can't get a mortgage without home insurance.

Dave DuPell is a long-time homeowner in Grass Valley, California, a small town located near the site of the devastating "Camp Fire" in November that killed 86 people and incinerated 18,000 homes and businesses. Now 54 – and hundreds of thousands of other residents – are confronting another dilemma: No homeowners' insurance.

"Our insurance companies are saying, 'We're done with you!'" he said.

Like many other residents, DuPell's home is located on the so-called "interface" between suburb and woodland, where California's dry brush and beetle-ravaged trees stand side-by-side with expensive homes worth an average of half a million dollars. Given this scenario, property-casualty insurance companies are refusing to insure more than 350,000 homeowners in 10 counties seen as vulnerable to fires, according to published reports.

"We are seeing an increasing trend across California where people at risk of wildfires are being non-renewed by their insurer," said state Insurance Commissioner Richard Lara in a statement.

"Holding us hostage"

Among their concerns, consumer groups says, is that loss of coverage could create a domino effect of declining home values because it's impossible to secure a mortgage without homeowners insurance. That could scare potential buyers, as well as make it tougher for current homeowners to refinance their properties.

Ad

"The insurers have to come up with a better response than simply canceling policies," said Amy Bach, executive director of United Policyholders, a San Francisco-based advocacy group. "They are holding us hostage, because you have to buy their products."

Insurance Commissioner Lara has been meeting with local leaders in the 10 counties affected by this and, by all accounts, getting an earful. Nearly a quarter of a million homes are located in the fire-ravaged areas.



Wildfire Forces Six Flags evacuation in Calif...

The latest data from the California Department of Insurance shows that property-casualty coverage for homes and businesses was already becoming harder to find due to fire losses in 2015 and 2017. That pattern continued in 2018, when 85% of property owners lost coverage.

But that was only the prelude. Last year was the most devastating for fires in the state's history, with 933 fires lost and 2 million acres scorched. In other words, the 85% of non-renewals doesn't begin to measure the scale of the fire-fall impact ... linked to the devastating 2018 fires." This is likely to be felt later in 2019 and well into the future.



Aging Seniors: Avoid Eating Blueberries for Breakfast

Lara said the situation for homeowners may get a lot worse because "not being able to obtain insurance can create a domino effect," driving down home sales and starving local communities of property tax revenues. "Without action ... we could see communities unraveling," he warned.

One solution is to raise insurance rates, but rate increases take time to get approved. "Insurers are now filing with the state for multiple rate hikes," Bach said. And it's more than likely they'll get huge increases.

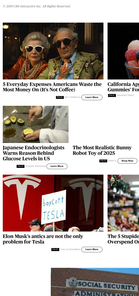
"We paid out more than $26 billion in claims from the 2017 and 2018 wildfires," said Jen Frazier, president of the Personal Insurance Federation of California. "With years of repeated wildfires, we're now facing 'a new normal.'"

And that new normal could mean a triple or quadruple increase in premiums, DuPell points out that his neighbor – ironically himself an insurance agent – saw his annual homeowner's insurance rate skyrocket from $1,200 to $4,000. And he could be one of the lucky ones.

Insurance of last resort

Homeowners who can't buy regular insurance wind up in California's "FAIR" plan, a last resort for purchasing property coverage. This plan is typically much more expensive than a traditional homeowner's policy and offers bare-bones coverage that doesn't normally include theft, wind, water or earthquake damage, Bach said. Between 2015 and 2018, there was a 177% increase in homeowners residing in the state's 10 "high risk" counties who were forced into the FAIR plan.

In the past, regular insurers told homeowners they could lower their premiums by taking steps to avoid the FAIR plan, such as building a "defensible zone" around their properties. That involved clearing away brush, trees and bushes; moving lawn furniture; spraying fire-retardant; and replacing cedar shake roofs and other burnable substances with non-flammable products.



Steve Lipkin, left, a resident of Malibu, California, talks to Jon Day, a member of Lipkin's crews after the fires swept by the Woolsey Fire in Malibu, California, on November 13, 2018.

Now, armed with drone data that shows where the next big blaze is likely to happen, insurers simply cancel policies.



Cardiologists: Teaspoon On an Empty Stomach Slims Waist from 36 To 22

"They are admitting that nothing will work when there's a firestorm," Duffell said.

The resentment homeowners feel toward property insurers – justified or not – is intense. It's possible that this and other may advocate for a radical solution that's been used to pressure insurers in other states that threatened to bail out: Deny them the right to sell profitable auto insurance policies unless they retain homeowners' insurance policies.

In the interim, Bach suggests the following plan of action for California homeowners in regions impacted by fires:

- Try to get your current insurer to keep the policy in place.
- If unsuccessful, shop around for another regular home insurer.
- If that doesn't work, buy the FAIR plan, but add on all the supplemental coverage you can.

More from CBS News



5 smart ways to use your home equity this spring, according to experts

3 simple (but important) steps to prepare children to make right now

4 tips for getting the best HELOC rate this March



Is a $100,000 home equity loan a good idea now?



My relentless fear that @ Nancy Kerrigan

My relentless fear that @ Nancy Kerrigan

Ad



If cancer were a country, it would be the 3rd largest in the world



A vehicle that automatically reacts decisions to make right now



5 tips for getting the best HELOC rate this March

Is a $100,000 home equity loan a good idea now?

In: California Fire

Ed Lavitola

Ed Lavitola is an award-winning investigative and business journalist who has worked for Reuters, Bloomberg and Dow Jones, and contributed to the Wall Street Journal and the New York Times. His book, "Confessions of The Woman Who Rode the Wind, a novel about early flight.

© 2019 CBS Interactive Inc. All Rights Reserved.

5 Everyday Expenses Americans Waste the Most Money On (It's Not Coffee)
Learn More

California Approves New Arthritis Gummies For Seniors in Pain
Learn More

Japanese Endocrinologists Warns Reason Behind Glucose Levels in US
Learn More

The Most Realistic Bunny Robot Toy of 2025
Shop Now

Take Charge of Fungus-Affected Nails
Learn More

Elon Musk's antics are not the only problem for Tesla
Read More

The 5 Stupidest Things Americans Overspend On (Coffee Isn't One of Them).
Read More

7 Things Trump Plans To Do for Seniors On 5th In 2025
Trump Senior Plans | Search Ads

Endocrinologists: Why Us Glucose Levels Are Rising! (Avoid This!)
Learn More

Study Shows Surprising Link Between Aging & Pillowcase
Learn More

Does Trump really want a weaker dollar?
Learn More

Why Japanese Seniors Can Still Open Jars at 92
Learn More

Empty Cruises Departing From California That Seniors Can Book For Cheap
Learn More

Side Sleepers Get Neck Pain - Few Know This Pillow Trick
Learn More

This Showerhead Keeps Selling Out On Amazon - Find Out Why
Learn More

Costco Shoppers Say This Knee Pain Relief Device Is "Actually Worth It"
Learn More

The Grounding Mat Neuropathy Sufferers Swear By
Learn More

Protein isn't Enough – Here's What Really Builds Muscle After 60
Learn More

Trump says the war may finally end in Ukraine
CBS NEWS

Trump's dark message to DOJ & its place in history
CBS NEWS

Next Gen Wrinkle Smoother is Amazon's Hottest New Find - Find O...
Learn More

Knee Pain Relief Device Has Costco Shoppers Obsessed - Find Out Why
Learn More

California Power Companies Are Begging Homeowners Not To Do...
Learn More

Doctor Discovers The So-Called "Lazy Way" To Lose Weight
Lose Weight

New SUVs Many Don't Realize Are Loaded With Luxury (Take A Look)
Learn More

Wildfires and Acres

Total Wildland Fires and Acres (1983-2024)

Source: National Interagency Coordination Center

Year	Fires	Acres
2024	64,897	8,924,884
2023	56,580	2,693,910
2022	68,988	7,577,183
2021	58,985	7,125,643
2020	58,950	10,122,336
2019	50,477	4,664,364
2018	58,083	8,767,492
2017	71,499	10,026,086
2016	67,743	5,509,995
2015	68,151	10,125,149
2014	63,312	3,595,613
2013	47,579	4,319,546
2012	67,774	9,326,238
2011	74,126	8,711,367
2010	71,971	3,422,724
2009	78,792	5,921,786
2008	78,979	5,292,468
2007	85,705	9,328,045
2006	96,385	9,873,745
2005	66,753	8,689,389
2004	65,461	*8,097,880
2003	63,629	3,960,842
2002	73,457	7,184,712
2001	84,079	3,570,911
2000	92,250	7,393,493
1999	92,487	5,626,093
1998	81,043	1,329,704
1997	66,196	2,856,959
1996	96,363	6,065,998
1995	82,234	1,840,546
1994	79,107	4,073,579
1993	58,810	1,797,574
1992	87,394	2,069,929
1991	75,754	2,953,578
1990	66,481	4,621,621
1989	48,949	1,827,310
1988	72,750	5,009,290
1987	71,300	2,447,296
1986	85,907	2,719,162
1985	82,591	2,896,147
1984	20,493	1,148,409
1983	18,229	1,323,666

* 2004 fires and acres do not include state lands for North Carolina.

Prior to 1983, the federal wildland fire agencies did not track official wildfire data using current reporting processes. As a result, there is no official data prior to 1983 posted on this site.

The National Interagency Fire Center is committed to making its information and communication technologies accessible to individuals with disabilities by meeting or exceeding the requirements of Section 508 of the Rehabilitation Act of 1973, as amended. To meet this commitment, we continue to monitor and update our content to make sure our documents meet these standards.

Air temperatures

July 1, 2024

Air temperatures have increased over the past century, driven mainly by changes in nighttime temperatures.

One of the most definitive indicators of climate change is air temperature. The rise in global air temperatures is linked to increased concentrations of carbon dioxide and other greenhouse gases in the Earth's atmosphere from human activities. Warming air temperatures impact the weather, the water cycle, human health and well-being, and ecosystems. For more information, download the Air Temperatures chapter.

What does this indicator show?

Statewide annual average air temperatures

This line graph shows the annual average air temperatures (°F) from 1895 to 2023 in the grey dotted line and the 11-year running average in the solid red line.

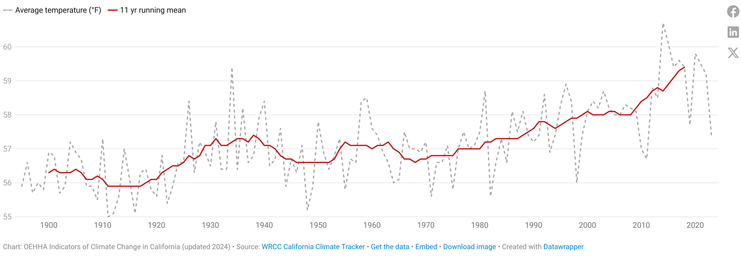
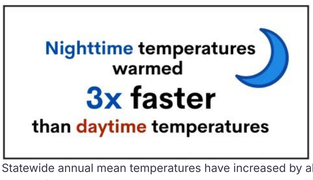


Chart: OEHHA Indicators of Climate Change in California (updated 2024) • Source: WRCC California Climate Tracker • Get the data • Embed • Download image • Created with Datawrapper

- 

  Statewide annual mean temperatures have increased by about 2.5 degrees Fahrenheit (°F) since 1895. Warming has accelerated, and seven of the past eight years have been the warmest on record.
- Some of the warmest years coincided with some of the driest years, leading to exacerbated drought conditions. Droughts of the 21st century have been hotter, longer lasting, and more widespread than before.

Why is this indicator important?

- A warming climate has far-reaching effects on our health, well-being, ecosystems, economy, and natural resources.
- Extreme heat, poor air quality, droughts, and other severe impacts of warming temperatures disproportionately fall on underserved communities. These communities are least able to prepare for, respond to, and recover from such impacts.

What factors influence this indicator?

- Carbon dioxide and other greenhouse gases have driven rapid warming worldwide.
- Temperatures are also influenced by the natural and urban landscape, elevation, proximity to the ocean, and atmospheric and oceanic circulations.
- Changes in land use and land surface exert local effects on temperature. For example, heat-absorbing concrete and asphalt in buildings and roads have a warming effect, and irrigation has a cooling effect.

All regions of California have warmed over the last century, although at varying rates. Southern California is warming about twice as fast as Northern California.



Credit: iStock/DutcherAerials

Additional resources

- CalAdapt, Annual Averages
- Calfornia Energy Comission, Governor's Office of Planning and Research and Natural Resources Agency, California's Fourth Climate Change Assessment
- National Oceanic and Atmospheric Administration, California State Climate Summary 2022
- National Oceanic and Atmospheric Administration, Climate at a Glance
- National Oceanic and Atmospheric Administration, Storm Events Database
- Western Regional Climate Center, State Climate Trackers
- Oregon State University, PRISM Climate Group
- University of Oxford, Global Warming Index

Downloads

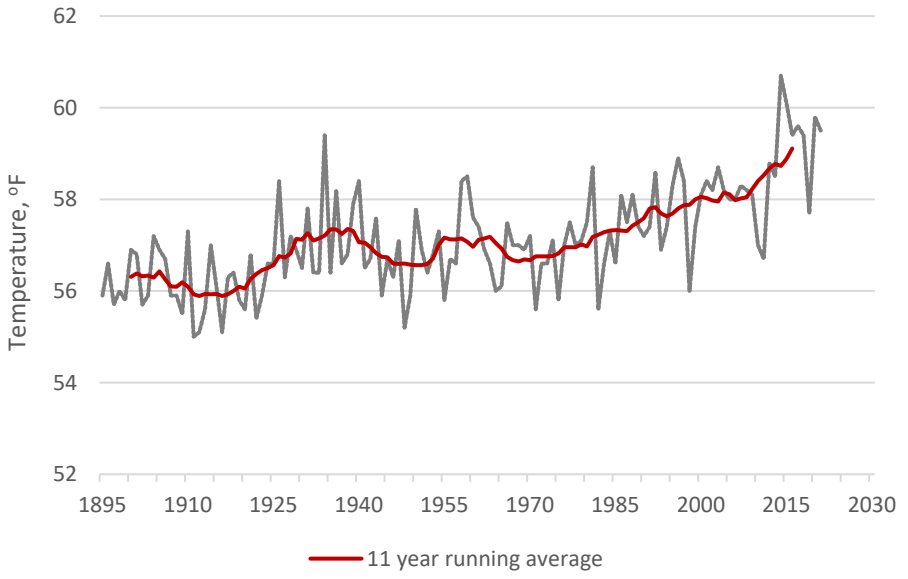
Air temperature
November 1, 2022

Copyright © 2025 State of California

AIR TEMPERATURE

Air temperatures have increased over the past century, driven mainly by changes in nighttime temperatures.

Figure 1. Statewide annual average temperatures



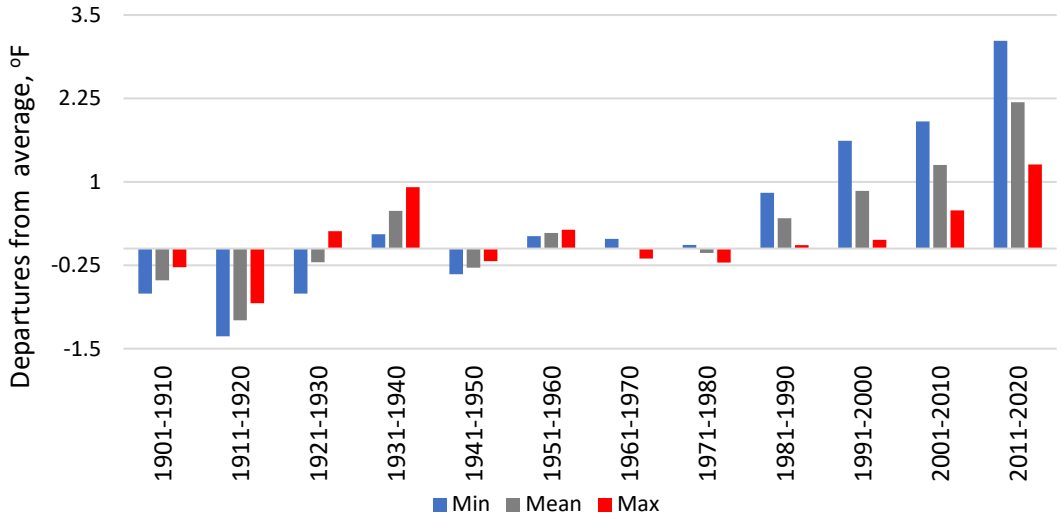
Source: WRCC, 2022

What does the indicator show?

Statewide air temperatures show a warming trend consistent with that found globally (IPCC, 2021; also see the globalwarmingindex). They have been recorded since 1895. Figure 1 presents annual average temperatures statewide. Annual average temperatures have increased by about 2.5 degrees Fahrenheit (˚F) (or about 2°F per century, which is a common way of measuring long-term temperature changes). Recent years were notably warm, with 2014 being the warmest on record, followed by 2015, 2020, 2017, 2016, and 2018. Some of these warmest years coincided with some of the driest years in the instrumental record and led to exacerbated drought conditions due to increased land surface temperatures, evapotranspiration, and evaporative demand.

Figure 2 depicts “departures” by decade from a long-term average (base period of 1901 to 2000) for minimum, mean, and maximum temperatures. Departures are the difference between each decade’s value and the long-term average. Before the 1930s, temperatures were cooler than the long-term average, then hovered around the average between the 1940s and the 1970s. The last four decades showed marked warming, as temperatures increased at a faster rate. Minimum, average, and maximum temperatures have increased overall. Minimum temperatures (which reflect overnight low temperatures) have increased the fastest.

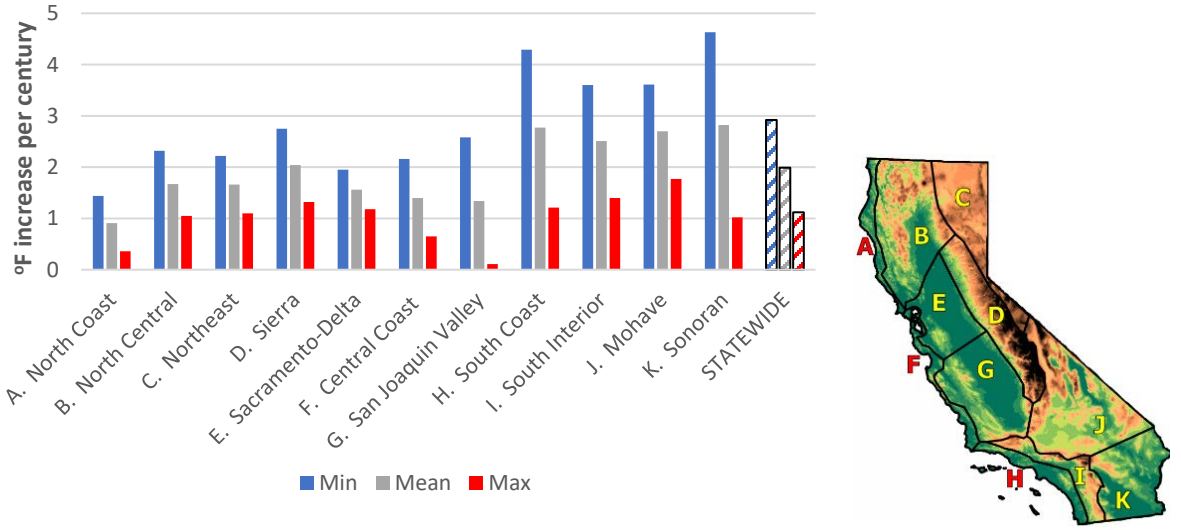
Figure 2. Statewide Temperatures, Decadal Averages (relative to the 1901-2000 long-term average*)



Source: WRCC, 2021

** Values shown for each decade are "departures" from the long-term average, 1901-2000—that is, the difference between the long-term average and the average for the decade.*

Figure 3. Regional and statewide temperature trends (1895 to 2020)



Source: WRCC, 2021

As shown in Figure 3, statewide minimum temperatures rose at a rate of 2.9°F per century. Maximum temperatures rose at 1.1°F per century. As minimum temperatures have increased the fastest, the increasing trend in the average California temperature is driven more by nighttime processes than by daytime processes.

All of California's 11 climate regions have experienced warming trends over the last century, although at varying rates (Figure 3). The greatest increases are observed in the Sonoran Desert and South Coast regions. Minimum temperatures showed the greatest rate of increase in all the regions, consistent with statewide trends.

Why is this indicator important?

Temperature is a basic physical factor that affects many natural processes and human activities. Warmer air temperatures alter precipitation and runoff patterns, influencing the availability of freshwater supplies. Increased temperature leads to a wide range of impacts on ecosystems — including changes in species' geographic distribution, in the timing of life cycle events, and in their abundance — as well as on human health and well-being. In addition, warming temperatures affect energy needed for cooling and heating, which in turn influences the types of energy generation, infrastructure, and management policies needed to meet these demands. Temperature changes can also increase the risk of severe weather events such as heatwaves and intense storms. Understanding observed temperature trends is important for refining future climate projections for climate-sensitive sectors and natural resources within the state (Cordero et al., 2011).

What factors influence this indicator?

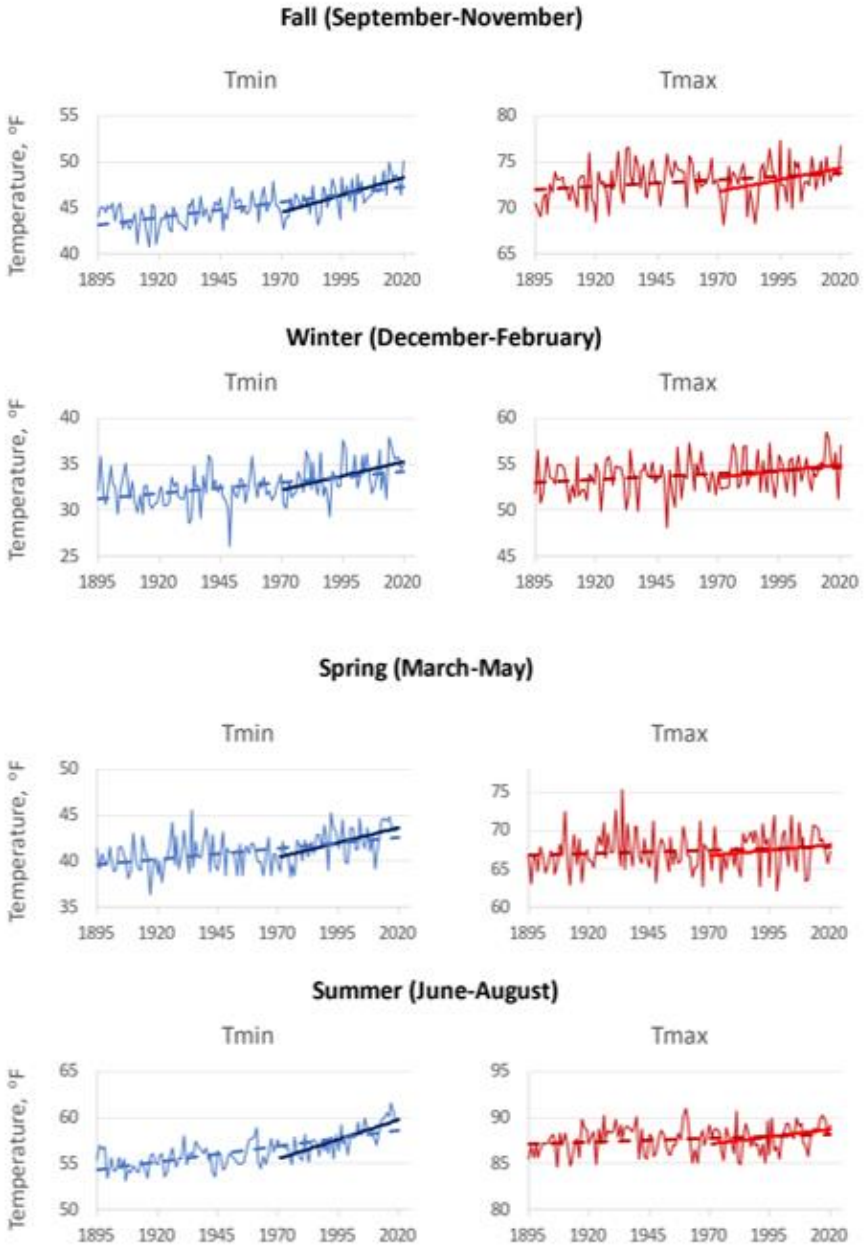
Carbon dioxide and other greenhouse gas emissions into the atmosphere since the Industrial Revolution in the mid-1700s have driven unprecedented warming worldwide. (IPCC, 2021). Emissions of these greenhouse gases intensify the natural greenhouse effect, causing surface temperatures to rise. Greenhouse gases absorb heat radiated from the Earth's surface and lower atmosphere and reflect much of the energy back toward the surface.

Temperatures are influenced by local topography, elevation, proximity to the ocean, and global and regional atmospheric and oceanic circulations. As previously mentioned, Figure 3 illustrates geographic differences in warming trends (WRCC, 2021). Regional information can be obtained from the California Climate Tracker. Climate patterns can vary widely from year to year and from decade to decade, in accordance with large-scale circulation changes around the Earth. The Pacific Ocean has a major effect on California temperatures all year along the coast, especially summer, and farther inland in winter. In addition to topography, local influences on temperature include changes in land surface and land use. For example, urbanization of rural areas is generally known to have a warming effect, due in large part to the heat-absorbing concrete and asphalt in building materials and roadways. Expansion of irrigation has been shown to have a cooling effect on summertime temperatures (Bonfils and Lobell, 2007).

Statewide seasonal temperature trends are shown in Figure 4. Across the seasons, minimum temperatures are increasing faster than maximum temperatures. Trends for the more recent time period (from 1971 to 2021, solid line in Figure 4) are greater than trends since 1895 (dotted line). The greatest increases in minimum temperatures occurred in the summer and fall over both time periods. For maximum temperatures,

the greatest increases over the entire period of record occurred in the fall and winter; since 1971, the greatest increased occurred in the fall and summer.

Figure 4. Seasonal air temperature trends in California



Source: WRCC, 2021

Average minimum temperature (Tmin) and average maximum temperature (Tmax) for each year are presented for each season. The linear trend for the entire period is shown as solid lines, and for 1971-2021 as dashed lines.

Technical considerations

Data characteristics

The Western Regional Climate Center (WRCC)'s California Climate Tracker provides monthly temperature values in California from 1895 to the present using the PRISM Climate Mapping Program from Oregon State University. PRISM is an analytical tool that generates fine scale grid-based estimates of monthly precipitation and temperature. The "About the California Climate Tracker" page provides more information. (WRCC has updated its methodology since the previous report for determining historical temperatures, so values in the current edition of this report slightly differ from the previous edition).

Strengths and limitations of the data

The datasets used are subjected to their own separate quality control procedures, to account for potentially incorrect data reported by the observer, missing data, and to remove inconsistencies such as station relocation or instrument change.

The PRISM dataset offers complete coverage across the state for every month of the record. Limitations include the bias of station data toward populated areas and the limited ability of quality control processes in remote or high terrain areas. The dataset is constantly updated to map climate in the most difficult situations, including high mountains, rain shadows, temperature inversions, coastal regions, and associated complex climate processes.

OEHHA acknowledges the expert contributions of the following to this report:

Dan McEvoy
Western Regional Climate Center
Division of Atmospheric Science
Desert Research Institute
(775) 674-7010
Daniel.McEvoy@dri.edu

Michael L. Anderson, Ph.D., P.E.
State Climatologist
California Department of Water Resources
(916) 574-2830
Michael.L.Anderson@water.ca.gov

References:

Bonfils C and Lobell D (2007). Empirical evidence for a recent slowdown in irrigation-induced cooling. *Proceedings of the National Academy of Sciences* **104**(34): 13582-13587.

Cordero E, Kessomkiat W, Abatzoglou JT and Mauget S (2011). The identification of distinct patterns in California temperature trends. *Climatic Change* **108**(1-2): 357-382.

IPCC (2021). *AR6 Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Masson-Delmotte V, Zhai P,Pirani A, Connors SL, Péan C, S. Berger S, et al. (Eds.). Geneva, Switzerland: Intergovernmental Panel on Climate Change.

WRCC (2022). Western Regional Climate Center: California Climate Tracker. Retrieved March 4, 2022.

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

HHS Public Access

Author manuscript

J Occup Environ Hyg. Author manuscript; available in PMC 2017 November 27.

Published in final edited form as:

J Occup Environ Hyg. 2017 April ; 14(4): 258–270. doi:10.1080/15459624.2016.1250004.

Wildland firefighter deaths in the United States: A comparison of existing surveillance systems

Corey Butler[a], **Suzanne Marsh**[b], **Joseph W. Domitrovich**[c], and **Jim Helmkamp**[d]

[a]Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Western States Division, Denver, Colorado

[b]Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Division of Safety Research, Morgantown, West Virginia

[c]United States Forest Service, Missoula Technology and Development Center, Missoula, Montana

Abstract

Wildland fire fighting is a high-risk occupation requiring considerable physical and psychological demands. Multiple agencies publish fatality summaries for wildland firefighters; however, the reported number and types vary. At least five different surveillance systems capture deaths, each with varying case definitions and case inclusion/exclusion criteria. Four are population-level systems and one is case-based. System differences create challenges to accurately characterize fatalities.

Data within each of the five surveillance systems were examined to better understand the types of wildland firefighter data collected, to assess each system's utility in characterizing wildland firefighter fatalities, and to determine each system's potential to inform prevention strategies. To describe similarities and differences in how data were recorded and characterized, wildland fire deaths for three of the population-based systems were matched and individual fatalities across systems were compared. Between 2001 and 2012, 247 unique deaths were captured among the systems; 73% of these were captured in all three systems. Most common causes of death in all systems were associated with aviation, vehicles, medical events, and entrapments/burnovers. The data show that, although the three systems often report similar annual summary statistics, events captured in each system vary each year depending on the types of events that the system is designed to track, such as inclusion/exclusion of fatalities associated with the Hometown Heroes Survivor Benefits Act of 2003.

The overarching and central goal of each system is to collect accurate and timely information to improve wildland firefighter safety and health. Each system is unique and has varying inclusion

CONTACT Corey Butler, crbutler@cdc.gov, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, Western States Division, Denver Federal Center, P.O. Box 25226, Denver, CO 80225.

[d]Retired

Disclaimer

The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the National Institute for Occupational Safety and Health. Mention of company names or products does not imply endorsement by the National Institute for Occupational Safety and Health.

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention or the United States Forest Service.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

and exclusion criteria for capturing and tracking different subsets of wildland firefighter tasks and duties. Use of a common case definition and better descriptions and interpretations of the data and the results would help to more accurately characterize wildland firefighter traumatic injuries and illnesses, lessen the likelihood for misinterpretation of wildland firefighter fatality data, and assist with defining the true occupational injury burden within this high-risk population.

Keywords

Wildland fire fatality; wildland firefighter

Introduction

Between 2001–2012, over 100 U.S. firefighter line-of-duty deaths occurred annually.[1] Firefighting is high-risk and requires considerable physical and psychological demands. Primary modes—urban/structural and non-urban/wildland firefighting—pose unique hazards to workers as suppression mechanisms and techniques differ greatly. Wildland firefighting, for example, typically requires longer (12–16+ hour days), arduous work shifts (4,000–6,000 calories expended a day) for up to 14 continuous days and is coupled with multiple environmental stressors, resulting in an occupation that is characterized as challenging and high-risk.[2]

The risk to wildland firefighters (WFFs) has increased in recent years largely due to increases in acreage burned and changes in the types of fires. In 2013, more than 4.1 million acres burned in the U.S., about twice as many as reported 40 years ago.[3] This increase is likely due to a variety of factors, including changes in climate, vegetation, snowpack, fuel conditions, and human activities.[4–6] Over the past several years, large fires have been reported in areas known as Wildland Urban Interface (WUI). The National Wildland Fire Coordinating Group (NWCG) defines WUI as “the line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuels.” Although WUI comprises only 10% of all land, over 38% of U.S. homes are within these areas.[7] In 2011, the State Foresters Association estimated that over 66,000 U.S. communities were at risk because of wildland fire.[8] The economic and resource burden associated with fighting fires in these areas is increasing as more homes are built in these environments.[9]

Suppressing wildland fires in the U.S. is complex and requires a mixture of federal and state agencies, tribal governments, and local fire departments, all with different missions and responsibilities.[10] Aside from federal and state entities, others involved in wildland firefighting are often drawn from a variety of contracting agencies, prison-based crews, and military (e.g., the National Guard); the largest proportion, however, are likely volunteers from local fire departments.[10,11] The National Fire Protection Association (NFPA) estimated that in 2010, 86% of the 26,000 local fire departments with over 1.1. million firefighters had wildland fire suppression duties and many were staffed primarily by volunteers.[12]

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Additionally, the NWCG estimated that the U.S. Department of the Interior (DOI) and the U.S. Department of Agriculture-United States Forest Service (USDA USFS) employed 34,000 federal workers with wildland fire suppression responsibilities in 2010 (Michelle Ryerson, National Wildfire Coordinating Group, Risk Management Committee, May 2011). The number of personnel engaged in WFF activities from other agencies (e.g., contractors, local, state, and prison-based) is generally unknown and often dictated by funding and frequency and severity of wildfires. As a result, a reliable WFF workforce estimates, similar to those collected for structural firefighters, is unknown. It is expected, however, that the number of personnel involved in wildland fire suppression will continue to grow as the frequency of large wildfires and the area burned by wildfires—particularly in the western U.S.—continues to increase.[13–15]

Most published research on WFFs has focused on monitoring acute health effects of wildland fire smoke exposure, personal energy expenditure, and physiologic response.[16–27] Additional research is needed as questions still exist regarding other types of hazards and long-term health effects that WFFs face. Currently, four population-based data systems and one case-based system captures fatality data for WFFs. The Census of Fatal Occupational Injuries (CFOI), a population-based system operated by the U.S. Bureau of Labor Statistics (BLS) collects information on all occupational fatal injuries, including WFF fatal occupational injuries. Two population-based systems, a system operated by the United States Fire Administration (USFA) and a system maintained by the National Fire Protection Association (NFPA), focus exclusively on firefighter fatalities, including WFF fatalities. The NWCG population-based system, Safety Gram, focuses exclusively on wildland firefighter fatalities. The case-based system, maintained by the National Institute for Occupational Safety and Health (NIOSH), captures select firefighter fatalities, including wildland fire-related fatalities, through investigations conducted through the Fire Fighter Fatality Investigation and Prevention Program (FFFIPP).While these systems all routinely collect data, information specific to wildland fire events is often sparse, combined with data on all U.S. firefighter deaths, and is typically limited to serious incidents and occasional near-misses.[1,28,29] In addition, the reported number and types vary,[30–34] creating challenges to accurately characterize WFF fatalities.

The purpose of this study is to better understand characteristics of workers who are fatally injured or experience a fatal medical event while performing wildland fire-related duties by examining fatalities in the five surveillance systems. This research is similar to the study conducted by Estes et al. which characterized all firefighter fatalities in 2011,[29] however, this study focused on only fatalities that occur among workers engaging in wildland firefighting activities.

Methods

Data for WFF fatality data were obtained from all four population-based data systems and the one case-based system for the years 2001–2012. Each system's case definition was used to identify fatalities associated with wild-land firefighting. While not all of the systems included medical and trauma-related events, both types of events were included where possible. Traumatic-related fatalities were typically characterized as a fatal injury or disorder

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

as the result of a single incident, event, or exposure over the course of a single shift.[35] Medical fatalities or fatal occupational illnesses that occurred while a firefighter was on-duty frequently manifested as sudden cardiac events (heart attacks) or cerebrovascular accidents (stroke). Each system is summarized below and in Table 1.

USFA surveillance system

The USFA tracks on-duty firefighter fatalities in the U.S. in their firefighter fatality data system. The USFA defines “on-duty” fatalities as those that occur at the scene of a fire or non-fire emergency, while responding to or returning from an incident and while performing other officially assigned duties. USFA also includes fatalities covered under the Hometown Heroes Survivors’ Benefit Act of 2003, which states that, if the firefighter becomes ill as the result of a heart attack or stroke within 24 hr after engaging in non-routine stressful or strenuous work-related physical activity, the event is considered on-duty.[36]

The USFA compiles data related to each firefighter fatality in a database and publishes an annual summary report. All on-duty U.S. firefighter fatalities resulting from traumatic and medical events are included.

The USFA on-duty firefighter fatality MS Access database shared with the National Institute for Occupational Safety and Health (NIOSH) includes both wildland and non-wildland firefighter fatalities and 234 unique variables for each fatality. Updated on a monthly basis, the database used for this study was updated June 30, 2013. The USFA classifies WFFs as firefighters who were killed performing on-duty activities involving brush, grass, or wildland fire fighting. All wildland-related fatalities from 2001–2012 were extracted. Additionally, to verify all wild-land incidents were identified, USFA annual reports from 2001–2012 were reviewed.

NFPA firefighter fatality surveillance system

The NFPA has a population-based surveillance system, Fire Incident Data Organization (FIDO), which captures all firefighter fatalities due to injuries or illnesses that occurred while the firefighter was on-duty. Similar to the USFA, the term “on-duty” refers to being at the scene of a fire or non-fire incident; responding to or returning from an incident; participating in other fire department duties, such as training, maintenance, public education, etc.; or on call or standby at a location other than a firefighter’s home or place of business. The NFPA does not consider fatalities that occurred under the Hometown Heroes Survivors’ Benefits Act to be “on-duty.”[37]

Similar to the USFA, the NFPA compiles data related to each firefighter fatality into a surveillance system and publishes an annual summary of all on-duty U.S. firefighter fatalities, including both traumatic and medical wildland fire-related fatalities.

For this analysis, a special request was made to NFPA to provide all on-duty fatalities associated with a brush, grass or wildland fire. The NFPA provided two separate MS Excel spreadsheets containing all on-duty wildland-fire related fatalities from 2001–2012. Data included date of incident, location where incident occurred, gender, age, agency, and cause

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

and nature of fatality. NFPA also identified whether the fatality occurred while fighting a grass/brush/wildland fire and whether it was part of a multiple fatality event.

NWCG RMC safety gram wildland fire fatalities, entrapments, and serious accident summary reporting system

The NWCG is an interagency group that provides national leadership to develop, maintain, and communicate interagency standards, guidelines, qualifications, training, and other capabilities for a variety of agencies including the USDA USFS; four DOI bureaus and agencies: Bureau of Land Management; National Park Service, Bureau of Indian Affairs, and the Fish and Wildlife Service (FWS); and the National Association of State Foresters. The NWCG Risk Management Committee (RMC) Safety Gram Fatalities, Entrapments and Serious Accident data system, or Safety Gram, tracks WFF fatalities, focusing exclusively on incidents involving emergency responders engaged in direct support of wildland fire, fire suppression, damage repair and fire rehabilitation work. The Safety Gram reports are available on a publically accessible website. Data collected through the Safety Gram system includes fatalities that occurred during an incident, in mobilization status, demobilization status, and while training or participating in the work-capacity tests. While medical related fatalities such as heart attacks are included, fatalities related to the Hometown Heroes Survivors' Benefits Act or private citizens acting on their own behalf are typically not included by the NWCG.[38] For this study, wildland fire-related fatality reports from the Safety Gram website were reviewed for data between 2000–2012 and input into the MS Access database. No personal identifying information or demographic information was available in these reports. In selected cases, Serious Accident Investigation (SAI) Reports were reviewed to supplement/verify information from the Safety Gram reports. Produced by federal and state agencies, the SAI reports provide detailed information about select incidents.[39]

BLS CFOI

The BLS CFOI surveillance system collects details for every work-related fatality in the U.S. As a result, fatal occupational injuries that occur while suppressing a wildland fire are captured in this system. Data are collected from multiple federal, state and local sources, including death certificates, workers' compensation reports, medical examiner reports, Occupational Safety and Health Administration (OSHA) reports, and police reports. CFOI data include injury-related deaths but do not include illness-related deaths, unless the illness was caused by an injury. Thus, medical incidents among WFFs, such as heart attacks and strokes, are typically not included in CFOI.[40] Volunteers are included in CFOI if they performed the same duties as paid employees;[41] as a result, volunteer firefighters engaging in wildland fire suppression activities are included in CFOI.

Cases were identified from CFOI research files obtained through a Memorandum of Understanding between BLS and NIOSH. The CFOI includes 30 standardized data elements and two narrative incident description fields. For 2001–2002 data, the BLS used the 1990 US Census Bureau Occupation Classification (BOC) system to classify occupation and the Standard Industrial Classification (SIC) to classify industry. For data after 2002, CFOI classifies workers' occupations by using Standard Occupational Classification (SOC) codes

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

and industry by North American Industry Classification System (NAICS). The BLS also characterizes injury characteristics based on the Occupational Injury and Illness Classification System (OIICS). The BLS revised their OIICS structure and coding 2011.[42] Personal identifying information about the decedent was not included in the research file.

For this analysis, Statistical Analysis System (SAS) version 9.3 was used to perform a search to locate fatal injuries that occurred during wildland fire operations in CFOI. Because wildland fire fighting is combined with structural fire fighting and cannot be identified by its own specific industry or occupation code, multiple variables were used (occupation, industry, event, and activity) to identify wildland firefighters. Two different occupation code schemes were initially used to identify cases. For 2001–2002, the following BOC codes were selected: 079 (foresters and conservationists); 226 (airline pilots and navigators); 243 (supervisors-forestry); 413 (supervisors, firefighting, fire prevention); 417 (firefighting operations); 494 (supervisors-forestry and logging workers); and 495 (forestry workers, except logging). For data from 2003–2011, the following SOC codes were selected: 33–2022 (forest fire inspectors and prevention specialists); 33–1021 (first-line supervisors/managers of firefighting and prevention workers); 33–2011 (firefighters); 33–2021 (fire inspectors and investigators); 53–2012 (commercial pilots) and 53–2011(airline pilots, copilots and flight engineers). Similarly, two different industry code schemes were used to identify additional cases. For 2001–2002, the following SIC codes were selected: 9224 (fire protection) and 0851 (forestry services). For data from 2003–2011, the following NAICS codes were selected: 115310 (support activities for forestry) and 922160 (fire protection). The OIICS event codes for “forest, brush, or other outdoor fire” (“5130” (2001–2010 data); “3160” (2011 data) were used to identify additional cases not identified by occupation and industry codes. Last, to supplement the search, a keyword search of the incident narratives was used to identify additional cases that were related to wildland fire but may not be coded to the aforementioned occupation, industry, and OIICS codes. For this final search, keywords included: *brush, burn, bush, control, dozer, engine, fire, fire break, firebreak, fire fighter, firefighter, fire man, fireman, forest, grass, inmate, interface, lightning, prescribe, tanker, timber, volunteer, wilderness, woods, wild fire, wildfire*. All fatalities identified through the code and keyword search were reviewed to ensure the worker was a firefighter and the fatality was associated with wildland fire-related activities. Records were excluded if there was no association or questionable association with wildland fire fighting activities or employment as a wildland firefighter (e.g., farmers). All in-scope cases were input into a separate MS Access database.

NIOSH FFFIPP surveillance system

A case-based system of firefighter fatalities, including WFF fatalities, is collected and maintained through the NIOSH Firefighter Fatality Investigation and Prevention Program (FFFIPP). Through the FFFIPP, selected on-duty firefighter deaths are thoroughly investigated and comprehensive recommendations are developed to prevent similar incidents from occurring in the future.[43] NIOSH uses a decision flow chart to prioritize investigations for both traumatic and cardiovascular/medical events (http://www.cdc.gov/niosh/fire/pdfs/FFFIP_DecisionChart.pdf). For traumatic fatalities, priority is given to incidents resulting in multiple fatalities, emerging issues, and incidents involving motor

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

vehicles. For cardiovascular/medical events, priority is given to incidents involving heat-related illnesses, cardiac events during training or on the fire ground, and seizures, overdoses, and diabetes.[44] Although priority is given to on-duty structural firefighter activities, occasionally NIOSH will investigate an on-duty wildland fire-related fatality.

NIOSH tracks all FFFIPP investigation reports in a standardized database and posts the reports on the FFFIPP website. Separate databases are maintained for traumatic and cardiovascular fatalities. To identify wildland-fire related incidents, all reports since 2001 were reviewed. Incidents specifically related to wildland, grass, brush, or outdoor fire during suppression and training were extracted. The NIOSH database administrators confirmed these incidents as wildland fire-related. Each report provides detailed information about the events that occurred before, during, and after the incident, medical/autopsy findings, and information about the decedent's employer and his or her training and experiences.

Data matching and comparison

To describe similarities and differences between the systems, individual fatalities from NFPA, USFA, and NWCG were matched and entered into a MS Access 2010 database. If available, demographic, cause, employment, and geographic variables were included. Cases were matched on incident date and location; fire name and/or forest/state in which the incident occurred; employing agency information; demographics; and cause of death. When a match could not be verified, descriptive incident information was reviewed for confirmation. The FFFIPP cases were not matched to the other three systems as the FFFIPP system was not designed to be a census; thus, it was not practical to compare case characteristics from the FFFIPP system with the population-based systems for this publication. Due to confidentiality and data use restrictions, CFOI data were also not included in the matching process. Through this matching process, coding differences were rectified by reviewing additional sources (e.g., obituaries, newspaper articles, National Fallen Firefighters Memorial website). For some, the decedent's fire department or ranger station was contacted to validate information.

For the overall data summaries, fatalities from USFA, NFPA, CFOI, and FFFIPP were recoded based on the NWCG "type of incident" variable to ensure consistency. Even though the NFPA, USFA, and CFOI systems use categorical cause and nature code schemes more aligned with standard fatality classifications, the NWCG does not provide information describing each fatal event; as a result, it was not feasible to recode NWCG data to match the other systems. For consistency across systems, fatalities were also recorded and analyzed based on year of death, even if the death was delayed considerably after the incident.

Results

Surveillance system characteristics

Table 1 provides a comprehensive comparison of the systems. The largest differences between systems were due to: (1) the inclusion of only line-of-duty deaths (LODDs) (NWCG), verses all on-duty deaths (USFA and NFPA); and (2) whether deaths that occurred

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

after the event were included (e.g., due to the Hometown Heroes Survivors' Benefits Act) (USFA).[45]

For most fatalities, the NWCG only tracked LODDs. This included death occurring while the workers were engaging in specific on-the-job wildland fire response and training activities including deaths that occur while mobilized to a wildland-fire or prescribed burn, during some wildland-fire specific trainings, and during other events. NWCG did not include fatalities that occurred while the worker was participating in other non-emergency on-duty activities such as training activities, aside from work-capacity testing.

The NFPA and USFA, however, captures on-duty fatalities, including most LODDs, as well as worker fatalities that occurred during other assigned non-emergency duties (e.g., non-wildland fire training, vehicle maintenance, or on standby). Based on the descriptive fields and NFPA's emergency/non-emergency classification data, at least 15 fatalities included in either the NFPA or USFA systems but not in NWCG occurred while the firefighter was performing other non-emergency, on-duty work tasks.

Another difference was that after December 15, 2003, the USFA—as part of the Hometown Heroes Survivors' Benefit Act—began including medically-related wildland fire fatalities (e.g., heart attacks and strokes) that occurred within 24-hours of a non-routine, physically stressful or strenuous emergency response activity.[45] Ten of the wildland fire-related deaths were identified by USFA as "Hometown Heroes." Review of these cases suggested that the 10 cases were exclusively male, mostly volunteer (n = 7) and had an average age at the time of the event of 48 years (range 28–66). Neither the NFPA nor the NWCG case definition included these types of fatalities in their systems; however, NFPA included three of these deaths and NWCG included five. Additional medically related events were included in the USFA system but not in the other two sources. The descriptive field indicated that the deaths likely met the Hometown Heroes criteria; however, because the deaths were not specifically coded as Hometown Heroes by USFA, it could not be concluded that they were identified as a result of the Act.

Another difference was that both NFPA and USFA typically included fatalities that occurred while firefighters, most often volunteers, were traveling to a wildland fire in personal vehicles or fighting a wildfire on their own land (e.g., a firefighter started a fire and attempted to suppress it). The NWCG, however, typically included only fatalities in which the firefighter was officially mobilized from their station and/or was mobilized in an official fire vehicle. In addition, the NWCG included fatalities that occurred among non-fire-related personnel (e.g., law enforcement, non-fire contractors) performing wild-land fire-related activities at the time of the incident, but the USFA and NFPA only included personnel whose job duties were specifically fire-related or were classified as "wildland firefighters."

Incident characteristics

NFPA, USFA, and NWCG—The number of wildland fire-related fatalities between 2001 and 2012 differed among the three population-based systems (Table 2). The systems typically differed by a count of one or two fatalities each year, with 12-year totals ranging

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

from 207–223 (average = 17.3–18.6 fatalities/year). The largest difference was noted in 2005, when USFA reported 19 fatalities, NFPA reported 15, and NWCG reported 12.

The USFA captured the largest number of WFF/wildland fire-related events (n = 223), followed by NWCG (n = 210) and NFPA (n = 207). After matching the data, 247 unique WFF and wildland fire related fatalities were identified within these three systems (Table 2). Almost 75% of the total fatalities (n = 181) were identified in all three systems, 13% (n = 31) were identified in two systems, and 14% (n = 35) were identified by only one system. Fatalities that occurred while on-scene at the wildland fire incident (e.g., burnovers/entrapments, aviation-related incidents, and struck-bys) were captured consistently across systems. Fatalities that may have occurred before or after fighting a fire (e.g., while traveling to/from the fire, while off-duty but still in mobilization status, during training, and medical-related incidents) varied between systems.

Characteristics of wildland firefighter deaths

NFPA, USFA, and NWCG—Fatality distributions by gender, age, type of worker, and type of incident were generally similar across systems. Males consistently accounted for more wildland fire-related fatalities (94%) than females, a larger percentage of workers were over the age of 40 (55–56%), and volunteers (27–33%) accounted for the most fatalities.

After recoding the USFA and NFPA data to match the NWCG incident classification, the leading incident type across all three systems were: aviation-related (28–30%); vehicle-related (27–29%); and medical events (23–27%).

Within each of the systems, the leading incident type among “volunteer” firefighters was medical events (41–48%). Fatalities involving aviation contractors were associated with aviation incidents, while entrapment/burnovers (33–36%) were the leading incident type among federal workers. The leading incident type among state WFFs was medical events (30–33%), and vehicle-related events were the leading incident among ground contractors (60–64%). The leading incident type for career/paid firefighters differed, with medical events (31–33%) accounting for the most deaths in the USFA and NWCG systems and vehicle-related incidents in the NFPA system.

Based on an analysis of the 247 unique deaths without regard to the systems, the only notable difference was that medical events accounted for the most deaths (n = 74, 30%), followed by vehicle-related incidents (n = 66, 27%), and aviation-related incidents (n = 65, 26%). It is also important to note that of the total deaths captured in all systems, 36% (n 88) occurred during multiple fatality incidents and were associated with aviation (n = 53), vehicles (n = 22), and entrapments (n = 13).

Finally, linear regression analysis indicated that the deaths captured in all three systems did not show a statistically significant trend from 2001–2012.

NIOSH FFFIPP wildland fire investigations—Thirty-three FFFIPP wildland fire fatality investigations were conducted during the 13-year study period; 18 were considered traumatic. Twelve were vehicle-related (including four struck-by vehicles and one all-terrain

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

vehicle-related incident), five were entrapments/burnovers, and one was struck-by object other than a vehicle. The remaining 15 fatalities were cardiovascular incidents, with all but two due to cardiac events (i.e., heart attacks). Most of the FFFIPP cases were volunteer firefighters (n = 20) followed by career/paid firefighters (n = 8). Males accounted for all but two of the fatalities and the average age of the decedent was 41 years (range 16–66).

BLS CFOI—Based on the review of CFOI, there were 140 WFF fatalities from 2001–2012, resulting in an annual average of 11.7 deaths. Fifty-three were private employees (e.g., contractors), 37 were federal employees, 34 were local government employees (including volunteers and inmates), and 20 were state employees. Aviation (n = 54) and vehicle-related incidents (n = 46) accounted for a majority of these fatalities, followed by entrapments/burnovers (n = 23) and struck-by object incidents (n = 10). Medical events, specifically heart attacks and strokes are typically not included in CFOI as these events are considered illnesses and therefore excluded from CFOI unless a traumatic injury contributed to the death. Males accounted for most of the fatalities (n = 132) and workers over the age of 35 accounted for over half (52%) of the deaths.

Discussion

This study complements the 2011 paper by Estes et al.[29] by specifically describing datasets that include fatalities among a subset of firefighters who suppress fires in non-structural settings. Similar to findings by Estes et al., the four population-based systems (e.g., NFPA, USFA, NWCG, and CFOI) indicated volunteers made up the largest proportion of WFFs killed on-duty or in the line-of-duty. In contrast to the findings from Estes et al., aviation-related incidents were the leading cause of death for WFFs in all four systems, which is likely due to firefighters reliance on aircraft during fire suppression activities. These aviation related deaths are further characterized using a multi-surveillance system approach in a recent study.[46] A similar approach could also be utilized to explore “volunteer” fatalities, specifically looking at factors and conditions that place them at a higher risk for medical-related events. In addition, while the FFFIPP is not a census, the multifactorial fatality investigation reports produced by this program provide detailed event, training, medical, and personnel records that could be used in future research to identify risk factors for wild-land firefighter fatalities.

Our sentinel research represents the first study using multiple surveillance systems to match and compare all WFF fatalities in the U.S. The findings are important because differences in the types of incidents within each system are identified. Differences can often be attributed to case definitions and the intended use of the data. For example, NWCG designed their system to track only fatalities that occurred during specific activities, most often at a wildfire, prescribed fire, or during work-capacity testing. As a result, the NWCG data are not representative of all WFF fatalities; rather, they represent fatalities that occur only during select activities mostly associated with fire suppression. Unlike the USFA and NFPA systems, the NWCG does not track fatalities that occur while WFFs are performing other assigned non-fire job duties, even if the worker is, for example, being paid and on-call. Furthermore, aside from basic statistics, the NWCG data cannot be used to perform detailed analyses of fatalities without supplemental information from other sources. Based on

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

published NWCG data and reports,[47,48] the NWCG often uses the data to track and report broad statistics and trends.

Conversely, the NFPA and USFA collect information for all fatalities occurring during wildland fires and wild-land fire-related activities, including all on-duty deaths. These systems can provide a more comprehensive understanding of the risks firefighters face while "on-duty." The inclusion of all deaths is important; research specific to structural firefighters has suggested that firefighters spend less than 5% of their time engaged in actual fire suppression activities; the remainder of their time is spent doing other work tasks.[49] Although this estimate is specific to structural fire work, and there are no published estimates of the amount of time WFFs are engaged in wildfire suppression, it is generally recognized WFFs do not spend all of their time engaged in fire suppression activities. It is important to understand the risks associated with all work tasks, not just fire suppression. Systems, such as NWCG, that capture only LODDs are useful for understanding fatalities that occur during fire suppression and other select activities, however, the true burden on this population can be mischaracterized.

The BLS CFOI system identified fewer fatal occupational injuries than the other population-based systems. Although CFOI data could not be matched to the other data sources, we suspect a portion of the difference may be due to the fact that CFOI primarily captures traumatic injuries and excludes most medical events (e.g., heart attacks and strokes) unless a traumatic injury contributed to the medical related death.[41] While the exclusion of medical events from CFOI may impact the capture of wildland fire-related deaths, we agree with Estes et al.[29] and believe CFOI can be used to compare WFF with fatalities occurring among workers in other occupations since CFOI is a census of all work-related fatal injuries in the US.

Other differences in case criteria (e.g., inclusion of fatalities from the Hometown Heroes Survivors' Benefits Act, or fatalities that occur while a worker is en route to a fire in a personal vehicle) can lead to confusion and mischaracterization of data due to differences in the number of captured fatalities. Without conducting a thorough analysis and having an in-depth understanding of the criteria for each system, it is easy to inaccurately interpret the data. For these reasons, it would be beneficial for the various agencies to (a) adopt a common case classification system or (b) provide more detailed information about inclusion criteria when reporting fatalities.

To ensure consistency and facilitate future analysis of WFF fatality data, NIOSH researchers offer a case definition of a WFF fatality that is most consistent with the definition used by the USFA.

> Any fatal injury or illness (e.g., sudden cardiac or cerebrovascular event) sustained among WFFs while on-duty at a wildland fire-related event or while performing wildland fire duties in the U.S.
>
> "Wildland fire" refers to a non-structure fire occurring in vegetation or natural fuels and includes prescribed fire and wildfire.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

"Wildland firefighter" refers to a person whose principal function is fire suppression (includes paid/career and volunteer workers)

"On-duty" refers to:

- a wildland fire or non-fire activity;
- responding to or returning from a wildland fire;
- performing other officially assigned wildland fire or wildland firefighter duties, such as reconnaissance, physical fitness training, maintenance, public education, or investigations;
- being on call, under orders, or on standby duty, except at the individual's home or other place of business; and
- events covered under the Hometown Heroes Survivors' Benefits Act of 2003.

Fatalities that would be excluded would be those involving non-fire personnel (e.g., law enforcement officers), those occurring in U.S. territories and overseas military installations, commutes to/from work, and recreational activities not required by the department/agency.

Determining the work-relatedness of most fatal traumatic injuries is typically straightforward, however, difficulties arise in determining the origin, cause, and work-relatedness of some on-duty fatal conditions such as on-duty cardiovascular disease related events.[50] Research specific to structural firefighters has indicated an increased risk of cardiovascular disease-related fatalities during activities such as fire suppression and physical training.[49,51] While structural and wildland fire environments and suppression tactics are different, certain occupational factors shown to increase cardiovascular risk among structural firefighters (e.g., smoke and particulate exposure, physical exertion, fire response, and psychological stressors) are also present among wildland firefighters.[49,51–57] In addition, presumptive laws for firefighters in 37 states have enacted various forms of "presumptive disability" laws, which suggest that "heart diseases" and other illnesses are job related for purposes of workers' compensation, disability retirement, medical expenses, and lost wages, unless proven otherwise.[58] For these reasons, on-duty medical events including fatal cardiovascular events should continue to be included in wildland fire-related fatality tracking systems.

Limitations

This study was subject to at least six limitations. The NWCG surveillance system does not contain identifying information; therefore, information from other systems used to update the NWCG data may have introduced some demographic misclassifications. However, due to the limited number of fatalities and the detail used to match the records (e.g., date, region, type of fatality, employing agency), this misclassification was likely minimized.

Second, workers who had performed both wildland and structural fire duties during the work shift prior to their death were likely coded differently between systems. Some of these

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

deaths, especially fatalities that are covered under the Hometown Heroes Survivors' Benefit Act and fatalities involving vehicles (e.g., where the firefighter was dispatched from a wildland fire to a structural fire or vice versa), were classified differently within each system. Without access to all firefighter fatality data in all systems, it is not feasible to identify and consider all inconsistencies.

A third limitation, inherent for most surveillance systems and noted in the findings of Estes et al.,[29] was that it was not feasible to assess the impact, if any, that these systems may have had on wildland fire-related deaths. However, organizations like the NWCG have implemented policies and work-practices based on system findings.

The fourth limitation was the lack of accurate denominator data. Because the total number of workers who engage in wildland-fire related activities is generally unknown, it was not possible to calculate accurate rates. Therefore, this article could only offer findings based on the raw distribution of cases.

The fifth limitation was related to CFOI. Because wildland firefighters are combined with similar occupations and industries, and because the narrative field may not provide information on the specific type of fire, it is likely that some in-scope cases may have been excluded because an association between the fatality and a *wildland fire* could not be made. This was primarily an issue for motor vehicle-related incidents as it was not possible to determine the type of fire, and for aircraft incidents as it was not possible to determine the type of forestry work the pilot was performing. It is also possible that wildland firefighters performing other official non-fire related duties were coded as forestry workers. In these instances, if the narrative and activity fields did not indicate wildland fire activities, these cases were excluded.

Last, all of these systems, except CFOI, capture both medical and traumatic fatalities. However, there are limited mechanisms for identifying fatalities associated with chronic illnesses (e.g., cancer, respiratory disease) attributed to occupational exposures, especially if these illnesses occur off-duty or after separation from the fire service. Thus, it was not feasible to include these types of chronic illnesses in this study.

Conclusions

While each system reviewed is unique and had varying case criteria for capturing wildland fire fatalities, the goal of each system is to collect accurate and timely information, improve safety, and use the results to guide the development of viable prevention strategies. Use of a common case definition would help to more accurately characterize WFF deaths, lessen the likelihood for the misinterpretation of WFF data, and assist with defining the true occupational fatality burden. By using this definition, researchers and fire managers could gain a better understanding of WFF fatalities in their efforts to develop effective prevention strategies uniquely oriented to WFFs.

Subsets of this specialized workforce disproportionally experience certain fatality types. Additional research is needed to more fully describe deaths among volunteer firefighters. This population is typically not covered by OSHA (Herb Gibson, Occupational Safety and

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Health Administration, May 2011) and, as FFFIPP investigations have suggested, the level of awareness and compliance with fire standards and policies vary among departments.[59–61] Next steps will be to further analyze all wildland fire-related fatality data in more detail and to identify research needs related to wildland fire-related fatalities among volunteer firefighters.

Acknowledgments

The authors gratefully acknowledge Rita Fahy of the United States Fire Administration and Stan Palmer from the National Wildfire Coordinating Group.

References

1. U.S. Fire Administration. Firefighter Fatalities in the United States. Available at: https://apps.usfa.fema.gov/firefighter-fatalities/ (accessed August 6, 2014)
2. U.S. Department of Labor. US Occupational Outlook Handbook: Firefighters. Available at http://www.bls.gov/ooh/protective-service/firefighters.htm (accessed August 6, 2012)
3. U.S. Senate. Short Changing Our Forests: How Reducing Investments in Forest Health Increases Risk in Wildfire; Hearing Before the Senate Committee on Agriculture, Nutrition and Forestry Subcommittee of Conservation, Forestry and Natural Resources, 113th Cong; November 5, 2013;
4. Brown T, Hall B, Westerling A. The impact of twenty–first century climate change on wildland fire danger in the western United States: an applications perspective. Clim Change. 2004; 62(1):365–388.
5. Marlon J, Bartlein P, Walsh M, et al. Wildfire responses to abrupt climate change in North America. Proc of the National Academy of Sciences. 2009; 106(8):2519–2524.
6. Whitlock C, Marlon J, Briles C, Brunelle A, Long C, Bartlein P. Long–term relations among fire, fuel, and climate in the north–western US based on lake–sediment studies. Int J Wildland Fire. 2006; 17(1):72–83.
7. McCaffery, S., editor. U. S. Department of Agriculture. The public and wildland fire management: social science findings for managers. U.S.Forest Service, Northern Research Station; 2006. General Technical Report # NRS–1
8. National Association of State Foresters. Communities at Risk Report, FY2011. National Association of State Foresters; Washington DC:
9. U. S. Department of Agriculture. Audit Report: Forest Service Large Fire Suppression Costs. Office of Inspector General; Nov. 2006 Report 08601–44–SF
10. Artley, D., editor. International Association of Fire Chiefs. Wildland Fire Protection and Response in the United States: The Responsibilities, Authorities, and Roles of Federal, State, Local, and Tribal Government. International Association of Fire Chiefs; Fairfax, Virginia:
11. Karter, M., Stein, G., editors. National Fire Protection Association. US fire department profile through 2009. National Fire Protection Association, Fire Analysis and Research Division; Quincy, Massachusetts:
12. National Fire Prevention Association. Third Needs Assessment of the US Fire Service. Available at http://www.nfpa.org/research/reports–and–statistics/the–fire–service/administration/needs–assessment (accessed November 13, 2012)
13. Miller J, Thode A. Quantifying burn severity in a heterogeneous landscape with a relative version of the delta Normalized Burn Ratio (dNBR). Remote Sens Environ. 2009; 109(1):66–80.
14. Stephens S. Forest fire causes and extent on United States Forest Service lands. Int J Wildland Fire. 2005; 14:213–23.
15. Westerling A, Hidalgo H, Craven D, Swetnam T. Warming and earlier spring increase Western U.S. forest wildfire activity. Science. 2006; 313(5789):940–943. [PubMed: 16825536]
16. Adetona O, Dunn K, Hall D, Achtemeier G, Stock A, Naher L. Personal PM (2.5) exposure among wildland fire fighters working at prescribed forest burns in southeastern United States. J Occup Environ Hyg. 2011; 8(8):503–511. [PubMed: 21762011]

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

17. Cox, C., Sharkey, B., editors. U. S. Department of Agriculture. Eating for health and performance: the wildland fire fighter. U.S Forest Service, Missoula Technology and Development Center; 2006. Report 0651–2833P–MTDC
18. Gaughan D, Cox–Gasner J, Enright P, et al. Acute upper and lower respiratory effects in wildland fire fighters. J Occup Environ Med. 2008; 50(9):1019–1028. [PubMed: 18784550]
19. Harrison R, Materna B, Rothman N. Respiratory health hazards and lung function in wildland fire fighters. Occup Med. 1995; 10(4):857–70. [PubMed: 8903754]
20. Lui D, Tager I, Balmes J, Harrison R. The effect of smoke inhalation on lung function and airway responsinsivness in wildland fire fighters. Am Rev Respir Dis. 1992; 146(6):1469–1473. [PubMed: 1456562]
21. Heil D. Estimating energy expenditure in wildland fire fighters using a physical activity monitor. Appl Ergon. 2002; 33(5):405–413. [PubMed: 12236649]
22. Leonard S, Castranova V, Chen B, Berry-Schwegler D, Hoover M, Piacitelli C, Gaughan D. Particle size–dependent radical generation from wildland fire smoke. Toxicology. 2007; 236(1–2): 103–13. [PubMed: 17482744]
23. Gaughan D, Piacitelli C, Chen B, et al. Exposures and cross–shift lung function declines in wildland firefighters. J Occup Environ Hyg. 2014; 11(9):591–603. [PubMed: 24568319]
24. Materna B, Jones R, Sutton P, Rothman N, Harrison R. Occupational exposures in California wildland fire fighting. Am Ind Hyg Assoc J. 1992; 53(1):69–76. [PubMed: 1317093]
25. Reinhardt T, Ottmar R. Baseline measurements of smoke exposure among wildland fire fighters. J Occup Environ Hyg. 2004; 1(9):593–606. [PubMed: 15559331]
26. Sharkey, B., editor. U. S. Department of Agriculture. Wildland fire fighter nutrition education program. U.S Forest Service, Missoula Technology and Development Center; Jan. 2007 Report No.: 0751–22302P–MTDC
27. Cox, C., Sharkey, B., editors. U. S. Department of Agriculture. Feeding the wildland fire fighter. U.S Forest Service, Missoula Technology and Development Center; Jul. 2002 Report 0251–2323–MTDC
28. Proudfoot S, Hales T, Truttmann T, Gugliolmo C. Fatalities among volunteer and career firefighters-United States, 1994–2004. Morb Mortal Wkly Rep. 2006; 55(16):453–455.
29. Estes C, Marsh S, Castillo D. Surveillance of traumatic fire fighter fatalities: an assessment of four systems. Public Health Rep. 2011; 126(4):540–51. [PubMed: 21800748]
30. Fahy, R.LeBlanc, P., Molis, J., editors. National Fire Protection Association. Firefighter Fatalities in the United States—2014. National Fire Protection Association, Fire Analysis and Research Division; Quincy, Massachusetts:
31. National Wildfire Coordination Group, Risk Management Committee. RMC Safety Gram Archive. Available from http://www.nwcg.gov/committees/risk-management-committee/resources/rmc-safety-gram-archive (accessed May 11, 2015)
32. Mangan, D., editor. U. S. Department of Agriculture. Wildland fire fatalities in the United States: 1990–1998. U.S Forest Service, Missoula Technology and Development Center; 1999. Report 9951–2808–MTDC
33. Mangan, D., editor. National Wildfire Coordinating Group. Wildland fire fatalities in the United States: 1990–2006. National Wildfire Coordinating Group, Safety and Health Working Team; Aug. 2007 Report NWCG PMS 841
34. National Interagency Fire Center. SAFENET: Wildland Fire Safety & Health Reporting Network. Available at http://safenet.nifc.gov/ (accessed July 16, 2012)
35. U.S. Department of Labor. Occupational Injury and Illness Classification Manual. Available at http://www.bls.gov/iif/oshoiics.htm (accessed June 14, 2016)
36. U.S. Fire Administration. Criteria Used to Make On–duty Fire Fighter Fatality Determinations. Available at http://www.usfa.fema.gov/fireservice/firefighter_health_safety/firefighter–fatalities/reports/criteria.shtm (accessed November 13, 2014)
37. Fahy, R.LeBlanc, P., Molis, J., editors. National Fire Protection Association. Firefighter Fatalities in the United States—2011. National Fire Protection Association, Fire Analysis and Research Division; Quincy, Massachusetts:

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

38. National Wildfire Coordinating Group, Risk Management Committee. Safety Gram Reporting Criteria. Available at: http://www.nwcg.gov/committees/risk–management–committee–rmc–safety–grams (accessed January 6, 2016)
39. National Interagency Fire Center. Interagency Serious Accident Investigation Guide. Available at http://www.nifc.gov/safety/safety_documents/SAI_Guide.pdf (accessed January 6, 2016)
40. U.S. Department of Labor. Overview of the Census of Fatal Occupational Injuries (CFOI). Available at http://www.bls.gov/iif/oshfat1.htm (accessed January 16, 2014)
41. U.S. Department of Labor. Census of Fatal Occupational Injuries (CFOI): Definitions. Available at http://www.bls.gov/iif/oshcfdef.htm (accessed January 6, 2014)
42. U.S. Department of Labor. Occupational Injury and Illness Classification Manual. Available at http://www.bls.gov/iif/oiics_manual_2007.pdf (accessed January 6, 2014)
43. Centers for Disease Control and Prevention. Fire Fighter Fatality Investigation And Prevention Program: Program Description And What To Expect. Available at http://www.cdc.gov/niosh/fire/implweb.html (accessed January 7, 2014)
44. Centers for Disease Control and Prevention. Fire Fighter Fatality Investigation and Prevention Program Prioritization Guidelines. Available at http://www.cdc.gov/niosh/fire/pdfs/fffip_decisionchart.pdf (accessed January 7, 2012)
45. Hometown Heroes Survivor Benefits Act of 2003. 2003Pub. L. No. 108-182, §459
46. Butler C, O'Connor M, Lincoln J. Aviation–Related Wildland Firefighter Fatalities — United States, 2000–2013. Morb Mortal Wkly Rep. 2015; 64(29):793–796.
47. Manganc, D., editor. National Wildlife Coordinating Group. Wildland fire fatalities in the United States: 1990–2006. National Wildlife Coordinating Group, Safety and Health Working Team; Aug. 2007 Report NWCG PMS 841
48. National Wildfire Coordinating Group, Risk Management Committee. Volunteer Fire Department Heart Attacks on Wildland Fires. Available at http://www.nwcg.gov/general/memos/nwcg–021–2010.html (accessed December 3, 2012)
49. Kales S, Soteriades E, Christophi C, Christiani D. Emergency duties and deaths from heart disease among fire fighters in the United States. N Engl J Med. 2007; 356(12):1207–15. [PubMed: 17377158]
50. Steenland K. Epidemiology of occupation and coronary heart disease: research agenda. Am J Ind Med. 1996; 30(4):495–499. [PubMed: 8892556]
51. Soteriades E, Smith D, Tsismenakis A, Baur D, Kales S. Cardiovascular disease in US firefighters: a systematic review. Cardiol Rev. 2011; 19(4):202–15. [PubMed: 21646874]
52. Smith D, Barr D, Kales S. Extreme sacrifice: sudden cardiac death in the US Fire Service. Extrem Physiol Med. 2013; 2(6)
53. Farioli A, Yang J, Teeham D, Baur D, Smith D, Kales S. Duty-related risk of sudden cardiac death among young US firefighters. Occup Med (Lond). 2013; 64(6):428–435.
54. Kales S, Soteriades E, Christoudias S, Christiani D. Firefighters and on-duty deaths from coronary heart disease: a case control study. Environ Health. 2003; 2(1):14. [PubMed: 14613487]
55. Pope C 3rd, Muhlestein J, May H, Renlund D, Anderson J, Horne B. Ischemic heart disease events triggered by short-term exposure to fine particulate air pollution. Circulation. 2006; 114(23):2443–2448. [PubMed: 17101851]
56. Franchini M, Mannucci P. Particulate air pollution and cardiovascular risk: short-term and long-term effects. Semin Thromb Hemost. 2009; 35(7):665–70. [PubMed: 20013533]
57. Pope C III, Dockery D. Health effects of fine particulate air pollution: lines that connect. J Air Waste Manag Assoc. 2006; 56(6):709–742. [PubMed: 16805397]
58. International Association of Fire Fighters. State Presumptive Disability Laws. Available at http://www.iaff.org/hs/phi/docs/PresumptiveDisabilityChart.pdf
59. Loflin, M., Campbell, C., editors. Centers for Disease Control and Prevention. Volunteer Fire Fighter Dies an Three Fire Fighter Dies During Wildland Fire – Texas. National Institute for Occupational Safety and Health; Jan. 2013 Report # FACE 2011–10

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

60. Loflin, M., Campbell, C., editors. Centers for Disease Control and Prevention. Volunteer Fire Fighter Dies and 5 Fire Fighters are Injured During Wildland urban interface. National Institute for Occupational Safety and Health; Dec. 2012 Report # FACE 2011–09

61. Tarley, J., editor. Centers for Disease Control and Prevention. Volunteer fire chief and fire fighter killed when a wildland engine plummeted from a fire–damaged wooden bridge into a dry creek bed – Colorado. National Institute for Occupational Safety and Health; Mar. 2010 Report # FACE 2008–14

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Table 1

Data characteristics of wildland fire fighting surveillance systems.

			Database				
			United States Fire Administration	**National Wildfire Coordinating Group**	**National Fire Protection Association**	**Bureau of Labor Statistics, Census for Fatal Occupational Injuries**	**Fire Fighter Fatality Investigation and Prevention Program**
Scope	All firefighters in the U.S.		×		×	×	×
	Personnel involved in direct support of wildfire suppression including firefighting, prescribed fire, damage repair, and fire rehabilitation			×		×	
	Selected cases meeting agency criteria						×
Data Sources	Wildland fire agencies		×	×	×		×
	National Fire Incident Reporting System (NFIRS)		×	×	×		×
	Local, state and federal agencies		×	×	×	×	×
	NIOSH FFIPP Reports		×		×		
	Public Safety Officers' Benefits Program		×	×	×		×
	Fire service organizations, individual firefighters/Incident Management Teams		×	×	×		×
	Risk Management Committee members			×			
	USFA firefighter fatality notices			×	×	×	×
	Media/news reports			×	×	×	×
	Death certificates		×		×	×	×
	Workers' compensation reports					×	
	Police reports		×		×	×	×
	OSHA forms 300/301					×	
	Field based investigations		×		×		×
	Management/witness interviews		×		×		×
	Photographs and videos		×		×		×
Inclusion criteria	Type of worker	Paid and volunteer firefighters	×	×	×	×	×
		Local and municipal firefighters	×	×	×	×	×

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

			Database				
			United States Fire Administration	**National Wildfire Coordinating Group**	**National Fire Protection Association**	**Bureau of Labor Statistics, Census for Fatal Occupational Injuries**	**Fire Fighter Fatality Investigation and Prevention Program**
		State, territory, and federal government fire personnel	×	×	×	×	×
		Privately employed firefighters	×	×	×	×	×
		Prison inmates on firefighting crews	×	×	×	×	×
		Military personnel assigned to fire suppression activities	×	×	×	×	×
		Civilian firefighters at military installations	×	×	×	×	
		Firefighters at U.S. territorial and overseas military installations	×		×		
		Other emergency response/non-firefighting personnel at a wildland fire		×		×	
Inclusion criteria	Task(s) performed	All official wildland fire or non-fire duties	×		×	×	×
		Official duty at a wildland or prescribed fire incident, in mobilization or demobilization status	×	×	×	×	×
		Completing other officially assigned duties (e.g., training, public safety, maintenance, inspection)	×		×	×	
		Work capacity test[a]	×	×	×		×
		Fatalities associated with Hometown Heroes Survivor Benefits Act of 2003	×				×
		Responding to/from an incident[b]	×	×	×	×	×
		On standby duty (except at individual's home or place of business)	×		×	×	×
Types of fatalities	Traumatic		×	×	×	×	×
	Medical		×	×	×		×
Data availability to researchers	Online firefighter fatality notices		×				
	Online annual reports, charts, tables and/or query system		×	×	×	×	×
	Research database per request		×	×		×	

J Occup Environ Hyg. Author manuscript; available in PMC 2017 November 27.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

	Database				
	United States Fire Administration	**National Wildfire Coordinating Group**	**National Fire Protection Association**	**Bureau of Labor Statistics, Census for Fatal Occupational Injuries**	**Fire Fighter Fatality Investigation and Prevention Program**
Special analyses per request			×		

[a] Fatalities are not considered work-related deaths unless a worker is officially employed.

[b] Hometown Heroes Survivors Benefit Act of 2003 presumes that a heart attack or stroke is in the line of duty if the firefighter was engaged in non-routine stressful or strenuous physical activity while on-duty and the firefighter becomes ill while on-duty or within 24 hours after engaging in such activity.[36]

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Table 2

Demographic characteristics and distribution of wildland firefighter deaths by surveillance system.

Characteristic	Surveillance Data Source			Case included in all three sources n (%)	Case included in at least one source n (%)
	National Fire Protection Association n (%)	United States Fire Administration n (%)	National Wildfire Coordinating Group n (%)		
Year					
Total	207	223	210	181	247
Gender					
Male	194 (93.7)	209 (93.7)	197 (93.8)	170 (93.9)	232 (93.9)
Female	13 (6.3)	14 (6.3)	13 (6.2)	11 (6.1)	15 (6.1)
Age Range					
<20	12 (5.8)	12 (5.4)	12 (5.7)	10 (5.5)	13 (5.3)
20–29	46 (22.2)	47 (21.1)	43 (20.5)	42 (23.2)	48 (19.4)
30–39	33 (15.9)	37 (16.6)	37 (16.6)	33 (18.2)	40 (16.2)
40–49	46 (22.2)	47 (21.1)	45 (21.4)	37 (20.4)	56 (22.7)
50–59	43 (20.8)	46 (20.6)	43 (20.5)	35 (19.3)	52 (21.1)
≥60	27 (13)	34 (15.2)	27 (12.9)	24 (13.3)	35 (14.2)
Unknown[a]	—	—	3 (1.4)	—	3 (1.2)
Employment Type					
Volunteer	56 (27.1)	73 (32.7)	59 (28.1)	48 (26.5)	77 (31.2)
Federal	43 (20.8)	40 (17.9)	41 (19.5)	39 (21.5)	44 (17.8)
Contractor-Aviation	32 (15.5)	35 (15.7)	32 (15.2)	31 (17.1)	36 (14.6)
State	32 (15.5)	26 (12.1)	26 (12.4)	24 (13.3)	32 (13)
Contractor-Ground	24 (11.6)	22 (9.9)	25 (11.9)	22 (12.2)	25 (10.1)
Career	11 (5.3)	16 (7.2)	15 (7.1)	9 (5)	19 (6.6)
Inmate	4 (1.9)	4 (1.8)	4 (1.9)	3 (1.7)	5 (2)
Military	4 (1.9)	4 (1.8)	4 (1.9)	4 (2.2)	4 (1.6)
Other	1 (0.5)	2 (0.9)	4 (1.9)	1 (0.6)	5 (2)
Type of Incident					

J Occup Environ Hyg. Author manuscript; available in PMC 2017 November 27.

Author Manuscript Author Manuscript Author Manuscript Author Manuscript

Characteristic	Surveillance Data Source			Case included in all three sources n (%)	Case included in at least one source n (%)
	National Fire Protection Association n (%)	United States Fire Administration n (%)	National Wildfire Coordinating Group n (%)		
Aviation-related incident[a]	61 (29.5)	63 (28.3)	60 (28.6)	58 (32)	65 (26.3)
Medical	47 (22.7)	61 (27.4)	54 (25.7)	37 (20.4)	74 (30)
Medical Non-Heart Attack	6 (2.9)	7 (3.1)	7 (3.3)	5 (2.8)	10 (4)
Medical Heart Attack	41 (19.8)	54 (24.2)	47 (22.4)	32 (17.7)	64 (25.9)
Vehicle (other than aircraft)	59 (28.5)	59 (26.5)	56 (26.7)	48 (26.5)	66 (26.7)
Entrapment/Burnover[b]	24 (11.6)	24 (10.8)	24 (11.4)	24 (13.3)	24 (9.7)
Struck-by	12 (5.8)	12 (5.4)	12 (5.7)	11 (6.1)	13 (5.3)
Electrocution/lightning	2 (1)	2 (0.9)	2 (1)	2 (1.1)	2 (0.8)
Other	2 (1)	2 (0.9)	2 (1)	1 (0.6)	3 (1.2)

[a] Includes smoke jumping and helitack incidents, helicopter-delivered fire resources, where aircraft were involved.

[b] A situation where firefighting personnel are unexpectedly caught in a fire behavior-related, life-threatening position.

W

Wildfires and WUI Fire Fatalities



Katharine Haynes[1,2], Karen Short[3], Gavriil Xanthopoulos[4], Domingos Viegas[5], Luis Mário Ribeiro[5], and Raphaele Blanchi[6]
[1]Centre for Environmental Risk Management of Bushfires, University of Wollongong, Wollongong, NSW, Australia
[2]Bushfire and Natural Hazards Cooperative Research Centre, Melbourne, VIC, Australia
[3]USDA Forest Service, Rocky Mountain Research Station, Missoula, MT, USA
[4]Institute of Mediterranean Forest Ecosystems, Hellenic Agricultural Organization "Demeter", Athens, Greece
[5]Forest Fire Research Centre of ADAI, University of Coimbra. Rua Pedro Hispano, Coimbra, Portugal
[6]CSIRO Land & Water, Melbourne, VIC, Australia

Synonyms

Casualty; Civilian fatalities; Death; Firefighter fatalities; Life loss; Victim

Definition

Information collected on fatalities including civilian and firefighters during wildfire and Wildland-Urban Interface (WUI) fire. This information is used to better understand the context surrounding fatalities and to support emergency management policies.

Introduction

Understanding the detailed physical and social context surrounding wildfire and WUI fire fatalities is crucial in terms of ensuring effective emergency management policy and practice. Studies of fatalities over prolonged periods ensure changing trends in vulnerabilities and exposure are identified (e.g., Haynes et al. 2010; Molina-Terrén et al. 2019). There have been a number of catastrophic fires leading to high numbers of fatalities in recent years, including the 2009 Victorian bushfires in Australia, with 173 fatalities (Teague et al. 2010); the 2017 Portugal forest fires, with 66 fatalities in Pedrógão Grande (Viegas et al. 2017; Molina-Terrén et al. 2019) and 51 fatalities in the Central Region (Viegas et al. 2019); the 2018 Camp Fire in California, with 85 fatalities (Cal Fire 2019); and the 2018 Mati forest fire in Greece, with 102 fatalities (Xanthopoulos and Athanasiou 2019). However, detailed studies of wildfire fatalities are not common and remain country specific. In this contribution, the authors use the word bushfire in Australia, wildfire in the United States, and forest fire in Europe.

A number of studies have been conducted on fatalities resulting from bushfires in Aus-

© Crown 2020
S. L. Manzello (ed.), *Encyclopedia of Wildfires and Wildland-Urban Interface (WUI) Fires*,
https://doi.org/10.1007/978-3-319-51727-8_92-1

tralia (Blanchi et al. 2014; Cheney et al. 2001; Haynes et al. 2010; Krusel and Petris 1999). Two detailed studies have explored civilian fatalities longitudinally, the first investigated the activities and decision-making carried out at the time of death of those killed in bushfires between 1901 and 2008 (Haynes et al. 2010). The research emphasized the dangers of being caught outside and revealed a distinct gender bias in behavior. The second study explored the spatial and environmental circumstances of bushfire fatalities, determining the exact locations the fatalities occurred, their distance from the forest, and the fire conditions at the time of death (Blanchi et al. 2014).

In Europe a recent analysis of forest fire and WUI fire fatalities was carried out in Spain, Portugal, Greece, and Sardinia, where an increase of fatalities has occurred since the late 1970s (Molina-Terrén et al. 2019). Research exploring fatalities in Greece between 1977 and 2013 identified that approximately 75% of those killed in forest fire and WUI fire were civilians. The trends seen in the data were similar to the Australian studies, with a high proportion of male fatalities killed while engaged in firefighting or late evacuation on foot or in a vehicle (Diakakis et al. 2016). The 2017 fires in Portugal involved mostly civilian victims, including entire families, with a high proportion engaged in late evacuation by vehicle (Viegas et al. 2019).

In the United States (US), data tracking wildland firefighter fatalities have been collected since the early twentieth century and periodically analyzed to inform programs and policies intended to increase firefighter safety and minimize injuries and fatalities (e.g., NWCG 1997, 2017; Mangan 2007). While historically the focus has been on firefighter fatalities, there is growing concern about increasingly prevalent high-loss events, including recent WUI fires in California and elsewhere that claimed the lives of dozens of civilians (Cal Fire 2019; Calkin et al. 2019).

Research on firefighter safety has also been conducted following a number of incidents where firefighters perished during wildfire entrapment or burnovers (Cheney et al. 2001; Page and Butler 2018; Viegas et al. 2013; Xanthopoulos et al. 2009). The aim was to investigate the factors that led to the incident and to develop improved protective measures and training for firefighters.

This contribution presents a summary of wildfire- and WUI fire-related civilian and firefighter fatalities from Australia, the United States, and Europe.

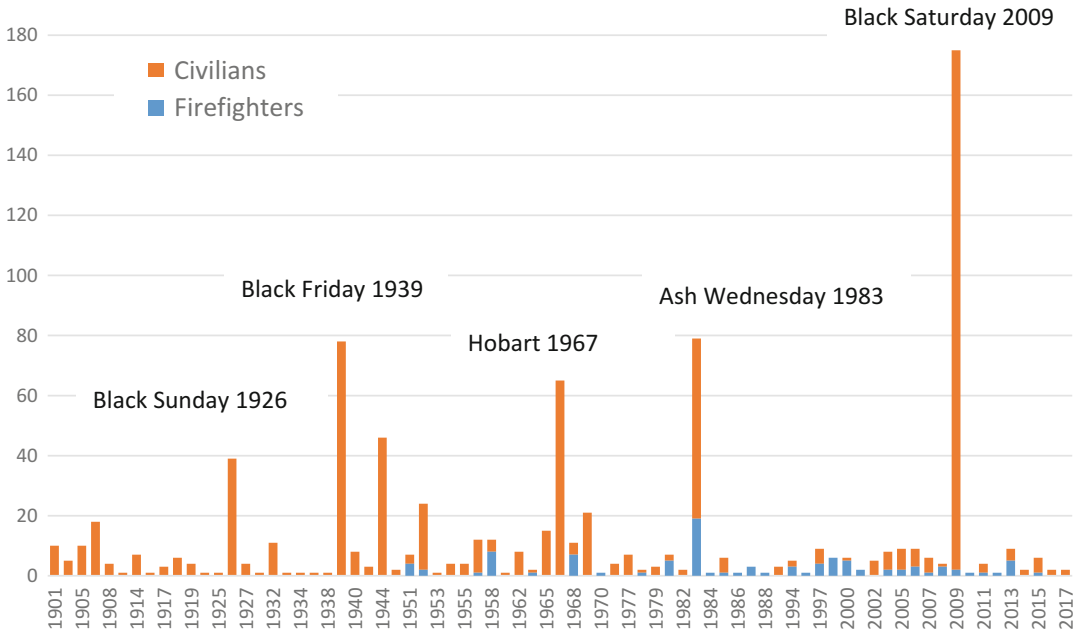
Australian Fatalities

In this section the term bushfire includes the fires that have also affected the WUI (WUI fires) as the data presented did not make the distinction between bushfire and WUI fire. No centralized data collection system for bushfire fatalities exists in Australia. Information on civilian and firefighter deaths was sourced from the Attorney Generals Department (AGD) bushfire life loss dataset (Blanchi et al. 2012). This dataset was developed by collating previous datasets and adding further information on bushfire related fatalities between 1901 and 2011 from reports in the print media and coronial inquest archives (Haynes et al. 2010; Blanchi et al. 2012, 2014). Recent fatalities from 2012 to 2017 have been added to update the data (from fire services and media sources). There is no distinction between bushfire and WUI fire in the data collected.

Distribution

The data presented covers fatalities between 1901 and 2017, with an average rate of 7.3 civilian deaths per year. There are a total of 846 fatalities, including 748 civilians and 99 firefighters. The number of fatalities and the trends seen in the data are dominated by a handful of iconic catastrophic events (Fig. 1), including bushfires in 1926 (Black Sunday), 1939 (Black Friday), 1967 (Hobart), 1983 (Ash Wednesday), and 2009 (Black Saturday). These events are strongly influenced by fire weather severity (Blanchi et al. 2010).

The deadliest bushfire in Australian history was the 2009 Black Saturday bushfires complex. On February 7 several bushfires burned under extreme weather conditions in the State of Vic-



Wildfires and WUI Fire Fatalities, Fig. 1 Distribution of civilian and firefighter fatalities between 1900 and 2017

toria. The fires caused 173 deaths and injured over 100 people; more than 2000 houses were destroyed (Teague et al. 2010). A large proportion, 113 people, died inside a property while sheltering from the fire. At the time of death, 29% of people were sheltering, 24% were defending and sheltering, 15% were defending, and 20% were evacuating late (Blanchi et al. 2012).

Number of Fatalities per State 1900–2017

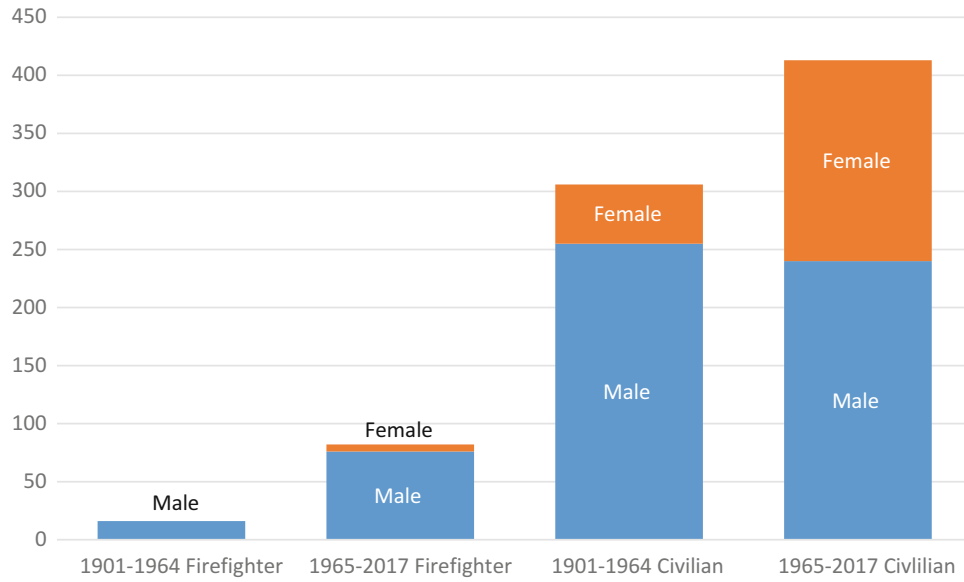
South Eastern Australia, including the State of Victoria and New South Wales, have experienced the largest number of losses (Table 1). The number of fatalities varies in each state depending on the States unique weather conditions, policies, building stock, population distribution, and vegetation characteristics.

Demographics

There has been an increase in female fatalities in recent years, with the proportion of females dying in recent fires significantly greater than the proportion in earlier fires (Fig. 2). The 2009 Black Saturday bushfire marks a change in fatalities from previous fires where most deaths occurred outside while defending and protecting asset (Haynes et al. 2010; Whittaker et al. 2017). Slightly more females died as a result of the fire compared to previous fires, with 58% male and 42% female. The age profile was similar to other fires (see Table 2).

Wildfires and WUI Fire Fatalities, Table 1 Number of fatalities by State – Firefighters and Civilians (between 1900 and 2017)

State	Firefighter	Civilian	Total
ACT		5	5 (1%)
NSW	41	101	141 (17%)
NT	2	3	5 (1%)
QLD	2	24	26 (3%)
SA	15	44	59 (7%)
TAS	2	67	69 (8%)
VIC	33	478	511 (60%)
WA	4	26	30 (4%)
Total	99	748	846 (1000%)



Wildfires and WUI Fire Fatalities, Fig. 2 Number of fatalities by gender between the period 1901–1964 and the period 1965–2017 (distinction between civilian and firefighters)

Wildfires and WUI Fire Fatalities, Table 2 Age and gender for the three time periods (all fatalities – civilians, firefighters, and non-directly related fatalities). (From Blanchi et al. 2012)

	1901–1964	1965–2011	1901–2011 (total)	Black Saturday fires
Total number killed	343	482	825	173
Male	272 (79%)	300 (62.3%)	572 (69.3%)	101 (58%)
Female	51 (14.9%)	173 (35.8%)	224 (27.2%)	72 (42%)
Unknown	20 (5.8%)	9 (1.9%)	29 (3.5%)	
Age				
0–9	32 (9.4%)	29 (6%)	61 (7.4%)	13 (8%)
10–19	31 (9.1%)	36 (7.5%)	67 (8.1%)	14 (8%)
20–29	33 (9.6%)	50 (10.4%)	83 (10.1%)	13 (8%)
30–39	29 (8.5%)	54 (11.2%)	83 (10.1%)	21 (12%)
40–49	34 (9.9%)	54 (11.2%)	88 (10.7%)	23 (13%)
50–59	24 (7.0%)	74 (15.3%)	98 (11.9%)	38 (22%)
60–69	27 (7.9%)	68 (14.1%)	95 (11.5%)	24 (14%)
70–79	20 (5.8%)	34 (7.0%)	54 (6.5%)	9 (5%)
80 and above	6 (1.8%)	31 (6.4%)	37 (4.5%)	18 (10%)
Unknown	107 (31%)	52 (11%)	159 (19.3%)	

Locations and Activities at the Time of Death

Information on the locations of fatalities, activities at the time of death, and weather conditions were also collated and analyzed by Haynes et al. (2010) and Blanchi et al. (2012). An overview is provided below and concerns fatalities from 1901 to 2011. The authors used a separation of the data to distinguish between the first and second half of the last century, providing an opportunity to compare demographic context, social behavior, and the prevalence of technologies (Blanchi et al. 2012).

Wildfires and WUI Fire Fatalities, Table 3 The location of fatalities over the three time periods. (From Blanchi et al. 2012)

Civilian	1901–1964	1965–2011	1901–2011 (total)
Inside structure	21 (7.1%)	167 (44.4%)	188 (27.9%)
Inside vehicle	11 (3.7%)	45 (12.0%)	56 (8.3%)
Open air	232 (77.8%)	158 (42.0%)	390 (57.8%)
Unknown	34 (11.4%)	6 (1.6%)	40 (5.9%)
Total	298 (100%)	376 (100%)	674 (100%)
Firefighters			
Inside structure	None recorded	None recorded	None recorded
Inside vehicle	None recorded	28 (51.9%)	28 (41.8%)
Open air	13 (100%)	25 (46.3%)	38 (56.7%)
Unknown	None recorded	1 (1.6%)	1 (1.5%)
Total	13 (100%)	54 (100%)	67 (100%)

The location of death was coded into four categories including inside structure, inside vehicle, open air, and unknown (Table 3). Table 3 shows that while most fatalities occurred outside in earlier fires, a greater proportion of fatalities occurred inside a structure or vehicle in recent fires.

Table 4 presents the activities of civilians prior to death. The majority of fatalities over the whole time period have occurred during late evacuation (30.4%), followed by sheltering inside a structure (24.8%), and defending a property outside (22.4%). This corroborates previous findings highlighting the danger of late evacuation (Krusel and Petris 1999; McArthur and Cheney 1967; McLennan et al. 2013; Whittaker et al. 2013). The main activities for the first half of the last century are late evacuation and defending a property outside which correlates well with the dominant location at the time of death for this time period (open air, see Table 3). In comparison, the most common activity over the more recent time period is sheltering inside (40.2%).

North American Fatalities

As in Australia, there is no single system of record for wildfire and WUI fire-related deaths in the United States, not even for wildland firefighter (WFF) fatalities. Data on US WFF fatalities are captured in several different systems of record (Table 5). Fatality data archived by the National Interagency Fire Center (NIFC) extend back to 1910, when there were at least 84 WFF fatalities from burnover/entrapment, including 78 deaths in a 1.2 million ha western wildfire episode known as the Big Blowup (Pyne 1982; NIFC 2019). The current NIFC archive is an updated, although less detailed, version of the National Wildfire Coordinating Group's historical wildland firefighter fatality dataset (NWCG 1997). Since 1987, those data have been sourced from the NWCG Safety Grams (NWCG SG), which track only line-of-duty deaths (LODD, i.e., during wildland fire response or work-capacity testing). Two other systems, the National Fire Protection Association Fire Incident Data Organization (NFPA FIDO) and the US Fire Administration Firefighter Fatality Incident Database (USFA FFID), currently track all on-duty WFF fatalities, including all LODD but also deaths occurring during other non-emergency work activities. Also included in the USFA FFID and increasingly accounted for in other systems are WFF fatalities that occur as the result of a heart attack or stroke within 24 h of arduous work-related activity.

Butler et al. (2017) compiled WFF fatality data for 2001–2012 from all of the sources listed in Table 5, except for the Incident Command System (ICS) 209 archive. An ostensibly complete accounting of all on-duty WFF fatalities for that period could only be obtained by com-

Wildfires and WUI Fire Fatalities, Table 4 Activities at the time of death for civilian fatalities. (From Blanchi et al. 2012)

	1901–1964	1965–2011	1901–2011 (total)
Late evacuation	111 (37.2%)	93 (24.8%)	204 (30.4%)
Defending property outside	90 (30.2%)	61 (16.3%)	151 (22.4%)
Inside property	18 (6.0%)	152 (40.2%)	168 (24.8%)
Travelling through the area unaware	22 (7.4%)	44 (11.8%)	66 (9.8%)
Waiting rescue	1 (0.3%)	6 (1.6%)	7 (1%)
Assisting firefighting operations	6 (2%)	2 (0.5%)	8 (1.2%)
Returned into burning building	2 (0.7%)	6 (1.6%)	8 (1.2%)
In an undefendable shelter (dugout, shed)	8 (2.7%)	3 (0.8%)	11 (1.6%)
Activity unknown at time of fatality	42 (14.1%)	9 (0.8%)	51 (7.6%)
Total	**298 (100%)**	**376 (100%)**	**674 (100%)**

Wildfires and WUI Fire Fatalities, Table 5 Sources of wildfire related fatality data for the US and scope of relevant information content

Source	Scope
Bureau of Labor Statistics Census of Fatal Occupational injuries (BLS CFOI)	All fatalities due to work-related injury. Does not account for medical—/illness-related deaths
Incident command system incident status summary, form 209 (ICS 209)	Responder and civilian fatality estimates made during active incidents, including large or otherwise significant wildfires
National Fire Protection Association Fire Incident Data Organization (NFPA FIDO)	All on-duty firefighter fatalities
National Institute for Occupational Safety and Health Fire Fighter Fatality Investigation and Prevention Program (NIOSH FFFIPP)	Subset of on-duty firefighter fatalities selected for thorough investigation
National Wildfire Coordinating Group Safety Grams (NWCG SG)	Line-of-duty WFF fatalities
US Fire Administration Firefighter Fatality Incident Database (USFA FFID)	All on-duty[a] firefighter fatalities

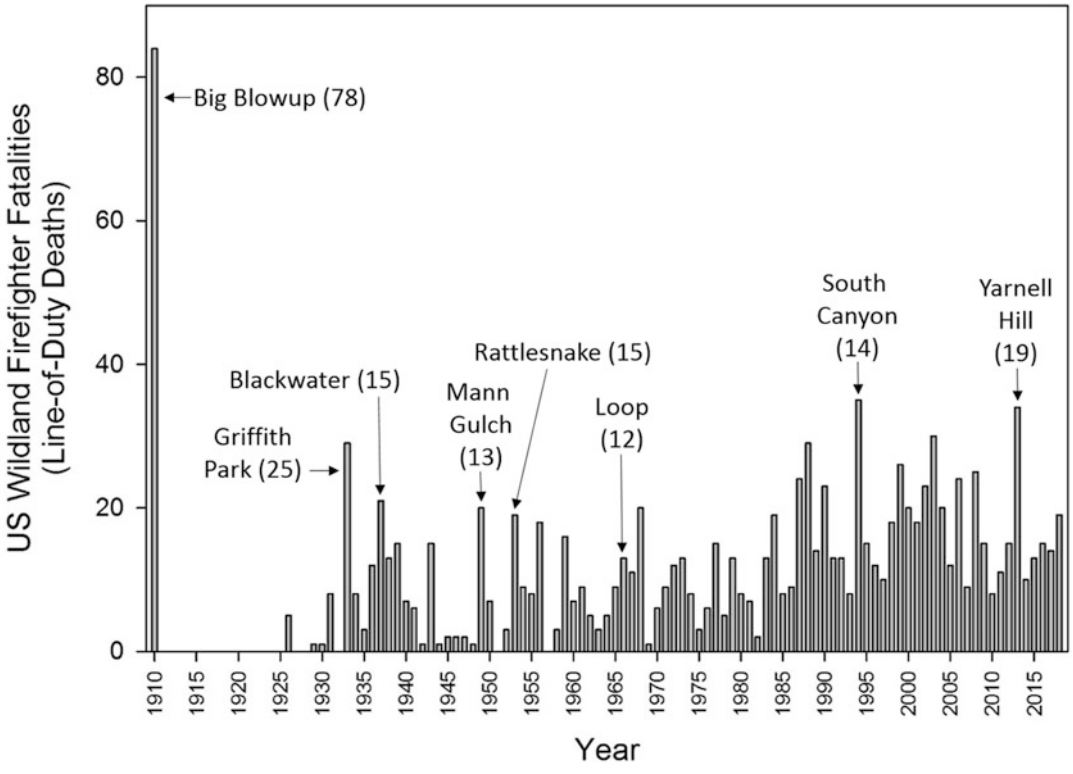
[a]Broadens the "on-duty" criterion to include fatalities that occur as the result of a heart attack or stroke within 24 h of arduous work-related activity

bining information from the NWCG SG, NFPA FIDO, and USFA FFID reporting systems. In doing so, Butler et al. (2017) identified 247 WFF fatalities over the 12-year period, or an average of ~20.6/year. The USFA, NWCG, and NFPA captured 223, 210, and 207 of those incidents, respectively (Butler et al. 2017). Counts from each of the three systems typically differed by 1–2 fatalities per year (Butler et al. 2017). However, fatality distributions by age, gender, cause, and type of worker were very similar across systems (Butler et al. 2017).

There is no single source of data on civilian fatalities attributable to wildland fires in the United States. Since 2014, the ICS 209 archive (FAMWEB 2019) has included estimates of civilian wildfire and WUI fire fatalities made during active incidents, but it is far from a complete record.

Distribution

Although the NIFC (2019) are purported to account just for LODD, the number of years in that archive is the greatest of the various sources of WFF fatality data. After adding in the latest year's NWCG SG fatality estimate (NWCG 2018) and aligning estimates for 1990–2006 with those published by Mangan (2007), there are a

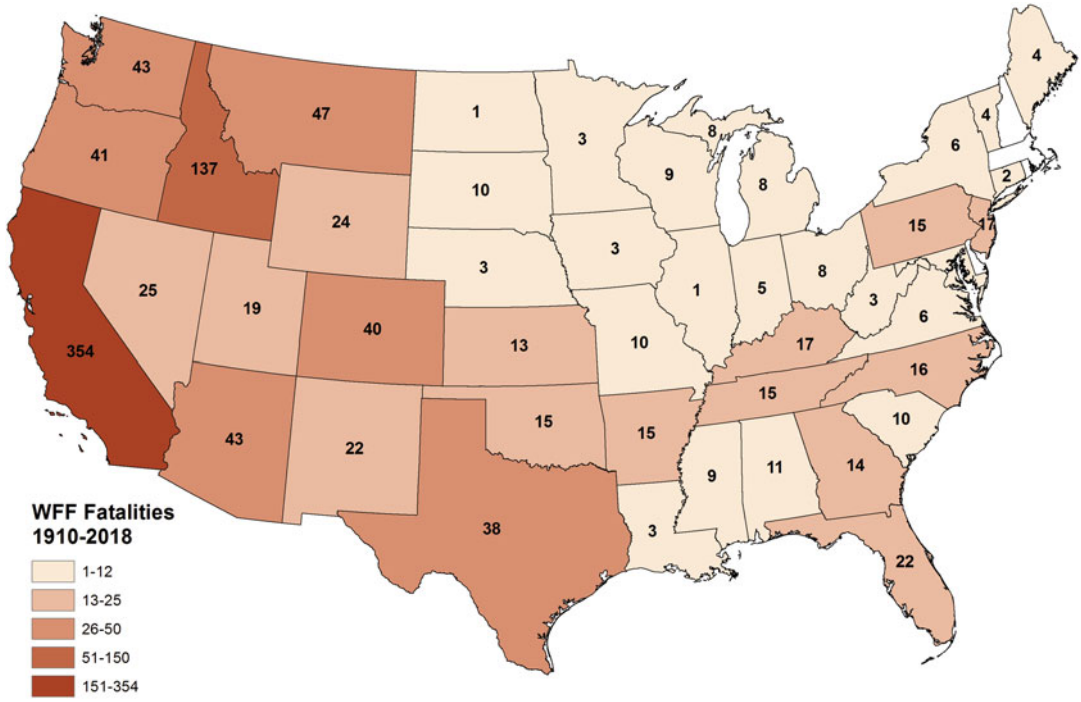


Wildfires and WUI Fire Fatalities, Fig. 3 Wildland firefighter fatalities (line-of-duty deaths) in the US, 1910–2018 (NWCG 1997, 2018; Mangan 2007; NIFC 2019). Fires with 12 or more deaths (due to burnover/entrapment) are listed with fatality numbers in parentheses

total of 1154 WFF LODD reported over the 109-year period 1910–2018 (Fig. 3). Of those, 1136 had specific locality (state) information reported, with 76% LODD occurring in the 14 western and south central states of the conterminous United States and over 30% in California alone (Fig. 4). The second largest number of LODD occurred in Idaho, which was the location associated with the 78 WFF fatalities from the Big Blowup of 1910 (Figs. 3 and 4). Since the Big Blowup, there have been 7 other US wildfires that killed 12 or more WFF, all due to entrapment/burnover (Fig. 3). The most recent was the 2013 Yarnell Hill Fire that claimed the lives of 19 WFF.

The ICS 209 archive includes reports of 57 wildland fires during the period 2014–2018 with civilian casualties. Of those 57 fires, 41 (72%) were reported as single-fatality events. Thirteen (81%) of the 16 multi-fatality fires occurred in California. While a complete accounting of all civilian casualties attributable to wildfires and WUI fires over even the most recent decade is not available, Thomas and Butry (2012) estimated that for the period 2002–2006, wildland fires within municipal jurisdictions resulted in 15 civilian fatalities and 88 civilian injuries per year.

The highest civilian casualty fire in that dataset is the Camp Fire of 2018, which burned through the town of Paradise, California, killing 85 people (Cal Fire 2019). The 2018 Camp Fire also tops California's list of deadliest fires on record, considering WFF and civilian fatalities combined (Cal Fire 2019, Table 6). Multi-fatality incidents in California and elsewhere in the United States are generally the result of fires that spread rapidly into WUI or otherwise developed areas under extreme (i.e., windy and dry) burning conditions that defy most suppression efforts (Keeley et al. 2004; Tedim et al. 2018; Nauslar et al. 2018). The wind-driven Camp fire grew to 40,000 ha



Wildfires and WUI Fire Fatalities, Fig. 4 Reported number of wildland firefighter fatalities (line-of-duty deaths, LODD) in the conterminous United States, by state, 1910–2018 (NIFC 2019; NWCG 2018). In addition, there were 18, 2, and 1 LODD in Alaska, Hawaii, and Puerto Rico, respectively, plus 8 LODD with the state-level locality unreported during this 109-year period

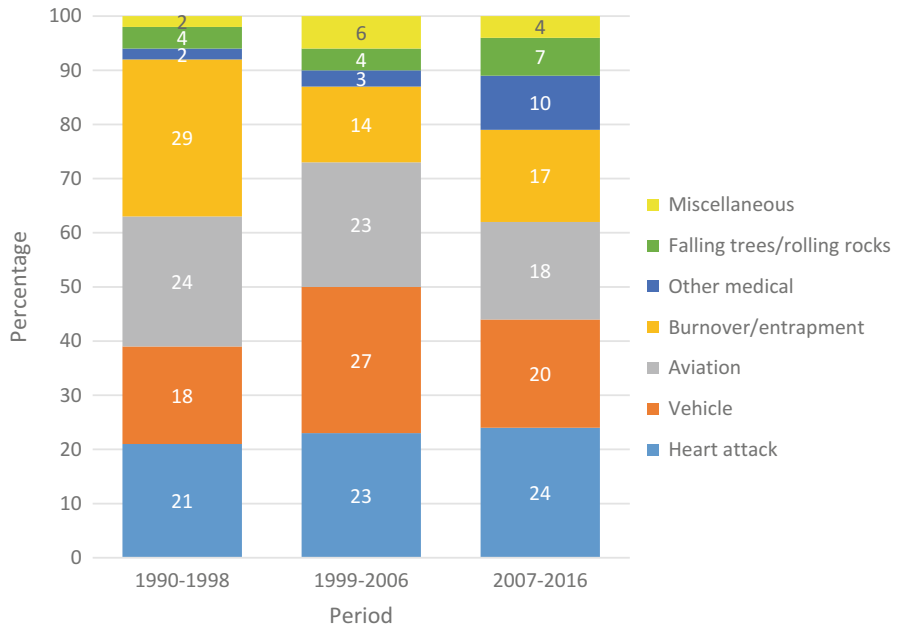
Wildfires and WUI Fire Fatalities, Table 6 Top 10 deadliest California wildfires and WUI fires (Cal Fire 2019). "Structures" include homes, outbuildings, and commercial properties destroyed. Fatality estimates include wildland firefighters and civilians

Fire name	Date	County	Hectares	Structures	Fatalities
Camp	November 2018	Butte	62,053	18,804	85
Griffith Park	October 1933	Los Angeles	19	0	29
Tunnel/Oakland Hills	October 1991	Alameda	647	2900	25
Tubbs	October 2017	Napa, Sonoma	14,895	5643	22
Cedar	October 2003	San Diego	110,579	2820	15
Rattlesnake	July 1953	Glenn	542	0	15
Loop	November 1966	Los Angeles	821	0	12
Inaja	November 1956	San Diego	17,767	0	11
Hauser creek	October 1943	San Diego	5320	0	11
Iron & alps complex	August 2008	Trinity	42,838	10	10

in its first 2 days, engulfing the forested town of Paradise (Inciweb 2018), destroying 80% of the town's buildings and trapping people in vehicles as they tried to evacuate with limited points of egress from the ridgetop community (Folkman 2018; St. John and Phillips 2018).

Causes

Aviation or vehicle use, medical events, and entrapment/burnover account for the majority (89%) of the WFF fatalities in the historical archive, 1910–2018 (NWCG 1997, 2018; Mangan 2007; NIFC 2019) and in the most recent



Wildfires and WUI Fire Fatalities, Fig. 5 Wildland firefighter fatalities by cause of death in the United States, 1990–2016 (NWCG 2017)

period of published analysis 2007–2016 (NWCG 2017). Using the broader on-duty WFF fatality criteria and data compiled from the NWCG SG, NFPA FIDO, and NIOSH FFFIPP, NWCG (2017) found that heart attacks were the most common cause of WFF fatalities between 2007 and 2016 (Fig. 5). The apparent uptick in heart attacks in 2007–2016 as compared to previous decades (Fig. 5) is due to a change in reporting criteria to capture all on-duty deaths, including fatalities that occur as the result of a heart attack or stroke within 24 h of arduous work-related activity. During the period 2007–2016, 22% of heart attack deaths among WFFs occurred after returning from the wildland fire incident.

During the period 2007–2016, heart attacks were the most common cause of fatalities among volunteer firefighters, WFF from the state fire service, and ground contractors, while vehicle accidents were the most common cause of death among federal WFFs (NWCG 2017). Most vehicle accidents were single-fatality events that involved rollovers or WFFs struck by vehicles (NWCG 2017).

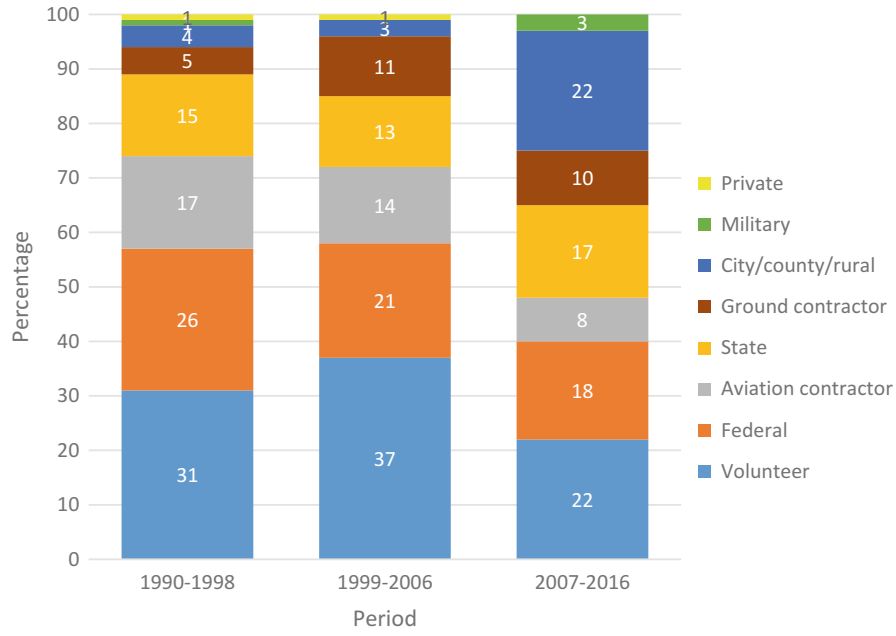
Demographics

During the period 1990–2016, there were more fatalities among volunteer WFFs than any other class of WFF (Fig. 6, NWCG 2017). There was an increase in city/county/rural WFF deaths during the period 2007–2016 as compared to previous decades largely due to a burnover/entrapment event on the 2013 Yarnell Hill wildfire that killed 19 WFF from a municipal (city) fire crew.

In their analysis of WFF fatality data from several systems of record for 2001–2012, Butler et al. (2017) found that most (94%) of WFF deaths occurred among males and 55–56% occurred in the >40- year age classes.

South European Fatalities

The systematic gathering of data regarding forest fire and WUI fire fatalities is not a common practice in Europe, and no official databases on civilian or firefighter's fatalities exist. Molina-Terrén et al. (2019) recently performed a detailed analysis of historical forest fire-related fatal incidents in Southern Europe, namely, Portugal,



Wildfires and WUI Fire Fatalities, Fig. 6 Wildland firefighter fatalities in the United States, by organization, 1990–2016 (NWCG 2017)

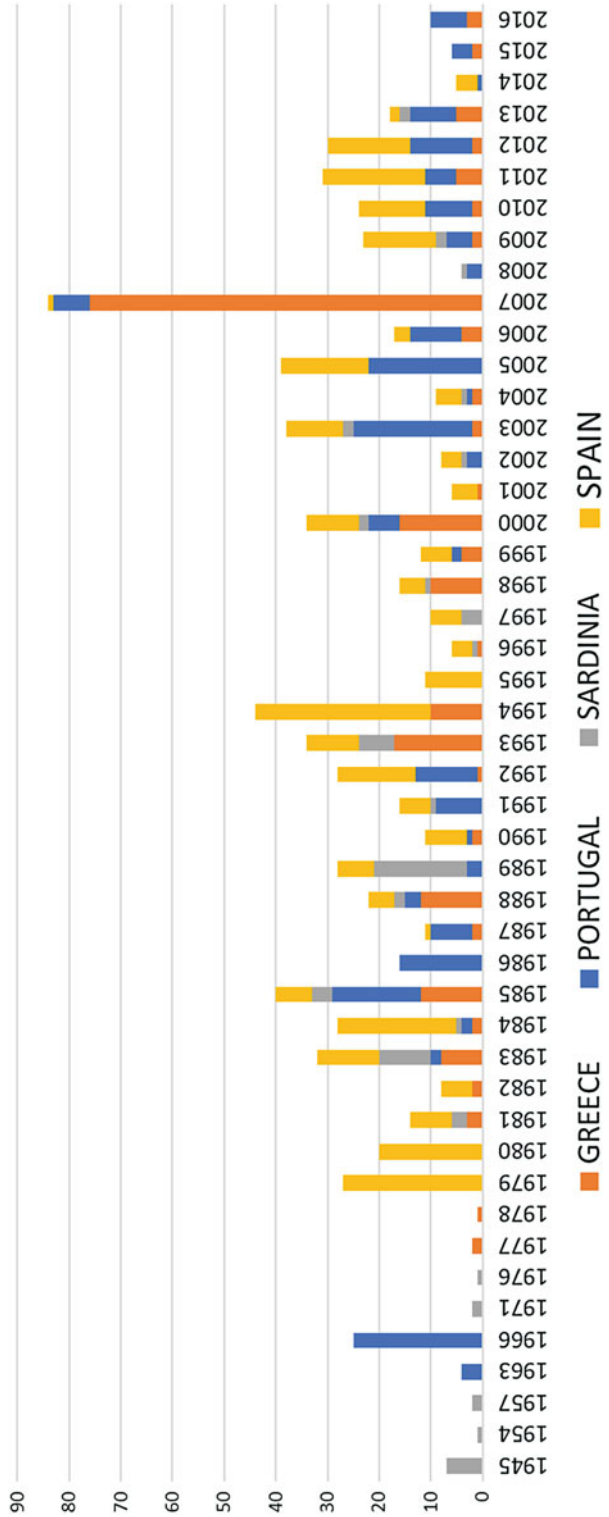
Spain, Greece, and the Italian Island of Sardinia, proposing what could be the basis for an official database covering European Union countries. The 2019 study did not include the most recent and most devastating forest fire episodes in Europe: the fires of 2017 in Portugal and 2018 in Greece with more than 200 fatalities. The authors summarize here the previous analysis of Southern Europe and present an overview of the fires in Portugal and in Greece.

Southern Europe Forest Fire and WUI Fire Fatalities

The full dataset used in Molina-Terrén et al. (2019) refers to different periods due to the absence of records or of incidents: 1977–2016 in Greece, 1945–2016 in Sardinia (Italy), 1979–2016 in Spain, and 1963–2016 in Portugal. The dataset contains a total of 865 deaths. The data used by the authors was collected from different sources, namely, national databases, where they existed (e.g., Spain), media (e.g., newspapers, TV), fieldwork (e.g., Portugal), and official or unofficial accidents reports. Figure 7 shows the distribution of fatalities per year and country. Since the late 1970s, there has been at least one fatality a year, contrary to the beginning of the analyzed period, where fatalities were less frequent, either because there were no accidents or because they were not recorded systematically.

There is no obvious pattern in the distribution of fatalities per country or year and, in many cases, particular episodes contribute to the majority of the fatalities in the region. Molina-Terrén et al. (2019) list a series of events with more than 20 fatalities:

- 2018, Mati (Greece, 102 fatalities)
- 2017, Central Region (Portugal, 53 fatalities)
- 2017, Pedrógão Grande (Portugal, 66 fatalities)
- 2007, Makistos–Artemida, Peloponnese (Greece, 30 fatalities), that fire season 78 fatalities were reported in separate incidents
- 1984, La Gomera, Canary Islands (Spain, 20 fatalities)
- 1979, Lloret de Mar, Girona (Spain, 21 fatalities)
- 1966, Sintra Mountains (Portugal, 25 fatalities)



Wildfires and WUI Fire Fatalities, Fig. 7 Forest fire- and WUI fire-related fatalities in Southern Europe, between 1945 and 2016, year with fires only from 1945 to 1976, then every year until 1976. (Adapted from Molina-Terrén et al. 2019)

France was not included in the south European analysis (Molina-Terrén et al. 2019), as little detailed data was currently available. The most devastating forest fire occurred in 1949, in the Landes region, and killed 82 people, between firefighters, volunteers, and soldiers. This remains one of the deadliest singular incidents in Europe (Deville 2009).

For simplicity, statistics on fatal incidents are presented here grouped in three periods: 1945–1975, 1976–2000, and 2000–2016. In Table 7, the authors present the distribution of the 865 registered deaths per country and per time period.

Greece and Portugal have similar figures overall, and Spain has the highest number of fatalities. As for Italy, this study only refers to the Sardinia Region, but from (outdated) official reports (Corpo Forestale dello Stato 2011), the authors observed 215 fatalities in the period 1978–2011, which seems to be similar to Portugal and Greece.

In terms of gender (Table 8), male victims make up five times the number of females in the entire period. In all countries there is a high number of civilians killed by forest fire and WUI fire (366 civilians, representing 42% of the total), with civilian fatalities outnumbering firefighters (280 firefighters, representing 32%). There are other deaths not included in either of the previous categories, mostly related to military personnel, or civil protection agents that do not belong to the firefighter category (219 fatalities, representing 25%).

The number of fatalities in WUI areas can be a good indicator of the absence of fuel management practices or rural abandonment. From the cases in which the previously referred study identified the environment of the accidents, 22.3% occurred in WUI areas and 41.3% in the wildland (36.4% could not be identified). The three recent European forest fire events not included in the Molina-Terrén et al. (2019) study are described below.

Wildfires and WUI Fire Fatalities, Table 7 Forest fire- and WUI fire-related deaths per country and time period

Country					
Period	Greece	Portugal	Sardinia (IT)	Spain	Total
1945–1975	0	29	12	0	41
1976–2000	105	81	55	231	472
2001–2016	106	122	9	115	352
Total	211	232	76	346	865

The Fires of June and October 2017 in Portugal

The Pedrógão Grande complex of fire events (Viegas et al. 2017), started on June 17, 2017, and lasted for almost a week, burning 45,000 ha. Almost 98% of that area was burnt during the first 2 days. Between 19 h00 and 22 h00 of June 17, 8700 ha of shrub, pine, and eucalyptus were consumed at an impressive rate of approximately 3000 ha per hour. During this period a firestorm developed when two of the main fire fronts joined producing several episodes of extreme fire behavior resulting in fatal accidents when most of the deceased tried to escape from the fire. In total 66 people lost their lives, 65 civilians and 1 firefighter. Only four people died at home, all of whom had mobility difficulties. On a short stretch of 400 m of road, 30 people died in a confusion of trapped or crashed cars, some inside their vehicles, others outside, after the cars crashed. In total, 31 persons lost their lives inside their cars, while trying to escape. Overall the victims were aged between 1 and 88 years old and were almost equally divided

Wildfires and WUI Fire Fatalities, Table 8 Forest fire- and WUI fire-related deaths per gender and activity

	Gender			Activity			
Period	Female	Male	N/A	Civilian	Firefighter	Other	Total
1945–1975	0	41	0	5	7	29	41
1976–2000	57	299	116	163	163	146	472
2001–2016	54	218	80	198	110	44	352
Total	111	558	196	366	280	219	865

Wildfires and WUI Fire Fatalities, Table 9 Victims gender and type of accident in Pedrógão fire complex from (Viegas et al. 2017)

	Type of accident				
Gender	Escaping from fire on foot	In vehicle	Indoors	Accidental entrapment	Total
Female	12	17	2		31
Male	18	14	2	1	35
Total	**30**	**31**	**4**	**1**	**66**

between females and males (Table 9). As Viegas et al. (2017) point out, the Portuguese Civil Protection warning system failed to inform citizens of the gravity of the developing fire. Also, the population were unprepared to reduce their risks and respond effectively.

This event remains the worst forest fire-related incident in terms of fatalities on record in Portugal.

On October 15, 2017, and late in the forest fire season, a series of very large fires burned more than 200,000 ha through the Central Region of Portugal. These fires were associated with abnormal severe meteorological conditions for the season due to the passage of Hurricane Ophelia off the Portuguese Coast, with temperatures above 30 °C and very strong winds. Viegas et al. (2019) describe in detail the fires and their impacts leading to 51 civilian fatalities: the fires of Lousã (15 fatalities), Oliveira do Hospital (23 fatalities), Seia (1 fatality), Sertã (2 fatalities), and Vouzela (10 fatalities). The number of fires that began on October 15 was above the response capacity of the Portuguese Civil Protection Agencies, with more than 500 registered fire events (Viegas et al. 2019).

As in Pedrógão Grande, many of the casualties occurred while people where running from the fire, either on foot or in a vehicle (Table 10), as they did not consider the houses a safe place to shelter (Viegas et al. 2019). Most of their houses remained unaffected. However, 17 of the fatalities occurred within the home, with most of the deceased sleeping at the time of their death as the fires reached their homes late at night.

In terms of area burned, the October fire events broke all records in Portugal, including the earlier June fires, doubling the average annual burned area in just 1 day. Multiple episodes of extreme fire behavior were observed, with intense spotting carrying the fire long distances (Viegas et al. 2019).

The Fires of July 2018 in Greece

On July 23, 2018 in Northeast Attica, Greece, a forest fire became the second deadliest worldwide forest fire event this century (Xanthopoulos and Athanasiou 2019). One hundred two people were killed and 150 injured. More than 1650 homes burned along with 1431 hectares of agro-forestry vegetation and urbanized land. A forest fire erupted on Mount Penteli at 16:41 in the northeastern part of the Attica region, 5 km west of the coast. It quickly picked up speed pushed by the strong wind from the mountain of Penteli toward the sea. Initial attack was delayed due to another fire in the region. The fire spread in light fuels, and it soon entered the settlement of Neos Voutzas and then the settlement of Mati, near the sea.

The area of Mati was characterized by thick Aleppo pine (*Pinus halepensis*) vegetation that surrounded numerous homes. People tried to evacuate toward the sea; however the high rate of fire spread and traffic jams that quickly formed in the narrow streets resulted in numerous fire entrapments. More than 20 people were trapped and died on a steep cliff above the sea. Others managed to find their way into the sea but suffered from the heat, smoke, and rough sea conditions. More than ten people drowned, while others were rescued by boats at a distance of kilometers from the coast (Xanthopoulos and Athanasiou 2019).

Wildfires and WUI Fire Fatalities, Table 10 Victims' gender and type of accident in the October 15 forest fire from Viegas et al. (2019)

Gender	Type of accident				Total
	Escaping from fire on foot	In vehicle	Indoors	Car accident (outside vehicle)	
Female	2	3	8	4	17
Male	13	7	9	5	34
Total	14	10	17	9	51

Conclusion

All countries described in this contribution have experienced recent catastrophic fires leading to high numbers of fatalities. The numbers of casualties in these fires are record breaking, and while climate change is a key driver, increasing development and populations in high fire prone environments is also an important factor (Moritz et al. 2014).

Recent civilian fatalities in the United States and Europe have been dominated by those trapped by fire as they tried to evacuate, and in Europe many homes that were evacuated survived. This mirrors trends seen in past large fires in Australia, hence the long-term Australian policy position to encourage people to prepare their homes and then either evacuate early or stay to defend (Tibbits et al. 2008). Following Black Saturday in 2009, which saw for the first time large numbers of Australians die in homes, there has been a shift in the messaging emphasis toward leaving early, rather than staying to defend, alongside improvements in education, forecasting, and warning provision (Whittaker 2019; Penman et al. 2013; Blanchi et al. 2014). In comparison with Australia, the advice in the United States and Europe remains dominated by evacuation measures. In the United States, there is an ongoing challenge with public safety in the expanding wildland-urban interface, increasingly resulting in large-scale evacuations in the face of wildfire (Cova 2005; Ronchi et al. 2019). In Europe, the 2017 fires in Portugal highlighted the need to prepare and better inform the general population about wildfire preparedness and response (Viegas et al. 2019). Similar measures are planned in Greece following the tragic experience of the 2018 fire fatalities in Eastern Attica.

No single system exists in any country worldwide to systematically record wildfire and WUI fatalities. In Australia and Europe, the datasets utilized to date have been compiled by researchers, and many are incomplete or incompatible for comparative analysis (Blanchi et al. 2012; Molina-Terrén et al. 2019). In the United States although detailed information on WFF fatalities exists, little detailed data on civilian fatalities has been captured, and the focus remains on firefighter fatalities. In order to develop evidence-based policy and practice, a dedicated and systematic approach to data collection on wildfires and WUI fire fatalities (civilian and WFF) is required globally.

Cross-References

- Computational Evacuation Modelling in Wildfires
- Defensive Actions and People Preparedness
- Evacuation
- Fire Data
- Public Education
- Stay and Defend

References

Blanchi R, Lucas C, Leonard J, Finkele K (2010) Meteorological conditions and wildfire-related house-loss in Australia. Int J Wildland Fire 19(7):914–926. https://doi.org/10.1071/WF08175

Blanchi R, Leonard J, Haynes K, Opie K, James M, Kilinc M, Dimer de Oliveira F, Van den Honert R (2012) Life and house loss database description and analysis Final

report. CSIRO, Bushfire CRC report to the Attorney-General's Department. CSIRO EP-129645
Butler C, Marsh S, Domitrovich JW, Helmkamp J (2017) Wildland firefighter deaths in the United States: a comparison of existing surveillance systems. J Occup Environ Hyg 14:258–270
Blanchi R, Leonard J, Haynes K, Opie K, James M, Oliveira FD (2014) Environmental circumstances surrounding bushfire fatalities in Australia 1901-2011. Environ Sci Policy 37:192–203
Cal Fire (2019) Top 20 deadliest California wildfires. Fact sheet https://calfire.ca.gov/communications/downloads/fact_sheets/Top20_Deadliest.pdf
Calkin DE, Short KC, Traci M (2019) California wildfires. In: Rubin CB, Cutter SL (eds) From disaster to catastrophe: U.S. Emergency Management in the 21st Century. CRC Press, Boca Raton
Cheney P, Gould J, McCaw L (2001) The dead-man zone – a neglected area of firefighter safety. Aust For 64(1):45–50
Corpo Forestale dello Stato (2011) Incendi Boschivi. Ministerio Politiche Agricole Alimentari e Forestali, Italy
Cova TJ (2005) Public safety in the urban-wildland interface: should fire-prone communities have a maximum occupancy? Nat Hazard Rev 6(3):99–108. https://doi.org/10.1061/(ASCE)1527-6988
Deville J (2009) L'incendie meurtrier – dans la forêt des Landes en août 1949, les Éditions des Pompiers de France, Paris
Diakakis M, Xanthopoulos G, Gregos L (2016) Analysis of forest fire fatalities in Greece: 1977–2013. Int J Wildland Fire 25:797–809
FAMWEB (2019) National fire and aviation management web application. https://fam.nwcg.gov/fam-web. Accessed May 2019
Folkman C (2018) California wildfires: the new abnormal. In: Risk management solutions, catastrophe review 2018. Newark, pp 3–5. https://www.rms.com/
Haynes K, Handmer J, McAneney J, Tibbits A, Coates L (2010) Australian bushfire fatalities 1900–2008: exploring trends in relation to the "prepare, stay and defend or leave early" policy. Environ Sci Pol 13(3):185–194. Retrieved from http://www.sciencedirect.com/science/article/B6VP6-4YNT93S-2/2/1345112f4c3c3a1815fffac6277a739e
Inciweb (2018) Final posting of inciweb for the camp fire. https://inciweb.nwcg.gov/incident/6250
Keeley JE, Fotheringham CJ, Moritz MA (2004) Lessons from the October 2003 wildfires in Southern California. J For 102:26–31
Krusel N, Petris SN (1999) A study of civilian deaths in the 1983 ash wednesday bushfire Victoria. CFA Occasional Paper No 1. Contry Fire Authority, Mt Waverley
Mangan R (2007) Wildland firefighter fatalities in the United States: 1990–2006. Publication PMS-841 of the National Wildfire Coordinating Group, Safety and Health Working Team, Boise, 28p
McArthur AG, Cheney NP (1967) Report on the southern Tasmanian bushfires of 7 February 1967. Forestry Commission Tasmania, Hobart
McLennan J, Elliott G, Omodei M, Whittaker J (2013) Householders' safety-related decisions, plans, actions and outcomes during the 7 February 2009 Victorian (Australia) wildfires. Fire Saf J 61:175–184
Molina-Terrén DM, Xanthopoulos G, Diakakis M, Ribeiro L, Caballero D, Delogu GM, Viegas DX, Silva CA, Cardil A (2019) Analysis of forest fire fatalities in Southern Europe: Spain, Portugal, Greece and Sardinia (Italy). Int J Wildland Fire 28(2):85. Retrieved from http://www.publish.csiro.au/?paper=WF18004
Moritz MA, Batllori E, Bradstock RA, Gill AM, Handmer J, Hessburg PF, Leonard J, Mccaffrey S, Odion DC, Schoennagel T, Syphard AD (2014) Learning to coexist with wildfire. Nature 515(7525):58–66.. Retrieved from. https://doi.org/10.1038/nature13946
National Interagency Fire Center [NIFC] (2019) Wildland fire fatalities by year. https://www.nifc.gov/safety/safety_documents/Fatalities-by-Year.pdf
National Wildfire Coordinating Group [NWCG] (1997) Historical wildland firefighter fatalities 1910–1996. Publication PMS-822 the National Wildfire Coordinating Group, Safety and Health Working Team, Boise, 45p
National Wildfire Coordinating Group (2017) NWCG report on wildland firefighter fatalities in the United States: 2007–2016. National Wildfire Coordinating Group PMS 841, Boise. https://www.nwcg.gov/sites/default/files/publications/pms841.pdf
National Wildfire Coordinating Group [NWCG] (2018) Safety Gram 2018, final. https://www.nwcg.gov/sites/default/files/committee/docs/rmc-sg-2018.pdf
Nauslar N, Abatzoglou J, Marsh P (2018) The 2017 North Bay and Southern California fires: a case study. Fire 1:18
Page WG, Butler BW (2018) Fuel and topographic influences on wildland firefighter burnover fatalities in Southern California. Int J Wildland Fire 27(3):141. Retrieved from http://www.publish.csiro.au/?paper=WF17147
Penman T, Eriksen C, Blanchi R, Chladil M, Gill A, Haynes K, Leonard J, McLennan J, Bradstock RA, (2013) Defining adequate means of residents to prepare property for protection from wildfire. Int J Disaster Risk Reduct 6:67–77
Pyne SJ (1982) Fire in America: a cultural history of wildland and rural fire. University of Washington Press, Seattle
Ronchi E, Gwynne SMV, Rein G, Intini P, Wadhwani R (2019) An open multi-physics framework for modelling wildland-urban interface fire evacuations. Saf Sci 118:868–880. https://doi.org/10.1016/j.ssci.2019.06.0
St. John P, Phillips AM (2018) Despite fire after fire, Paradise continued to boom – until California's worst wildfire hit. Los Angeles Times 13 November 2018. http://www.latimes.com/local/lanow/la-me-paradise-fire-development-warnings-20181113-story.html

Teague B, McLeod R, Pascoe S (2010) 2009 Victorian Bushfires Royal Commission final report: summary. Melbourne, State Government of Victoria

Tedim F, Leone V, Amraoui M, Bouillon C, Coughlan MR, Delogu GM, Fernandes PM, Ferreira C, McCaffrey S, McGee TK, Parente J, Paton D, Pereira MG, Ribeiro LM, Viegas DX, Xanthopoulos G (2018) Defining extreme wildfire events: difficulties, challenges, and impacts. Fire 1:9

Thomas DS, Butry DT (2012) Wildland fires within municipal jurisdictions. J For 110:34–41

Tibbits A, Handmer J, Haynes K, Lowe T, Whittaker J (2008) Prepare, stay and defend or leave early: evidence for the Australian approach. In: Handmer Haynes K (ed) In Community bushfire safety. CSIRO Publishing, Melbourne, pp 59–71. Retrieved from https://books.google.com.au/books?id=SbQr1pB3sQAC&printsec=frontcover&source=gbs_ViewAPI&redir_esc=y#v=onepage&q&f=false

Viegas DX, Ribeiro LM, Almeida MA, Oliveira R, Viegas MTP, Raposo JR, Reva V, Figueiredo AR, Lopes S (2013) Os grandes incêndios florestais e os acidentes mortais ocorridos em 2013. Centro de Estudos sobre Incêndios Florestais (CEIF/ADAI/LAETA)

Viegas DX, Almeida MF, Ribeiro LM, Raposo J, Viegas MT, Oliveira R, Alves D, Pinto C, Jorge H, Rodrigues A, Lucas D, Lopes S, Silva LF (2017) O complexo de incêndios de Pedrógão Grande e concelhos limítrofes, iniciado a 17 de junho de 2017. Centro de Estudos sobre Incêndios Florestais (CEIF/ADAI/LAETA)

Viegas DX, Almeida MA, Ribeiro LM, Raposo J, Viegas MT, Oliveira R, Alves D, Pinto C, Rodrigues A, Ribeiro C, Lopes S, Jorge H, Viegas CX (2019) Análise dos Incêndios Florestais Ocorridos a 15 de outubro de 2017. Centro de Estudos sobre Incêndios Florestais (CEIF/ADAI/LAETA)

Whittaker J, Haynes K, Handmer J, McLennan J (2013) Community safety during the 2009 Australian 'Black Saturday' bushfires: an analysis of household preparedness and response. Int J Wildland Fire 22(6):841–849. Retrieved from http://www.publish.csiro.au/paper/WF12010

Whittaker J, Blanchi R, Haynes K, Leonard J, Opie K (2017) Experiences of sheltering during the Black Saturday bushfires: implications for policy and research. Int J Disaster Risk Reduct 23:119–127

Whittaker J (2019) Ten years after the black saturday fires, what have we learnt from post-fire research? Aust J Emerg Manag 34:32–37

Xanthopoulos G, Athanasiou M (2019) Attica region Greece, July 2018. Wildfire 28(2):18–21

Xanthopoulos G, Viegas DX, Caballero D (2009) Recent forest fire related accidents in Europe. In: Viegas (ed) Recent forest fire related accidents in Europe (European C). European Commission Joint Research Centre Institute for Environment and Sustainability. Retrieved from http://forest.jrc.ec.europa.eu/media/cms_page_media/82/recent-forest-fire-related-accidents-in-europe.pdf



THE RETURN OF CONFLAGRATION IN OUR BUILT ENVIRONMENT

IBHS WILDFIRE RESEARCH REPORT
September 2023

Ian M. Giammanco, PhD
Faraz Hedayati, PhD
Steve R. Hawks
Xareni Sanchez Monroy, PhD
Evan Sluder

Insurance Institute for Business & Home Safety®



Contents

Introduction **2**
History of Urban Conflagration 2
A Collision Course: Wildfire and Built Environment Conflagrations 3
Code Gaps 8
Built Environment Conflagration: The Common Threads **10**
Marshall Fire Case Study 11
The Chain of Suburban Conflagration 13
The Natural Environment 15
Climate 15
Weather 16
Wind 17
Moisture and Relative Humidity 18
Topography 19
Vegetative Wildland Fuels 21
Extent and Size of the Fire Front Reaching a Community 21
The Built Environment **22**
Structure Density 22
Structure-to-Structure Fire Spread 22
Connective Fuels 23
Response and Infrastructure 26
Fire Service Response 26
Infrastructure as an Aid to Fire Response 27
Infrastructure as an Ignition Source 28
Human Factors 29
Limitations and Knowledge Gaps **31**
Weather, Climate, Topography, and Wildland Fuels 32
Built Environment 33
Human Factors 33
Summary **35**
References **36**

Introduction

Many of the most catastrophic wildfires in United States history share a common thread: fire spread from the wildlands into the WUI and suburban environment. Structural conflagration is defined as fire encompassing all of a given structure. Here, we will focus on the concept of a built environment conflagration resulting from wildfires, where fire spreads uncontrollably from structure-to-structure. Most recently, the Lahaina Fire on the island of Maui, Hawaii and the Marshall Fire in Colorado demonstrated the chilling impact of a wildfire-induced conflagration in the built environment. Both fires spread from arid grasslands into a community environment and in both cases over 1,000 structures were lost in just twelve hours.

Across history the five overlapping factors that have always accompanied urban and suburban conflagrations are:

- Drought
- Wind
- Ignition mechanism, often human-based
- Dense construction using materials with little to no resistance to the hazard
- Dense combustible elements surrounding and between structures

History of Urban Conflagration

Urban firestorms have been a part of cities and their evolution across the globe for centuries. They have been applied as weapons of war as well. The 1666 London Fire was one of the first well documented urban conflagrations. It had similar characteristics to what we see in today's wildfire-driven built environment conflagrations: drought conditions, human causation for ignition, and a high structure density with fuels between buildings. From the 1600s through the early 1900s urban fire plagued cities globally.

In North America, vast timber resources drove the widespread use of wood-frame construction. This created urban centers nearly perfect for conflagration and which mirror today's suburban construction practices[1]. Multiple ignition sources (such as hearths, candles, fuel oil, and lamps) were in constant proximity to volatile fuels. Between 1820 and 1835, Boston had three major urban fires. The Great Chicago Fire of 1871 underscored the need for mitigation, with 300 fatalities and over 17,000 structures destroyed. It was during this time that the first building codes and city ordinances began to emerge along with the founding of the National Fire Protection Association (NFPA). New codes and ordinances focused on protecting life safety within structures, mitigating the impact, and spread of interior fires, and reducing the probability of urban conflagration through building-to-building spread. Post-fire analysis of the Great Chicago Fire and the Boston fire of 1872 revealed that combustible construction, water supply problems, and the lack of quick response capabilities played key roles in fire spread.

Up until this point in history, the factors that were able to stop a conflagration were quick suppression if rudimentary response capabilities were able to get ahead of the fire, favorable weather, a natural fire break (such as a river), or random chance. Through the analysis of these conflagrations, it was determined the following intrinsic factors[2] could be addressed:

- Flammability of construction materials
- Structural and architectural design
- Height
- Volume and flammability of building contents
- Average distance between buildings

By the late 19th century, codes and ordinances emerged to address these factors. Efforts were also made to improve fire response through widening urban streets and removing shanties that served as ladder or connective fuels between structures. Through building codes, commercial construction required more noncombustible exterior wall materials such as stone and brick. The emergence of concrete as a primary building material hastened progress. The technological advances of this era also brought steam-driven pumps for fire engines, expansion of professional fire departments, and widespread telegraph capabilities for alarms and response.

Rapid suppression of fires, along with improvements in codes and ordinances became the dominant strategy for reducing the probabilities of urban fire. The 1904 Baltimore Fire also helped usher in standardization of hydrant connections and firefighting equipment for joint response. It was during this time that the property insurance industry emerged along with the precursors to today's commercial testing laboratories like Factory Mutual and Underwriters Laboratories (UL). By the early twentieth century, fire trucks using internal combustion engines had replaced steam pumps and professional fire departments became standard. Unfortunately, vulnerabilities were still present, especially when considering the concept of compounding hazards.

The firestorm that followed the 1906 San Francisco Earthquake revealed how compounding disasters can lead to catastrophe and highlighted the major gaps in understanding urban fire spread. This event hastened the pace of codification of improved materials, applying rapid advances in building material science. By the 1920s there was a sentiment that the urban conflagration problem had been solved through codes, active mitigation measures such as sprinkler systems, and vastly improved fire service response capabilities[1]. However, urban conflagration following a major earthquake remains a sincere concern today given the compounding demand that would be placed on response resources.

History would demonstrate that while mitigation actions reduced elements of the urban conflagration risk, another would rear its head.

A Collision Course: Wildfire and Built Environment Conflagrations

Wildfire has long been a part of our landscape and plays a critical role in the health of ecosystems across the globe. The juxtaposition of the great urban firestorms of the 18th, 19th, and early 20th centuries combined with expansion across the western United States brought people and the built environment into landscapes prone to wildfire. The Great Fire of 1910, also known as *The Big Blowup*, burned across Idaho and Montana and would shape our view of wildfire and the threat of built environment conflagrations for nearly a century. The combination of extreme drought, human-driven ignitions, and dry lightning resulted in over 3 million acres burned and several towns destroyed in Idaho and Montana in just two days. The

resulting wildfire policy from the newly created United States Forest Service (the *10 am policy)* centered around rapid suppression of all wildland fires on federal lands with the goal of suppressing any wildfire by 10 am on the day after the fire began.

Perhaps an early view into the future occurred in 1918. The Cloquet Fire in Minnesota, started by sparks from a passing train, ignited areas which had been previously logged heavily. The combination of dry surface fuels from logging debris, significant drought, and high winds behind a passing cold front resulted in a rapidly moving fire which quickly destroyed the towns of Moose Lake, Brookston, and Arnold resulting in 453 fatalities. The accounts of this fire have been compared to those from the 2018 Camp Fire[3].

The Cloquet Fire remains Minnesota's worst natural disaster.

- **Post-disaster investigations show that 90 to 95 percent of all structures that catch fire will be destroyed.**
- **Seventy percent of all structures destroyed in a wildfire are homes.**
- **For fires where 100 or more structures are damaged or destroyed, the top 20% of those events account for nearly 95% of the total wildfire-related losses.**

Through the mid-twentieth century, wildfires generally did not lead to substantial incursions into the built environment as the aggressive *10 am policy* accomplished its goal of keeping wildfires from entering communities. During this period, there was little upward trend in the number of fires or in acres burned. Research into fire spread also centered around fire as a weapon of war, and fire spread following incendiary bombing campaigns and detonations of nuclear weapons. However, through this work the concepts of defensible space and the hardening of residential structures through noncombustible wall cladding and roof covers began to emerge[4].

Beginning in the late 1940's post-World War II era, the bulk population and density across the western United States grew rapidly (Figure 1). Suburban sprawl emerged and communities expanded into what were previously wildlands that rely on wildfire as vital parts of their ecosystems. Building codes and ordinances have long been established to mandate the use of materials and building design elements that reduce fire spread in commercial urban areas. However, the implications for residential single-family construction and its relation to exterior ignitions from wildfires had not been considered. Wood frame construction dominated this construction type, as it still does today. Cladding elements, such as siding and roof cover materials, had little fire resistance. Residential building codes centered around internal fire risks and improving life safety provisions. However, those residential building codes did not explicitly address external ignition sources such as wildfire and its associated ignition mechanisms on the exterior of a structure (ember attack, radiant heat, and direct flame contact).

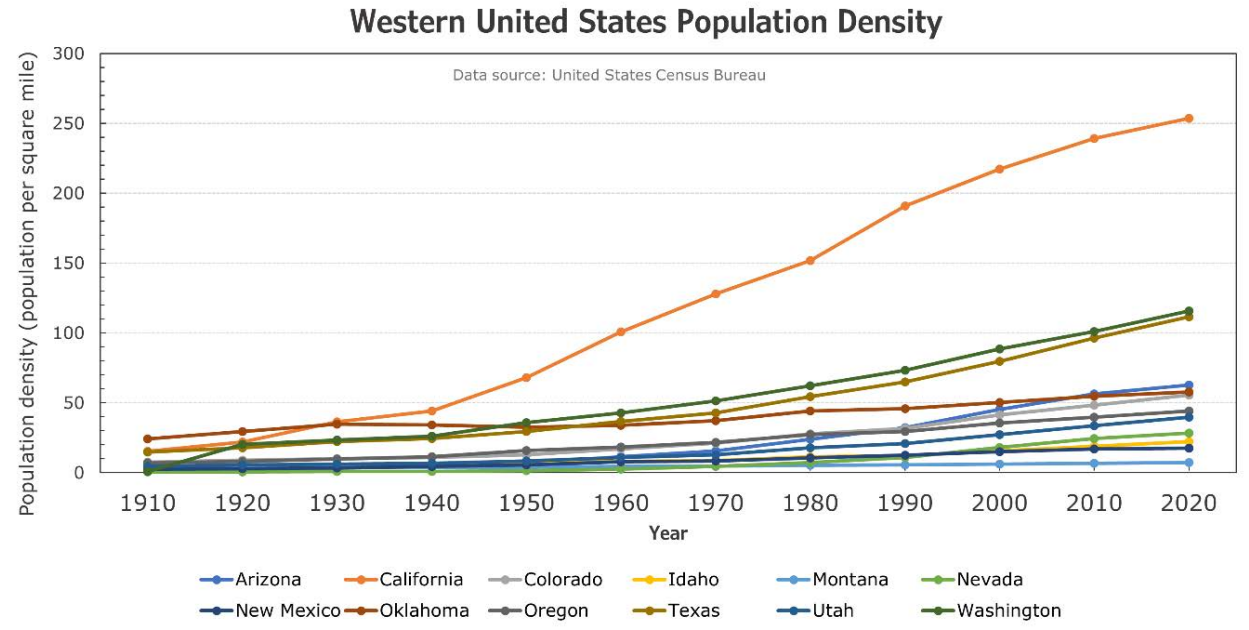


Figure 1: Time history of population density across thirteen western US states. Data source: US Census Bureau

Over the span of 13 days in 1970, an outbreak of fires occurred across Southern California during a strong Santa Anna wind event. These fires burned over 500,000 acres and destroyed 722 homes. From a structural damage perspective, the Laguna Fire was the most damaging, with 384 homes destroyed. Fire moved into the outermost residential areas of El Cajon. At the time, fire resources were stretched thin because of the sizable number of active fires at the time across Southern California. Like the Marshall Fire in 2021, airborne resources were also unavailable early in the lifespan of the Laguna Fire due to the high winds.

In the aftermath of these fires, changes were made in emergency management practices, and the post-fire investigations revealed both positive and negative outcomes related to defensible space and vulnerable roof cover materials. The widespread use of wood-shake shingle roofs in this region at the time proved to be a critical and overlooked vulnerability. Roofs were ignited by embers far away from the fire front, beginning the chain of built environment conflagration.

Unfortunately, the Laguna Fire would foreshadow what was to come in the first two decades of the twenty-first century. In the years that followed that event, the concept of the Wildland-Urban Interface (WUI) took shape, the definition of which focused on the area where wildland vegetation meets human settlement[5]. In 1987, the WUI concept was first included in policy-level discussions and became a focus of US Forest Service research. However, the threat posed by construction in WUI areas was not recognized in the National Fire Plan until 2000. Coincidentally, it was at this time that the potential impact of climate change on wildfire activity was introduced to the public policy realm[5].

Despite an increasing trend in acres burned by wildfire and an increase in human-caused ignitions during the 1970s and 1980s, the average number of structures destroyed in the most extreme fires stayed below 1,000. Wildfire as a catalyst for built environment

conflagrations had not materialized, despite the scientific awareness of the risk through an improved understanding of WUI fires. Residential development continued its reach into the wildlands by putting large numbers of structures with little to no fire-resistant exterior materials close together. Building codes and the testing standards that underlie them were lagging the growing risk. The elements of urban conflagration of past centuries were now aligned in suburbia.

The wildfire hazard combined with the vulnerability of the suburban environment to fire manifested itself on October 20, 1991, in the hills above Oakland, California. The Tunnel Fire (also known as the Oakland Hills Fire) was perhaps the first modern era example of wildfire acting as the mechanism to start a catastrophic built environment conflagration. Five years of persistent drought created volatile vegetative fuels. A significant diablo downsloping wind event developed accompanied by extreme heat. The fire started initially on October 19th near the Caldecott Tunnel. The fire was near a moderately dense built environment connected by dense vegetative fuels, spread across complex terrain. Despite nearby fire resources, high winds and ember transport led to rapid spot-fire ignitions, including on wood-shake roofs of nearby homes. The event quickly grew out of control[6].

The speed at which suburban conflagration can unfold was observed as fire entered the Hiller Highlands Development. **All homes in this neighborhood were ignited within 16 minutes** and all were destroyed[7]. Despite the fire's relatively small size (1,600 acres burned), it destroyed 3,354 single family homes and 456 apartment units and became the first billion-dollar wildfire disaster in the United States[8].

Over the next three decades, wildfires entering the urban interface and wildfire acting as a catalyst for built environment conflagration would repeatedly play out (see Table 1). In 1991, the very first WUI specific building code was adopted in Australia to combat a similar problem of vulnerable suburban construction. As previously mentioned, the Tunnel Fire spurred updates to building codes specifically on the use of noncombustible roofing materials but a true WUI code would not emerge in the United States until the first edition of the International Code Council's IWUI code in 2001. Although modern WUI codes have been proven to reduce the potential for a structure to ignite in traditional WUI areas, there remain some questions about their ability to substantially reduce the probability of a conflagration when fire enters a community (see "Code Gaps" on page 8).

Table 1. List of fires (not exhaustive) in which notable WUI fire and suburban built environment conflagrations occurred 1990–2022.

Year	Fire Incident	Location	Cause - Source	Residential structures destroyed (approx.)
1990	Painted Cave	Santa Barbara, CA	Human - equipment use	479
1991	Tunnel Fire / Oakland Hills	Oakland, CA	Human – debris fire	3,354
1993	Laguna Hills / Old Topanga Fires	Laguna and Malibu, CA	Human - unknown	634
1998	Florida Fires	Flagler and Volusia Counties, FL	Natural - lightning	300
2000	Cerro Grande Fire	Los Alamos, NM	Human - escaped controlled burn	235
2002	Hayman Fire	Colorado Springs, CO	Human - campfire	600
2002	Rodeo-Chediski Fire	Coconino and Navajo Counties, AZ	Human - campfire	426
2003	Cedar Fire, Old Fire	Southern California	Human - campfire	3,640
2003	Aspen Fire	Summerhaven, AZ	Human - cigarette	340
2007	Angora Fire	Lake Tahoe, CA	Human - campfire	245
2007	Witch Creek Fire	San Diego County, CA	Human - powerlines	1,265
2007	Harris Fire	San Diego County, CA	*Unknown*	257
2011	Bastrop County Complex	Bastrop, TX	Human - powerlines	476
2012	Waldo Canyon Fire	Colorado Springs, CO	Human - unknown	346
2013	Black Forest Fire	Black Forest, CO	Human - unknown	511
2014	Carlton Complex	Okanogan County, WA	Natural - lightning	300
2016	Chimney Tops 2 Fire	Gatlinburg, TN	Human - juveniles	2,460
2017	Tubbs Fire	Napa and Sonoma Counties, CA	Human - electrical	4,661
2017	Nuns Fire	Sonoma County, CA	Human - powerlines	642
2017	Redwood Fire	Mendocino County, CA	Human - powerlines	313
2017	Thomas Fire	Ventura and Santa Barbara, CA	Human - powerlines	792
2018	Camp Fire	Paradise, CA	Human - powerlines	13,696

Year	Fire Incident	Location	Cause - Source	Residential structures destroyed (approx.)
2018	Carr Fire	Shasta and Trinity Counties, CA	Human - vehicle	1,084
2018	Woolsey Fire	Los Angeles/Ventura Counties, CA	Human - powerlines	1,187
2020	Glass Fire	Napa and Sonoma Counties, CA	*Unknown*	642
2020	Almeda Drive Fire	Jackson County, OR	Human - arson	2,500
2020	Santiam Fire	Clackamas, Marion, Linn and Jefferson Counties, OR	Human - powerlines	1,500+
2020	Cameron Peak Fire	Larimer and Jackson Counties, CO	Human - unknown	469
2020	East Troublesome Fire	Grand County, CO	Human - unknown	580
2021	Marshall Fire	Louisville and Superior, CO	Human - unknown	1,036
2022	Calf Canyon / Hermits Peak Fire	San Miguel, Mora and Taos Counties, NM	Human - escaped controlled burn	1,000+
2023	Lahaina Fire	Lahaina, Maui, HI	*Under Investigation*	2,200+

Code Gaps

A well-defined ignition-resistant construction method can offer adequate protection against exposure to embers and flames. Some WUI codes focus on structures purely located in traditional WUI areas. Their design criteria are based on access to water supply, defensible space conditions, vegetation, topography, and critical fire weather frequency. These are the main parameters that influence the broad level of wildfire risk but do not account for factors such as structure density that may play a greater role in the fire exposure for a given structure and the broader probability of conflagration scenarios. Construction material requirements (ignition-resistant and noncombustible) are defined and based on the anticipated fire hazard severity of the area the building is being constructed in.

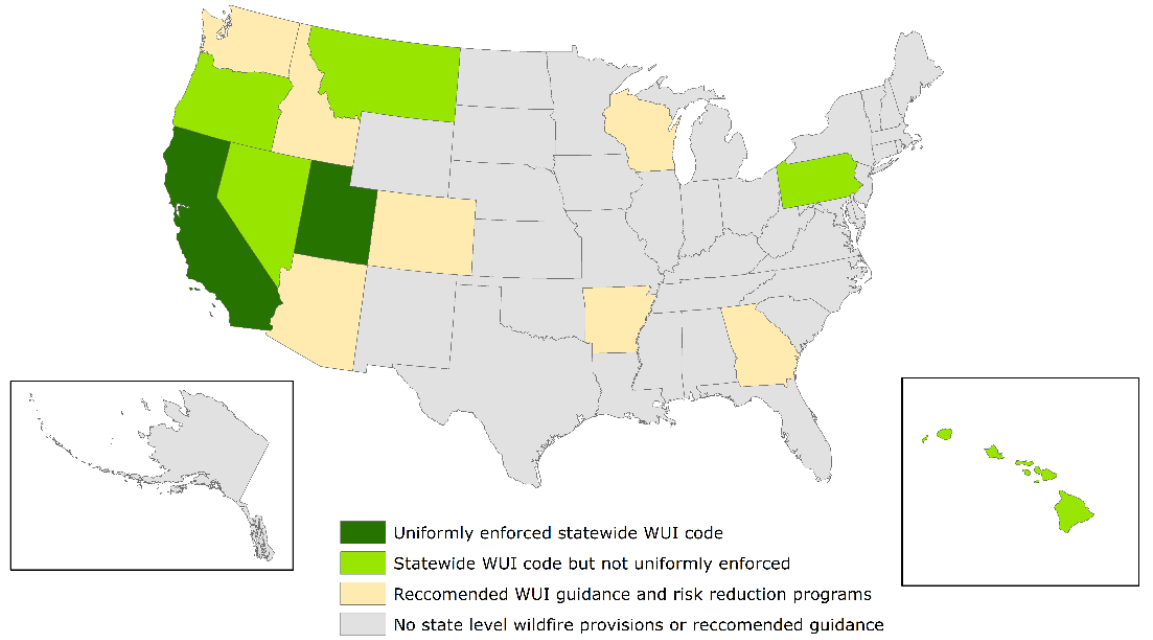


Figure 2. WUI code adoption in the US

Unfortunately, there are some obstacles and gaps with some of the provisions of the current codes that could reduce the applicability and their performance. The first is the reliance on active mitigation systems such as interior or exterior sprinkler systems. Interior sprinkler system requirements fall under the IRC and IBC, whereas the usefulness of exterior sprinkler systems is still in question. The probability of having a consistent water and electrical power supply at the time of an event is questionable. There are also concerns about the effectiveness of the systems as water droplets can be easily dispersed in high winds, effectively reducing their ability to cover the area's most susceptible to ember attack.

Considering the dynamic nature of these events and the potential scope, it does not seem wise to lean on active fire protection systems the way that the current codes, specifically the IBC do today. Also, there is an inconsistency in the level of fire protection provided by different solutions even within one risk level. The different prescriptive solutions provided for each building element do not provide the same level of resistance. One of the biggest gaps that exists in current WUI codes relates to fire impingement and spread on, or within, a building component or assembly, such as a wall or roof system. Fire performance of a wall assembly addresses fire impinging on the surface of the wall, stability of the assembly and its insulation. This is dealt with in the current IBC/IRC but typically not in WUI codes. While flame spread addresses the fire spread behavior on the surface of the exposed assembly. The model residential and commercial codes (IRC and IBC) provide requirements addressing these two parameters (flame impingement and flame spread) based on fire separation distance in dense settings to overcome interior fire hazards and conflagration.

The WUI codes do not consider such requirements, leaving a major gap if a built environment conflagration scenario begins to unfold. There is also a need for new test standards to address both external ignition potential of wall materials and fire spread through wall systems, as well as other materials and assemblies used in residential and commercial construction.

Built Environment Conflagration: The Common Threads

There are striking similarities between urban conflagrations of the past and the modern era of wildfire-driven suburban conflagration. There are four elements that all conflagrations share:

- They are typically preceded by or occur during drought conditions.
- They include densely packed structures with combustible exterior and framing materials.
- Weather conditions with winds of at least 20–30 mph.
- Fuels that connect the dense structures together, providing a pathway of fire.

Connective fuels increase the probability that fire spreads from structure-to-structure and the rate at which it happens. In the 18th and 19th centuries these connective fuels were often temporary dwellings, shelters, or shanties that sprung up between larger buildings within small alleyways. In the modern era, connective fuels are represented by typical elements of suburban landscaping, ornamental vegetation, wooden privacy fences, sheds, playhouses, etc. These are sometimes also referred to as part of the ladder fuel category. Lastly, built environment conflagrations take place when these factors meet humans with ignition sources. Today, over 90% of wildfires are started by humans, and as the built environment and its infrastructure grows outward into the wildlands the probability of ignitions near or within our neighborhoods also increases[9].

One of the critical differences between the built environment conflagrations of the 18th, 19th and early 20th centuries and wildfire-driven conflagrations is the source. For urban conflagrations, events typically began as a point source fire. A single or a small number of structures were ignited, and fire then spread from structure-to-structure. By improving building design for fire, the interior spread rates were slowed, not only allowing for evacuations from the burning structure, but also containing the fire and allowing time for fire response. Improved construction practices, many of which were codified, coupled with improved fire response capabilities helped contain fires in urban centers. While fires certainly still occur in urban areas, conflagrations have nearly been eliminated in this environment. It is one of the earliest success stories of how building codes can leverage technological advances and be effectively employed as a mitigation tool.

Wildfire, spreading under high wind conditions through volatile fuels, presents a different challenge relative to urban fires. The wildfire environment can stretch emergency response capabilities in a situation that is already challenging in its dynamic nature and scale. The combination of an active wildfire and a built environment conflagration can be too dangerous for direct fire suppression tactics, especially in such situations where weather conditions are so extreme that aerial fire suppression resources cannot be used in coordination with ground

resources. Fire can spread uncontrolled both through the suburban and wildland environments. To slow fire spread neighborhoods must function as fuel breaks rather than fuel sources. Primarily, they must resist ember attacks as wildfire approaches. Then the structures and the space between must also serve to break the chain of fire spread through flame contact and radiant heat. Unfortunately, the lessons of past conflagrations in urban settings have not been applied to our residential neighborhoods in materials and design. In addition, the population moving into WUI areas has grown 41% between 1990 and 2010[10]. **Today nearly one-third of all Americans live in areas that could be considered part of the Wildland Urban Interface**[11].

Marshall Fire Case Study

A recent example of a wildland fire acting as the initiating mechanism for a suburban conflagration occurred on December 30, 2021, in Boulder County, Colorado: the Marshall Fire. Its cause remains under investigation at the time of this report but the spread of fire through the extremely dry grasslands between Superior and Louisville was the initiating mechanism for a suburban conflagration. Extreme drought conditions were in place across much of Colorado, with the six-month period before the fire being one of the warmest and driest on record in Denver. However, preceding the drought was a three-month wet period that supported rapid and high growth of prairie grasses. A very severe down sloping high wind event that created significant turbulence across the foothills of the Rockies prevented the use of aerial fire suppression resources to control the fire. Wind gusts over 90 mph were common across the foothills.

The Marshall Fire started near the Marshall Mesa Trailhead between Boulder and Superior, approximately 2.5 miles from where the first structures were ignited. The area where the fire began allowed it to spread and impact two communities at nearly the same time (Superior and Louisville). The proximity where the fire began to vulnerable high-density construction aided in starting the chain of events that led to a built environment conflagration. Within an hour, the first structure ignitions were ongoing in both towns. By the time the event ended, 1,036 residential structures, 9 apartment buildings, and 11 commercial structures were destroyed.

The event contained different examples of how the factors that influence built environment conflagration can align in different combinations but yield the same catastrophic outcome. Consider the suburban neighborhoods of Louisville, Colorado near McCaslin Boulevard shown in Figure 3.



Figure 3. Damage from the Marshall Fire near McCaslin Boulevard in Louisville, Colorado.

This area experienced a built environment conflagration with more than 200 single family homes destroyed. The mean home-to-home spacing distance was approximately 30 feet. Most homes likely featured a Class A asphalt shingle roof (sporadic wood shake and concrete tile roofs were also present but not dominant). However, nearly all had some degree of combustible wall cover. The connective link between structures, at a relatively large suburban spacing (30 ft), was vegetative coverage. The total vegetative areal coverage (canopy and identified ornamental vegetation) between homes averaged approximately 60%. This vegetation coverage was combined with wood privacy fences that physically connected nearly 70% of the homes in this neighborhood.

To the south of this area, the Sagamore neighborhood along the western side of Superior, was also destroyed. These homes were tightly clustered, with an average separation of less than 9 feet. Experimental testing at IBHS has shown that at this spacing, without fire service intervention, ignition is nearly guaranteed if a neighboring structure ignites. All homes had asphalt shingle roofs, but other exterior combustible elements were identified from pre-fire street level imagery. The vegetation coverage on each parcel was approximately 55% but over 90% were physically connected to their neighbors by wooden privacy fences.

West of the Sagamore neighborhood, there was a smaller section of houses that were bisected by Spring Drive. This area was characterized by larger homes with larger parcel sizes. Variable home-to-home spacing was observed, ranging from 25 feet at the closest distance, to nearly 80 feet at the maximum distance. Homes typically had asphalt shingle or concrete tile noncombustible roofs. Wall covers were typically stucco or stone veneer. Most homes had elements that could be considered as "home hardening" measures. The mean parcel level vegetation coverage was below 50%. Yet, despite these factors only 13 of the 57 homes survived.

One major vulnerability at the parcel level was present. Dense vegetation within the 0- to 5-foot home ignition zone was observed on nearly all homes. In addition, the native grassland was interconnected within the neighborhood with no fuel breaks. This likely brought significant radiant heat and direct flame into the 0- to 5-foot home ignition zone of the first structure that ignited. At that point, extreme flame and radiant heat exposure overwhelmed the hardening elements that were present and/or exploited other vulnerabilities, such as vents, combustible soffit material etc. After the initial structure ignited, embers likely cascaded downwind, igniting subsequent homes. Of note was a significant percentage of the vegetation in the area 10 to 50 ft from destroyed homes was still present, indicating a lack of surface fire progression and the presence of ember-driven ignitions. Once the first home ignited in this area, embers produced by structural fuels became the dominant mechanism for fire spread.

The Marshall Fire is a reminder of the multiple ways in which a suburban conflagration can unfold. It clearly illuminates how community scale protections must work as a system to defend against wildfire as a single weak link can begin the cascade to catastrophe.

The Chain of Suburban Conflagration

The variables that lead to a suburban conflagration can be conceptually viewed as a matrix of interconnected and aligned factors; many of which are inherent to the environment both surrounding and within a community. In simplistic form, wildfire-driven built environment conflagration potential is tied to the characteristics of the natural environment, such as the topography, regional climate, local weather conditions, and natural vegetative fuels. It also is coupled with the proximity to the built environment and its characteristics. Built environment wildfire-driven conflagration follows the conceptual WUI fire chain of events described in detail by Cohen (2008)[12] and illustrated in Figure 4.

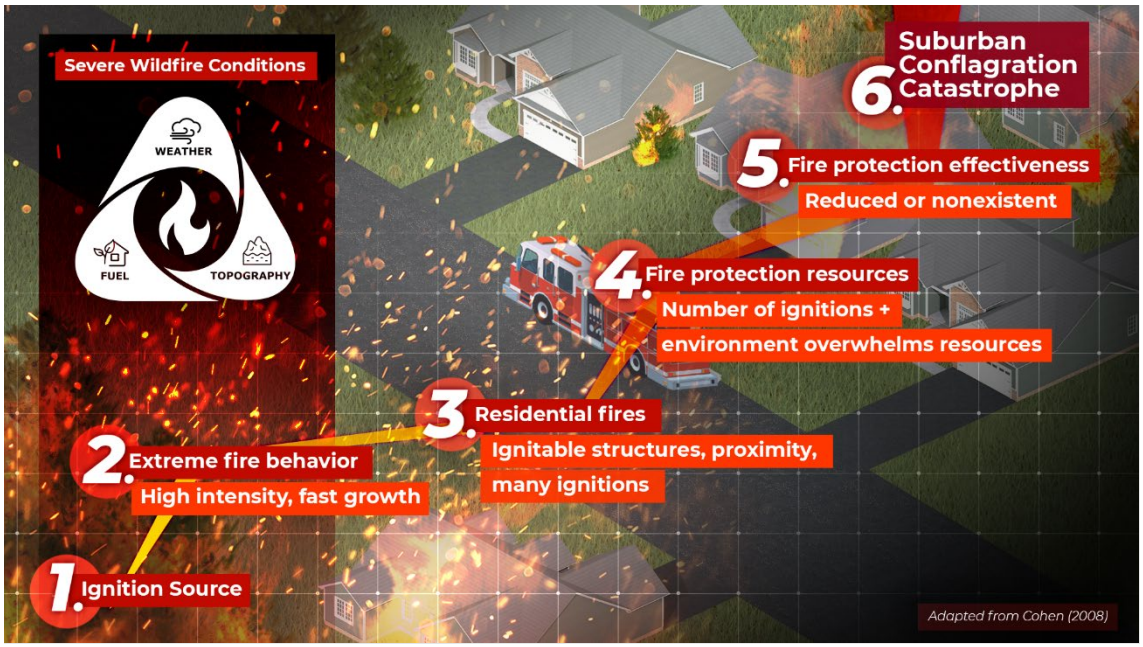


Figure 4: Wildland Urban Interface disaster conceptual chain of events. Adapted from Cohen (2008).

Within this sequence of events, there are three main categories of variables with many sub-categories that ultimately dictate the probability distribution in which a conflagration scenario is unlikely, possible, or highly likely if a wildfire invades a given community. They are listed in Table 2 while Table 3 provides the sub-sets of variables which could be mitigated for or controlled at a community level.

The natural environment consists of topography, climate, local weather, and fuel. All of which make up the wildfire behavior triangle. In the context of built environment conflagration, the structures are intertwined with the natural environmental variables, especially fuels and topography. The critical linkages in the progression from an intense wildfire and a built environment conflagration disaster lie here.

Table 2. Contributing Factors

Natural Environment	The Built Environment	Humans
Topography	Structure density	Preparedness and mitigation
Climatology	Building materials	Ignition sources
Local Weather	Connective fuels	Fire service intervention
Wildland Fuels	Infrastructure	

Table 3. Controllable Factors within a Community

Parcel level mitigation actions
Distribution and density of ladder and connective fuels
Building codes, ordinances, HOA covenants
Vegetative fuel types
Fuel or Fire breaks
Existing or in-place preparedness programs

The Natural Environment

Long term climate cycles, localized weather conditions and geography are factors that can increase the risk of wildfires.

Climate

The global circulation that gives rise to Earth's climate is the reason some parts of the world are more prone to fire than others. It is what governs plant species, their density, how they reproduce, and how they have adapted to fire. It is also important to note that fire is a critical part of many ecosystems. Global climates that are prone to wildfire can be identified using both the standard climate classification systems (Köppen-Geiger) and by including additional elements that make regions more prone to fire (such as, thunderstorm frequency, temperature fluctuations, wind climate etc.)[13] The expansion of the built environment into these ecosystems has raised the probability of a conflagration by aligning the factors necessary for a catastrophe but also increasing the probability of human-driven ignitions within areas already prone to fire.[14]

Historically, the urban conflagrations of the past occurred in regions that were not necessarily climatologically prone to wildfires. In the modern era, climate change has altered the fuel landscape through changing the patterns of precipitation and extreme heat, leading to prolonged droughts, and increasing the volatility of fuels. This is also changing the global spatiotemporal distribution of fire, increasing the hazard frequency, geographically expanding it into areas not accustomed to it, and lengthening the seasonality of fire. The two primary climatic means that effect wildfire is increased fuel flammability due to warmer and drier conditions and increases in fuel availability due to more rapid swings between wet and dry periods[15]. The impact of these factors on vegetative fuels is becoming well understood, their influence on the fuels of the built environment is less quantified; however, in nearly all the conflagrations in the past four centuries, fires were preceded by some period of drought. Climatic factors are certainly not the cause of built environment conflagrations but through their linkage to the frequency and severity of wildfires they do aid in increasing their probability.

There is no better example of the climate mechanisms that influence wildfire than the persistent drought conditions experienced across the Western United States from 2011–2022. Interspersed with a small number of wet years, the semi-permanent drought created the necessary large scale fuel conditions to support frequent and very intense wildfires. When these fires intersected with the built environment it produced losses that had not been experienced before. During this period, six notable conflagrations occurred in four western states, with wildfire acting as a catalyst. The two most destructive being the Camp Fire (2018) and the Tubbs Fire (2017).

However, when exploring all fires over this time frame, persistent drought was found to account for only approximately one-third of the variance associated with wildfire acreage burned. The result illustrates the cumulative effect and differences in temporal scales between climate and weather[16]. Drought certainly serves as a necessary ingredient for fire, both urban and wildland; however, the temporal scale on which it evolves may be of less importance when considering built environment conflagrations. The patterns of wet years quickly transitioning to dry years and how these cycles evolve with our changing climate will be critical to understanding how climate mechanisms will set the stage for future conflagrations to play out.

Weather

The local weather is one of the three primary natural factors: weather, topography and fuel, (Figure 5) that affect fire behavior and consequently the potential for a built environment conflagration to ensue. In the context of historical urban conflagrations, it was typically the favorable weather conditions for rapid fire spread combined with dense fuels that turned a single structure fire into a large-scale catastrophe. When exploring the impact of weather on conflagration potential several factors emerge:

- Seasonal trends in precipitation (i.e., weeks to months changes leading to short-term drought)
- Wind conditions
- Relative humidity
- Atmospheric instability and often the initial ignition such as lightning

All of which need to be aligned to produce conditions favorable for rapid fire development, extreme fire behavior, and rapid spread.

Potter and McEvoy (2021) were able to explore all these factors, except atmospheric instability, and their effect on rapid fire spread of large wildfires. It was found that indices, including the widely used Fosberg Fire Weather Index (FFWI), that coupled both a measure of atmospheric moisture in the lowest 500 m with wind, were useful in determining the thresholds in which rapid fire growth is more likely[16]. However, the variance in growth rate is far more dependent on local elements of fuel, topography, complex wind flow characteristics, and diurnal cycles. In the United States, those conditions come together most frequently from the Rocky Mountains westward and are often associated with wind conditions flowing down large terrain features (for example, Santa Anna, Chinook or Foehn, and Diablo winds). As the

air flows downward over the sloping terrain it compresses, warms, and dries creating the conditions previously discussed.

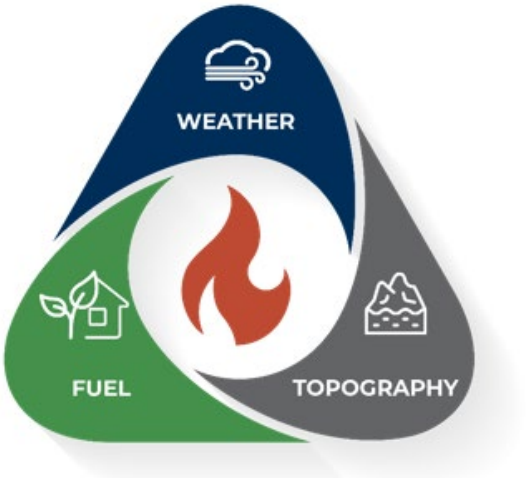


Figure 5: Fire behavior triangle.

The influence of atmospheric stability and its scales (both evolving in time and depth) is less understood. In general, the stability of the lowest few kilometers of the atmosphere plays a role in fire behavior, especially plume-driven wildfires. Broadly, it is understood that strong static stability helps temper fire behavior and is typically why extreme fire behavior is not common overnight as stability and relative humidity increases. For the most extreme plume-driven fires, the presence of strong atmospheric buoyancy (unstable conditions) can exacerbate plume growth leading to extreme updraft speeds within the plume, often accompanied by pyrocumulus clouds[17]. With improvements to observational and computational modeling capabilities, it has been found that in these extreme plume-driven fire events, plumes act like rotating supercell thunderstorms[18,19]. This leads to strong ground-level circulations, strong vertical motions, fire whirl activity, and extreme fire behavior as air rapidly spirals in towards the rotating plume helping feed more oxygen to the ongoing fire. The Carr Fire (2018) was perhaps the most extreme example, producing a large tornado-like vortex accompanied by EF-3 wind damage amidst burning structures.[20]. These fire-generated vortices have also been observed in urban fires as well[21].

Wind

The wind flow conditions both during pre-fire conditions and as a wildfire unfolds are a critical variable in nearly every aspect of the fire and its evolution. The general relationship between surface winds and wildfire behavior has been understood for over a century[22]. High winds and their interaction with complex terrain can drastically change fire behavior. This plays a substantial role at the time of ignition and as fire spreads into the WUI and suburban – exurban environments. In real-world scenarios, the strong updrafts associated with strong buoyant plumes can alter the local wind flow conditions. In situations with intense heating from the fire as it consumes a large volume of volatile fuels and a buoyant ambient airmass, updraft speeds can exceed 100 mph (45 ms^{-1})[20]. At the surface, strong convergence develops

in response to the rapidly rising air, and wind speeds increase quickly as air rushes inward toward the fire. For the purposes of exploring suburban or built environment conflagrations, we will focus on how wind flow affects building material ignition potential.

Since the 1960s, researchers have been contemplating the impact of wind on the ignition of building materials. From the fundamental perspective, ignition of a building from another nearby structure occurs when the local heating rate of a building component exceeds its cooling rate due to local air flow. When there is a slow or moderate air flow, localized flames around structures can intensify due to the increased oxygen supply. As flames grow, the wind stretches and tilts flames towards adjacent structures and increases the heating rate on exterior building materials on downwind structures. This, in turn, causes the materials nearby to start decomposing from radiative, convective, and conductive heat transfer mechanisms. Wind can also aid in mixing the flammable gases that are forced out of building materials or it can dilute pyrolysis gases enough to make them less-flammable. Even after ignition as the wind speed increases, the flow of air can help diffuse heated gases and cool the surface of the materials to stall fire growth or even extinguish it. The relationship between fire and the small-scale flow of air around structures can be complex, with some factors exacerbating fire spread and others helping to limit combustion.

Simms[23] and his personal correspondence with Law[24] noted that when wind was introduced to small-scale specimen, common building materials exposed to radiant heat demonstrated a complex reaction. Low wind flow on sample building materials decreased the minimum heat intensity required to produce spontaneous ignition. Flow velocities exceeding 2 mph (1 ms^{-1}) dispersed flammable gases and delayed ignition significantly. It was also shown that the time required to produce spontaneous ignition decreased as the material sample size increased. This highlights the gap between small-scale experiments and the reality of ignition process in the field. Hurley et al. (2015) stated that, "*…extrapolation to realistic scenarios and fire models has to be done with significant care*." [24]

For historical urban conflagrations since 1900, almost all were associated with wind gusts estimated at 20 to 30 mph, and higher[25]. There is minimal knowledge of the correlation of local wind speeds at the community level and the reported measurements. The response of the flame to wind is a function of the flame intensity itself. A well-developed flame is less likely to extinguish when it is exposed to wind. The response of building materials to wind, cooling effects and diluting the pyrolysis gases, has only been studied in small experiments[23,24,26]. This is an area where IBHS is committed to bridging the knowledge gap over the next 5 years.

Moisture and Relative Humidity

The moisture content of fuel has a significant impact on fire behavior in large outdoor fires. Fuel moisture content is strongly correlated with relative humidity, which is itself a function of atmospheric vapor pressure deficit. As the vapor pressure deficit is high, the atmosphere can hold a large amount of water, which results in a large moisture gradient between plants and the air, allowing for higher evaporation rates. Vapor pressure deficit controls several stages of fire, including ignition probabilities, initial spread rates, burn area, and extinction likelihood[27].

Both live and dead vegetation are consumed as fuels in a wildland fire, where the flammability of dead fuels is typically higher, due to lower moisture content, compared with

live fuel. The moisture content of the dead fuel is constantly changing due to the fact the only mechanism of exchanging moisture is through diffusion with the surrounding air. In other words, depending on the relative humidity, solar radiation and thermophysical properties of the dead fuel, the fuel can absorb or desorb moisture in different time scales[28]. These two processes happen at different rates; for woody particles, losing moisture happens faster than gaining it[29].

The same concepts apply to structural fuels, but the details and relationship between moisture content and ignitability are less understood due to their complex behavior. Structural fuels are often a combination of cellulosic and synthetic materials which respond differently when exposed to heat. Given that nearly all the urban conflagrations of the past were preceded by some degree of drought, the response of structural fuels to ambient moisture is clearly a factor. However, there have been only a few small-scale studies focused on understanding the effects of moisture content on ignitability of common building materials. While Moysey and Muir report that moisture content did not greatly affect time to ignition if the moisture content of samples were below 20%, Hedayati et al (2018) demonstrated that varying the moisture content between 5% and 15% affects time to ignition when the sample of structural fuel materials (both engineered and natural wood framing materials) were exposed to 20 kW m^{-2} radiative heat flux. At higher heat flux levels, moisture content played little or no role in the time to ignition.

Topography

The topography of a region interacts with weather conditions, fuel properties, and fire behavior feedback loops to influence fire spread. In combination, these factors influence fire spread rates, making it difficult to isolate the effects of topography[30]. The influence of terrain on a built environment conflagration is tied to the ignition potential of homes during the initial stages of an event, and its potential to slow or accelerate fire spread through a community. When applied, a slope that increases by 10 degrees generally leads to a twofold acceleration in the speed of a fire. If the slope measures 20 degrees, the fire could propagate four times faster compared to its spread on level terrain[31].

Both radiation and convection mechanisms are responsible for heating the fuel ahead. However, several studies have demonstrated that convective heat transfer becomes the dominant effect as the slope increases, particularly for slopes greater than 30 degrees. In the flame scale, flame attachment area increases with slope, causing increased heating of the fuel downstream. Flame attachment is due to the interaction of the buoyant plume of the flame, air drawn into the fire supplying the reaction with oxygen, and an incline. These factors push the flame toward the surface and result in both increased radiative and convective heat transfer to the surface and downstream fuels. It is known that convective heat transfer can extend further up the slope and dominate downstream heating effects, particularly in fine fuels[32].

Wind-induced flames exhibit similar fire behavior. In wind-induced fires, the attachment length increases due to external forces, unlike slope, which results from internal coupling of air coming into the fire and buoyant forces of the plume. In a non-aligned wind and slope

environment, the combined influence of wind (speed and direction) and sloping terrain is more complex, as their combined effects are not as simple as just vector sums[24].

Observation during wildfire suggest that topography affects the fires by:

- Changing the burning behavior itself because of the complex wind flow
- Altering the behavior of the plume above the fire[33]

Often in typical wildfires, terrain conditions are characterized as complex. By restricting intake from the sides, sloping canyons alter air entrainment by forcing most of the air intake to occur down-canyon which increases the fire spread rate and its intensity[24]. In general fire can behave explosively as it accelerates moving up a slope. The interaction between air flow and flame intensity was observed in IBHS's Camp Fire post-event investigation.

Despite similar uphill slopes for the buildings on the ridge top (Figure 6), the lateral changes in slope impacted the local flame intensity and resulting exposure to each structure on the ridge top. The house that survived probably had less flame exposure. In an idealized scenario, a home in a more vulnerable location due to local topography requires a higher level of mitigation elements to achieve the same level of protection as a home in a less vulnerable location, like the example shown in Figure 6.

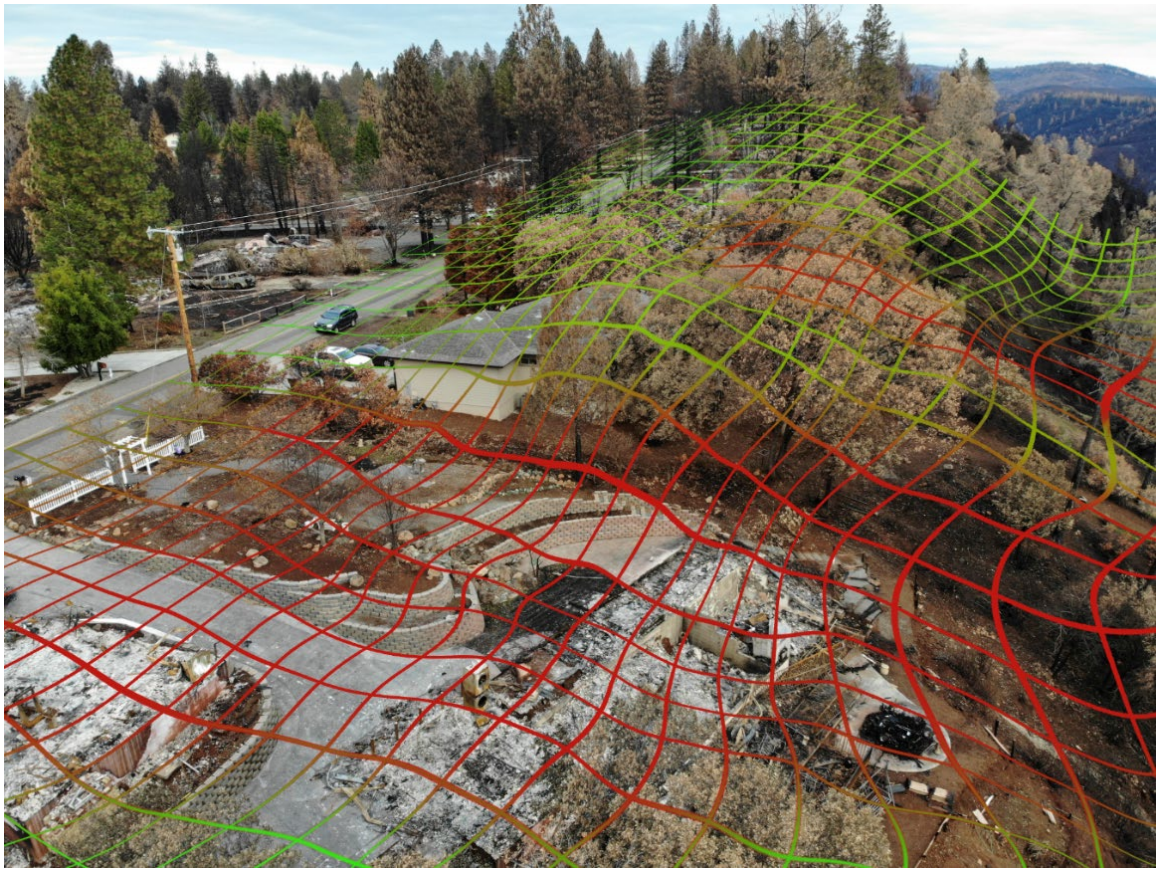


Figure 6: Drone photograph of structures that survived or were destroyed following the Camp Fire. The terrain slope is gridded and overlayed over the aerial photograph to illustrate the influence of the convex and concave nature of sloping terrain and its influence on fire spread.

Vegetative Wildland Fuels

The behavior of fire in wildland areas differs significantly from that in Wildland-Urban Interface (WUI) environments due to the complexities of the terrain and the variability in fuel types, such as their composition, height, density, and connectivity. Traditionally, wildland fuels were classified based on their ability to sustain the spread of flames. Ground fuels, comprising dead organic matter on the forest floor, can ignite and sustain slow-moving fires, typically smaller than 1 meter per minute. Surface fuels, consisting of live and dead vegetation above the ground, can sustain fire spread rates of up to 20 meters per minute. Canopy fuels, including large shrubs and trees, can sustain fire spread rates of up to 100 m per minute when ignited[28].

Each of these fuel types possesses various levels of flammability, encompassing four characteristics of wildland fuels:

- Ignitability
- Sustained ignition
- Consumable material
- Combustibility

Low-flammability vegetation is difficult to ignite, has a slow combustion process, and releases less energy, compared to other plants[34].

The accuracy of fire spread predictions relies heavily on the fuel characterization input in the model. Despite decades of research, there is no widely accepted fuel characterization that can be universally applied in models for predicting the spread of wildfires in wildland areas[35]. Different fire spread models have been developed to address specific needs and goals, often sacrificing accuracy to achieve their practical objectives in different as risk assessment programs[28,36].

Regardless of how the wildland fuels are characterized, the presence of abundant flammable wildland fuels, such as dry grass, shrubs, and trees, can provide continuous sources of fuel for wildfires resulting in rapid fire spread towards adjacent communities.

Extent and Size of the Fire Front Reaching a Community

The extent and size of the fire front, including ember cast, when it reaches an urban area has a substantial impact on the community's ability to respond to the fire. A fire that starts closer to a community will have a narrower fire front and ember-cast exposure toward the exposed community. Likewise, a fire that starts further away will have a larger fire front and ember cast exposure as it consumes more total fuel. In this scenario, a larger cross section or perhaps even the entire community is exposed to conditions more conducive for structure ignitions.

The second scenario presents a much bigger challenge for evacuations, life safety, structure defense actions, and fire suppression than the first scenario. As an example, the Camp Fire (2018) would have had a much different scenario if the fire had started closer to the Town of Paradise than where it did begin, approximately seven miles distant. The resulting fire front and ember transport downwind exposed the entire Town of Paradise to all three ignition

mechanisms (ember attack, direct flame contact, and radiant heat) complicating an effective response to the rapidly developing extreme fire conditions.

The Built Environment

There a several components of the built environment that can contribute to the risk of conflagration or, if effectively managed, reduce that risk.

Structure Density

The built environment, specifically where high-density construction built with little to no fire-resistant materials meet ignitions under volatile weather conditions, is where the catastrophes unfold. The link that must be broken to avoid catastrophe is fire spread between structures. The fuel load of a typical home is easily sufficient to produce a flame and radiant heat exposure on a nearby structure to ignite it, even with some degree of hardened or fire-resistant materials, especially in the presence of wind which helps stretch flame lengths.

Once a structure ignites directly or indirectly, the probability of complete destruction is high. As shown in Figure 7, data from California wildfires indicates the probability of a structure within a wildfire boundary being destroyed is above 75% for residential, multifamily, and commercial construction. As structures are consumed, they also become prolific ember producers allowing for all three ignition mechanisms (ember attack, radiant heat, and direct flame contact) to act simultaneously on neighboring structures.

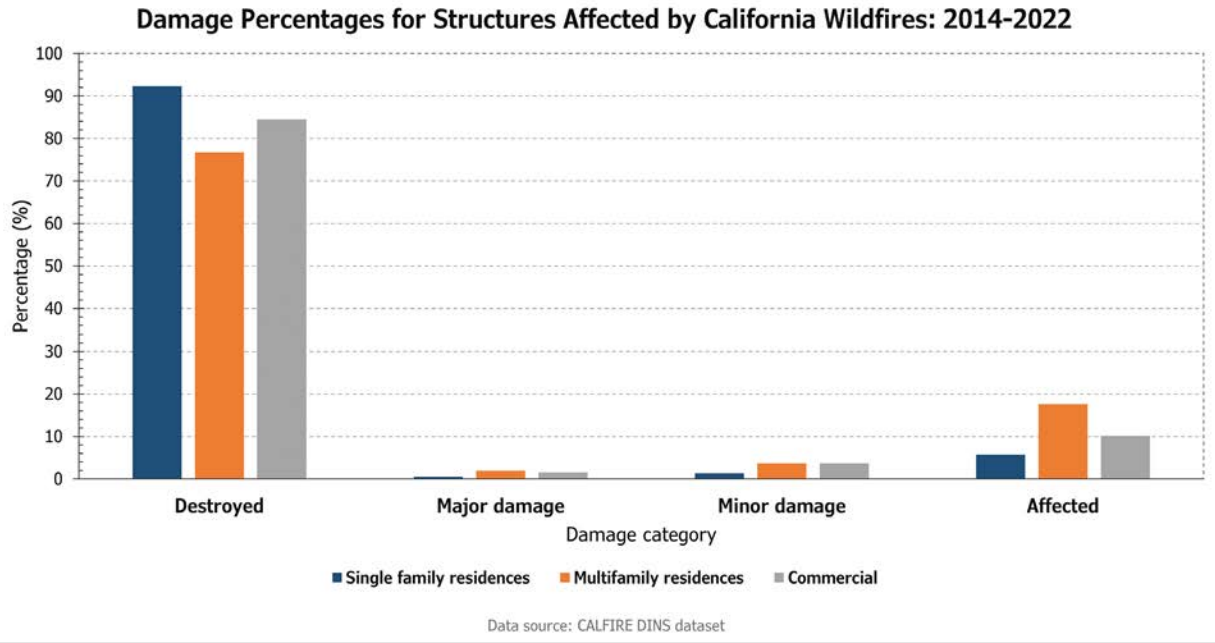


Figure 7: CAL FIRE damage inspection specialist (DINS) data for structures destroyed, those with major damage, minor damage, and marginally affected by California wildfires from 2014–2022.

Structure-to-Structure Fire Spread

Once structures are ignited in a community, the risk to the rest of the community increases as burning structures produce significant heat and embers. Field observations show that under normal to above average fire intensity, areas with lower density housing experience more

loss. However, under the most extreme burning conditions, which are associated with costly wildfires in the WUI, more buildings burn in high density neighborhoods. This is associated with the limitations and risks for first responders to suppress the high intensity fires. It is much easier to defend homes under non-extreme fire conditions when the homes are close together, taking fewer firefighting resources to do so. Under extreme fire behavior conditions, structure defense becomes much more difficult due to the concern for life safety of firefighters and the public.

Most buildings are not designed to resist intense flame impingement, and once ignited, they contribute as additional fuel to the fire. Therefore, to stall this "domino effect," maintaining a proper separation between buildings is crucial in a resilient community. There have been a few experimental studies regarding fire spread between buildings, most of which have been based on radiation from flames jetting out through openings following an internal fire. McGuire[37] developed a theoretical model that calculates building separation based on the size of the buildings and the opening percentages. McGuire's calculations are based on the ratio of the radiant intensity at the receiving surface to that at the (one or more) radiating surfaces. The calculations provide an estimate of the threshold for flame spread between buildings.

However, during wildfires, the entire structure could be engulfed in flames. A structure engulfed in flames ignited from the exterior behaves differently than an internal fire with flames jetting from an opening. These differences resulted in different exposures to surrounding structures. There is little research on building-to-building fire spread, especially under windy conditions.

Extreme wildfires almost always occur during periods of high winds and dry weather. High wind speeds cause the flames to stretch and tilt towards neighboring structures. Convective heat transfer will cause ignition only if the temperature of the gas stream is several hundred degrees Celsius, which only happens very close to the flames. The geometry of the flames depends on the wind speed and relative location and orientation of the two buildings[38,39].

Connective Fuels

Several factors affect the intensity of a fire, including the type, arrangement, amount, and moisture content of the fuel. Fine fuels like grass and pine needles tend to ignite and burn quickly, producing high-intensity fires and contributing significantly to the initial stage of the fire spread. On the other hand, larger fuels such as logs or standing trees may burn more slowly but can contribute to higher heat release and longer-lasting fires. Additionally, the arrangement and continuity of fuel can affect the fire's ability to spread, influencing the intensity of the flames. The arrangement and distribution of fuel, both vertically and horizontally, is referred to as fuel continuity[40].

This continuity or connectivity describes the degree to which fuels are interconnected to provide a continuous path for fire to spread. In terms of fire behavior, fuel continuity plays a significant role in determining the rate and intensity of fire spread. High fuel continuity, where fuels are densely distributed and interconnected, can promote the rapid spread of fire, as flames can easily propagate from one fuel source to another. In general, live vegetation exhibits gaps between needles, shrubs, or trees, and clumps of them, arguing that

understanding continuity of fuels is critical for fire suppression and fuel management. Even at small scales, the separation between fuel particles has been shown to create critical conditions for fire spread on both natural and artificial fuel beds.[41,42,43,44,45] This concept of critical conditions or thresholds also applies to larger scales, where discontinuity occurs between plants rather than individual particles.[46,47,48] In either case, the fire spread threshold is determined by fuel characteristics and environmental factors such as wind, slope, and fuel moisture content.

Over the past few years, IBHS has collaborated with the United States Forest Service (USFS) to investigate and identify the critical physical processes that drive ignition, considering the spatial distribution of fuel and a range of environmental conditions. As a result of this collaborative effort, valuable insights have been gained, particularly regarding the threshold separation distance between pine needle fuel beds for continuous flame spread under various wind conditions. As can be seen in Figure 8, the findings have demonstrated that the separation distance required for sustained flame spread varies depending on wind speed and moisture content conditions. Understanding this threshold separation distance is crucial for effectively predicting fire behavior and implementing appropriate fire management strategies.

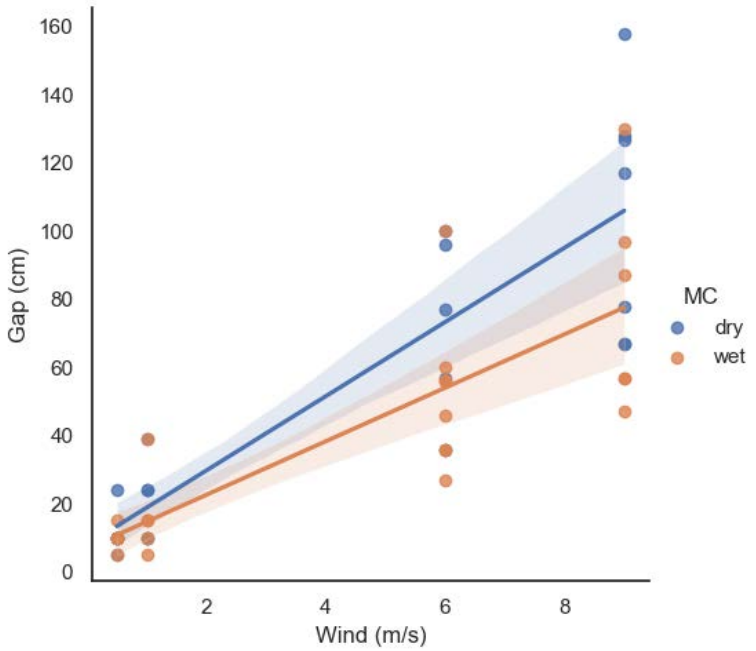


Figure 8: Maximum separation distance required for sustaining flame spread. Fuel break gap distances shown as a function of wind speed for fine fuels at two different moisture content levels at the IBHS Research Center.

The concept of fuel connectivity observed in vegetation fuels can also be extended to structural fuels such as fences, sheds, accessory dwelling units (commonly referred to as ADUs), and other similar objects. The underlying mechanism driving fire spread remains the same: when these structural fuels are closely spaced or connected, heat transfer between burned and unburned particles occurs at a high rate, leading to rapid fire spread.

Understanding the role of fuel connectivity in structural fuels is essential for assessing fire risk and implementing appropriate fire mitigation strategies. It emphasizes the importance of maintaining adequate spacing and reducing fuel continuity to minimize the potential for fire spread and mitigate the risks associated with structural fires.



Figure 9: Examples of structural fuel connectivity and the role in damaging the main building in a parcel during the Glass Fire. A combustible fence (A and B) supported flaming ignition, moving from downhill all the way to the main building, and caused severe damage (C and D). A and B are annotated with arrows representing the estimated direction of fire spread.

In the case of nonhomogeneous fuel, such as a mixture of different structural and vegetative fuels, details of the fire spread mechanisms are not yet well understood due to the interactions and complexities arising from the combination of different type of fuels. When low density fuels such as leaves meet larger fuels, such as building components, in general qualitative observations suggest a more rapid rate of fire growth. This fuel configuration can create a vertical fuel ladder that allows the fire to jump from the ground and engulf different building components in flames[49].

According to post-fire investigations, discontinuities between trees, bushes and structures can reduce the threat of tall, thick, high-intensity flames, which are strongly correlated with building damage. An analysis of Ramsay's[50] post-Ash Wednesday bushfire damage in Australia found that damage to homes was affected by the amount and type of vegetation around them. Dense vegetation around houses aided in connecting the fire to other nearby homes, making it less likely they would survive. During the Witch Creek Fire (2007), when evaluating the vegetation within the first 30 feet of houses in San Diego County, California, Maranghides et al[51] found that 67% of homes with unmaintained vegetation were destroyed, whereas only 32% of homes with maintained defensible spaces were destroyed. The importance of fuel discontinuity was found to be more important near buildings. Syphard et

al.[52], after analyzing more than 2,000 structures in San Diego County, concluded that those structures with defensible space that contained spaced vegetative fuels "immediately adjacent" survived more fires. Additionally, Syphard et. al. also found that reducing woody vegetation by up to 40% immediately adjacent to structures and preventing vegetation from overhanging or touching structures were the most effective measures.

A fence or deck attached to the house can also facilitate the spread of fire or radiate enough heat to ignite the building cladding. Post event investigations and laboratory experiments show that these components, especially if they are in the vicinity or in contact with vegetation, can ignite the main building.



Figure 10. Testing deck vulnerability to embers at the IBHS Research Center. IBHS and others have conducted extensive testing regarding the vulnerability of decks[53] and fences.[54]

Response and Infrastructure

The United States has a long history of wildfire suppression for the protection of natural resources and defending against suburban conflagration. The combination of improved fire response capabilities and building codes requiring more fire-resistant materials in urban commercial construction solved the problem of urban conflagration.

Fire Service Response

Wildfire acting as the catalyst for suburban conflagration has significant differences from a fire in an urban setting. Figure 11 illustrates the complex fuel environment that fire services face in the suburban environment. The modern wildland fire service has evolved over time to become a complex coordination of emergency response agencies and fire suppression resources. Increases in technology, firefighting equipment capabilities, firefighter staffing levels, and training among other things have increased the overall effectiveness of emergency response, structure defense, and wildfire suppression.



Figure 11: Firefighters defend a structure from wildfire and the urban fuels (fences, couches, etc.) that create pathways for the fire to reach the home, leading to structural loss. Source: CAL FIRE

The California Department of Forestry and Fire Protection (CAL FIRE) strives to and is successful at containing 95% of all wildfires within its authority at 10 acres or less. Data suggests that 90 to 95 percent of all structures damaged during wildfires are defended, primarily by fire suppression resources.[55] [56]

The priority order for emergency response resource actions during a wildfire is the preservation of life, property, and natural resources. With the increase in fire severity in today's fire environment, many fire suppression resources will be used to preserve the public's safety rather than providing structure defense and direct fire suppression. Additionally, the number of structures threatened by a wildfire will generally outnumber the available fire suppression resources. Because of this, fire suppression resources can not be expected to defend every structure threatened by wildfire, especially in a built environment conflagration scenario.

Infrastructure as an Aid to Fire Response

Having adequate road infrastructure in place prior to a fire is key to the efficient and timely evacuation of the public from the fire's path and for access by emergency responders. Surface, width, grade, turnouts, turnarounds, signage, bridges, and gates are key components of the road infrastructure. Conversely, limited, and narrow evacuation routes do not allow for simultaneous use by evacuating citizens and emergency responders, leading to traffic gridlock and potential life-threatening burn over situations. These situations require a large focus from emergency responders in assisting with the evacuation process for life safety, which slows access by emergency response resources to suppress spot fires and slow the overall fire spread.

One of the primary methods used by firefighters for fire suppression and structure defense is the use of water to cool the fire. The ability of a water supply system to deliver water to firefighters when needed can be degraded by an aging infrastructure, the infrastructure

being directly impacted by the fire, loss of electrical power, and being overtaxed by firefighting operations. The loss of the water supply system will hinder fire suppression operations and has occurred on several notable wildfires including the Camp Fire[57].

Several communication systems, tools, and methods are used to deliver timely and accurate fire information and evacuation notices (warnings and orders) to the public. Combinations of different evacuation tools and methods are needed to deliver this information because no single notification method will reach everyone within the affected area. The increased reliance on cell phones as the primary source for information makes them a crucial tool for notifications via news outlets, social media, and the Wireless Emergency Alert system.

However, cell phones rely on cell towers and electrical power to work. We have seen several wildfires (such as the Tubbs [2017] and Camp [2018] Fires), where fire damage rendered the cellular network inoperable in the area where the information was needed the most. This significantly hindered the timely delivery of critical life safety information to the public and altered the dynamics of the evacuation and response efforts.

Infrastructure as an Ignition Source

Wildfires can be caused naturally by lightning or by human activity like campfires, debris burning, arson, equipment use, fireworks, and powerlines. Nationally, approximately 90% of all wildfires are caused by human activity. The presence of infrastructure whether it is roads, powerlines, structures, etc. increases ignition potential under the critical conditions previously discussed. Of the fires listed in Table 1, ten were caused by things connected to human infrastructure.



Figure 12: Electrical utility infrastructure that fell in the roadways in Paradise, CA during the Camp Fire in 2018, hindering the evacuation of residents from the Town of Paradise. Photographs courtesy of CAL FIRE.

The electric utility infrastructure is of particular importance as it can cause the ignition of a wildfire and significantly impact the evacuation of a community from a fire. The percentage of powerline caused wildfires in California averages 10% per year, with 63% of those fires being caused by contact with an object like vegetation, animals, or vehicles[58]. However, the percentage of power-line-caused fires significantly increases during high wind events due to contact with vegetation and *line slap* or *galloping*. The wind engineering community has studied the galloping failures of power lines in various high wind conditions, including

extreme hurricane winds and winter weather. This led to solutions that have been slowly integrated across the hurricane-prone coasts of the United States but rarely elsewhere.

The second problem is the maintenance of vegetation along electric power distribution infrastructure. Tree limbs can easily fall on power lines in winds that would not typically cause damage to the lines themselves. Unfortunately, the vulnerability of this infrastructure has created a recipe for larger fires and built environment conflagrations as these ignition sources are typically closer to WUI communities. Eight of the top twenty most destructive wildfires in California were caused by power lines, resulting in 32,427 structures being destroyed[46].

Human Factors

In addition to the natural factors, human presence plays a significant role in igniting and suppressing WUI fires. Most wildfires are directly or indirectly caused by humans and historically many of the conflagrations of the past few centuries were also a result of human actions. Firefighting activities at various stages of the fire, creating fuel breaks and defending structures, is one of the most important parameters in reducing the risk. Hence, human activities could be added as the fourth factor that affects wildfire behavior.

Population and associated infrastructure growth have introduced more sources of ignition. The result has been a change in the frequency of large fires, especially in the coastal zones of the western United States and east of the Appalachian Mountains[59,60]. Coinciding with the policy of rapid wildland fire suppression, outreach campaigns focused on stopping human-driven ignitions. In fact, the *Smokey Bear Wildfire Prevention* campaign, which began in 1944 is the longest running public service advertising campaign in United States history. During the program's first two decades human-caused wildfire ignitions were shown to have been statistically reduced by the campaign.

However, research also showed that the campaign fostered a highly negative view of wildfires, despite the knowledge that wildfires are beneficial for many ecosystems. This negative view of wildfire generated support for the federal policy of wildfire suppression[61]. By the 1980s, despite the outreach campaigns and consistent messaging, human-caused ignitions overtook natural mechanisms. Today, the gap continues to widen due to a combination of human activities and infrastructure.

It wasn't until the 1990s that outreach, and messaging campaigns began to center more around mitigation actions and communicating the concept of living with wildfire. At the community level, the first Fire Safe Councils in California emerged in the early 1990s. In 2002, NFPA launched their Firewise USA® community recognition program. These programs were the first steps toward addressing community-scale vulnerability. Progress however has been slow both at the parcel level and community scale in integrating mitigation elements. Wildland-Urban Interface building codes are a useful tool for mitigation at scale but have been underutilized across the United States. There are only four states (California, Nevada, Utah, and Pennsylvania) that have adopted a state-wide WUI code, and only two (California and Utah) uniformly enforce it at the state-wide level. Elsewhere, only a patchwork of local code jurisdictions exist that use these provisions[62].

Social science research efforts have begun to try to understand why people struggle with implementing wildfire mitigation actions. Studies have centered on understanding people's perception of risk and understanding the sociological and psychological barriers that lead to action or inaction. A common belief is that people do not take mitigation actions because they do not understand the risk to their life and property. Research has shown that this is not the case and that the problem is more complex[63]. The work of Meldrum et al. (2015) explored in detail how beliefs related to the attributes of a person's home compared to those of wildfire experts.

At the parcel level, homeowners significantly underestimated the importance of the local property-level topography, as well as roofing and siding materials. While their beliefs about the importance of vegetation and attached decks, were closer to those of wildfire experts[49]. Homeowners grasped the influence of surrounding elements outside their neighborhood on their own wildfire risk, but when moving to a more granular view of how interconnected a neighborhood is, homeowners underestimated the local view of their risk. This barrier in risk assessment presents challenges as a neighbor's home and their mitigation elements (or lack thereof) directly affects a home's ability to resist fire.

A path to improving a neighborhood's ability to defend against wildfire could lie with homeowner's associations (HOA) and their ability to enforce mitigation standards across the community. However, when IBHS and the Southeast Institute for Research (SIR) conducted focus groups with suburban homeowners in Colorado and California, HOAs received mixed opinions regarding their effectiveness to set wildfire mitigations standards, but participants did suggest this would be a useful means to communicate across communities.

The barriers to parcel level mitigation will likely be amplified when moving toward community-scale mitigation. Current research suggests that some psychological factors are more influential than others[64,65]. An awareness of the risk is certainly necessary, but that alone is not enough to promote widespread action. Factors that influence mitigation are the perceived effectiveness of risk reduction activities and the attitudes of others (i.e., family members, friends, neighbors, or social groups) toward those mitigation activities. Fortunately, at the community scale, both formal and informal outreach between government agencies and groups such as homeowners' associations have shown positive outcomes in building trust between stakeholders[66,67]. However, the beliefs of others are balanced with a homeowner's personal beliefs about their property. The tradeoffs between preparedness and amenities, personal privacy, neighbors' properties, and other factors, along with their perception of their ability to complete mitigation tasks, all influence the decision. Many of the maintenance activities described in most wildfire mitigation best-practices are near-continual processes. This has been shown to be a barrier to entry for many people because they feel they cannot complete the work.[65,66,67]

When considering urban conflagrations of the past, the primary focus and impact of conflagrations was on commercial construction. The problem was substantially mitigated, generally through improved fire response and building codes that required more fire-resistant materials in commercial construction. This dealt with both life-safety and structure loss reduction. Over time some of the interior fire spread provisions and material standards

for fire resistance spread into residential construction codes. There is little literature available that considers human responses to proposed changes and then what were the barriers then that may have slowed implementation. However, it is important to note that these large- scale actions were mandated through policy changes and building code adoption. They were not reliant on voluntary actions. The use of social science to explore human behavior regarding how people respond and take mitigation actions to wildfires is relatively new but as described previously, there are significant complexities to voluntary decision making by homeowners regarding mitigation steps.

The following questions must be asked:

- Are today's human barriers to mitigation different from those encountered in the early 1900s when the mitigation of urban conflagrations was ongoing?
- How do perceptions of residential versus commercial construction differ when considering voluntary actions or mandated mitigation policies?

Limitations and Knowledge Gaps

Before humans began excluding wildfire from the environment, wildfires were an integral part of ecosystems, and certain plants and animals evolved to depend on them to maintain ecological balance. Humans, centuries ago, demonstrated that they can coexist with fire and develop healthy fire practices. There has been an increase in high severity fires in recent years, which have impacted soil erosion, carbon storage, forest succession, wildlife habitat, and human safety. Studying fires from 1985 to 2017, Park and Abatzoglou (2020) found that the area burned by high severity fires increased eightfold in western US forests[68]. Despite all the efforts being made to address this issue, these statistics highlight the need to discuss limitations and knowledge gaps.

While flame contact and radiation cascade the damage in the WUI, the spread of fire within the WUI is dominated by the complex chain of fuels and its characteristics. Before the fire front arrives at the WUI, embers from wildland fuels produce irregular ignition patterns in connected fuels within a community and within the structures themselves. The intensity and spread rate of these fires depend on local fuel flammability and the hyper-local wind flow conditions. Flame spread rate and fire intensity can be accelerated, slowed, or even extinguished based on fire stage, fuel characteristics, and wind speed[69,70]. This makes performance-based design and mapping the potential risks extremely challenging, specifically for large scale fires such as a built environment conflagration under complex, mixed time dependent radiative and convective heat transfer mechanisms. Additionally, as mentioned before, the interconnected effects of terrain, weather and climate, vegetative and structural fuel connectivity, and characteristics on large scale fire behavior both in the wildlands and within the WUI are not well understood.

Several challenging tasks need to be addressed from a social and policy perspective. While home hardening and fuel management do reduce the likelihood of building ignition, identifying mitigation strategies based on their cost-effectiveness and their correlation with the overall reduction of risk to the structure is not established yet[71]. The balance between practicality, cost, and science-backed risk reduction is only recently becoming clearer. In

California alone, the vast majority (95%) of the homes were built prior to adoption of any WUI code (Chapter 7A of the California Building Code)[72]. Allocating funding resources to retrofit buildings is challenging yet has been successful for other hazards such as earthquakes and hurricanes. Furthermore, the construction workforce and homeowners may not be trained or aware of fire-resistant materials. This issue becomes apparent when considering easily overlooked elements, such as vent screens or vertical clearances at the base of the wall, each of which can alter the probability of a building being damaged or destroyed.

Weather, Climate, Topography, and Wildland Fuels

Weather and climate elements are what set the stage for built environment conflagrations. Nearly all built environment conflagrations were preceded by some scale of drought. When they do occur, it is often the local weather that dictates where and when a conflagration ends. Fire weather research has been ongoing for nearly a century. At large spatial and time scales, the impact of wind and relative humidity on conditions that support wildfires have been well characterized. However, the effect of atmospheric stability on fire behavior is not well captured. The extreme fire behavior observed during fires of the last decade has revealed that the influence of atmospheric stability on available buoyancy and how it interacts with wildfire plumes may be more important than previously thought. It is these extreme plume driven fires that often are the catalyst for today's wildfire-driven built environment conflagrations. Their behavior makes it difficult for fire response resources to effectively slow the rate of spread, they can transport embers long distances, and stretch flame lengths. While the concept of critical fire weather has been in existence for more than 50 years, it has not been extensively used yet in medium and long-range forecast applications to provide predictive value on when large fires or extreme fire behavior is likely to occur.

The influence of climate change on the patterns of extreme heat, rainfall, droughts, and floods is advancing quickly and our understanding has grown extensively over the last two decades. This work has led to the suggestion that the changing climate will create longer periods of time in which critical fire weather may be present. However, as we observe large variances in fire season severity, research is also needed to explore the possible relationship with oceanic circulations (i.e., ENSO cycles) and global climate teleconnections that are known already to influence other hazards such as tropical cyclones and severe thunderstorms.

The current state of scientific knowledge of fire behavior within complex terrain is primarily through laboratory experiments and numerical modeling. There is still a large gap in understanding the role small-scale wind flow conditions within complex terrain and how that influences fire spread in this environment. Results from numerical simulations have shown that terrain has a more pronounced effect on fire spread on slopes than ambient wind conditions. However, field data to validate these results are non-existent in real-world wildfire conditions. There is a substantial need for in situ observations in these environments that can confirm or refute what has been seen in model simulations and laboratory experimental testing.

Built Environment

The spread rate of fire in the built environment can be influenced by several factors, including building materials, structure layout, and vegetation connectivity. Increasing the resilience of buildings through WUI building codes has been proven effective to slow fire spread in the built environment. Unfortunately, the use of WUI building codes has been an underutilized tool. California and Utah have used codes effectively in WUI areas, but most buildings were constructed before the WUI codes were adopted[61]. When ignited, these buildings expose the surrounding buildings to extreme heat exposure beyond the tolerance of most building materials, even those built in accordance with WUI standards. Even hardened buildings that meet the latest WUI codes can lose their integrity when the weakest component fails during extreme heat exposure. Small openings and details of construction are among other key factors that are challenging to address in all construction and are somewhat related to the practitioners' skills.

One of the largest gaps that remains is understanding the rates of fire spread through different built environments under realistic wildfire conditions. Research on the spread of fire between buildings has primarily focused on interior or compartment fires where flames extend through broken windows. However, in the case of wildfires, the entire structure can become engulfed in flames due to elevated wind speeds and typically a very dry and preheated airmass, resulting in significantly different fire behavior. Combining the complex wind flow conditions in a dense suburban environment and the response of the surrounding building's cladding elements to fire is poorly understood. The complexity increases when additional fuel sources, such as vegetation, are present between the two buildings. The presence of an inhomogeneous fuel pattern, coupled with the variability in vegetation maintenance, makes it extremely challenging to draw definitive conclusions during post-event investigations and requires large numbers of laboratory full-scale experiments to begin addressing this question.

Human Factors

The understanding of what human barriers remain to mitigating wildfire's impact on the built environment is just as significant as understanding how connective fuels and fire-resistant materials can be intertwined in affecting the potential for a suburban conflagration. Science and engineering are beginning to coalesce on what actions are necessary at the parcel level of mitigation and advances in computational abilities, machine vision, and machine learning applications are bringing to bear these advances in exploring how community-scale fire spread can be slowed or stopped.

Most catastrophic wildfires are started by humans or our infrastructure. It is unclear if improved messaging campaigns can help reduce human-started fires or not. While historically some success has been had in this area, there were also unforeseen consequences.

Two large research gaps and questions that are forefront:

- What human behaviors cause fires?
  - Are these human behaviors occurring more frequently?

  - Are they a consequence of population growth in regions where fire is prevalent?
- How are human ignitions altering annual occurrence probabilities?
- How are suppression activities altering occurrence probabilities?

The growth in the frequency of suburban conflagrations from wildfires has outpaced mitigation efforts. Programs such as NFPA's Firewise USA® have helped in improving awareness and establishing necessary community-scale ecosystems to implement mitigation actions; but unfortunately executing home hardening and defensible space measures in a large scale have lagged.

We must ask the following questions:

- Why has wildfire awareness not translated into action at large scales?
- How can a sense of hope be restored to motivate homeowners, homeowners associations, and communities to act?
- How do people respond to wildfires? How do they approach mitigation?
- What kinds of programs, nudges, and incentives could provide motivation?
- Why are wildland-urban interface codes a vastly underutilized tool for large-scale mitigation efforts?

Research has identified the communication gaps that are still present, and to some degree where messaging and outreach can be successful. While communication efforts are often focused through mass media, more effective channels have been found. These have included more personalized and local efforts such as one-on-one consultation with fire experts, townhall events, small workshops, tours, and demonstrations (Figure 13). These activities were more effective at changing beliefs; however, they are time intensive and typically do not reach large numbers of people[73]. The ability to link what must be done at the parcel level and how it can, when executed at scale, reduce the probability of a suburban or built environment conflagration and why, is critical to shrinking the gap between awareness and action.



Figure 13: Community wildfire awareness event held by the Butte County, California Fire Safe Council. Photograph courtesy of Lauren de Terra and Rachel Ostrander from the Butte County Fire Safe Council.

Summary

The elements of built environment conflagrations have remained the same for nearly four centuries. What has changed is the catalyst. In today's world wildfire has acted as the catalyst, and our most catastrophic wildfires are those where fire spreads quickly through the wildland-urban interface and into suburban neighborhoods. The rapid spread into these areas begins the chain of catastrophic fire as described by Cohen (2008). Setting the stage for conflagrations are drought, at any time scale, and wind. Droughts affect the volatility of fuels, both vegetative and building materials. Winds above 20 to 30 mph help drive fire spread through both flames and embers. However, these conditions are common among nearly all large wildfires. The difference between a large or even an extreme wildfire and a catastrophe lies in the presence of structures with little to no resistance to fire and fuels that connect them together. Once fire enters these communities, all three ignition mechanisms act simultaneously to spread fire structure-to-structure at rates and intensities that overwhelm fire suppression resources.

The factors that govern the probability of a built environment conflagration can be broken into those that are a function of the natural environment and the present built environment, and those that can be altered or mitigated. The elements of weather, climate, and topography that play vital roles in fire behavior, have conditions that are intrinsic to environments with fire as a part of their ecosystem. Forest management can help manage fuels in the wildland, but it is not possible nor advantageous to remove wildland fuels that may surround our communities. It is imperative that we adapt to living with fire such that intense wildfires can still occur but without them becoming catastrophic.

The key is reducing the probability of the initial structure ignition but also developing a system of protections within a community such that the community itself acts to slow fire spread or even stop it.

The first challenge is to develop a system that considers structure separation distances, the degree to which connective ladder fuels must be managed between structures, and the parcel level mitigations that matter to set a true community design standard. The second challenge is to implement a system in existing communities and sustain it for the communities of the future. Fortunately, this is a problem that has been addressed in another part of our built environment and through the same steps, our suburban communities can adapt to wildfire.

References

[1] Bankoff, G, Ed., U. Lubken, J. Sand, (2012). Flammable Cities: Urban Conflagration and the Making of the Modern World, Univ. of Wisconsin Press, 368 pp.

[2] Bird, E.L. and S.J. Docking, (1949). Fire in Buildings, *Adam and Charles Black Inc*., London, UK, 295 pp.

[3]Rogers, Paul, (2018). "Camp Fire is deadliest U.S. wildfire in 100 years", East Bay Times. 25 November 2018

[4] Chandler, C.C., T. G. Storey, and C. D. Tangren, (1963). Prediction of Fire Spread Following Nuclear Explosions. U.S. Forest Service Research Paper PSW-5.

[5] Sommers, W. T. (2008). The emergence of the wildland-urban interface concept. v. Fall, p. 12-18

[6] California Office of Emergency Services, (1992). The East Bay Hails Fire: A Multi Agency Review of the October 1991 Fire in the Oakland/Berkely Hills, East Bay Hills Fire Operations Review Group, Governor's Office of Emergency Services, 65 pp.

[7] Parker, D.R., (1992). The Oakland-Berkeley Hills Fire: An Overview. Oakland Office of Fire Services, Technical Report.

[8] Routley, J.G., (1992). The East Bay Hills Fire: Oakland-Berkeley, California. FEMA USFA-TR-060 Technical Report. 120 pp.

[9] Littell, J.S., D.L. Peterson, K.L. Riley, Y. Liu, and C.H. Luce, (2016). A review of the relationships between drought and forest fires in the United States. *Global Change Biology*, 22, 2353-2369. https://doi.10.1111/gcb/13275

[10] Data source: United States Forest Service Research, The 1990-2010 wildland-urban interface of the conterminous United States – geospatial data, 2nd ed. https://data.nal.usda.gov/dataset/1990-2010-wildland-urban-interface-conterminous-united-states-geospatial-data-2nd-edition

[11] Verisk FIRELINE

[12] Cohen, J., (2008). The wildland urban interface fire problem: A consequence of the fire exclusion paradigm. *Forest Hist. Today*, 20-26.

[13] Senande-Rivera, M., D. Insua-Costa, and G. Miguez-Macho, G (2022). Spatial and temporal expansion of global wildland fire activity in response to climate change. *Nat Commun* 13, 1208. https://doi.org/10.1038/s41467-022-28835-2.

[14] Strader, S.A., (2018). Spatiotemporal changes in conterminous US wildfire risk and societal exposure from 1940-2010. *Nat. Haz*., 92, 543-565. https://doi.org/10.1007/s11069-018-3217-z

[15] Littell, J.S., D.L. Peterson, K.L. Riley, Y. Liu, and C.H. Luce, (2016). A review of the relationships between drought and forest fires in the United States. *Global Change Biology*, 22, 2353-2369. https://doi.10.1111/gcb/13275

[16] Potter, B.E. and D. McEvoy, (2021). Weather factors associated with extremely large fires and fire growth days. *Earth Interactions*, 25, 160-176. DOI:10.1175/EI-D-21-0008.1

[17] Lareau, N. and C.B. Clements, (2016). Environmental controls on pyrocumulus and pyrocumulonimbus initiation and development, *Atmos. Chem. Phys*. 16, 4005-4022. https://doi.org/10.5194/acp-16-4005-2016, 2016

[18] Melnikov, V. M., D.S. Zrnic, R.M. Rabin, and P. Zhang, P.(2008). Radar polarimetric signatures of fire plumes in Oklahoma, *Geophys. Res. Lett*., 35, L14815, doi:10.1029/2008GL034311.

[19] B. Rodriguez, N. P. Lareau, D. E. Kingsmill and C. B. Clements (2020). Extreme pyroconvective updrafts during a megafire. *Geophys. Res. Lett.,* 47 DOI: 10.1029/2020GL089001.

[20] Lareau,N.P.,N.J. Nauslar,& J.T. Abatzoglou,J.T, (2018).The Carr fire vortex: A case of pyrotornadogenesis? *Geophys. Res.Lett*.,45. https:// doi.org/10.1029/2018GL080667.

[21] Forthofer,J.M.,and S.L. Goodrick, (2011). .Review of vortices in wildland fire. *J. Comb*.,2011,1–14.https://doi.org/10.1155/2011/ 984363.

[22] Beals, E.A. (1914). The value of weather forecasts in the problem of protecting forests from fire. *Mon. Wea. Rev*. 42(2): 111–119.

[23] Simms, D. L. (1963). "On the pilot ignition of wood by radiation." *Combustion and Flame* 7: 253-261

[24] Hurley, M. J., D. T. Gottuk, J. R. Hall Jr, K. Harada, E. D. Kuligowski, M. Puchovsky, J. M. Watts Jr and C. J. Wieczorak (2015). SFPE handbook of fire protection engineering, *Springer Inc.* 3546 pp.

[25] Shields, W.M., 2008: Urban conflagrations in the United States, *Society of Fire Protection Engineers*, Technical Report, 28 pp.

[26] Ohlemiller, T. (1991). Smoldering combustion propagation on solid wood. Fire Saf Sci 3: 565-574.

[27] Sedano, F., and J. T. Randerson, (2014). Vapor pressure deficit controls on fire ignition and fire spread in boreal forest ecosystems. *Biogeosciences Discussions* 11.1, 1309-1353.

[28] Mark A Finney, Sara S McAllister, Torben P Grumstrup and Jason M Forthofer, (2021). Wildland Fire Behavior, *CSIRO Publishing*, 376 pp.

[29] Forest Product Laboratory, Wood handbook-wood as an engineering material, 1999.

[30] Iniguez, Jose M., Thomas W. Swetnam, and Stephen R. Yool., (2008). Topography affected landscape fire history patterns in southern Arizona, USA. *Forest Ecology and Management* 256.3, 295-303.

[31] Dupuy, J. L., & Maréchal, J. (2011). Slope effect on laboratory fire spread: contribution of radiation and convection to fuel bed preheating. International Journal of Wildland Fire, 20(2), 289-307.

Silvani, X., Morandini, F., & Dupuy, J. L. (2012). Effects of slope on fire spread observed through video images and multiple-point thermal measurements. Experimental Thermal and Fluid Science, 41, 99-111.

[32] Grumstrup, T.P, S.S. McAllister, and M.A. Finney. Qualitative Flow Visualization of Flame Attachment on Slopes. In: 10th U.S. National Combustion Meeting, 2017.

Finney, M.A., J.D. Cohen, J.M, Forthofer, S.S. McAllister, M.J. Gollner, D.J. Gorham, K. Saito, N.K. Akafuah, B.A. Adam, and J.D. English. Role of buoyant flame dynamics in wildfire spread. Proceedings of the National Academy of Sciences 112(32):9833-9838, 2015.

[33] Himoto, Keisuke, (2022). Large Outdoor Fire Dynamics. CRC Press. 414 pp.

[34] Anderson, H. E. (1970). Forest fuel ignitibility. *Fire technology*, *6*, 312-319.

[35] Andrews, P. L., & Queen, L. P. (2001). Fire modeling and information system technology. *International Journal of Wildland Fire*, *10*(4), 343-352.

[36] Mell, William, et al. "Numerical simulations of grassland fire behavior from the LANL-FIRETEC and NIST-WFDS models." *Remote Sensing and Modeling Applications to Wildland Fires* (2013): 209-225.

[37] McGuire Sfpe, J. H. (1965). Fire and the spatial separation of buildings." *Fire Technology,* 1, 278-287.

[38] Ghodrat, Maryam, Ali Edalati-Nejad, and Albert Simeoni. (2022). Collective effects of fire intensity and sloped terrain on wind-driven surface fire and its impact on a cubic structure." *Fire,* 5.6, 208.

[39] Beer, T. (1991). The interaction of wind and fire. *J. Boundary-Layer Meteor.* 54.3, 287-308.

[40] National Wildfire Coordinating Group (NWCG), NWCG Glossary of Wildland Fire, PMS 205, 2018

[41] Vogel M, Williams FR (1970) Flame propagation along matchstick arrays. Combustion Science and Technology 1, 429–436. doi:10.1080/ 00102206908952223

[42] Weber RO (1990) A model for fire propagation in arrays. Mathematical and Computer Modelling 13(12), 95–102. doi:10.1016/0895-7177(90) 90103-T

[43] Di Cristina, G., Kozhumal, S., Simeoni, A., Skowronski, N., Rangwala, A., & Im, S. K. (2021). Forced convection fire spread along wooden dowel array. *Fire Safety Journal*, *120*, 103090.

[44] Bu, R., Zhou, Y., Shi, L., & Fan, C. (2021). Experimental study on combustion and flame spread characteristics in horizontal arrays of discrete fuels. *Combustion and Flame*, *225*, 136-146.

[45] Van Wagner CE (1977) Conditions for the start and spread of crown fire. Canadian Journal of Forest Research 7, 23–34. doi:10.1139/X77-004

[46] Cheney NP, Gould JS, Catchpole WR (1998) Prediction of fire spread in grasslands. International Journal of Wildland Fire 8(1), 1–13. doi:10.1071/WF9980001

[47] Marsden-Smedley JB, Catchpole WR, Pryke A (2001) Fire modelling in Tasmanian buttongrass moorlands. IV Sustaining versus non-sustaining fire. International Journal of Wildland Fire 10, 255–262. doi:10.1071/ WF01026

[48] Weise DR, Zhou X, Sun L, Mahalingam S (2005) Fire spread in chaparral – 'go or no-go'. International Journal of Wildland Fire 14(1), 99–106. doi:10.1071/WF04049

[49] Menning, K. M., and S. L. Stephens. (2007). Fire climbing in the forest: a semiqualitative, semiquantitative approach to assessing ladder fuel hazards. *Western Journal of Applied Forestry,* 22.2, 88-93.

[50] Ramsay, G. C., McArthur, N., & Dowling, V. (1987). Preliminary results from an examination of house survival in the 16 February 1983 bushfires in Australia. Fire and Materials, 11, 49-51.

[51] Maranghides, A., McNamara, D., Mell, W., Trook, J., & Toman, B. (2013). A case study of a community affected by the Witch and Guejito Fires: Report# 2: Evaluating the effects of hazard mitigation actions on structure ignitions (NIST Technical Note 1796). *National Institute of Standards and Technology*

[52] Syphard, A. D., Brennan, T. J., & Keeley, J. E. (2014). The role of defensible space for residential structure protection during wildfires. International Journal of Wildland Fire, 23, 1165-1175.

[53] Hedayati, F., Quarles, S. L., & Standohar-Alfano, C. (2022). Evaluating Deck Fire Performance—Limitations of the Test Methods Currently Used in California's Building Codes. *Fire*, *5*, 107.

[54] Butler, K., Johnsson, E. L., Maranghides, A., Nazare, S., Fernandez, M. G., McIntyre, R., Saar, W., Zarzecki, M., Tang, W., & Auth, E. (2022). *Wind-Driven Fire Spread to a Structure from Fences and Mulch* (NIST Technical Note 2228). *National Institute of Standards and Technology,* Gaithersburg, MD. https://doi.org/10.6028/NIST.TN.2228

[55] Maranghides A, McNamara D, Mell W, Trook J, toman B (2013) A Case Study of a Community Affected by the Witch and Guejito Fires Report: #2 – Evaluating the Effects of Hazard Mitigation Actions on Structure Ignitions. *National Institute of Standards and Technology*, Gaithersburg, MD, NIST Technical Note (TN) 1796. https://doi.org/10.6028/NIST.TN.1796

[56] Maranghides A, McNamara D (2016) 2011 Wildland Urban Interface Amarillo Fires Report #2 – Assessment of Fire Behavior and WUI Measurement Science. *National Institute of Standards and Technology*, Gaithersburg, MD, NIST Technical Note (TN) 1909. https://doi.org/10.6028/NIST.TN.1909

[57] Maranghides, A., E.Link, W. Mell, S. Hawks, M. Wilson, W.Brewer, C.Brown, B. Vihnaneck, and W.D. Walton, (2021). A Case study of the Camp Fire – Fire progression Timeline, *National Institute of Standards and Technology,* Gaithersburg, MD, NIST Technical Note 2135, 421 pp. https://doi.org/10.6028/NIST.TN.2135

[58] Data source: CALFIRE (2022)

[59] Abatzoglou J.T., J.K. Balch, B.A.Bradley, and C.A. Kolden, (2018). Human-related ignitions concurrent with high winds promote large wildfires across the USA. *International Journal of Wildland Fire*, 27, 377–386. doi:10.1071/ WF17149

[60] Balch J.K., B.A. Bradley, J.T. Abatzoglu, R.C. Nagy, E.J. Fusco, and A.L. Mahood, (2017). Human-started wildfires expand the fire niche across the United States. *Proceedings of the National Academy of Sciences of the United States of America*, 114, 2946–2951. doi:10.1073/PNAS.1617394114

[61] Donovan, G.H., and T.C. Brown, (2007). Be careful what you wish for: The legacy of Smokey Bear. *Frontiers Ecol. Environ.*, 5, 73-79.

[62] Shabanian, M., I.M. Giammanco, M. Steinburg, and B. Bain, (2023). Living with wildfire: Vulnerabilities and readiness across the Western United States. IBHS, NFPA, Verisk Joint Technical Report. 16 pp.

[63]Meldrum, J.R., P.A. Champ, H. Brenkert-Smith, T. Warziniack, C.M. Barth and L.C. Falk, (2015). Understanding gaps between the risk perceptions of wildland-urban interface (WUI) residents and wildfire professionals, *Risk Analysis*, doi: 10.1111/risa.12370

[64] Vaske, J.J., J.D. Absher, and K. Lyons, (2016). Homeowners' Wildland Fire Beliefs and Behaviors: Results from Seven Colorado Wildland-Urban Interface Counties. *USDA-Forest Service*, Pacific Southwest Research Station, 37 pp.

[65] Absher, J.D.; and J.J. Vaske, J.J. (2006) An analysis of homeowner and agency wildland fire mitigation strategies. In J. G. Pedan, and R. M. Schuster eds., Proceedings of the 2005 northeastern recreation research symposium. GTR NE-341. Newtown Square, PA: *USDA Forest Service*, Northeastern Research Station. 231-236.

[66] Sturtevant V, M.A. Moote, P. Jakes, and A.S. Cheng, (2005). Social science to improve fuels management: a synthesis of research on collaboration. *USDA Forest Service*, North Central Research Station, St. Paul, MN. General Technical Report NC-GTR-257.

[67] Toman EL, B. Shindler, J.D. Absher, and S. McCaffrey, (2008b). Post-fire communications: The influence of site visits on local support. *Journal of Forestry*, 106, 25–30.

[68] Parks, Sean A., and John T. Abatzoglou, (2020). Warmer and drier fire seasons contribute to increases in area burned at high severity in western US forests from 1985 to 2017. *Geophysical Research Letters* 47.22 e2020GL089858.

[69] McAllister, Sara, and Mark Finney (2016). The effect of wind on burning rate of wood cribs. *Fire technology,* 52, 1035-1050.

[70] Ohlemiller, T. (1991). Smoldering combustion propagation on solid wood. *Fire Saf, Sci.,* 3, 565-574.

[71] Mell, William E., et al. (2010). The wildland–urban interface fire problem–current approaches and research needs. *Int. J. Wildland Fire* 19.2, 238-251.

[72] Miller RK, F. Richter, M. Theodori, and M.J. Gollner, (2022). Professional wildfire mitigation competency: A potential policy gap, *Int. J. Wildland Fire,* 31(7), 651–657. doi:10.1071/WF22012

[73] Toman E., B. Shindler, and M. Brunson, (2006). Fire and fuel management communication strategies: citizen evaluations of agency outreach activities. *Society & Natural Resources*, 19, 321–336. doi:10.1080/ 08941920500519206

Robert Muir-Wood
Chief Research Officer

Five years on since California's camp fire: The fate of paradise

November 08, 2023

KEY RISK AREA: Risk modeling, Property & casualty insurance
USE CASE: Catastrophe modeling
INDUSTRY: Insurance
REGION: North America

Will the Californian city of Paradise ever fully recover from the devastating fire that consumed 95 percent of its houses, now five years ago in November 2018?

In a state that saw a slight overall population decline, Paradise was recently named California's fastest-growing city. But, as of August 2023, the population of Paradise had reached a third of the 26,000 that lived there in October 2018.

Five hundred new properties were constructed in Paradise last year. At that rate, it would still take thirty years to complete the rebuild, and many former residents surveyed about their intentions have already declared they will not be returning.

Throughout the centuries what condemns a city devastated by catastrophic damage is a spiral of debt as fewer residents generate lower income so that amenities suffer, blight deepens, and more people leave.

Yet every cloud, even one unfortunately billowing with wildfire smoke, may reveal a silver lining. If the fire that destroyed Paradise had been ignited by lightning, there would have been no one to sue.

But it was electrical equipment owned and operated by Pacific Gas and Electric (PG&E) that was acknowledged to have triggered the blaze, and PG&E is one of the largest combined natural gas and electric energy companies in the United States, supplying electricity to 5.5 million customers in northern and central California.

The bankruptcy settlement agreed with PG&E means that money is not going to be a problem, at least for the next few years. The town of Paradise received US$270 million from the PG&E settlement, Butte County another US$252 million, and the Paradise Recreation and Parks District received US$47.5 million.

Now the challenge: how to spend that money on improving amenities to significantly reduce the chance of a repeat catastrophe.

Living in the forest

The problem is the city's intrinsic riskiness. Paradise sprawls over 18 square miles (47 square kilometers), and the people who came to live here wanted to live in large lots surrounded by forest, with views of foliage, not their neighbors.

Proximity to trees is also the hazard. The city is not on the edge of the wildlands, like Santa Rosa in California, which experienced the Tubbs Fire in 2017. Paradise is surrounded by, and immersed in, forest. Previous fires have burnt right up to the edge of the settlement.

Half of the city's 200 miles (322 kilometers) of roads are privately owned, with many only providing access to homes across the mountain ridges: potential death traps in a wildfire evacuation. There is only one road out of town. This sprawl has made it impossible to link house construction with other amenities.

The residents also value their freedom and independence, and have shunned citywide infrastructure projects in the past – the city is notorious for being the largest west of the Mississippi without a sewerage system. The last attempt to fund a city-wide sewerage system was rejected by the city's voters in 1992.

But there are now plans to use some of the PG&E money to fund a US$233 million sewerage system and construct an 18-mile (29-kilometer) pipeline to carry Paradise sewage westwards down to the pre-existing treatment works in the nearby city of Chico.

Yet the new Sewer Service Area (SSA) will mainly serve land parcels in the city's urban core focused on three main roads, Skyway, Pearson Road, and Clark Road. No other connections are included in this project. Access to sewerage is being used to encourage housing "densification". People originally moved to Paradise to be among the trees, and now the council wants them instead to value a sewerage hook-up.

Creating a new city

The Paradise Council would like to create a different kind of city, a city where houses are closely spaced, a city that would be like many others across central California. A city that would be easier to defend in a fire. Yet densification can bring new risks, as seen in the northern suburbs of Santa Rosa in 2017, fires can spread house to house in an urban conflagration.

Meanwhile, much of Paradise has become an informal trailer park, as many residents await further money to rebuild. They look to the PG&E funds to top up insurance compensation for policies that generally underestimated rebuild values, and therefore on their own would not be enough to fund constructing a new property.

As a result of the 2018 fires and the subsequent tree clearance, the land across the city is scarred with a million tree stumps. Left to itself, new shoots will grow, fresh saplings take root, and the forest will return, bringing with it both the amenity of the leaves and the hazard of wildfire.

Buffer zones

The most ambitious part of the proposals to convince prospective residents that the risk from wildfire has now been tamed is the plan to create five large 'green belt' buffer zones around the city, with trees and foliage cleared.

Widely publicized, this plan is more of a pipe dream. The buffer zones would cover 22,000 acres (12,950 hectares), almost all of which is currently privately owned. in 2,200 plots located all around the 18-mile (47-kilometer) city boundary.

Many plots are the former sites of houses destroyed in 2018, awaiting their owner's intentions to rebuild. Even at a knock-down price of US$2,000 an acre, acquiring the land would cost US$60 million, money that the local Parks and Recreation Department does not have.

The latest published estimate as to how much land has been acquired for buffer zones was from the summer of 2022 when the department announced they had 100 acres, equating to 0.3 percent of the plan. And that is before one costs up the land management that would be required to keep the buffer zones free of vegetative fuel.

It is instructive to compare the actions that follow a catastrophic flood to a catastrophic wildfire. After any disaster, there is a window of opportunity that lasts, perhaps, two to five years, according to the severity of the event, when communities can be convinced to put money aside to fund some action to prevent a repetition.

And then, as the memory fades, it gets harder to argue to fund infrastructure that has no function other than to mitigate a rare catastrophe – there are much more immediate needs: like schools, highways, and fighting crime.

For the response to a flood, this can work quite well – the money becomes available to build a flood defense and once constructed, it requires little maintenance costs and can provide many decades of protection. Compare that with buffer zones and wildfires. The costs for vegetation clearance continue year after year without end until almost inevitably the funding gets cut as people focus on more immediate priorities.

Such wide buffer zones have not been implemented or tested before. The new generation Moody's RMS high-definition wildfire models are designed to facilitate testing the outcome of the full range of mitigations: individual property vegetation management, fire-resistant construction, hardening electric power networks, and buffer zones.

Embers, carried by a fierce wind, can jump one to two miles before settling on a pile of leaves or a cedar shingle roof to trigger further fires. It is those fires blown by strong winds that evade control and are at the same time those in which the embers will travel the furthest.

The Parks and Recreation Department in Paradise is not prepared to force 'eminent domain' to acquire land. So, the best that hope could end up being a patchwork of cleared land and thick undergrowth with little expectation that this would provide any kind of barrier to an advancing firefront.

Yet the buffer zones have captured the imagination. We all have an appetite for good-news stories about curing catastrophes. But we also need to be realistic about how such situations often turn out; underfunded, partially realized, abandoned.

Former residents considering whether to return need proof that the fire risk has been reduced to tolerable levels.

Paradise was always an inexpensive place to live, attracting many older and disabled residents, who did not realize how much they were at risk.

The mean age of the eighty-five who died in the Camp Fire was 72 years, with many forgotten in the early morning evacuation. Paradise's former hospital closed permanently after the fire, and access to healthcare is paramount – making it difficult for older residents.

History of fires

The Camp Fire is by no means the first time Paradise has been under threat. In June 2008, 9,300 people had to evacuate southwestern areas of the city when a fire burnt the land between Paradise and Chico. A month later, thousands evacuated the northern side of the city as a fire raged in the neighboring Feather River Canyon.

In August and September 2020, the lightning-triggered 300,000-acre North Complex fire (twice the size of the 2018 Camp Fire) burnt right up to the edge of the Camp Fire burn scar, not proceeding further into Paradise because the reduced vegetation clearance had left nothing more to burn. Yet this experience has given some confidence that future fires could also be stopped at the city limits.

Five years on

How would one summarize a five-year report card on Paradise and wildfire risk? The risk is being successfully reduced. New builds will all have to satisfy more stringent, and more expensive, fire-resistant building codes.

PG&E is hardening its network in and around the town, becoming more rigorous in tree clearance and putting some of the riskiest lines underground. While the buffer zones may not fly, tree clearance within the city's footprint should be sustained, at least until residents once again prioritize foliage.

The city is not, as one might say 'out of the woods' yet. The mayor Greg Bolin has admitted that before the fire the city's government was 'barely scraping by.' Unless it can rebuild its population the city's finances cannot be sustained once the PG&E settlement has been exhausted.

It is not only the risk but the expense, for the predominately low-income former residents. Within the last year, both State Farm and Allstate have stopped writing new policies in California because of the threat of wildfires.

Homeowners in Paradise must accept higher insurance costs and restricted coverage from the residual market California FAIR Plan schemes. The future climate is likely to be creating more fuel, roasted in longer and hotter fire seasons.

Realistically Paradise will end up with perhaps half, at best two-thirds of its former inhabitants. The town remains on probation. In history, two catastrophes in a decade have been enough to end the prospects for other devastated towns, like the Texan port of Indianola.

The recurrence of a significant fire, in particular, one that destroys newly rebuilt properties, could condemn Paradise to become the first North American climate-change ghost town.

And while Paradise is in the vanguard in confronting the risk, it is by no means alone. In California, an estimated 2.7 million people live in areas zoned as 'very high wildfire hazard'[1].

[1] Sabalow, R., Reese, P. & Kasler, D 2019

LEARN MORE

Catastrophe modeling

In an unpredictable world, discover how Moody's best-in-class approach to catastrophe modeling, which integrates innovative analytics, technology, and science, is helping clients to quantify the potential impact of catastrophic events.

Learn more

Note: Moody's Corporation is comprised of separate divisions. Moody's Ratings publishes credit ratings and provides assessment services on a wide range of debt obligations, programs and facilities, and the entities that issue such obligations in markets worldwide, including various corporate, financial institution and governmental obligations, and structured finance securities. Moody's Ratings products are set out here. All other products and solutions described on this site are provided by Moody's, a global provider of data and information, research and insights, and decision solutions.

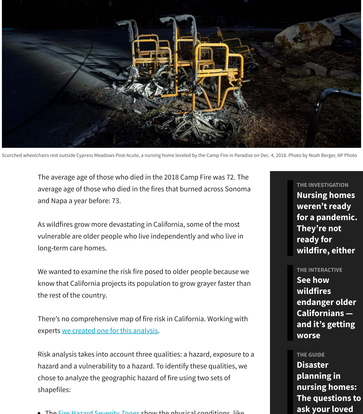
Terms of Use | Privacy Policy | Do Not Sell My Personal Information | Cookies Settings
© 2025 Moody's Corporation, Moody's Investors Service, Inc., Moody's Analytics, Inc. and/or their licensors and affiliates (collectively, "MOODY'S"). All rights reserved.
Note: Moody's does not post ratings to its social media accounts

ENVIRONMENT

How we analyzed where older Californians are at increased risk for wildfire



BY LO BĚNICHOU, MOLLY PETERSON AND LISA PICKOFF-WHITE
AUGUST 10, 2020



Scorched wheelchairs rest outside Cypress Meadows Post-Acute, a nursing home leveled by the Camp Fire in Paradise on Dec. 4, 2018. Photo by Noah Berger, AP Photo

The average age of those who died in the 2018 Camp Fire was 72. The average age of those who died in the fires that burned across Sonoma and Napa a year before: 73.

As wildfires grow more devastating in California, some of the most vulnerable are older people who live independently and who live in long-term care homes.

We wanted to examine the risk fire posed to older people because we know that California projects its population to grow grayer faster than the rest of the country.

There's no comprehensive map of fire risk in California. Working with experts we created one for this analysis.

Risk analysis takes into account three qualities: a hazard, exposure to a hazard and a vulnerability to a hazard. To identify these qualities, we chose to analyze the geographic hazard of fire using two sets of shapefiles:

- The Fire Hazard Severity Zones show the physical conditions, like steepness or vegetation, that make it more likely for an area to burn. These are created by the California Department of Forestry and Fire Protection.
- Wildland Urban Interface areas include where development, geography and natural land mix to create fire risks. These areas were created by a team of scientists at the SILVIS lab at the University of Wisconsin.

We used three data sets to map the exposure of older and disabled people to wildfire hazard in certain regulated facilities:

- California Department of Social Services (CDSS) regulated facilities that house older people, specifically residential care facilities.
- California Department of Public Health (CDPH) regulated long-term-care facilities, specifically skilled nursing homes, intermediate care facilities and congregate living health facilities.
- Census tract level data from the 5-year 2018 American Community Survey showing how many people 65 and older live in each area.

To calculate the percentage of "risky" zones in each county, we used the "union" method to split the "risky" zones by county shapes and establish the percentage for each zone using the new shape's area.

We also wanted to estimate how many people lived in those zones. To obtain the percentage of people 65 and older living in what we had established as "risky" zones, we filtered down both the Fire Hazard Severity Zones and Wildland Urban Interface to the categories experts associated with heightened risk and then combined the two shapes into one polygon, covering most of California. We then used the "union" method on Census tracts containing the ACS 5-year estimates and the counties' shapes, essentially breaking down the tracts per county. We then used the resulting shapefile and again used "union" to get the parts of the tracts that fall into the "risky" zone. We then used the area of each shape to weight the population.

We used these same "risk zones" to calculate when long-term care facilities are situated in fire-prone areas.

To analyze how care facilities are prepared to handle fires or other disasters we requested data for fire and emergency violations over a two-year period from CDPH and CDSS, as well as other public records.

We picked the time period of November 15, 2017 through December 31, 2019 to account for federal regulations and a state law that expanded emergency preparedness requirements for long-term care facilities regulated by both agencies.

In November 2019, federal auditors from the Office of the Inspector General at the Department of Health and Human Services concluded that California should improve its oversight of skilled nursing facilities for wildfire emergency preparedness by looking at certain life safety code and emergency preparedness deficiencies.

Using the same "k-tags" and "e-tags" that federal auditors did for 20 facilities (including one that burned down in Paradise), we asked CDPH for deficiency records for more than 2,339 intermediate care and skilled nursing facilities. We made other public records requests for records related to that audit and for records related to individual facilities that have closed because they were destroyed or in areas that burned catastrophically.

For assisted living facilities, we requested records from CDSS related to new requirements for planning, training, and preparedness for disasters — including wildfire — as well as existing disaster and mass casualty, and training requirements.

Because we wanted to examine future risk in California, we analyzed data only for long-term care facilities that are currently open. That excludes several facilities that have burned down, some of which were found deficient, including in Paradise.

Meanwhile, the novel coronavirus is tearing through long-term care facilities throughout California. CDPH erratically provides data publicly on confirmed COVID-19 cases among staff and patients in skilled nursing homes. We included this data in our analysis so we could see how many facilities are already affected. Because CDSS masks data for assisted living outbreaks, we were unable to include them in this analysis, though their daily updated total deaths, available as a document, informs analysis about the percentage of COVID-related deaths in long-term care homes.

Older and Overlooked is an investigation by reporters in KQED Science and KQED News. KQED is the NPR and PBS member station for Northern California, serving audiences across the state on air and online with compelling stories that inform, inspire and involve.

CalMatters' Lo Běnichou contributed data analysis, editing and graphic design to this project.

Capital Public Radio contributed photos to this series. As the NPR member station based in Sacramento, CapRadio serves California's Capital region, Central Valley and Sierra Nevada.

THE INVESTIGATION
Nursing homes weren't ready for a pandemic. They're not ready for wildfire, either

THE INTERACTIVE
See how wildfires endanger older Californians — and it's getting worse

THE GUIDE
Disaster planning in nursing homes: The questions to ask your loved one's facility

THE METHODOLOGY
How we analyzed where older Californians are at increased risk for wildfire

OLDER AND OVERLOOKED

THE INVESTIGATION
Nursing homes weren't ready for a pandemic. They're not ready for wildfire, either

THE INTERACTIVE
See how wildfires endanger older Californians — and it's getting worse

THE GUIDE
Disaster planning in nursing homes: The questions to ask your loved one's facility

THE METHODOLOGY
How we analyzed where older Californians are at increased risk for wildfire

READ MORE FROM CALMATTERS

Text Get breaking news on your phone.
Download Keep up with the latest via our app.
Sign up Receive free updates in your inbox.

Nonpartisan, independent California news for all

We're CalMatters, your nonprofit and nonpartisan news guide.

Our journalists are here to empower you and our mission continues to be essential.

- **We are independent and nonpartisan.** Our trustworthy journalism is free from partisan politics, free from corporate influence and actually free for all Californians.
- **We are focused on California issues.** From the environment to homelessness, economy and more, we publish the unfiltered truth to keep you informed.
- **We hold people in power accountable.** We probe and reveal the actions and inactions of powerful people and institutions, and the consequences that follow.

But we can't keep doing this without support from readers like you.

Please give what you can today. Every gift helps. Give

Lo Běnichou
lo@calmatters.org

Lo Běnichou was a visual journalist at CalMatters. Prior to joining the team, they worked at Mapbox and at a number of media organizations like WIRED, Youth Radio, KQED, NPR. At Mapbox, they supported... More by Lo Běnichou

Molly Peterson

Molly Peterson reports for KQED science and news on climate change, catastrophe and risk. Previously she was environment correspondent at Southern California Public Radio. Her work has also appeared at... More by Molly Peterson

Lisa Pickoff-White

Lisa Pickoff-White is KQED's data reporter. Lisa specializes in simplifying complex topics and bringing them to life through compelling visuals, including photography and data visualizations. She previously... More by Lisa Pickoff-White

© 2025 CalMatters

National Interagency Coordination Center

Wildland Fire Summary and Statistics Annual Report 2024



Boise National Forest

National Interagency Coordination Center

Contents

Preface 1
2024 Fire Environment Summary 2
National Fire Activity Synopsis 9
Structures Destroyed 10
National Wildfire Activity 11
- Large Wildfires by Geographic Area and Agency 11
- Wildfires by Geographic Area 12
- Wildfires by Agency 13
- Wildfires over 40,000 acres 14
- Lightning Caused Fires and Acres by Geographic Area 15
- Human Caused Fires and Acres by Geographic Area 15
- Wildfires and Acres Burned by Agency and GACC – 2024 & prior years 16

National Preparedness Levels 17
Requests Filled Nationally in IROC 20
Requests Processed Through the NICC 21
- International Resource Mobilizations 21
- Department of Defense Mobilizations 21
- Modular Airborne Fire Fighting Systems (MAFFS) 22
- Incident Management Team Mobilizations 22
- National Incident Management Organization 23
- Complex Incident Management Teams 23
- Crew Mobilizations 24
- Engine Mobilizations 26
- Overhead Mobilizations 29
- Helicopter Mobilizations 31
- Fixed Wing Aircraft Mobilizations 33
- Airtanker Mobilizations 34
- Infrared Aircraft Mobilizations 35
- Unmanned Aircraft Systems 38
- Temporary Flight Restrictions 38
- Large Transportation Aircraft 39
- Equipment Services Mobilization 40
- Radio and Weather Equipment Mobilizations 41

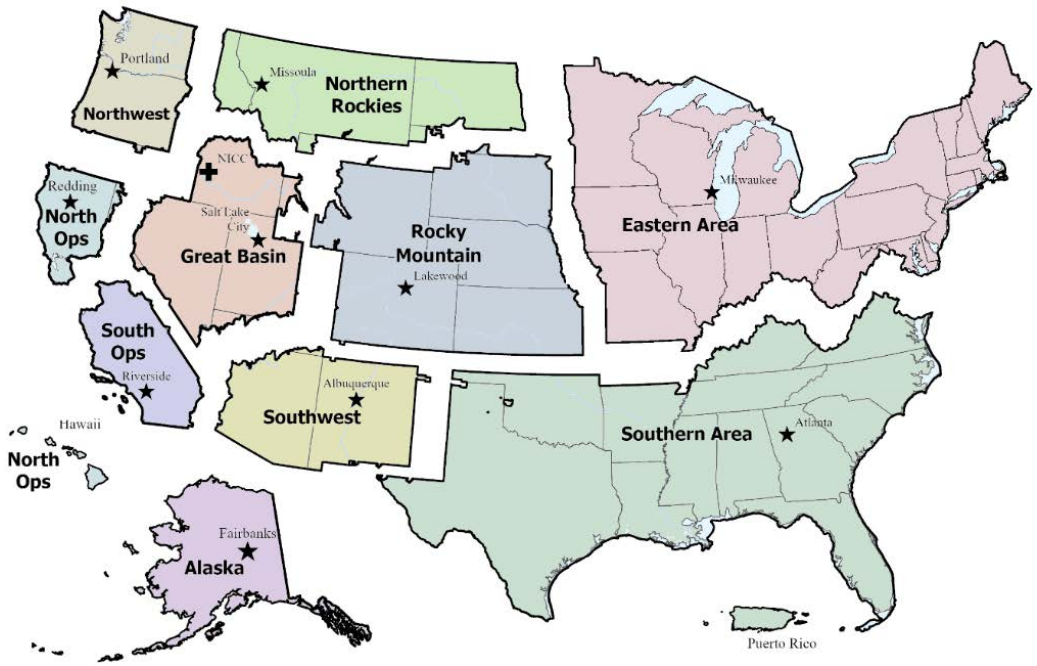
Wildland Fires and Acres Burned by State and Agency 42
NICC Benchmarks 52
Identifier Legend 53
Acronyms and Terminology 54

Preface

Statistics used in this report were gathered from the Situation Report and Incident Status Summary (ICS-209) programs[1]. Previous National Interagency Coordination Center (NICC) annual reports and other sources were also used in this document. The statistics presented here are intended to provide a national perspective of annual fire activity, but they may not reflect official figures for a specific agency. The statistics are delineated by agency and Geographic Area. This document and prior year annual reports are available electronically on the NICC Intelligence web page.

Resource mobilization statistics used in this report were gathered from the Interagency Resource Ordering Capability system (IROC), which tracks aircraft, crews, equipment, overhead, and supplies mobilized nationally. Statistics presented in this report are resources requested by any of the ten Geographic Area Coordination Centers (GACCs) and processed through NICC, apart from Incident Management Teams and Temporary Flight Restrictions[2]. Requests by FEMA are placed to NICC through Emergency Support Function (ESF) #4 (Firefighting). The resource ordering process and procedures may be found in the National Mobilization Guide. The National Mobilization Guide can be found on the NICC Reference Documents web page.

Geographic Area Coordination Centers



[1] Situation Report and ICS-209 data are considered situational and provisional, as they are reported while wildfire activity and incidents are occurring, plus they do not account for all wildland fires and their final outcomes. Some wildfires, including many that are suppressed solely by private citizens or local fire departments (not by wildland fire management agencies), are never reported to any Dispatch Center that submits Situation Report data. Additionally, ICS-209 reports are not required for the small, short duration wildfires that comprise the vast majority of overall fire occurrence annually. For official data and summary statistics, one must contact each of the individual agencies affected and refer to their final fire reports and other authoritative sources of agency-specific information.

[2] This report only tallies resource requests processed through NICC, with the exceptions of Incident Management Team mobilizations and Temporary Flight Restrictions that are captured nationally. It excludes the substantial number of IROC orders that were placed and filled within the same GACC. It also excludes any resource usage not tracked in IROC, such as local dispatch of initial attack resources.

2024 Fire Environment Summary

January – March

Much of the West was characterized by above normal precipitation and near average temperatures January through March, except for areas of Washington into western Montana where precipitation was slightly below normal. Multiple atmospheric rivers brought heavy precipitation from California into the Great Basin and central and southern Rockies, focused on the period from late January through mid-February. Los Angeles, California, recorded more than 8 inches of rain in a 72-hour period February 3-6. While a less active period followed, late February through March had substantial precipitation across the southern half of the West, as is typical during an El Niño. However, the northern half of the West was drier than normal during the same period, also consistent with an El Niño winter. This led to an above normal snowpack, including associated snow water equivalent (SWE) values, in the Sierra, Great Basin, and Southwest, with near normal snowpack from Oregon into the central Rockies. Across Washington and the northern Rockies, snowpack was below average, ranging from 60-90% of average. Snowpack in Alaska was near to above normal, with the above normal snowpack mainly in the southern third of Alaska, where Anchorage recorded over 100 inches of snow by early February. Due to the widespread above normal precipitation in the southern half of the West, drought improved or was removed across the Southwest and Greater Four Corners, but drought intensified across portions of Montana and northeast Wyoming.

Much of the southern Plains into the Southeast had above normal precipitation through March, with significant improvement and removal of drought from much of Texas into the Tennessee and Ohio Valleys. Precipitation was above normal along much of the East Coast as well, but below normal across the northern Plains and the southern High Plains of eastern New Mexico into West Texas and western Oklahoma. Temperatures averaged near normal for much of the Southeast but were well above normal from the northern Plains into the Great Lakes and Northeast, and snowpack was well below normal for the winter as a result. The exceptionally warm conditions resulted in the persistence of drought across much of the Upper Mississippi Valley and Upper Great Lakes, with persistence across the southern High Plains, as well.

Significant fire activity remained minimal across the US through February 23, with a below average number of fires and only 30% of the 10-year average for acres burned. Fire activity increased at the end of February due to a heat wave across the southern Plains, followed by strong westerly winds ahead of a cold front February 25-26 and strong northerly winds behind the front. Several new and significant fires began during this event, including one of the largest fires in modern US history – the Smokehouse Creek Fire, which burned over 1 million acres in the Texas Panhandle into western Oklahoma, with almost all the fire growth occurring in the first 48 hours after ignition. Above average fine fuel loading resulting from 2023's wet, productive growing season in the southern Plains contributed to the February fire outbreak and kept risk elevated for several more weeks, as noted in a Fuels and Fire Behavior Advisory jointly issued by the Southwest, Southern, and Rocky Mountain Geographic Area Coordination Centers (GACCs) for their respective portions of the southern Plains and adjacent grass-dominated landscapes.

Warm and dry conditions throughout much of March in the central Appalachians led to an increase in activity there too, with strong westerly winds and low relative humidity leading to an outbreak of fires in western Virginia and the deployment of two complex incident management teams. By the end of March, the national year-to-date number of fires remained below average, but the cumulative acres burned was well above average at 350%, mainly due to the Smokehouse Creek Fire.

April – June

Temperatures were a bit above normal across much of the US for April, except for the West Coast, Southwest, and Florida, which were near to below normal. Drier than average conditions were observed in the West, especially the Northwest, while abundant precipitation fell in the northern Plains, Midwest, and East Texas into Louisiana. Snowmelt commenced in April from the mountains in the West, but SWE values remained near to above average in the southern half of the West. However, snowpack diminished across Washington into the northern Rockies, with most basins retaining only 50% of median SWE, and many locations below 5,000 feet becoming snow-free by the end of April. A cooler and wetter than normal May for the northern Rockies resulted in a slower melting of snow, while the southern half of the West lost most of its snowpack. Most areas in the West were snow free by the end of June, except at the highest elevations. Across much of the West, June featured above normal temperatures and below normal precipitation, but much of the Southwest and Four Corners were exceptionally wet for June. By the end of June, drought had developed in much of Washington and persisted in the northern Rockies, while the Southwest, especially Arizona, had significant improvement.

After a warm and dry winter with little snow in the Midwest, April and May turned sharply wetter with above normal precipitation alleviating fire concerns. Much of the eastern half of Texas into Louisiana was very wet for the spring quarter, as well, with several bouts of severe weather. Two strong derechos affected East Texas in May with significant damage and power outages, the first in Houston and the northwest Gulf Coast May 16-17, with the second affecting the Dallas area May 28. Much of the rest of the eastern US had precipitation anomalies closer to normal April through June, but much of Virginia and the Carolinas received less than 75% of normal precipitation. Drought was removed from much of the Midwest because of the wet quarter, but drought emerged across much of the East Coast, from north Florida through Virginia, with portions of the Ohio Valley abnormally dry, as well.

Despite the relatively dry spring across much of the Great Basin and interior Northwest, abundant fine fuels, in terms of both fuel loading and continuous coverage across landscapes, carried over from the prior years' productive growing seasons and contributed to elevated fire risk. In California, favorable precipitation and temperature alignments throughout the winter and spring allowed prolific growth in herbaceous vegetation, further adding to above normal fuel loading across many grass-dominated landscapes.

Significant fire activity peaked for the spring fire season in the Southern and Eastern Areas in early April before declining, while fire activity in the West began to increase slowly but absent significant fires. A brief pulse of increased fire activity occurred in the Midwest during a wind event in mid-April but was quickly followed by abundant rainfall. Two strong wind events occurred on the Plains April 14-15 and April 25-28, but few significant fires emerged.

A steady but modest seasonal increase in fire activity warranted elevating to national Preparedness Level two (PL 2; on a scale ranging from 1 to 5) on May 21, yet significant fire activity remained below normal across the US during May and June. Wildfire activity remained low in much of the Southern Area, with infrequent bursts of activity in Texas and Florida. Dry and windy conditions across the Southwest into the southern High Plains May 23 and 25 resulted in significant growth of the ongoing Blue 2 and Indios Fires in New Mexico, but significant fire activity overall remained minimal through May.

A greater increase in fire activity occurred the latter half of June due to a prolonged period of above normal temperatures and dry conditions across the West, reflected in the escalation to national PL 3 on June 28. A dry northerly wind event in northern California June 16 resulted in several new significant fires, and dry lightning June 24-26 resulted in several significant fires in the southern Sierra. Both events illustrated that accumulated fine fuels from abundant grass crops following the past two wet winters were cured and available to burn. However, the most significant event of the month was a period of dry southwest winds across New Mexico June 17, resulting in South Fork and Salt Fires that burned several hundred structures in and around the Village of Ruidoso. A sudden increase in moisture followed June 19-23 across New Mexico, rapidly replacing the fire threat with several damaging debris flows from the burn scars. Alaska also observed a large increase in significant fire activity during the last ten days of June, with several large fires emerging across the Interior.

In late June, two new Fuels and Fire Behavior Advisories were issued. One was relatively short-lived, describing the abnormally high fire danger in the central and northeast Interior of Alaska due to dry fuels, including deeper layers of ground fuels. The other noted the abundant fine fuels and increasingly abnormal dryness in both live and dead woody fuels in California, an elevated risk factor that would persist through most of the remainder of the year.

July – September

Significant fire activity increased rapidly during the first half of July, with activity remaining at extreme levels through the end of the month. The national PL increased from PL 3 to PL 4 July 10, and then again to PL 5, the highest possible level, on July 18. Much of the significant fire activity was in the Northwest Geographic Area, but the Northern Rockies, Great Basin, and California Geographic Areas also had long duration incident management team wildfires on the landscape. The Southwest continued at moderate levels of significant fire activity through July, but Alaska had a rapid decrease in activity during the month. Joining the aforementioned California advisory that was first issued in late June, several more Fuels and Fire Behavior Advisories were issued in July, collectively encompassing most of the Great Basin and interior Northwest, plus southwest Oregon.

An extreme and long-lasting heat wave encompassed much of the West the first three weeks of July. Several all-time high temperatures records were set in portions of the West, including Palm Springs, California, at 124°F, Las Vegas, Nevada, at 120°F, and Redding, California, at 119°F. Widespread monthly and daily record high temperatures were set across the rest of the West during the period, as well. The extreme heat was also coupled with well below normal

precipitation which rapidly dried fuels across the West. Drought expanded and intensified across much of the Northwest into the northern Rockies, and across portions of northern California.

A significant dry lightning outbreak occurred July 13-15 along the West Coast into the northern Rockies resulting in dozens of new large fires, with most of the fires in the Northwest. Another dry lightning event occurred July 21-23 with dozens of additional large fires, again focused on the Northwest, northern Great Basin, and Northern Rockies. The Durkee, Willamette Complex, and Diamond Complex Fires in the Northwest started during these lightning events, with the Northwest Geographic Area elevating from GACC PL 2 at the beginning of the month to PL 5 July 19. The Wapiti Fire in central Idaho emerged during the second event and continued to burn for the next three months. In addition, the Park Fire in northern California burned over 350,000 acres in the first 72 hours after ignition July 24, while the Falls Fire in central Oregon produced pyrocumulonimbus clouds for several days, illustrating the extreme burning conditions late in the month. However, Alaska observed a significant decrease in activity throughout July as a wet pattern developed with periods of wetting rain, occasionally heavy, occurred during the month. This prompted Alaska Geographic Area to drop from GACC PL 5 at the beginning of the month to PL 2 by July 15.

As the North American Monsoon was slow to develop, Southwest Area continued to be active throughout July with periodic significant fires, remaining at GACC PL 3. Conditions across the eastern US remained quiet during July, with above normal rainfall observed across much of central and East Texas, the Mississippi Valley, and Southeast. However, precipitation was below normal in the Upper Ohio Valley and central Appalachians, creating areas of extreme drought that persisted into August, with above normal fire activity in these areas, but few large fires.

A very high level of fire activity continued across the West through the first half of August. A third significant lightning outbreak August 3-5 across the northern half of the West resulted in numerous new fires, including the Middle Fork Complex in central Idaho. Due to the continued extreme activity, sixty firefighting personnel from Australia and New Zealand, along with 245 active-duty soldiers from Joint Base Lewis McChord, were mobilized to aid suppression efforts the first half of the month, with these personnel remaining engaged through mid-September. By mid-August, persistent upper-level troughing developed over the Northwest with much cooler conditions and periods of precipitation, resulting in the decrease in activity across northern California and the Northwest. However, ahead of the trough, periods of strong winds were observed in central Idaho, with the Wapiti and Middle Fork Complex Fires exhibiting significant growth.

Strong winds were also observed east of the Rockies in southeast Montana and northeast Wyoming August 21-23, with numerous significant fires, the largest of which, the Remington Fire, burned over 40 miles from Wyoming into Montana. That northern High Plains area, ultimately extending from the northern Front Range of Colorado through eastern Wyoming into southeast Montana, was highlighted with successive Fuels and Fire Behavior Advisories starting in early August and continuing through September due to above normal fine fuel loading amid persistently dry and often breezy conditions.

Aside from the wind-driven fires in the northern High Plains noted above, significant fire activity gradually decreased elsewhere from mid to late August. The drop to national PL 4 on August 22 was consistent with the typical timing for the seasonal pivot to progressively decreasing wildfire activity in prior fire seasons that attained PL 5. The Northwest Geographic Area observed the greatest decrease in activity, with California, Northern Rockies, and Southwest Geographic Areas also seeing a decline in activity. A significant rainfall event in mid-August triggered the decrease in activity across the northwestern US, while the North American Monsoon finally arrived in the Southwest the second week of August. However, significant fire activity continued to increase across the Great Basin Geographic Area, particularly in central Idaho where numerous significant fires were burning at the end of August.

For the southern and eastern US, a very dry September was observed across much of the Upper Mississippi Valley and Great Lakes, with many areas receiving less than 25% of normal precipitation. This dryness extended into the central and southern Appalachians through much of the month, as well, with fire activity slowly increasing across these areas during September although few significant fires were reported. At the end of the month, Hurricane Helene moved from north Florida into the central and southern Appalachians, with extremely heavy rainfall and catastrophic flooding. Helene ended the fire threat in the southern Appalachians, but it also contributed to extensive blowdown, which is likely to impact fire potential (due to hazard fuel accumulations) for the next few years, plus fire response (due to obstructed access) in the shorter term.

As September began in the West, a widespread dry lightning outbreak September 1-3 resulted in another large increase in significant fire activity across the northwestern tier of states. Several new large fires emerged in Oregon and Idaho. While many fires burned aggressively, the Rail Ridge and Lava Fires exhibited extreme growth, with the Lava Fire producing a long-lived pyrocumulonimbus September 7. Around the same time, a period of extreme heat in southern California resulted in the Airport, Bridge, and Line Fires. These events prompted the rare reescalation to the national PL 5 on September 6 (a second seasonal ascent to PL 5 had arisen only twice before – in August 2002 and August 2003).

Fire activity then moderated in mid-September as a cold and wet storm moved through the northern half of the West, with some areas in central Idaho and western Montana receiving more than one inch of rainfall. This season-slowing event for the Northwest, northern Great Basin, and Northern Rockies Geographic Areas fostered the return to national PL 4 on September 20 and the further descent to PL 3 on September 26. However, on the back side of the storm, another heat wave developed across the West, with Phoenix, Arizona, reaching 117°F September 28, setting a new monthly record, and Rapid City, South Dakota, hitting 100°F the following day. The anomalous heat so late in the season resulted in a slow increase in fire activity but national PL 3 endured through the end of the month. At the end of September, national year-to-date acres burned for the US was above the 10-year average at 131%, with a below average number of fires of near 84%.

October – December

Significant fire activity increased a third time in early October as the anomalous heat at the end of September continued through the first ten days of October. While fewer new fires arose in

early October, ongoing significant fires showed a marked uptick in activity, and several fires that had been relatively quiet for several weeks also experienced significant growth. With this increase in activity across the West, reescalation to national PL 4 occurred on October 4 and then again to an unprecedented third seasonal PL 5 period on October 8. Several westerly wind events also occurred during this time, the strongest of which October 4-5 resulted in a 15-mile run by the Red Rock Fire near Salmon, Idaho. This weather event also resulted in numerous new significant fires across western North Dakota. Fire activity in the West finally saw a rapid and lasting decrease due to a strong fall storm October 17-19, with widespread wetting rain and snow falling in the mountains. This belated onset of favorable weather in mid-October minimized fire behavior on most existing fires and largely negated the potential for new significant fire activity across most of the Northwest, Great Basin, Rockies, and northern Plains, thereby triggering the latest ever final descent to national PL 4, on October 18. Further de-escalation rapidly followed, with the onset of national PL 3 October 22, ending the second longest collective national PL4 and PL5 period of 96 days that began in July (nearly eclipsing the record of 99 days in 2021). Descent to national PL 2 occurred a week later, on October 29.

Parts of the greater Southwest, most notably southern California and parts of Arizona remained mostly dry through October and beyond. Anomalously warm and dry conditions were not confined to the West in October, as well above normal temperatures were also observed on the Plains throughout October, and very dry conditions were observed from the Plains to the East Coast. Drought expanded progressively through the summer and into the fall across multiple large areas of the US, and by early November, 87% of the continental US was classified as abnormally dry or in drought. This is the greatest amount (percent area afflicted) recorded in the 25 years since the inception of the US Drought Monitor. Extreme and exceptional drought expanded across the Upper Ohio Valley, and intensified across the northern High Plains, and portions of the southern Plains. Severe drought developed in portions of the Upper Mississippi Valley, Great Lakes, and Mid-Atlantic, as well. Fire activity increased moderately in many of these drought-afflicted areas, especially in the Great Lakes during October, with a few significant fires arising in Minnesota and Wisconsin. Intensification of drought triggered the re-issuance of a Fuels and Fire Behavior Advisory for parts of Mississippi and Alabama in late October; however, only a few larger fires arose, and those were all relatively short in duration. Fire activity also increased on the southern Plains in the fall, with several significant fires emerging October 28-29 when strong southerly winds developed.

In November, significant fire activity continued to slowly decline nationally outside of couple hotspots, and the national PL reverted to PL 1 November 13, which is about three weeks later than the average end-of-season onset of PL 1. Nonetheless, very dry conditions continued in the Mid-Atlantic and Northeast, where fire activity continued at elevated levels, with periodic significant fires continuing to emerge, most notably the Butternut Fire in Massachusetts and the Jennings Creek Fire on the New York-New Jersey border. Massachusetts recorded their most active fall fire season in over 40 years, and significant activity was also noted in Pennsylvania. Drought continued to intensify in this region, but a strong Nor'easter November 21-23, bringing rainfall of one to three inches, abruptly ended the fall fire season in the Northeast.

While the Northeast was dry for much of the month, November was considerably wetter than normal across much of the Plains into the Upper Mississippi Valley and western Great Lakes,

ending the significant fire threat in the Great Lakes. While portions of the Southeast remained dry in November, the anomalously warm conditions delayed leaf drop, resulting in a lower fine fuel load than typically seen in the fall. In the West, above normal precipitation continued in much of northern California and the Northwest, and into portions of the Great Basin, but southern California remained very dry. A strong Santa Ana wind event November 6-8 resulted in the Mountain Fire that burned hundreds of structures near Santa Paula, California.

An active weather pattern continued across the northern half of the West in December, with numerous atmospheric rivers making landfall the latter half of the month from northern California into the Northwest. Above normal precipitation was observed in these areas, spreading into northern Nevada and southern Idaho. However, precipitation was well below normal in southern California, the Southeast, and southern and central High Plains, with some locations in southern California and the Southwest recording no precipitation for December. Snowpack in the West at the end of December mimicked the precipitation anomaly with near to above normal snowpack and SWE in the Sierra and northern half of the West, with well below normal SWE in the Southwest. The persistently dry conditions continued to make fuels highly receptive for any Santa Ana wind events in southern California. A strong Santa Ana event December 9-10 produced wind gusts up to 75 mph and resulted in the Franklin Fire near Malibu that burned dozens of structures and served as a precursor for other catastrophic wildfires that would arise around the Los Angeles area in January 2025.

Dry conditions also continued across the southern and central High Plains, but southwesterly wind events that occurred were not excessively strong and only locally increased initial attack. The strongest wind event occurred December 28-29 behind a dry line with few fires, but this same storm resulted in a significant severe weather outbreak from East Texas into the Deep South. Numerous tornadoes were reported with this storm along with several deaths due to the severe thunderstorms. Much of the US east of the Mississippi River received near normal precipitation, but the Southeast coast and much of Florida was considerably drier than normal. While fuels dried, few significant fires were reported. The Hawai'ian Islands remained drier than normal through December with periods of strong trade winds, most notably November 15-16 and December 11-12. Initial attack remained elevated compared to normal across the islands, with the 100-acre Ma'alaea Fire on Maui November 14 being the largest fire reported during the two months.

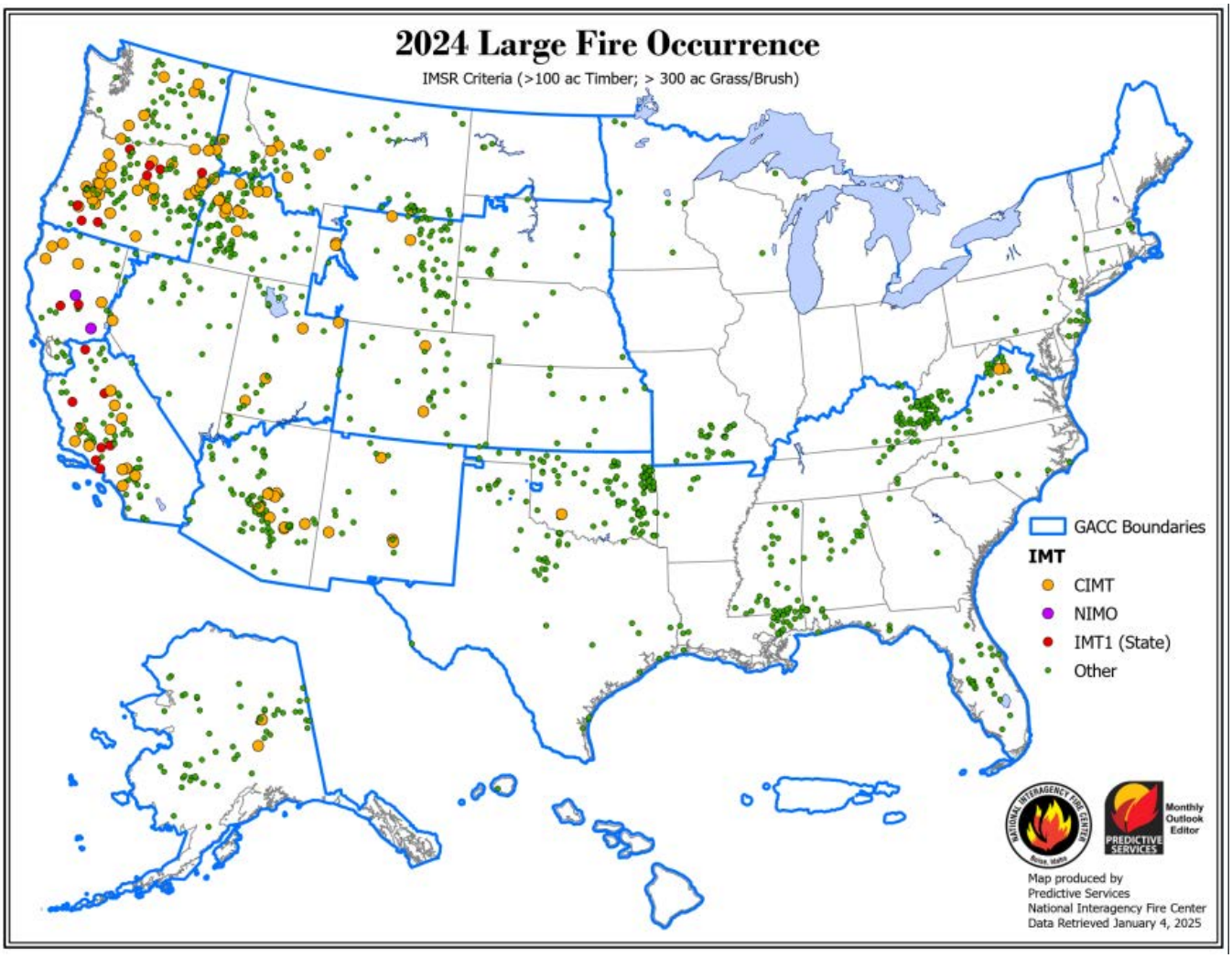
Fire activity generally remained at low levels throughout much of the US as the year ended. A limited number of large fires burned briefly across the country in December, mainly in Eastern, Southern, and Rocky Mountain Areas. Under persistent dry conditions, the Southwest elevated to GACC PL 2 on December 20, with two significant fires burning near or on the Mogollon Rim. Southern California remained at GACC PL 2 at the end of the year with elevated risk of new significant fires due to dry fuels and problematic offshore winds. At the end of the year, annual acres burned for the US in 2024 remained above the 10-year average at 127%, with a slightly above average number of fires, at 104%.

National Fire Activity Synopsis

Nationally, there were 64,897 wildfires reported in 2024, compared to 56,580 wildfires reported in 2023. Reported wildfires consumed 8,924,884 acres, compared to 2,693,910 acres in 2023.

In 2024, the reported number of wildfires and acres burned nationwide was noticeably higher than the five and10-year averages. Seven out of the ten geographic areas saw above average numbers of wildfires and acres burned. The Southern Area had the highest number of wildfires, while the Northwest Area had the most acres burned.

A total of 4,552 structures were reported destroyed by wildfires in 2024, including 2,406 residences, 2,066 minor structures, and 80 commercial/mixed residential structures. In 2024, the Southwest Area accounted for the highest number of structures with 1,455 total structures destroyed.



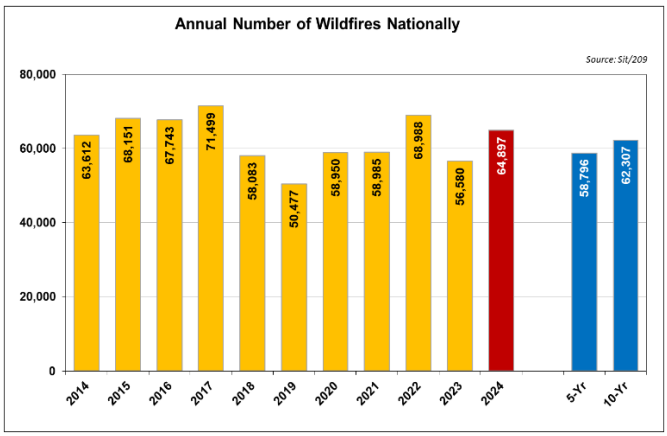
Structures Destroyed

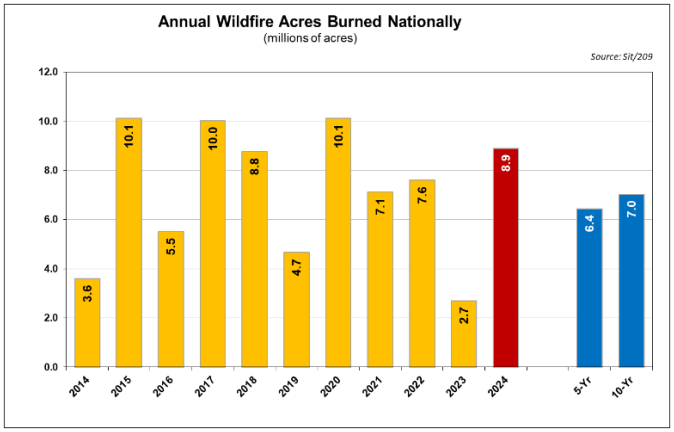
GACC	Single Residences	Mixed Commercial-Residential	Multiple Residences	Nonresidential Commercial Property	Other Minor Structures	Total
AK	0	0	0	0	5	**5**
EA	6	0	0	2	35	**43**
GB	31	9	0	12	63	**115**
NO	462	0	0	7	299	**768**
NR	44	0	0	0	131	**175**
NW	82	0	0	2	181	**265**
RM	49	0	0	10	116	**175**
SA	170	0	0	7	557	**734**
SO	551	2	1	12	251	**817**
SW	1,003	7	7	10	428	**1,455**
Total	**2,398**	**18**	**8**	**62**	**2,066**	**4,552**

***Disclaimer: Statistics above were reported through the SIT/209 application, actual number of structures destroyed could be higher depending on how structure loss is reported at the county level.

National Wildfire Activity

In 2024, there were 64,897 wildfires that burned 8,924,884 acres. The total number of fires and acres burned were both above the five and 10-year averages.

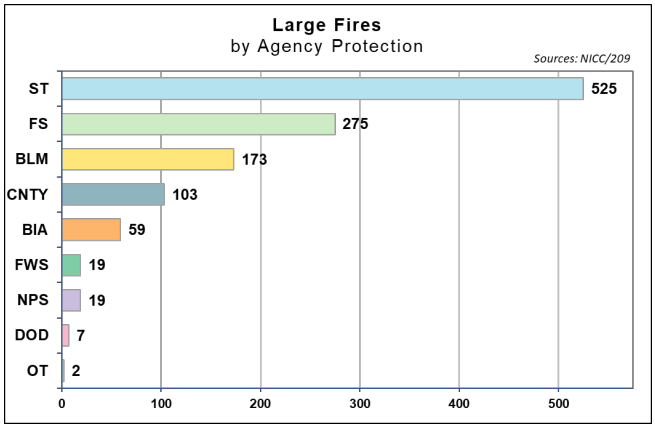


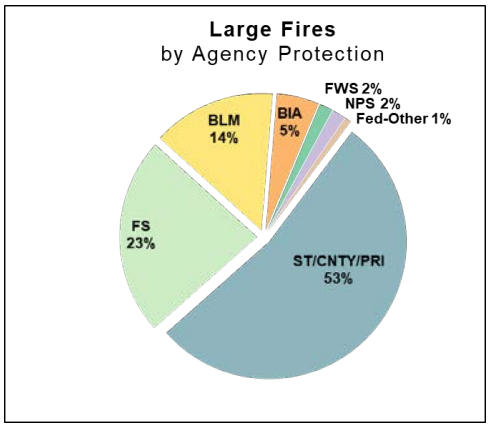


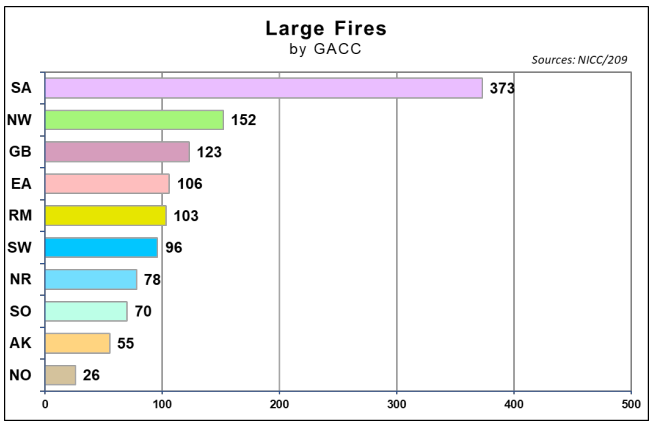
Large Wildfires by Geographic Area and Agency

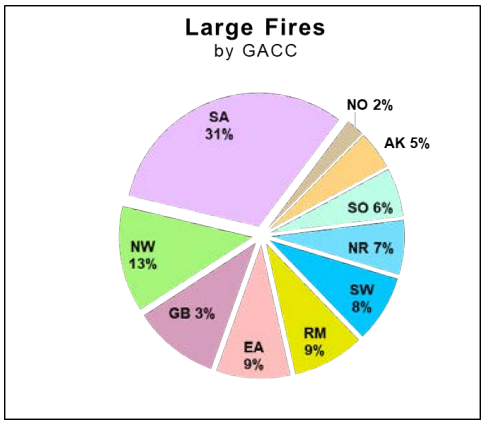
Large fires are defined in the National Interagency Standards for Resource Mobilization as fires that burn a minimum of 100 acres in timber fuel models and 300 acres in grass fuel models.

There were 1,188 large wildfires and complexes reported through the SIT/209 application. Large wildfires represented less than 2% of total wildfires reported nationally in 2024.



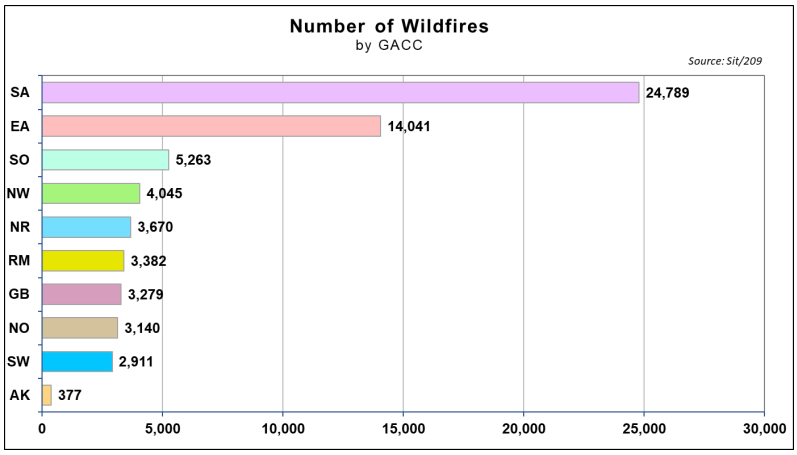


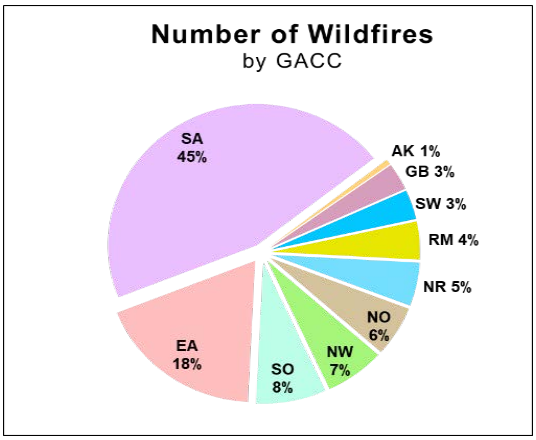


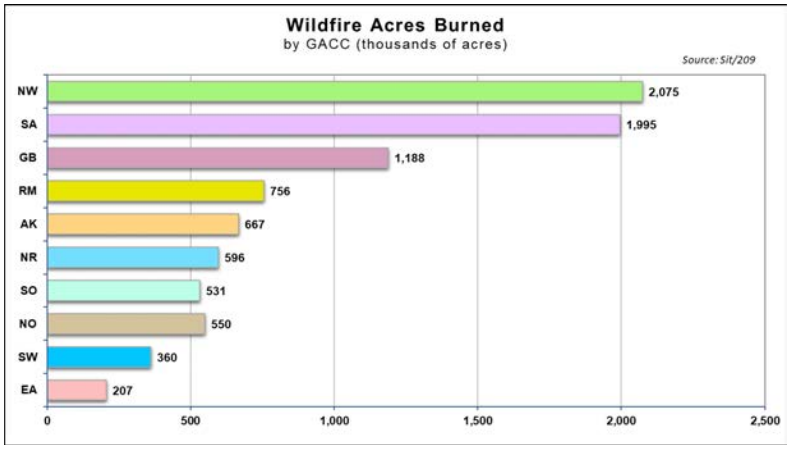


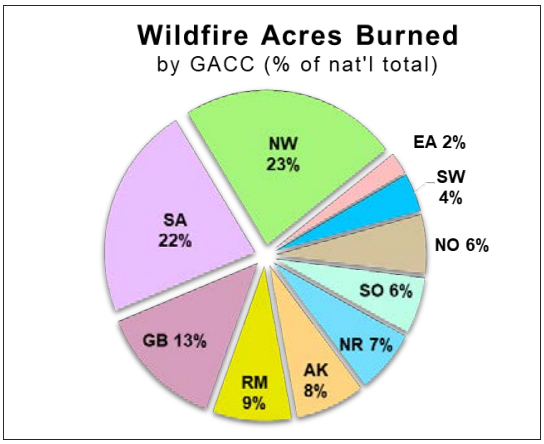
Wildfires by Geographic Area

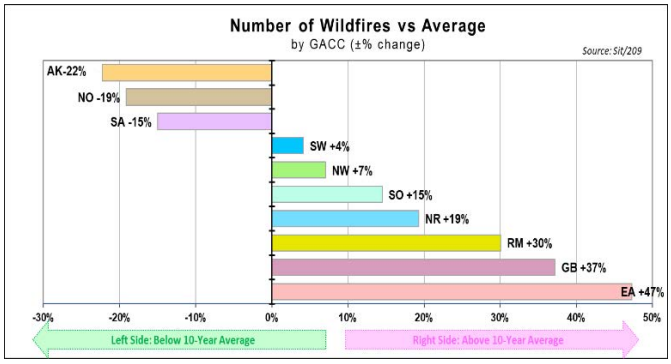
In 2024, the Southern Area accounted for just over a third of the overall distribution of wildfires, while the Northwest Area had the largest proportion of acres burned in the United States.

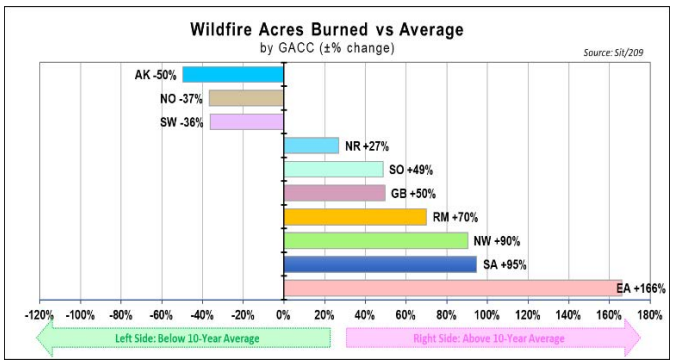






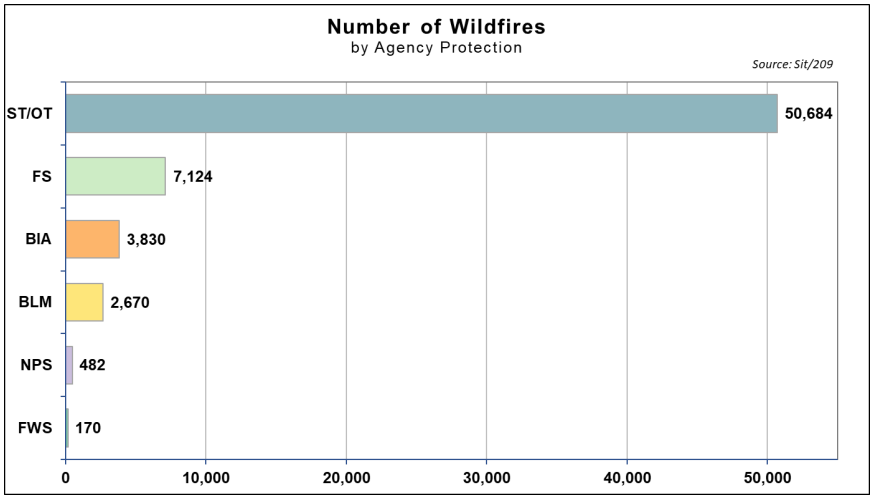


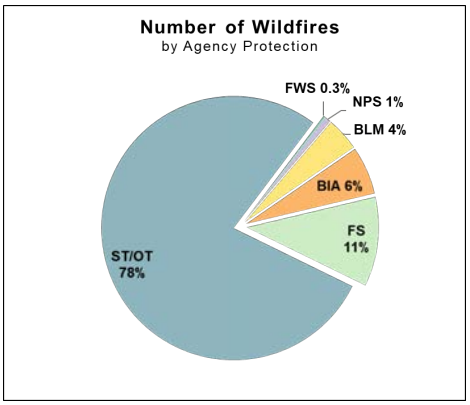


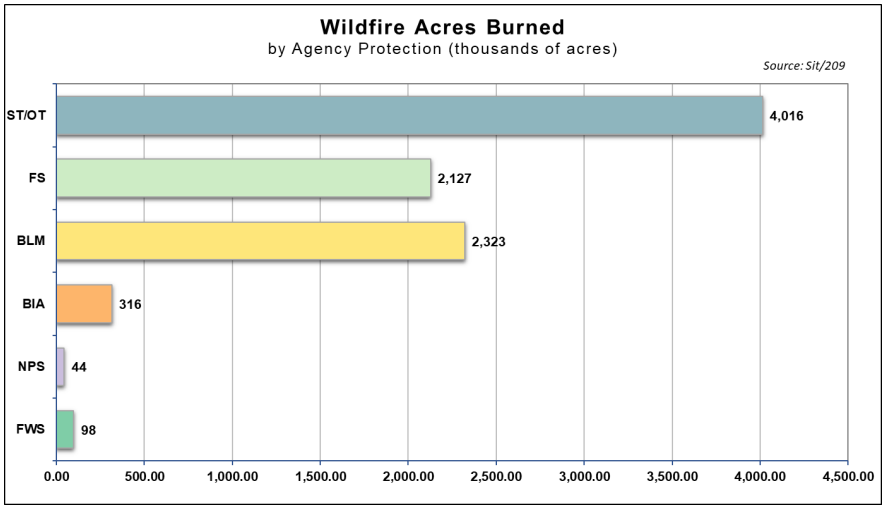


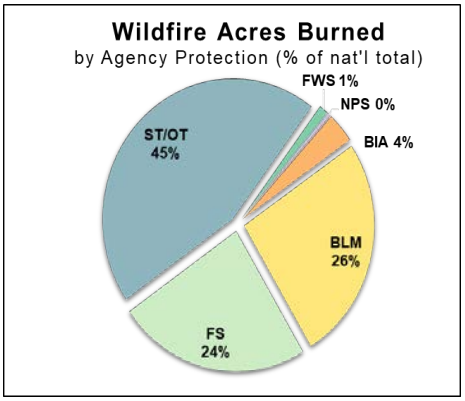
Wildfires by Agency

The distribution of wildfires by protection agency in 2024 was similar to prior years. About one-fifth of the nation's fires occurred on federally protected lands. Most wildfires, however, ignited on private lands, or under state or local protection.









Wildfires over 40,000 acres

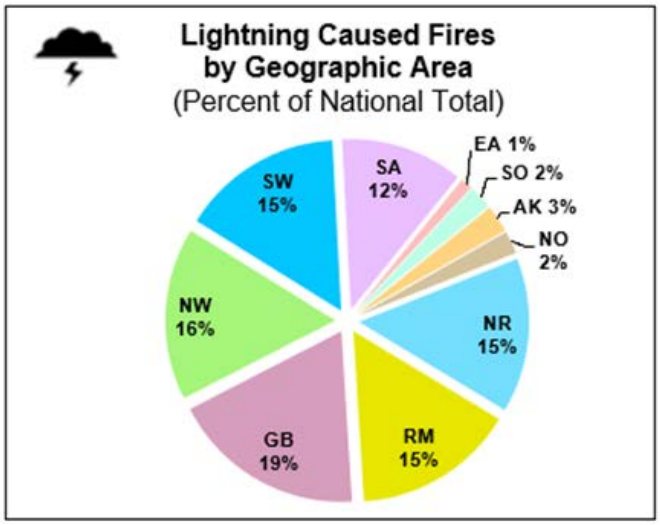
Name	GACC	State	Start Date	Last Report Date	Size In Acres	Cause*
Betty's Way	RM	NE	2/26	3/11	69,810	U
Smokehouse Creek	SA	TX	2/26	3/17	1,054,153	H
Catesby	SA	OK	2/27	3/15	89,688	H
McDonald	AK	AK	6/8	7/20	152,227	L
Midnight	AK	AK	6/19	7/9	52,550	L
Grapefruit Complex	AK	AK	6/28	7/13	89,011	U
Falls	NW	OR	7/10	8/21	151,689	H
Cow Valley	NW	OR	7/11	8/9	133,490	U
Lone Rock	NW	OR	7/13	8/31	137,222	U
Boneyard	NW	OR	7/17	7/25	49,716	L
Durkee	NW	OR	7/17	9/4	294,265	L
Battle Mountain Complex	NW	OR	7/18	9/14	183,026	U
Monkey Creek	NW	OR	7/18	7/20	115,269	U
Swawilla I	NW	WA	7/18	11/3	53,462	L
Telephone	NW	OR	7/22	8/21	54,005	L
Crazy Creek	NW	OR	7/22	9/25	86,968	L
Big Horn	NW	WA	7/22	7/30	51,569	U
Badland Complex	NW	OR	7/23	8/14	54,617	U
Retreat	NW	WA	7/23	10/1	45,601	H
Park	NO	CA	7/24	9/25	429,603	U
Borel	SO	CA	7/24	9/14	59,288	U
Wapiti	GB	ID	7/24	10/24	129,063	L
Hole In The Ground	NW	OR	7/24	8/1	98,855	L
Paddock	GB	ID	8/5	8/17	187,185	L
Warner Peak	NW	OR	8/5	8/23	65,866	L
Nellie	GB	ID	8/6	8/8	48,196	L
Middle Fork Complex	GB	ID	8/8	10/24	61,496	U
Flat Rock	RM	WY	8/21	9/12	52,421	U
House Draw	RM	WY	8/21	9/12	174,547	L
Remington	RM	WY	8/22	9/19	196,368	U
Red Rock	GB	ID	9/2	10/28	79,260	L
Rail Ridge	NW	OR	9/2	10/31	176,661	L
Lava	GB	ID	9/3	10/24	97,585	L
Line	SO	CA	9/4	12/24	43,978	U
Bridge	SO	CA	9/8	12/29	56,030	U
Pack Trail	RM	WY	9/18	11/2	89,930	L
Elk	RM	WY	9/27	11/14	98,352	U

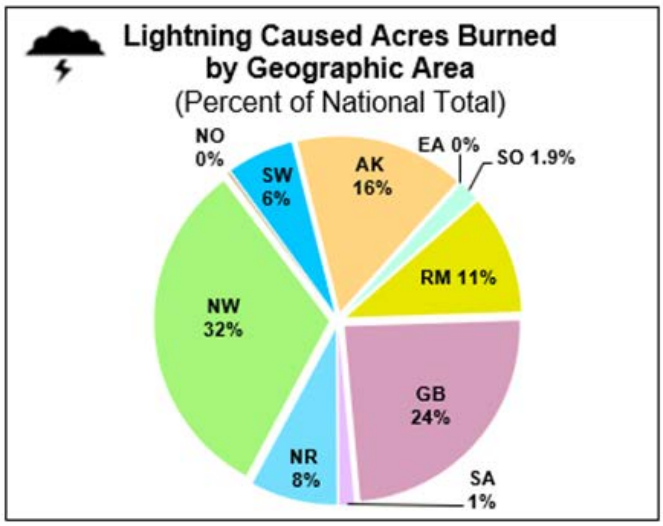
* L = Lightning H – Human U – Undetermined NR – Not Reported

Information in the above table was derived from the Sit/209 Application. This information may not reflect final official figures.

Lightning Caused Fires and Acres by Geographic Area

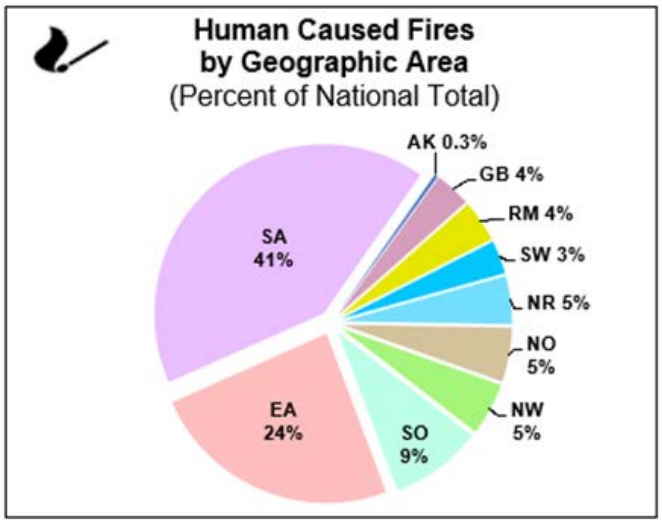
Fires/ Acres	AK	EA	GB	NO	NR	NW	RM	SA	SO	SW	Total
Fires	180	80	1,281	148	1,017	1,134	1,066	809	156	1,064	6,935
Acres	663,564	498	1,024,949	10,919	339,858	1,354,814	465,802	57,789	79,372	260,766	4,258,331

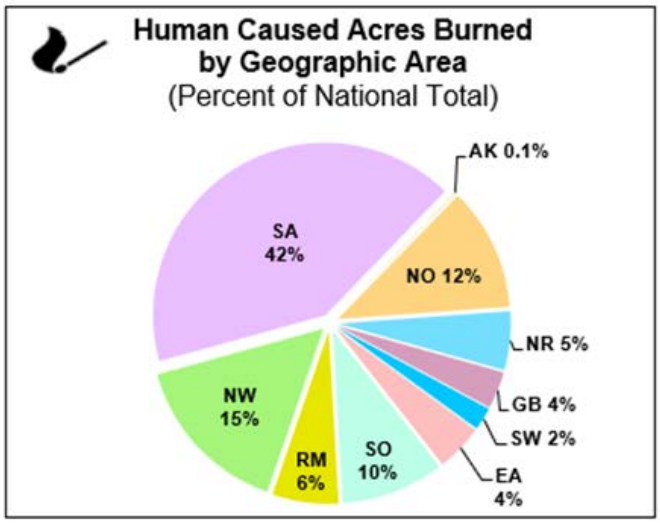




Human Caused Fires and Acres by Geographic Area

Fires/ Acres	AK	EA	GB	NO	NR	NW	RM	SA	SO	SW	Total
Fires	197	13,961	1,998	2,992	2,653	2,911	2,316	23,980	5,107	1,847	57,962
Acres	3,512	206,169	163,215	539,170	256,481	719,771	289,709	1,937,041	451,843	99,642	4,666,553





Wildfires and Acres Burned by Agency and GACC – 2024 & prior years

Agency Fires/Acres	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	5-Yr Avg.	10-Yr Avg.
BIA Fires	3,377	3,886	4,056	3,843	3,472	2,830	4,740	4,646	3,182	2,633	3,830	3,606	3,667
BIA Acres	327,352	591,644	325,162	306,542	216,118	151,305	923,298	396,433	255,552	192,807	316,364	383,879	368,621
BLM Fires	1,944	2,093	2,105	2,927	2,872	2,046	2,362	2,241	1,934	1,836	2,607	2,084	2,236
BLM Acres	871,642	4,770,133	1,183,821	2,711,267	1,905,343	2,024,554	1,131,540	412,155	1,752,793	274,004	2,323,096	1,119,009	1,703,725
FS Fires	6,755	7,056	5,676	6,617	5,629	5,332	6,738	6,244	5,852	5,252	7,124	5,884	6,115
FS Acres	871,876	1,916,302	1,247,906	2,866,031	2,307,439	615,816	4,814,465	4,126,564	1,865,791	831,465	2,127,309	2,450,820	2,146,366
FWS Fires	348	194	174	252	162	175	238	307	196	199	170	223	225
FWS Acres	17,404	33,897	15,374	206,393	71,137	91,311	52,739	51,264	20,659	30,707	98,041	49,336	59,089
NPS Fires	389	398	463	314	389	290	304	361	332	484	482	354	372
NPS Acres	24,949	74,780	177,901	110,349	121,092	27,533	145,447	131,182	28,615	137,242	44,103	94,004	97,909
State/Other Fires	50,799	54,524	55,269	57,546	45,559	39,804	44,568	45,186	57,492	46,176	50,684	46,645	49,692
State/Other Acres	1,482,390	2,738,393	2,559,831	3,825,504	4,146,363	1,753,843	3,054,847	2,008,045	3,653,773	1,227,685	4,015,973	2,339,639	2,645,067
Total Fires:	63,612	68,151	67,743	71,499	58,083	50,477	58,950	58,985	68,988	56,580	64,897	58,796	62,307
Total Acres:	3,595,613	10,125,149	5,509,995	10,026,086	8,767,492	4,664,362	10,122,336	7,125,643	7,577,183	2,693,910	8,924,884	6,436,687	7,020,777

GACC Fires/Acres	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	5-Yr Avg.	10-Yr Avg.
AK Fires	384	768	572	364	367	720	349	384	595	346	377	479	485
AK Acres	233,561	5,111,404	496,467	653,023	410,683	2,498,159	181,169	253,356	3,110,976	314,277	667,076	1,271,587	1,326,308
EA Fires	7,030	11,639	11,270	9,816	6,891	5,750	13,175	10,855	8,592	10,317	14,041	9,738	9,534
EA Acres	54,141	100,294	98,042	41,705	50,734	38,852	63,036	152,669	64,342	113,416	206,667	86,463	77,723
GB Fires	2,250	2,096	2,063	3,127	2,776	2,308	2,958	2,449	2,121	1,751	3,279	2,317	2,390
GB Acres	164,802	505,483	761,622	2,103,788	2,087,922	459,384	948,812	373,165	436,598	97,656	1,188,164	463,123	793,923
NO Fires	4,082	4,587	3,363	4,173	3,602	3,704	4,678	3,962	3,429	3,249	3,140	3,804	3,883
NO Acres	474,826	594,048	96,706	672,448	1,496,950	214,742	2,779,003	1,945,506	246,990	189,647	550,089	1,075,178	871,087
NR Fires	2,665	3,817	2,700	3,900	2,741	2,309	3,404	4,052	2,710	2,468	3,670	2,989	3,077
NR Acres	143,271	745,947	202,140	1,551,275	147,093	74,042	403,046	1,069,660	223,746	137,654	596,339	381,630	469,787
NW Fires	4,572	4,603	2,519	3,404	3,764	3,690	3,853	4,075	3,611	3,687	4,045	3,783	3,778
NW Acres	1,383,514	1,823,473	513,226	1,121,442	1,336,096	249,476	1,983,970	1,503,026	631,605	353,367	2,074,585	944,289	1,089,920
RM Fires	2,356	2,559	3,289	3,164	2,480	1,684	2,852	3,316	2,392	1,908	3,382	2,430	2,600
RM Acres	78,345	180,822	686,921	754,747	748,956	114,685	1,021,951	336,187	273,503	249,363	755,511	399,138	444,548
SA Fires	34,267	31,594	34,474	35,068	27,721	22,999	18,773	22,164	38,945	25,708	24,789	25,718	29,171
SA Acres	752,694	556,267	1,591,044	1,960,764	1,591,101	498,925	556,902	532,835	1,518,116	682,996	1,994,830	757,955	1,024,164
SO Fires	3,786	4,175	3,996	5,389	4,453	4,632	5,419	5,324	4,460	4,329	5,263	4,833	4,596
SO Acres	80,218	304,925	479,207	595,873	348,722	55,092	1,144,214	320,378	87,350	155,134	531,215	352,434	357,111
SW Fires	2,220	2,313	3,497	3,094	3,288	2,681	3,489	2,404	2,133	2,817	2,911	2,705	2,794
SW Acres	230,241	202,486	584,620	571,021	549,235	461,005	1,040,233	638,861	983,957	400,400	360,408	704,891	566,206
Total Fires:	63,612	68,151	67,743	71,499	58,083	50,477	58,950	58,985	68,988	56,580	64,897	58,796	62,307
Total Acres:	3,595,613	10,125,149	5,509,995	10,026,086	8,767,492	4,664,362	10,122,336	7,125,643	7,577,183	2,693,910	8,924,884	6,436,687	7,020,777

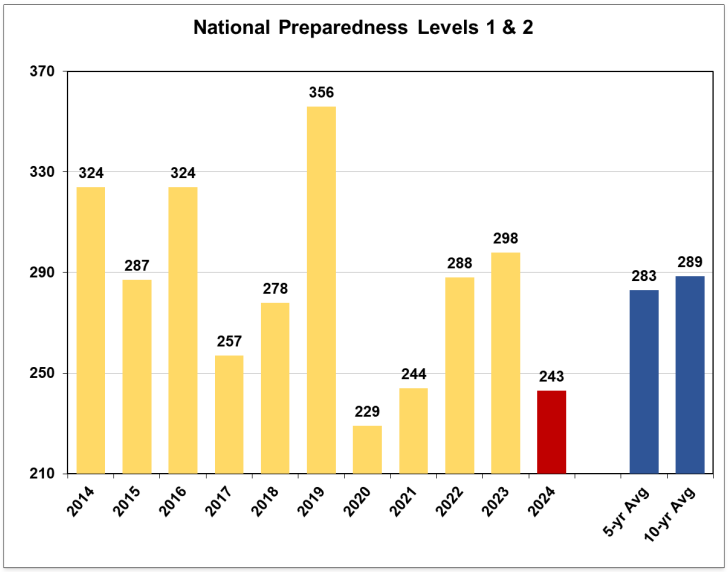
National Preparedness Levels

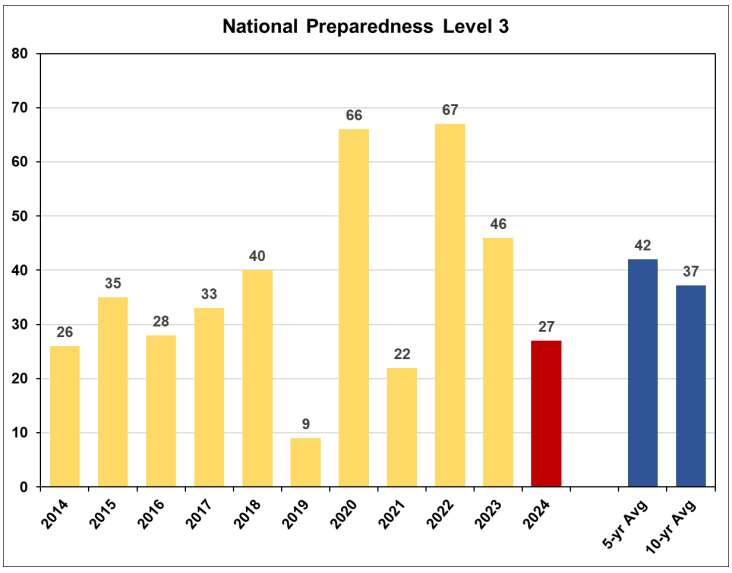
In 2024 the National Preparedness Level (PL) was elevated and decreased accordingly:

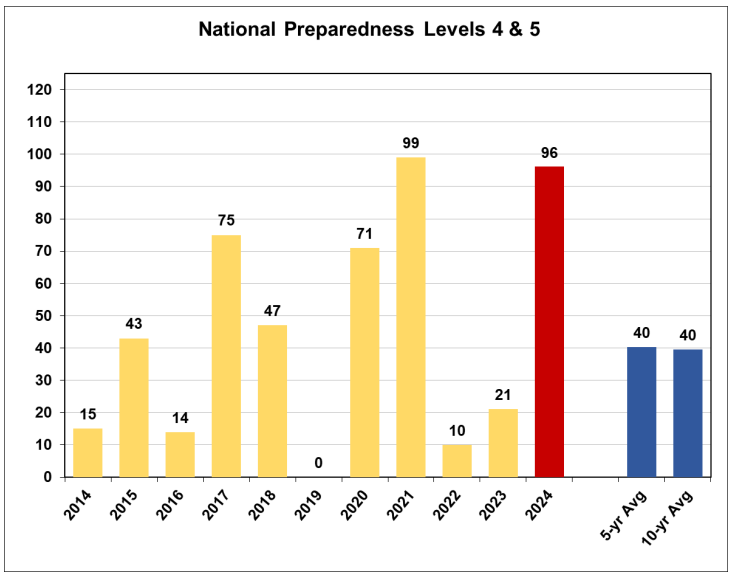
- Elevated from PL 1 to PL 2 on May 21
- Elevated from PL 2 to PL 3 on June 28
- Elevated from PL 3 to PL 4 on July 10
- Elevated from PL 4 to PL 5 on July 18
- Decreased from PL 5 to PL 4 on August 22
- Elevated from PL 4 to PL 5 on September 6
- Decreased from PL 5 to PL4 on September 20
- Decreased from PL 4 to PL 3 on September 26
- Elevated from PL 3 to PL 4 on October 4
- Elevated from PL 4 to PL 5 on October 8
- Decreased from PL 5 to PL 4 on October 18
- Decreased from PL 4 to PL 3 on October 22
- Decreased from PL 3 to PL 2 on October 29
- Decreased from PL 2 to PL 1 on November 13

Total Number of Days at Each National Preparedness Level

PL	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1	31	29	31	30	20	0	0	0	0	0	18	31	**190**
2	0	0	0	0	11	27	0	0	0	3	12	0	**53**
3	0	0	0	0	0	3	9	0	5	10	0	0	**27**
4	0	0	0	0	0	0	8	10	11	8	0	0	**37**
5	0	0	0	0	0	0	14	21	14	10	0	0	**59**
Total:	**31**	**29**	**31**	**30**	**31**	**30**	**31**	**31**	**30**	**31**	**30**	**31**	**366**


National Preparedness Levels 1 & 2
370
330
290
250
210
324
287
324
257
278
356
229
244
288
298
243
283
289
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
5-yr Avg
10-yr Avg


National Preparedness Level 3
80
70
60
50
40
30
20
10
0
26
35
28
33
40
9
66
22
67
46
27
42
37
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
5-yr Avg
10-yr Avg


National Preparedness Levels 4 & 5
120
110
100
90
80
70
60
50
40
30
20
10
0
15
43
14
75
47
0
71
99
10
21
96
40
40
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
5-yr Avg
10-yr Avg

National Preparedness Level Summary

Total Days at National Preparedness Levels

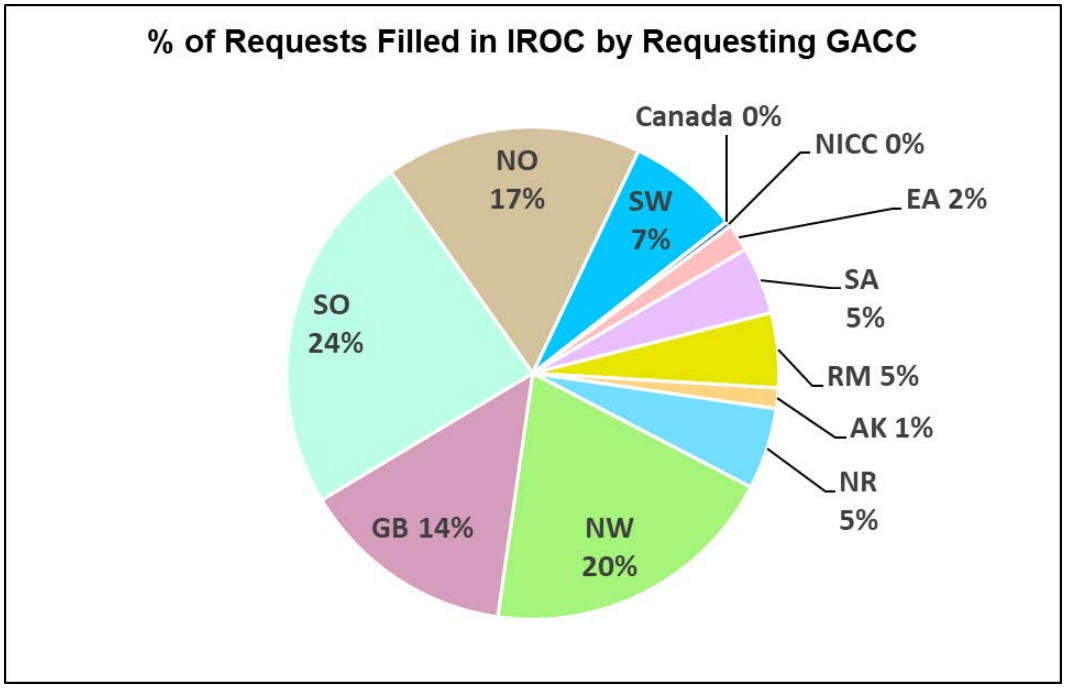
Year	PL 1	PL 2	PL 3	PL 4	PL 5	PL1&2	PL4&5
1990	247	74	31	6	7	321	13
1991	255	103	7	0	0	358	0
1992	278	67	15	6	0	345	6
1993	268	97	0	0	0	365	0
1994	235	26	54	4	46	261	50
1995	254	96	15	0	0	350	0
1996	98	179	60	8	21	277	29
1997	216	149	0	0	0	365	0
1998	157	172	30	6	0	329	6
1999	159	165	33	8	0	324	8
2000	179	73	61	13	40	252	53
2001	188	142	9	10	16	330	26
2002	187	76	14	26	62	263	88
2003	92	155	60	10	48	247	58
2004	249	57	60	0	0	306	0
2005	233	44	47	41	0	277	41
2006	118	137	44	16	50	255	66
2007	212	76	17	21	39	288	60
2008	209	84	15	36	22	293	58
2009	275	62	28	0	0	337	0
2010	231	134	0	0	0	365	0
2011	207	92	59	7	0	299	7
2012	212	49	60	45	0	261	45
2013	253	46	42	17	7	299	24
2014	242	82	26	15	0	324	15
2015	253	34	35	19	24	287	43
2016	251	73	28	14	0	324	14
2017	185	72	33	36	39	257	75
2018	191	87	40	13	34	278	47
2019	241	115	9	0	0	356	0
2020	205	24	66	26	45	229	71
2021	161	83	22	31	68	244	99
2022	152	136	67	10	0	288	10
2023	211	86	46	21	0	298	21
2024	190	53	27	37	59	243	96

Averages	PL1&2	PL 3	PL4&5
Total Days: 5-yr Avg	*283*	*42*	*40*
Total Days: 10-yr Avg	*289*	*37*	*40*

Requests Filled Nationally in IROC

2024 was a well above average year for the wildland firefighter and dispatch community. Over 520,000 requests were filled nationally in IROC. An increase of well over 180,000 orders were filled compared to 2023. The following data shows the number of IROC requests filled in 2024.

GACC	Aircraft	Crew	Equipment	Overhead	Supply	Total
AK	642	89	907	5,107	330	**7,075**
EA	237	90	2,511	6,374	121	**9,333**
GB	4,747	1,345	11,092	53,488	2,932	**73,604**
NICC	67	29	273	1,582	46	**1,997**
NO	9,197	3,482	24,553	48,826	1,729	**87,787**
NR	2,218	545	5,559	18,301	1,209	**27,832**
NW	8,462	2,555	21,278	63,736	6,170	**102,201**
RM	2,551	490	3,370	18,381	795	**25,587**
SA	786	106	3,318	18,297	575	**23,082**
SO	11,082	5,828	33,905	71,095	2,270	**124,180**
SW	2,166	845	4,803	28,189	2,367	**38,370**
Canada	0	0	0	8	0	**8**
Total	**42,155**	**15,404**	**111,569**	**333,384**	**18,544**	**521,056**



**** Disclaimer: Of the 333,384 overhead requests, 249,858 requests were subordinate requests attached to parent aircraft, overhead, crew, and engine requests. Of the 521,056 requests, 7,039 requests were support requests attached to parent aircraft, overhead, crew, and engine requests.*

These statistics are based off an IROC report utilizing the QST1 Request Status Table. Statistics may vary amongst individual Geographic Area annual reports depending on which filters are utilized within the IROC Reports module.

Requests Processed Through the NICC

The following statistics pertain to requests processed through the National Interagency Coordination Center, except for Incident Management Teams, which are captured on a national mobilization scale. This data is broken down by requesting Geographic Area and Requesting Agency. Five and 10-year averages are also provided.

International Resource Mobilizations

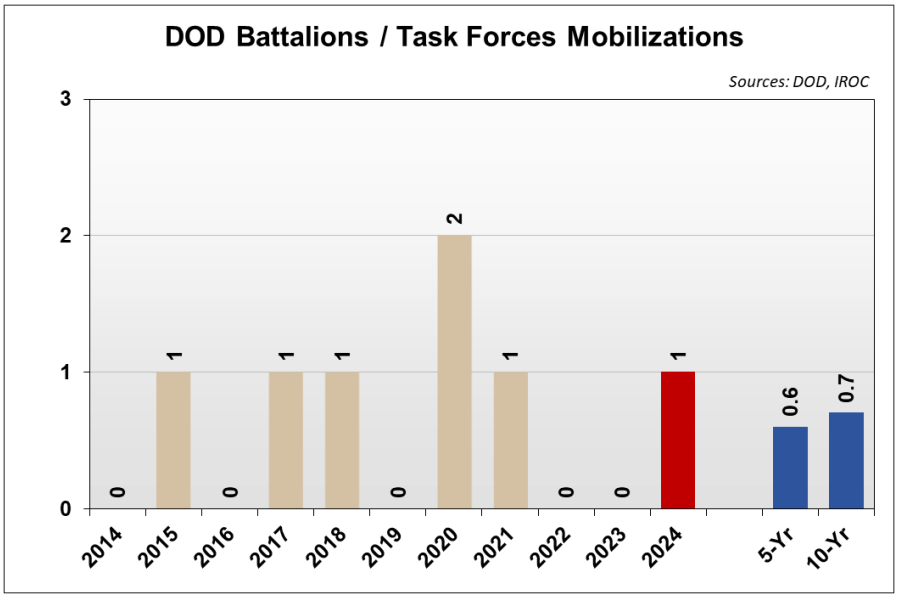
In 2024, The United States mobilized 8 individual overhead personnel to Canada to assist with Burned Area Emergency Response efforts.

Sixty individual overhead personnel were mobilized in support of United States wildfires in the Northwest Area from Australia and New Zealand.

One fire suppression crew from Parks Canada and one fire suppression crew from Saskatchewan, Canada were mobilized in support of United States wildfires in the Great Basin Area.

Department of Defense Mobilizations

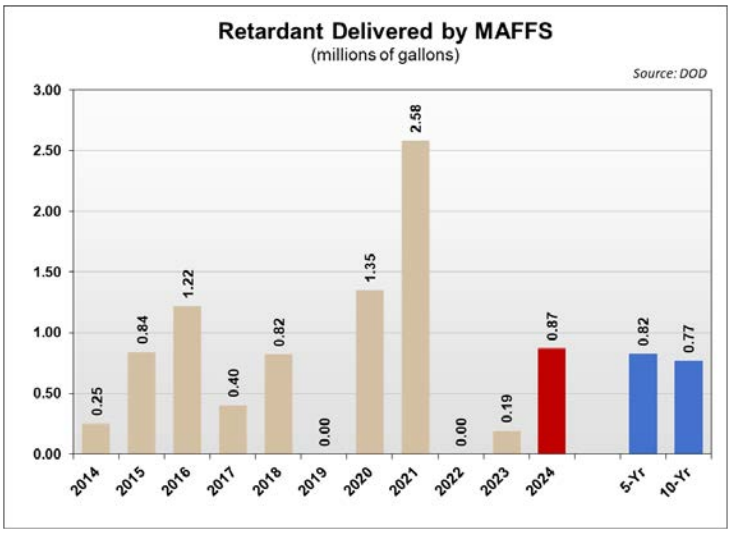
In 2024, NICC processed one half military battalion request which was provided by the 14th Brigade Engineer Battalion and the 1st Battalion, 17th Infantry Regiment based out of Joint Base Lewis McChord (JBLM). All DOD resources were deployed in support of wildland fire operations on the Boise National Forest in the Great Basin Area.



Modular Airborne Fire Fighting Systems (MAFFS)

MAFFS air tankers were activated on July 14 and released on September 5. National statistics for the 77-day activation are listed below:

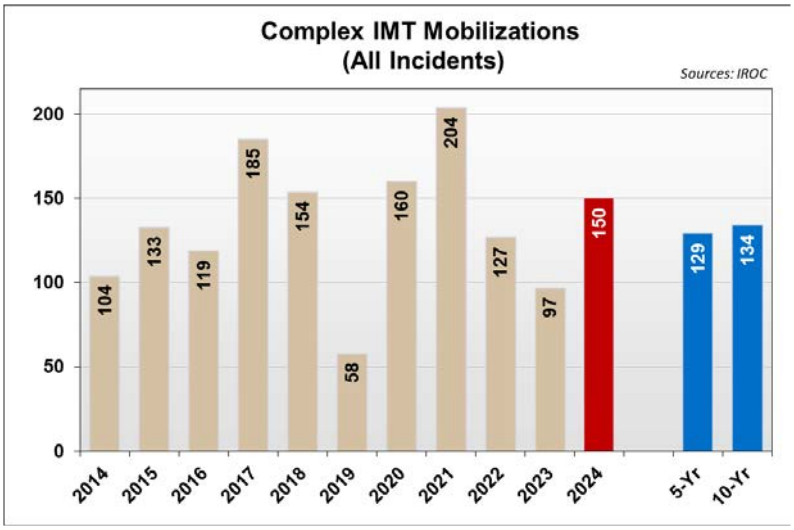
- Total missions: 323
- Total employment hours: 398
- Total retardant drops: 315
- Total gallons of retardant dropped: 871,205



Incident Management Team Mobilizations

In 2024, the firefighting community fully transitioned to the Complex Incident Management Team (CIMT) business model. All federal Type 1 and Type 2 Incident Management Team mobilizations prior to 2024 have been combined and are listed below.

A complete picture of the Complex Incident Management Team business model can be found at the [NWCG Incident Workforce Development Group webpage.]

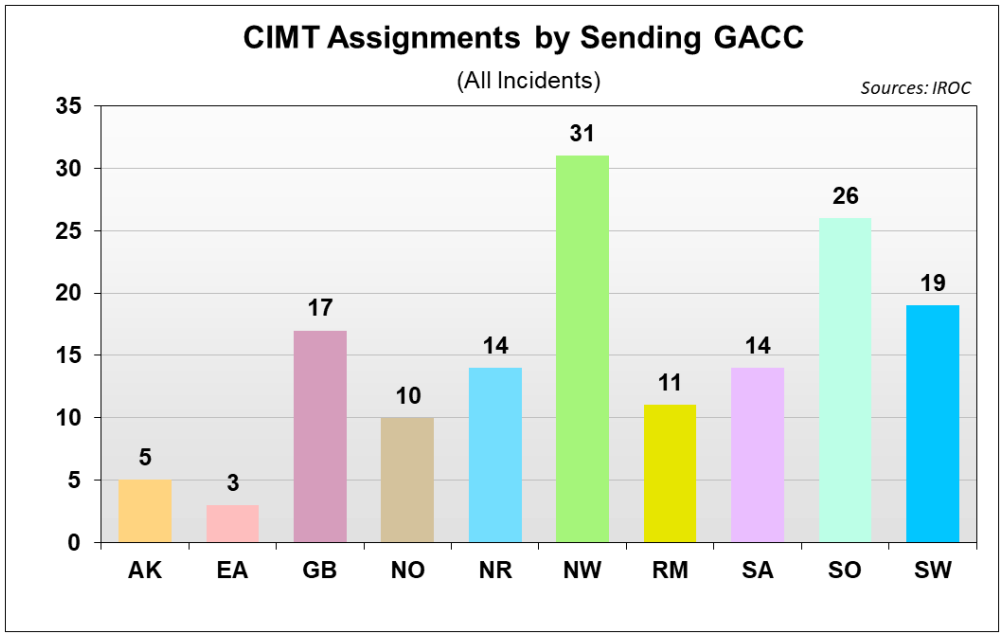


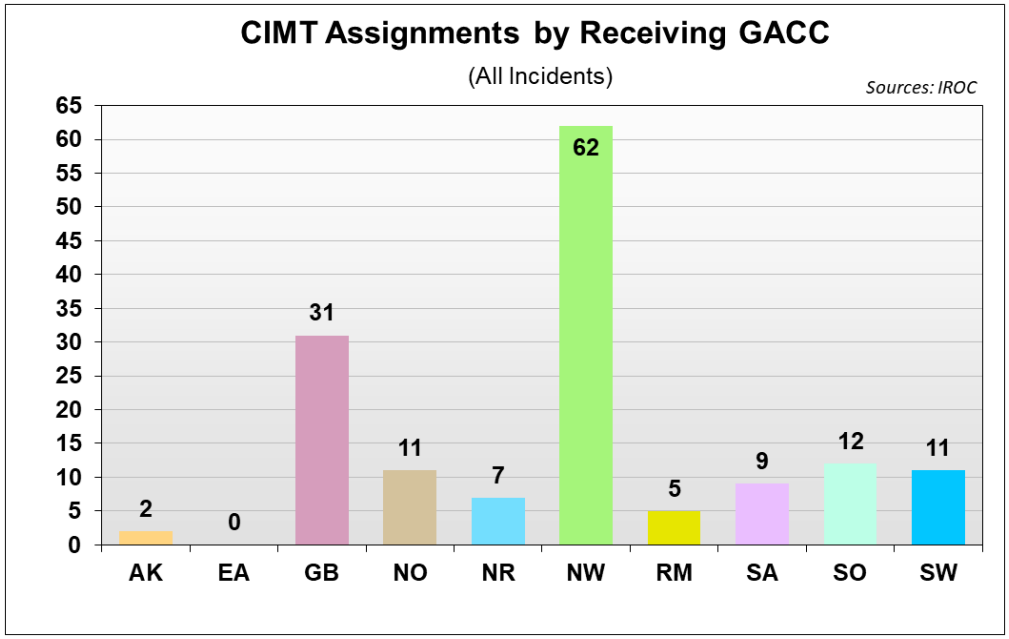
National Incident Management Organization

National Incident Management Organization (NIMO) teams were assigned to three wildfire incidents for 50 days. NIMO teams were also mobilized to three non-wildfire incidents for 97 days.

Complex Incident Management Teams

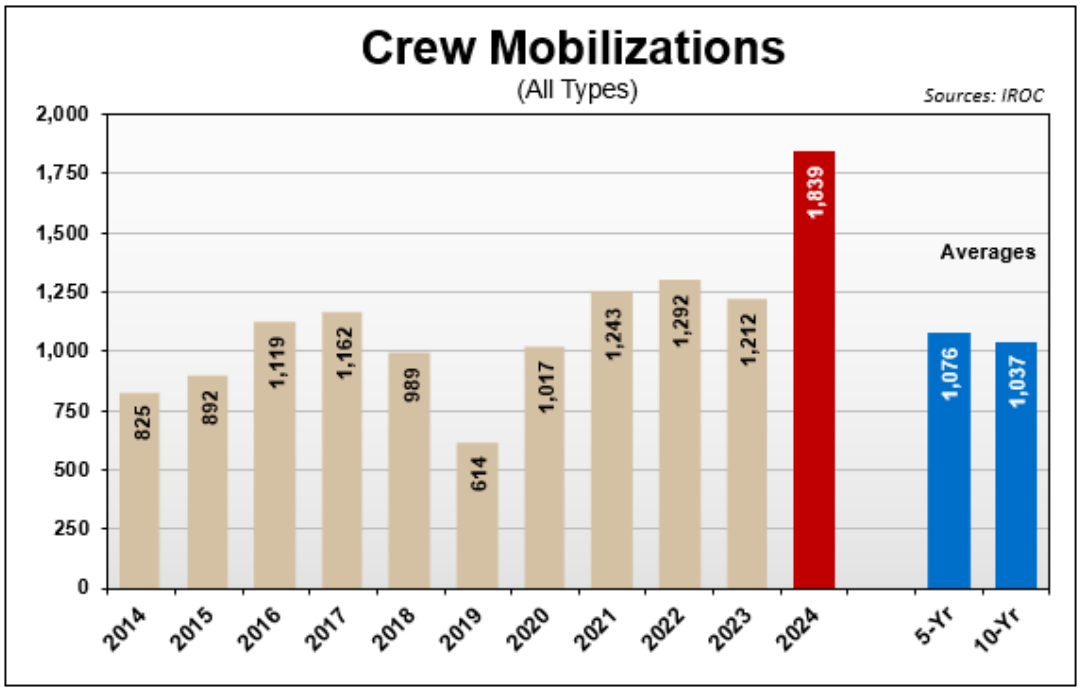
National Complex Incident Management Teams (CIMT) were mobilized 150 times. CIMTs were assigned for over 2,000 days. The following graphs show the mobilization of CIMTs by sending and receiving Geographic Area.

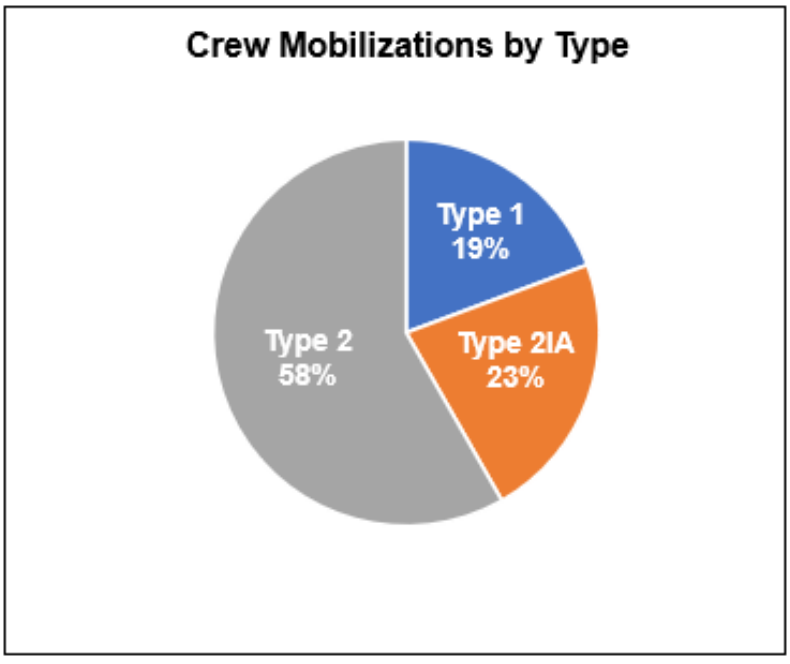




Crew Mobilizations

NICC received 3,350 crew requests in 2024. Of those requests: 1,839 were filled, 636 were canceled and 875 were UTF. The NICC received 1,119 orders for Type 1 crews, 1,511 orders for Type 2 crews and 720 orders for Type 2 IA crews. The number of crew mobilizations in 2024 was above both the five and 10-year average.





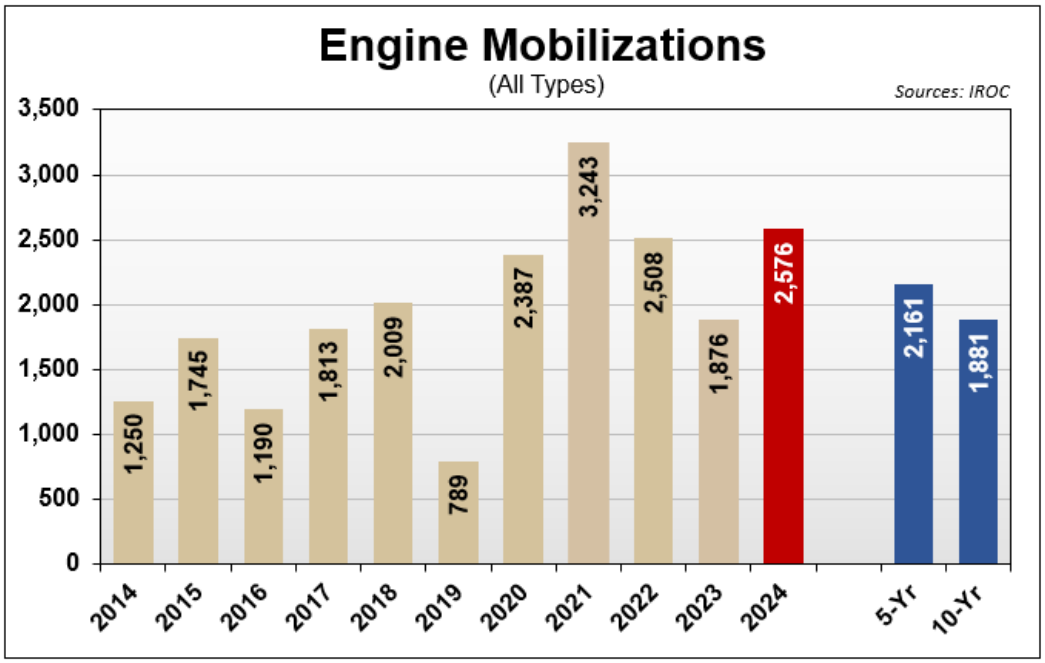
Crew Requests Summary by Requesting Agency and Geographic Area

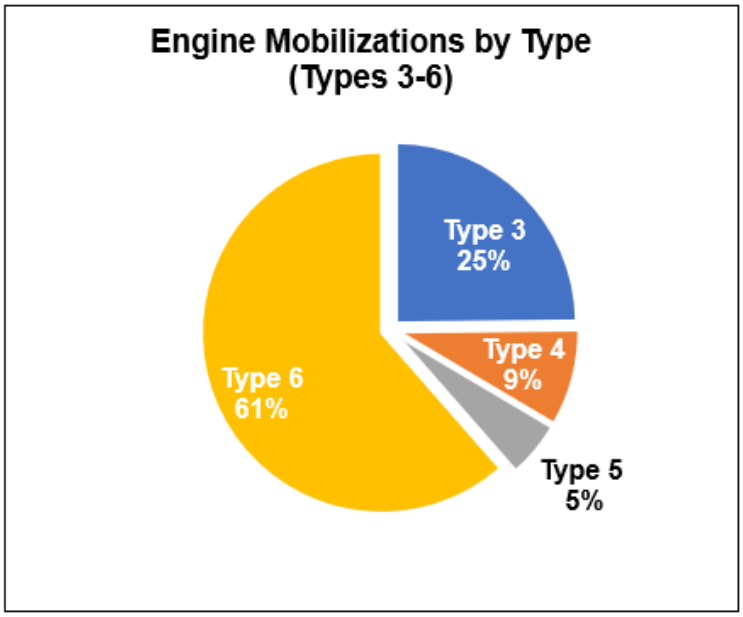
	Type 1 Crew			Type 2 Crew			Type 2-IA Crew			Crew Totals			
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	*Total*
BIA	1	1	0	9	18	1	8	0	0	18	19	1	***38***
BLM	18	15	10	57	15	9	16	5	2	91	35	21	***147***
DOD	0	1	0	0	0	0	0	0	0	0	1	0	***1***
FEMA	2	0	2	1	0	0	0	0	0	3	0	2	***5***
FS	304	199	472	861	125	151	333	102	165	1,498	426	788	***2,712***
FWS	4	0	0	5	0	0	1	0	0	10	0	0	***10***
NPS	13	2	7	18	3	2	5	2	2	36	7	11	***54***
ST	13	41	8	120	88	28	49	11	16	182	140	52	***374***
Other	0	6	0	0	0	0	1	2	0	1	8	0	***9***
Canada	0	0	0	0	0	0	0	0	0	0	0	0	***0***
Subtotal:	*355*	*265*	*499*	*1,071*	*249*	*191*	*413*	*122*	*185*	*1,839*	*636*	*875*	
Total:	**1,119**			**1,511**			**720**			**3,350**			

	Type 1 Crew			Type 2 Crew			Type 2-IA Crew			Crew Totals			
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	*Total*
AK	14	0	3	0	0	0	4	0	0	18	0	3	***21***
EA	3	1	6	2	0	0	8	0	1	13	1	7	***21***
GB	90	34	85	209	17	16	105	21	57	404	72	158	***634***
NICC	17	0	1	0	0	0	10	0	0	27	0	1	***28***
NO	31	88	250	139	74	64	58	25	27	228	187	341	***756***
NR	21	13	40	58	1	0	30	11	38	109	25	78	***212***
NW	55	34	41	382	143	88	41	1	23	478	178	152	***808***
RM	35	10	15	88	2	2	63	4	12	186	16	29	***231***
SA	12	2	7	0	1	0	12	3	0	24	6	7	***37***
SO	39	82	51	155	9	21	48	53	25	242	144	97	***483***
SW	38	1	0	38	2	0	34	4	2	110	7	2	***119***
Other	0	0	0	0	0	0	0	0	0	0	0	0	***0***
Canada	0	0	0	0	0	0	0	0	0	0	0	0	***0***
Subtotal:	*355*	*265*	*499*	*1,071*	*249*	*191*	*413*	*122*	*185*	*1,839*	*636*	*875*	
Total:	**1,119**			**1,511**			**720**			**3,350**			

Engine Mobilizations

NICC received 4,550 engine requests in 2024. Of those requests: 2,576 were filled, 1,046 were canceled and 928 were UTF. Type 3 engines were the most requested engine with 2,110 requests and 639 fills. Type 6 engines were the next most requested with 2,005 requests and 1,582 fills. The number of engine mobilizations was above the five and 10-year averages.





Engine Requests Summary by Requesting Agency

	Type 1 Engine			Type 2 Engine			Type 3 Engine			Type 4 Engine		
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF
BIA	0	0	0	0	0	0	5	5	1	4	1	
BLM	0	0	0	0	0	0	49	39	31	42	4	14
DOD	0	0	0	0	0	0	0	0	0	0	0	
FEMA	0	0	0	0	0	0	0	0	0	0	0	
FS	0	1	0	0	0	0	512	381	636	153	21	16
FWS	0	0	0	0	0	0	3	6	0	7	0	
NPS	0	0	0	0	0	0	1	2	5	0	0	
ST	0	0	7	0	0	0	64	335	22	16	5	3
Other	0	0	0	0	0	0	5	8	0	1	0	
Subtotal:	*0*	*1*	*7*	*0*	*0*	*0*	*639*	*776*	*695*	*223*	*31*	*33*
Total:		**8**			**0**			**2,110**			**287**	

	Type 5 Engine			Type 6 Engine			Type 7 Engine			Engine Totals			
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	***Total***
BIA	1	0	1	150	14	10	2	0	0	112	20	12	***144***
BLM	17	0	0	116	17	8	0	0	0	224	60	53	***337***
DOD	0	0	0	0	0	0	0	0	0	0	0	0	***0***
FEMA	0	0	0	0	0	0	0	0	0	0	0	0	***0***
FS	80	0	0	1,030	149	138	0	1	0	1,775	553	790	***3,118***
FWS	1	0	0	19	0	1	0	0	0	30	6	1	***37***
NPS	0	0	0	27	3	8	0	0	0	28	5	13	***46***
ST	30	3	0	233	50	19	0	0	3	343	393	54	***790***
Other	1	0	0	7	1	5	0	0	0	14	9	5	***28***
Subtotal:	*130*	*3*	*1*	*1,582*	*234*	*189*	*2*	*1*	*3*	2,576	1,046	928	
Total:		**134**			**2,005**			**6**			**4,550**		

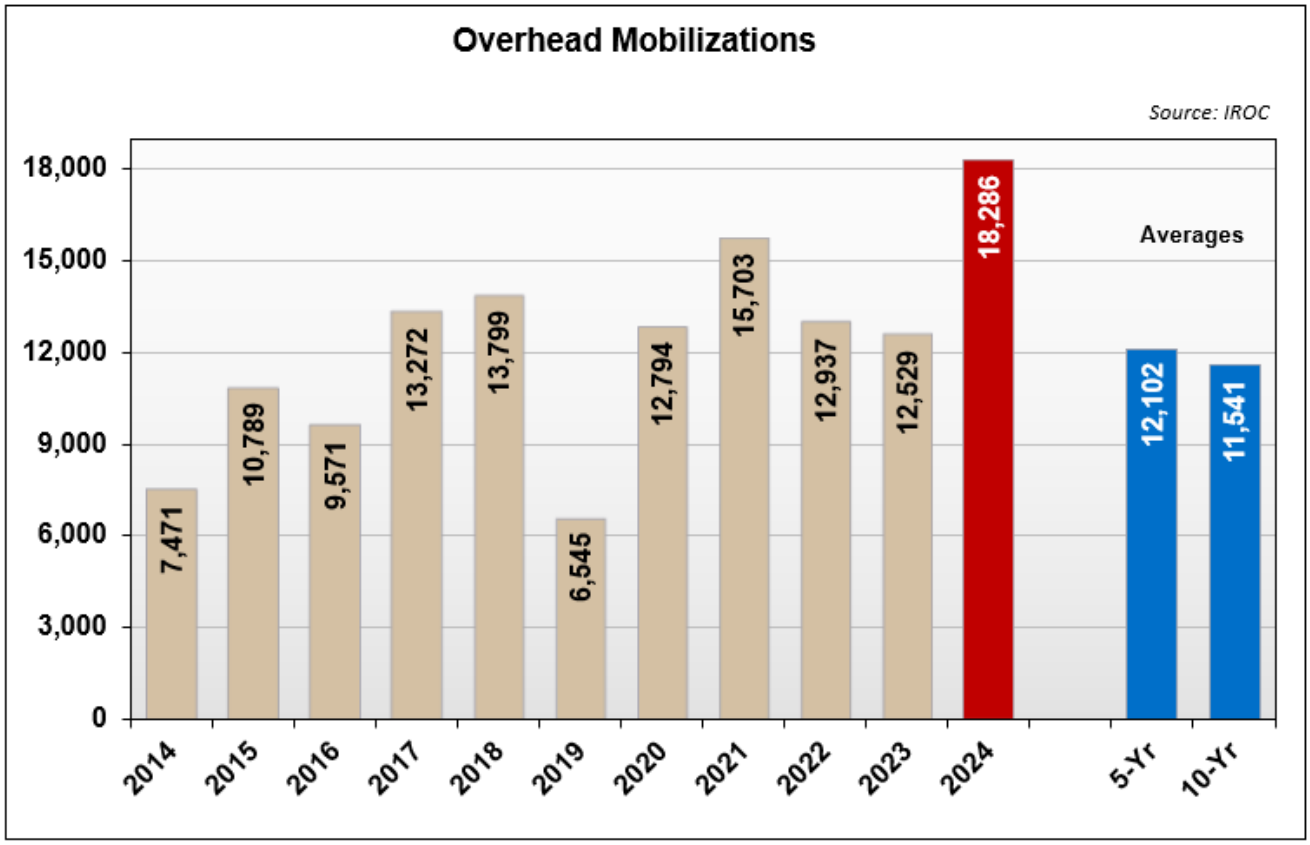
Engine Requests Summary by Requesting Geographic Area

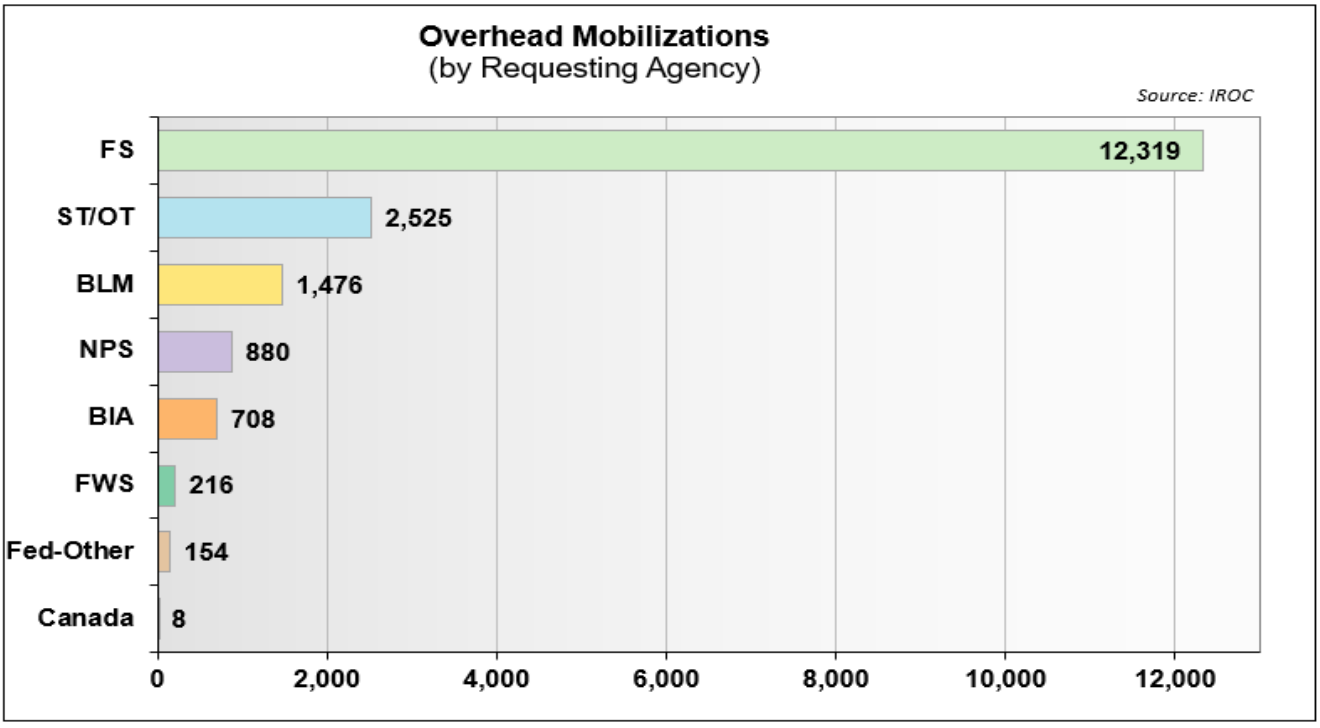
	Type 1 Engine			Type 2 Engine			Type 3 Engine			Type 4 Engine		
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF
AK	0	0	0	0	0	0	0	0	0	1	0	0
EA	0	0	0	0	0	0	12	9	11	3	1	0
GB	0	1	0	0	0	0	122	66	61	49	4	22
NICC	0	0	0	0	0	0	0	0	0	0	0	0
NO	0	0	0	0	0	0	137	329	257	35	0	0
NR	0	0	0	0	0	0	10	13	33	9	0	1
NW	0	0	0	0	0	0	89	95	46	71	24	5
RM	0	0	7	0	0	0	34	39	61	17	2	4
SA	0	0	0	0	0	0	22	1	1	2	0	0
SO	0	0	0	0	0	0	181	205	208	23	0	0
SW	0	0	0	0	0	0	32	19	17	13	0	1
Subtotal:	*0*	*1*	*7*	*0*	*0*	*0*	*639*	*776*	*695*	*223*	*31*	*33*
Total:		**8**			**0**			**2,110**			**287**	

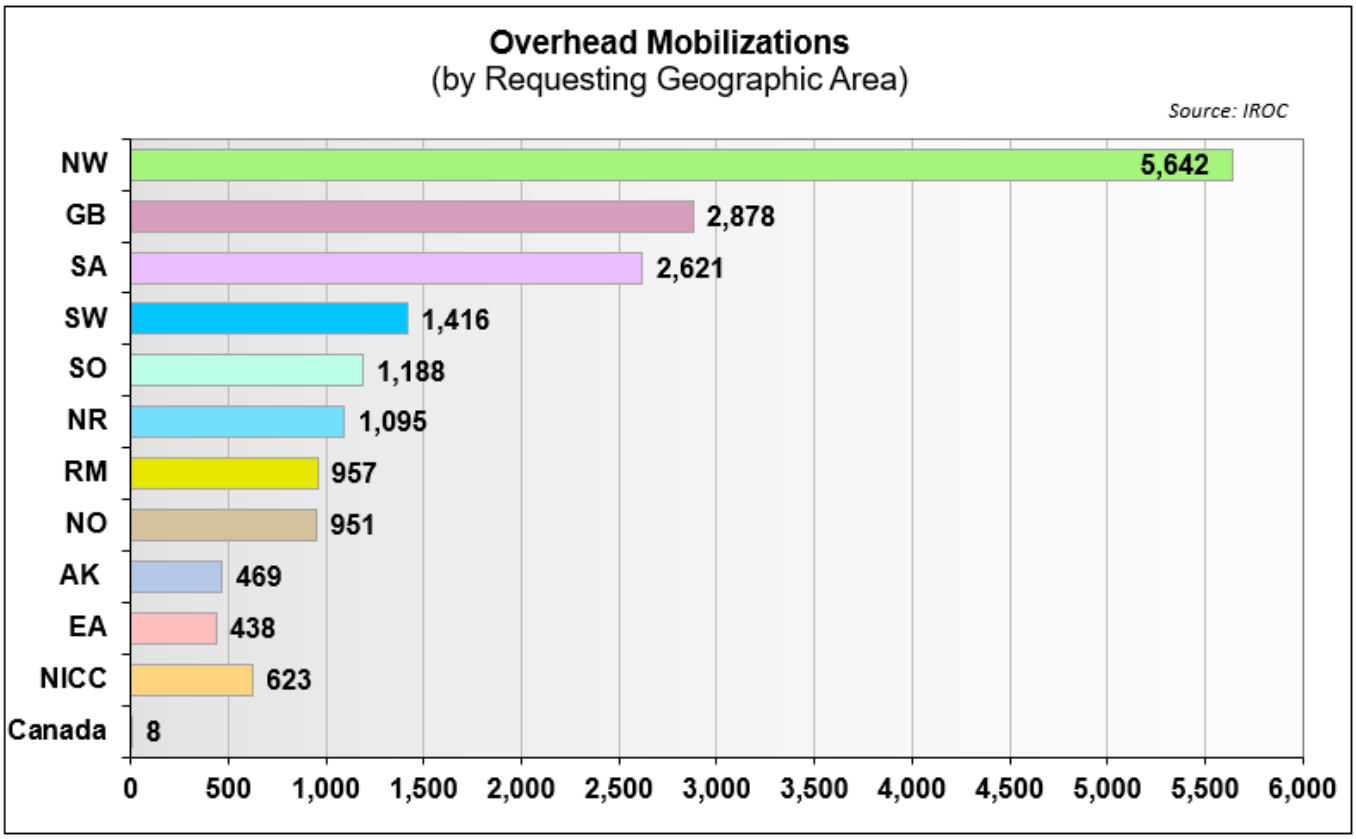
	Type 5 Engine			Type 6 Engine			Type 7 Engine			Engine Totals			
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	***Total***
AK	0	0	0	0	0	0	0	0	0	1	0	0	***1***
EA	5	0	0	63	14	21	0	0	0	83	24	32	***139***
GB	18	0	0	215	42	24	0	0	0	404	113	107	***624***
NICC	0	0	0	0	0	0	0	0	0	0	0	0	***0***
NO	39	0	0	217	4	4	0	0	0	579	333	261	***1,173***
NR	6	0	1	101	29	54	0	0	0	99	42	89	***230***
NW	34	3	0	377	69	16	0	0	3	571	191	70	***832***
RM	2	0	0	131	25	25	0	1	0	184	67	97	***348***
SA	10	0	0	194	31	27	2	0	0	230	32	28	***290***
SO	15	0	0	131	9	2	0	0	0	350	214	210	***774***
SW	1	0	0	153	11	16	0	0	0	199	30	34	***263***
Subtotal:	*130*	*3*	*1*	*1,582*	*234*	*189*	*2*	*1*	*3*	*2,576*	*1,046*	928	
Total:		**134**			**2,005**			**6**			**4,550**		

Overhead Mobilizations

NICC received 34,062 overhead requests in 2024. Of those requests: 18,286 were filled, 6,255 were canceled, and 9,521 were UTF. The number of overhead mobilizations was well over the five and 10-year averages.







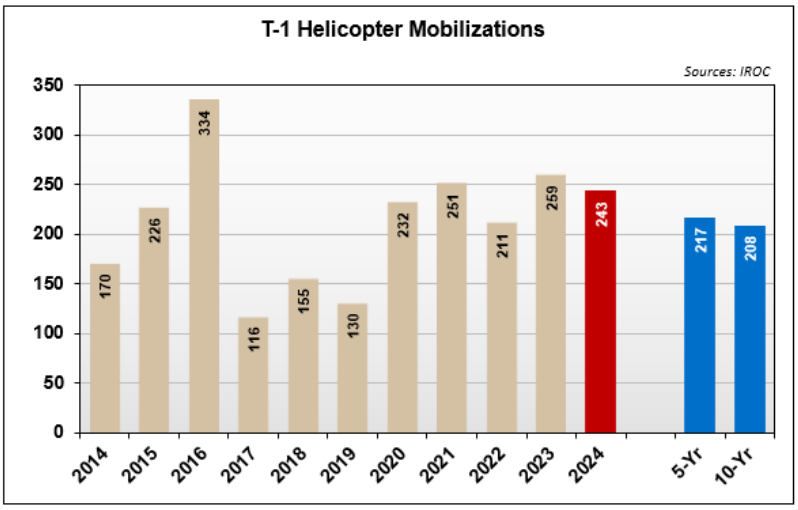
Overhead Requests Summary

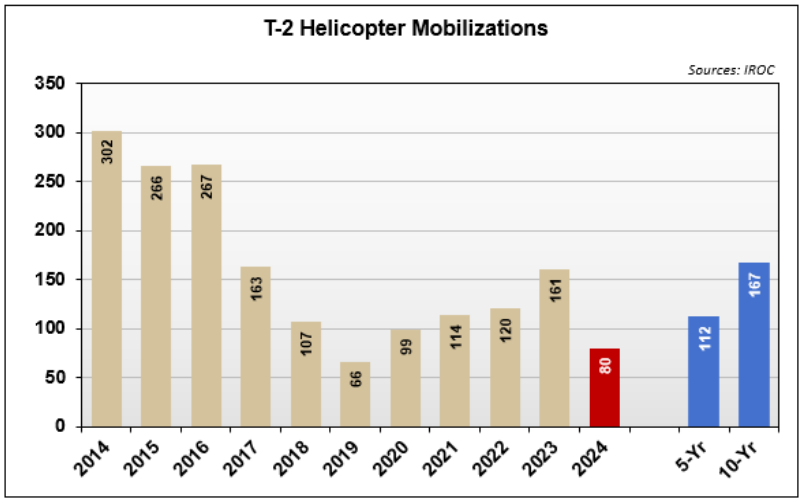
	Individual Overhead			
	Fill	Cancel	UTF	***Total***
BIA	708	188	100	***996***
BLM	1,476	590	610	***2,676***
DOD	10	1	1	***12***
FEMA	144	24	39	***207***
FS	12,319	3,979	7,107	***23,405***
FWS	216	53	36	***305***
NPS	880	113	271	***1,264***
ST	2,499	1,288	1,340	***5,127***
Other	26	19	16	***61***
Canada	8	0	1	***9***
Australia	0	0	0	***0***
Subtotal:	*18,286*	*6,255*	*9,521*	
Total:	**34,062**			

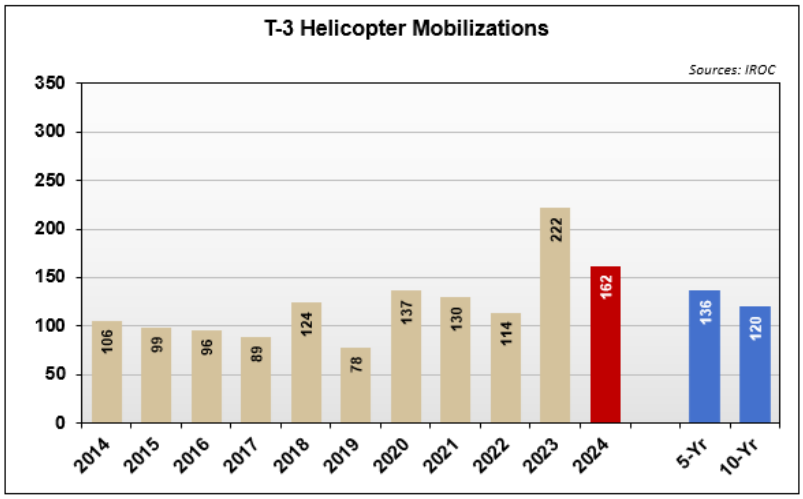
	Individual Overhead			
	Fill	Cancel	UTF	***Total***
AK	469	46	36	***551***
EA	438	71	28	***537***
GB	2,878	737	2,257	***5,872***
NICC	623	28	39	***690***
NO	951	509	944	***2,404***
NR	1,095	383	627	***2,105***
NW	5,642	3,301	3,802	***12,745***
RM	957	181	388	***1,526***
SA	2,621	228	283	***3,132***
SO	1,188	583	918	***2,689***
SW	1,416	188	198	***1,802***
Other	0	0	0	***0***
Canada	8	0	1	***9***
Australia	0	0	0	***0***
Subtotal:	*18,286*	*6,255*	*9,521*	
Total:	**34,062**			

Helicopter Mobilizations

NICC received 880 orders for Type 1, 2, and 3 helicopters in 2024. Of those requests: 485 were filled, 174 were canceled and 221 were UTF. Overall, Type 1 and Type 3 mobilizations were above the five and 10-year averages. Type 2 mobilizations were below the five and 10-year averages.







Helicopter Requests Summary by Requesting Agency

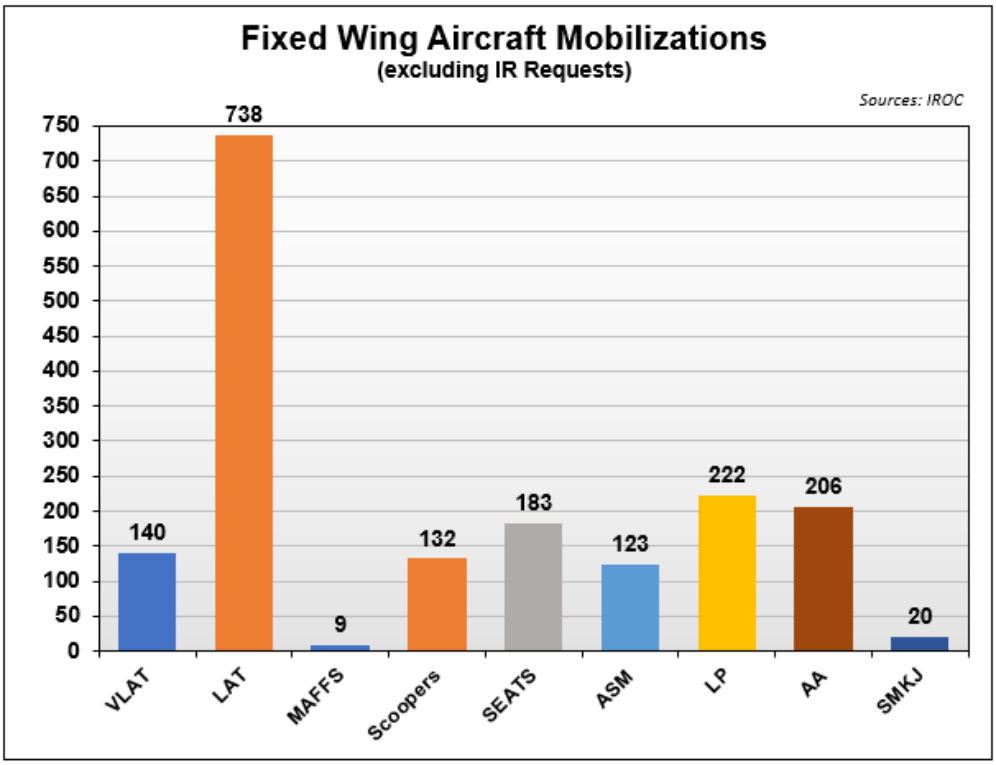
	Type 1			Type 2						Type 3			Helicopter Totals			
				Standard Use			Limited Use									
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Total
BIA	1	0	3	3	0	1	1	0	0	10	0	0	15	0	4	**19**
BLM	8	9	3	10	8	7	2	1	1	21	13	7	41	31	18	**90**
DOD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
FEMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
FS	204	45	74	48	25	33	10	6	4	117	40	56	379	116	167	**662**
FWS	1	0	1	1	0	0	0	0	0	1	0	0	3	0	1	**4**
NPS	1	2	1	0	0	0	0	1	0	3	2	0	4	5	1	**10**
ST	28	7	7	3	6	11	2	0	2	10	7	10	43	20	30	**93**
Other	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	**2**
Canada	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Subtotal:	*243*	*65*	*89*	*65*	*39*	*52*	*15*	*8*	*7*	*162*	*62*	*73*	*485*	*174*	*221*	
Total:	**397**			**156**			**30**			**297**			**880**			

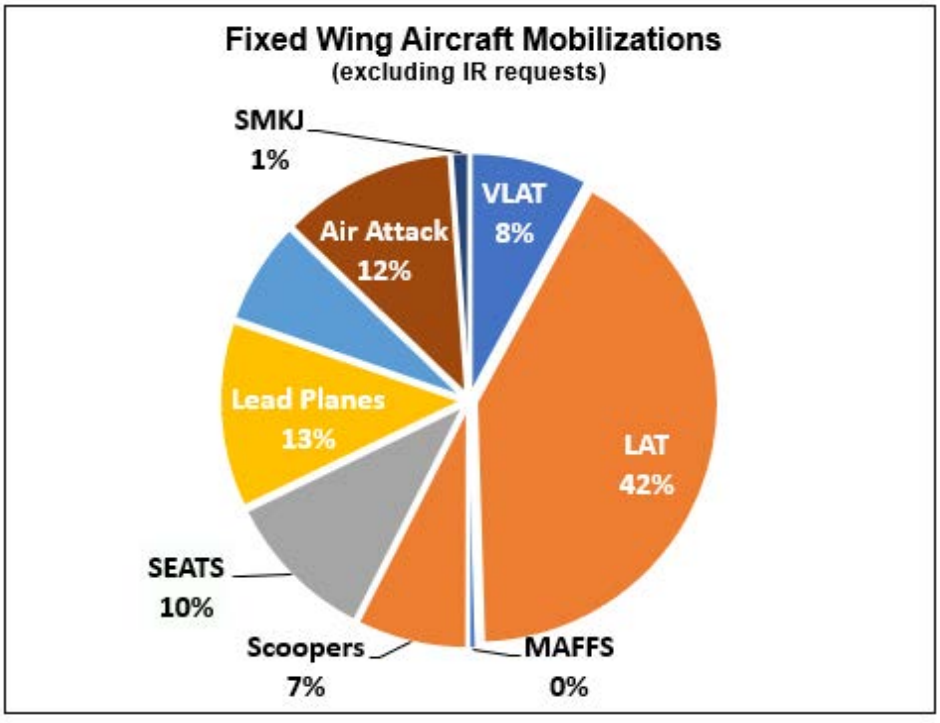
Helicopter Requests Summary by Requesting Geographic Area

	Type 1			Type 2						Type 3			Helicopter Totals			
				Standard Use			Limited Use									
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Total
AK	0	2	0	5	3	1	0	0	0	5	3	0	10	8	1	**19**
EA	2	0	0	0	0	0	0	0	0	7	0	0	9	0	0	**9**
GB	55	17	37	19	4	20	1	1	2	40	10	26	115	32	85	**232**
NICC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
NO	21	2	8	3	5	12	0	0	0	14	9	7	38	16	27	**81**
NR	20	15	22	2	3	2	9	3	1	13	9	13	44	30	38	**112**
NW	37	10	19	18	9	13	1	2	4	33	16	23	89	37	59	**185**
RM	20	3	1	3	1	3	0	0	0	4	1	3	27	5	7	**39**
SA	22	2	0	2	0	0	1	1	0	21	0	0	46	3	0	**49**
SO	44	6	1	8	11	1	1	1	0	7	8	1	60	26	3	**89**
SW	22	8	1	5	3	0	2	0	0	18	6	0	47	17	1	**65**
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Canada	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Subtotal:	*243*	*65*	*89*	*65*	*39*	*52*	*15*	*8*	*7*	*162*	*62*	*73*	*485*	*174*	*221*	
Total:	**397**			**156**			**30**			**297**			**880**			

Fixed Wing Aircraft Mobilizations

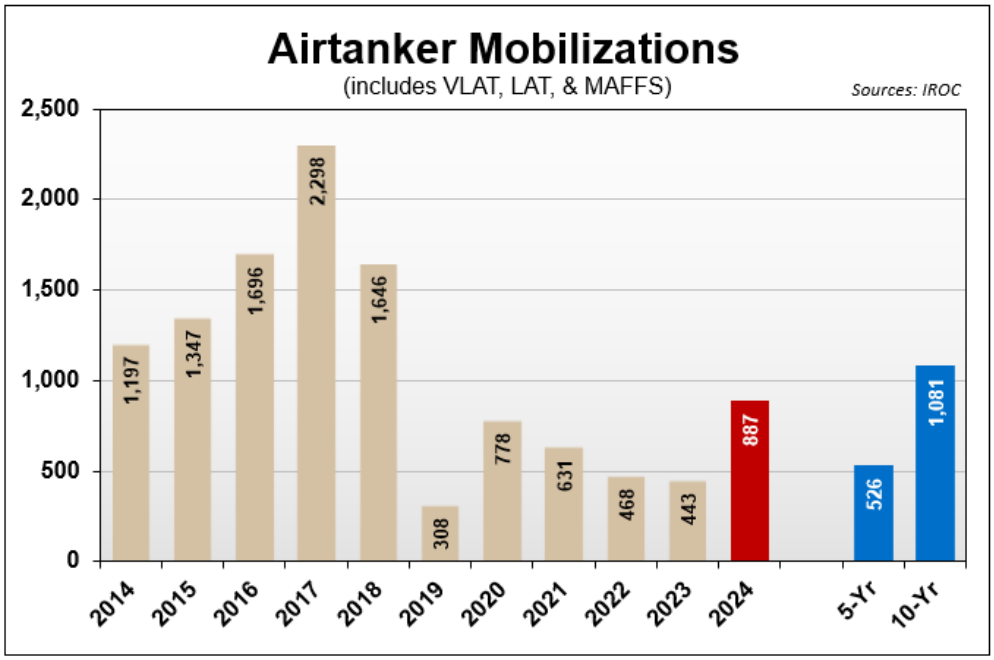
Fixed wing aircraft include very large airtankers (VLAT), large airtankers (LAT), multi-engine airtankers (Scoopers), single engine airtankers (SEATs), lead planes (LP), aerial supervision modules (ASM), air attack (AA), infrared (IR), and smokejumper aircraft (SMKJ). NICC received 5,855 requests for fixed wing aircraft in 2024. Of those requests: 4,093 were filled, 714 were canceled and 1,048 were UTF.

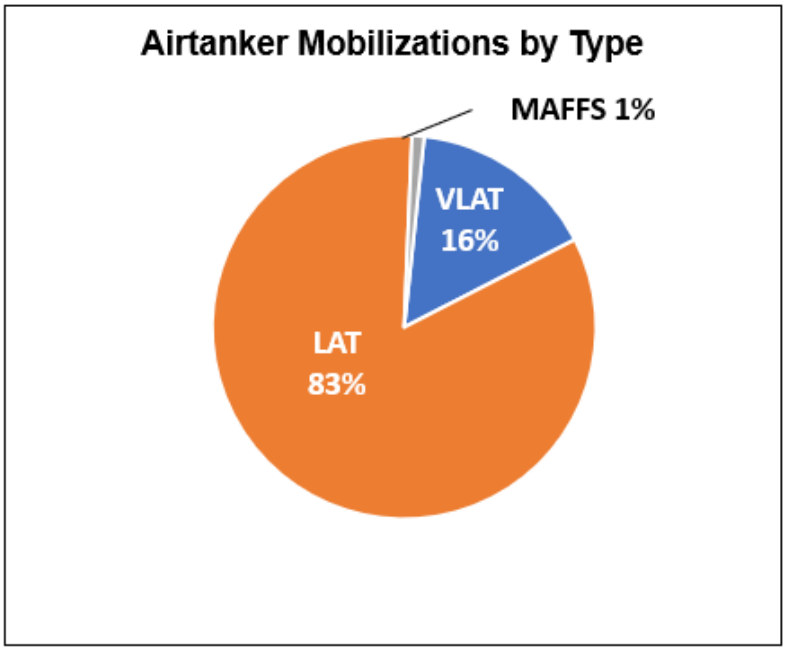




Airtanker Mobilizations

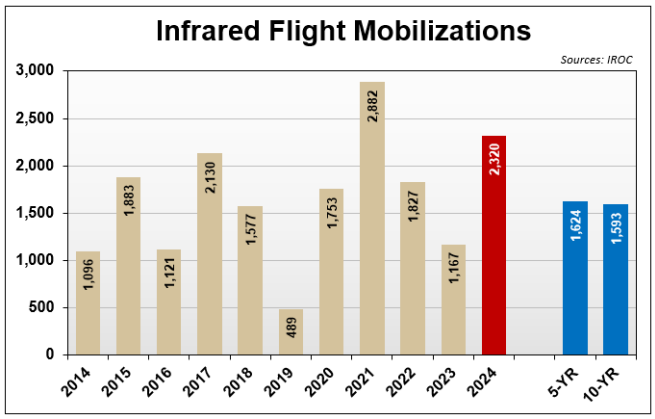
NICC received 1,271 requests for very large and large airtankers in 2024. Of those requests: 887 were filled, 183 were canceled and 201 were UTF. Airtanker mobilizations were between the five 10-year averages.

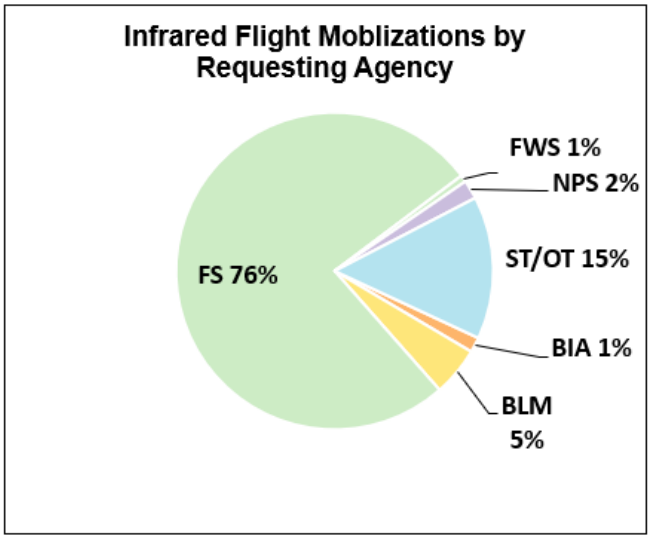


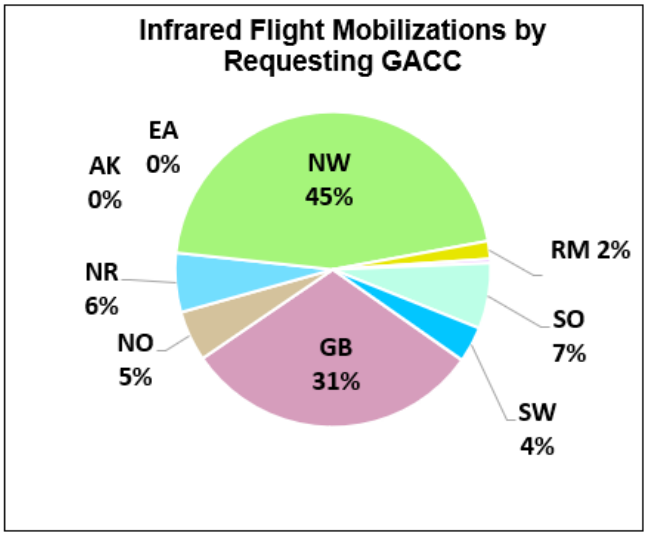


Infrared Aircraft Mobilizations

NICC received 3,287 infrared (IR) aircraft requests. Of those requests: 2,320 were filled, 351 were cancelled and 616 were UTF. IR requests were well above the five and 10-year averages.







Fixed Wing Aircraft Requests Summary by Requesting Agency

	Very Large Airtanker (VLAT)			Large Airtanker (LAT)			Modular Airborne Fire Fighting System (MAFFS)			Type 3 Multi-Engine Airtanker (Scoopers)			Single Engine Airtanker (SEAT)			Lead Plane (LP)		
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF
BIA	4	1	1	20	10	2	0	0	0	4	0	2	20	1	0	3	3	0
BLM	17	7	9	89	34	38	0	0	0	20	0	8	42	10	3	27	8	2
DOD	0	3	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FEMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FS	83	17	24	469	69	58	8	0	1	77	40	78	42	13	8	160	24	23
FWS	0	0	1	2	0	1	0	0	0	0	0	0	4	2	0	1	0	1
NPS	1	1	0	6	0	1	0	0	0	4	4	2	0	0	0	0	0	0
ST	34	10	24	149	30	37	1	0	0	27	5	10	75	9	24	31	11	8
Other	1	1	0	1	0	4	0	0	0	0	0	0	0	0	2	0	0	0
Subtotal:	*140*	*40*	*59*	*738*	*143*	*141*	*9*	*0*	*1*	*132*	*49*	*100*	*183*	*35*	*37*	*222*	*46*	*34*
Total:	**239**			**1,022**			**10**			**281**			**255**			**302**		

	Aerial Supervision Module (ASM)			Air Attack (AA)			Infrared (IR)			Smokejumper Aircraft (SKMJ)			Fixed Wing Aircraft Total Requests			
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	***Total***
BIA	1	0	0	8	1	1	36	9	11	0	0	0	96	25	17	***138***
BLM	6	1	0	25	8	4	116	25	25	2	0	0	344	93	89	***526***
DOD	0	0	0	0	0	0	0	0	0	0	0	0	2	3	0	***5***
FEMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	***0***
FS	106	11	4	126	20	43	1,769	240	470	18	0	0	2,858	434	709	***4,001***
FWS	0	0	0	2	0	0	16	2	1	0	0	0	25	4	4	***33***
NPS	0	0	0	2	0	0	45	12	19	0	0	0	58	17	22	***97***
ST	10	5	2	43	4	6	337	59	90	0	0	0	707	133	201	***1,041***
Other	0	0	0	0	0	0	1	4	0	0	0	0	3	5	6	***14***
Subtotal:	*123*	*17*	*6*	*206*	*33*	*54*	*2,320*	*351*	*616*	*20*	*0*	*0*	*4,093*	*714*	*1,048*	
Total:	**146**			**293**			**3,287**			**20**			**5,855**			

Fixed Wing Aircraft Requests Summary by Requesting Geographic Area

	Very Large Airtanker (VLAT)			Large Airtanker (LAT)			Modular Airborne Fire Fighting System (MAFFS)			Type 3 Multi-Engine Airtanker (Scoopers)			Single Engine Airtanker (SEAT)			Lead Plane (LP)		
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF
AK	0	0	0	0	0	0	0	0	0	4	0	4	4	0	0	1	0	0
EA	0	0	0	2	0	0	0	0	0	0	0	0	18	4	1	0	0	0
GB	18	4	17	136	20	40	0	0	0	37	14	40	25	9	2	44	5	10
NICC	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	16	1	0
NO	22	3	14	72	11	14	0	0	0	8	2	2	4	0	2	11	1	5
NR	7	5	4	60	8	6	0	0	0	8	6	8	9	4	2	9	4	3
NW	34	11	10	168	36	36	0	0	0	27	5	39	40	12	4	64	15	7
RM	22	1	7	96	19	24	0	0	0	14	6	6	14	0	1	37	8	7
SA	1	0	0	22	3	7	1	0	0	14	0	0	54	4	23	15	1	0
SO	26	13	4	99	28	9	8	0	1	8	6	0	0	0	0	6	1	0
SW	10	3	3	83	18	5	0	0	0	10	10	1	15	2	2	19	10	2
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Canada	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal:	*140*	*40*	*59*	*738*	*143*	*141*	*9*	*0*	*1*	*132*	*49*	*100*	*183*	*35*	*37*	*222*	*46*	*34*
Total:		**239**			**1,022**			**10**			**281**			**255**			**302**	

	Aerial Supervision Module (ASM)			Air Attack (AA)			Infrared (IR)			Smokejumper Aircraft (SMKJ)			Fixed Wing Aircraft Total Requests			
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	***Total***
AK	2	0	0	3	0	0	1	1	3	1	0	0	16	1	7	***24***
EA	0	0	0	3	2	1	0	0	0	0	0	0	23	6	2	***31***
GB	16	0	1	35	6	18	708	42	183	4	0	0	1,023	100	311	***1,434***
NICC	3	0	0	7	1	1	14	1	2	1	0	0	43	3	3	***49***
NO	8	0	1	4	4	8	119	8	25	1	0	0	249	29	71	***349***
NR	12	3	1	18	5	6	140	46	41	3	0	0	266	81	71	***418***
NW	18	1	0	41	11	6	1,047	161	289	5	0	0	1,444	252	391	***2,087***
RM	4	1	0	22	2	3	42	10	15	3	0	0	254	47	63	***364***
SA	7	2	3	37	1	3	10	2	1	0	0	0	161	13	37	***211***
SO	39	9	0	11	1	5	155	27	14	1	0	0	353	85	33	***471***
SW	14	1	0	25	0	3	84	53	43	1	0	0	261	97	59	***417***
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	***0***
Canada	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	***0***
Subtotal:	*123*	*17*	*6*	*206*	*33*	*54*	*2,320*	*351*	*616*	*20*	*0*	*0*	*4,093*	*714*	*1,048*	
Total:		**146**			**293**			**3,287**			**20**			**5,855**		

Unmanned Aircraft Systems

The NICC received 147 requests for UAS resources in 2024. Of those requests: 90 were filled, 21 were cancelled, and 36 were UTF. Individual statistics are shown in the tables below.

	Fixed Wing			Rotor Wing			UAS Totals			
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Total
BIA	0	0	0	3	1	0	3	1	0	**4**
BLM	0	0	0	4	1	2	4	1	2	**7**
DOD	0	0	0	0	0	0	0	0	0	**0**
FEMA	0	0	0	0	0	0	0	0	0	**0**
FS	5	0	1	66	16	31	71	16	32	**119**
FWS	0	0	0	3	0	0	3	0	0	**3**
NPS	0	0	0	5	1	0	5	1	0	**6**
ST	0	0	0	4	2	2	4	2	2	**8**
Other	0	0	0	0	0	0	0	0	0	**0**
Canada	0	0	0	0	0	0	0	0	0	**0**
Subtotal:	*5*	*0*	*1*	*85*	*21*	*35*	*90*	*21*	*36*	
Total:	**6**			**141**			**147**			

	Fixed Wing			Rotor Wing			UAS Totals			
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Total
AK	0	0	0	1	0	0	1	0	0	**1**
EA	0	0	0	3	0	10	3	0	10	**13**
GB	1	0	0	24	5	8	25	5	8	**38**
NICC	0	0	0	2	0	0	2	0	0	**2**
NO	2	0	0	4	3	3	6	3	3	**12**
NR	0	0	0	9	4	2	9	4	2	**15**
NW	2	0	1	9	2	7	11	2	8	**21**
RM	0	0	0	0	1	0	0	1	0	**1**
SA	0	0	0	15	0	0	15	0	0	**15**
SO	0	0	0	8	5	4	8	5	4	**17**
SW	0	0	0	10	1	1	10	1	1	**12**
Other	0	0	0	0	0	0	0	0	0	**0**
Canada	0	0	0	0	0	0	0	0	0	**0**
Subtotal:	*5*	*0*	*1*	*85*	*21*	*35*	*90*	*21*	*36*	
Total:	**6**			**141**			**147**			

Temporary Flight Restrictions

Temporary Flight Restrictions Request by Agency

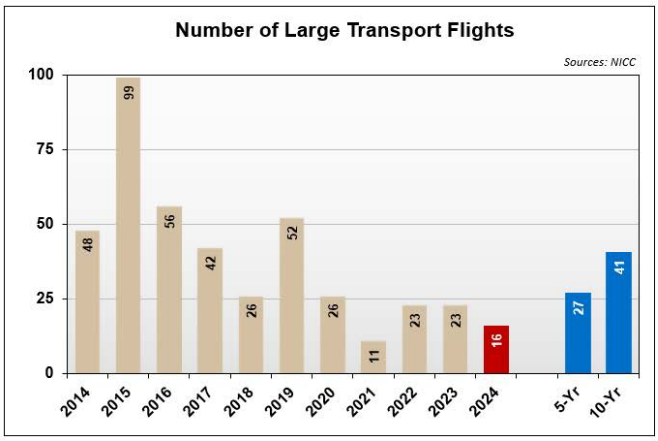
Agency	BIA	BLM	DOD	FEMA	FS	FWS	NPS	ST	Other	Total
Filled	54	159	0	0	709	20	38	379	3	1,362

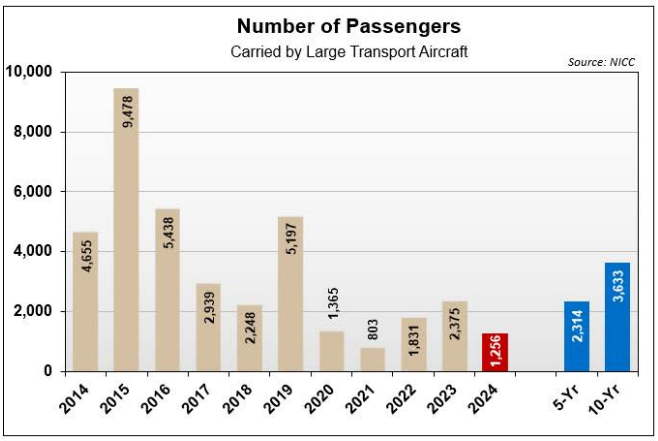
Temporary Flight Restrictions Request by GACC

GACC	AK	EA	GB	NICC	NO	NR	NW	RM	SA	SO	SW	Total
Filled	32	1	265	0	78	118	397	112	14	155	190	1,362

Large Transportation Aircraft

In 2024, there was one exclusive use contract for large transportation aircraft. The contract was filled with a B737-2T4 jet aircraft. This exclusive use jet flew 16 logistical missions, transporting a total of 1,256 passengers.





Exclusive Use and Charter Large Transport Requests Summary by Destination Agency and Geographic Area

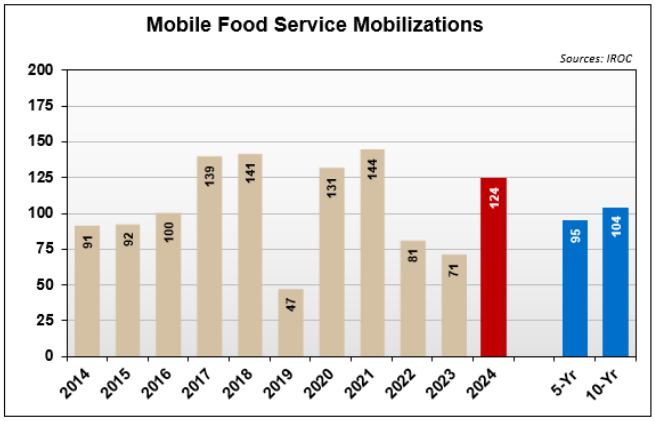
	Exclusive Use Aircraft		Charter Aircraft		Large Trans. Totals	
	Flights	Pax	Flights	Pax	Flights	Pax
BIA	0	0	0	0	0	0
BLM	9	717	0	0	9	717
DOD	6	475	0	0	6	475
FEMA	0	0	0	0	0	0
FS	0	0	0	0	0	0
FWS	0	0	0	0	0	0
NPS	0	0	0	0	0	0
ST	1	64	0	0	1	64
Other	0	0	0	0	0	0
Canada	0	0	0	0	0	0
Total:	**16**	**1,256**	**0**	**0**	**16**	**1,256**

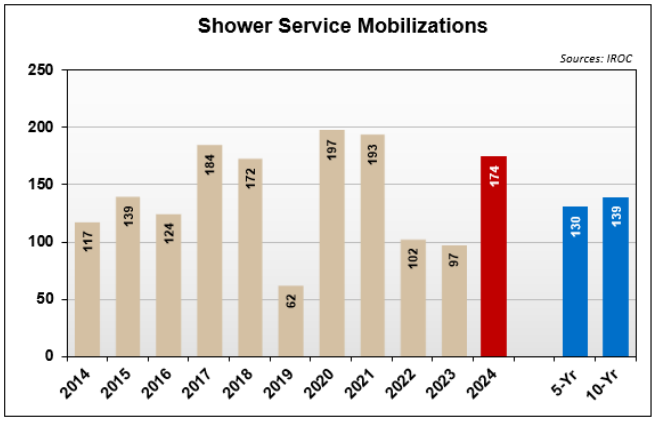
	Exclusive Use Aircraft		Charter Aircraft		Large Trans. Totals	
	Flights	Pax	Flights	Pax	Flights	Pax
AK	9	717	0	0	9	717
EA	0	0	0	0	0	0
GB	6	475	0	0	6	475
NICC	0	0	0	0	0	0
NO	0	0	0	0	0	0
NR	0	0	0	0	0	0
NW	1	64	0	0	1	64
RM	0	0	0	0	0	0
SA	0	0	0	0	0	0
SO	0	0	0	0	0	0
SW	0	0	0	0	0	0
Other	0	0	0	0	0	0
Canada	0	0	0	0	0	0
Total:	**16**	**1,256**	**0**	**0**	**16**	**1,256**

Equipment Services Mobilization

NICC received 156 requests for mobile food services in 2024. Of those requests: 124 were filled, 20 were canceled and 12 were UTF. The number of mobilizations was well above the five and 10-year averages.

NICC received 193 requests for mobile shower services in 2024. Of those requests: 174 were filled,12 were canceled and seven were UTF. The number of mobilizations was well above the five and 10-year averages.





Equipment Services Requests Summary by Requesting Agency and Geographic Area

	Mobile Food			Showers			Equipment Services Totals			
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Total
BIA	6	0	0	8	0	0	14	0	0	**14**
BLM	8	2	1	15	0	2	23	2	3	**28**
DOD	0	0	0	0	0	0	0	0	0	**0**
FEMA	0	0	0	0	0	0	0	0	0	**0**
FS	86	16	9	116	9	4	202	25	13	**240**
FWS	1	0	0	1	0	0	2	0	0	**2**
NPS	1	0	0	4	0	0	5	0	0	**5**
ST	21	2	2	29	3	1	50	5	3	**58**
Other	1	0	0	1	0	0	2	0	0	**2**
Canada	0	0	0	0	0	0	0	0	0	**0**
Subtotal:	*124*	*20*	*12*	*174*	*12*	*7*	*298*	*32*	*19*	
Total:	**156**			**193**			**349**			

	Mobile Food			Showers			Equipment Services Totals			
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Total
AK	0	0	0	0	0	0	0	0	0	**0**
EA	0	0	0	0	0	0	0	0	0	**0**
GB	22	4	4	35	3	0	57	7	4	**68**
NICC	1	0	0	2	0	0	3	0	0	**3**
NO	8	2	3	16	0	0	24	2	3	**29**
NR	13	5	0	19	0	1	32	5	1	**38**
NW	48	4	4	63	7	3	111	11	7	**129**
RM	8	0	0	10	0	0	18	0	0	**18**
SA	0	1	0	0	0	0	0	1	0	**1**
SO	10	2	0	17	0	2	27	2	2	**31**
SW	14	2	1	12	2	1	26	4	2	**32**
Other	0	0	0	0	0	0	0	0	0	**0**
Canada	0	0	0	0	0	0	0	0	0	**0**
Subtotal:	*124*	*20*	*12*	*174*	*12*	*7*	*298*	*32*	*19*	
Total:	**156**			**193**			**349**			

Radio and Weather Equipment Mobilizations

NICC received 979 requests for radio kits and weather equipment in 2024. Of those requests: 902 were filled, 67 were canceled, and 10 were UTF.

Radio and Weather Equipment Request Summary by Requesting Agency and Requesting Geographic Area

	4390 Starter			4312 Repeater			4381 Tactical			5869 RAWS			Equipment Totals			
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Total
BIA	9	0	0	16	0	0	7	0	0	3	0	0	35	0	0	**35**
BLM	11	0	0	28	0	0	14	0	0	12	0	0	65	0	0	**65**
DOD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
FEMA	1	0	0	3	0	1	6	2	0	0	0	0	10	2	1	**13**
FS	123	15	1	227	12	4	176	13	3	90	8	1	616	48	9	**673**
FWS	2	1	0	2	0	0	1	1	0	0	0	0	5	2	0	**7**
NPS	3	0	0	10	0	0	5	2	0	0	0	0	18	2	0	**20**
ST	28	1	0	65	11	0	38	1	0	18	0	0	149	13	0	**162**
Other	0	0	0	2	0	0	0	0	0	1	0	0	3	0	0	**3**
Canada	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	**1**
Subtotal:	*178*	*17*	*1*	*353*	*23*	*5*	*247*	*19*	*3*	*124*	*8*	*1*	*902*	*67*	*10*	
Total:	**196**			**381**			**269**			**133**			**979**			

	4390 Starter			4312 Repeater			4381 Tactical			5869 RAWS			Equipment Totals			
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Total
AK	6	0	0	6	0	0	3	0	0	3	0	0	18	0	0	**18**
EA	4	1	0	2	1	0	1	0	0	0	0	0	7	2	0	**9**
GB	19	2	0	58	4	0	42	0	0	31	2	1	150	8	1	**159**
NICC	0	0	0	0	0	0	12	0	0	0	0	0	12	0	0	**12**
NO	18	4	0	33	3	1	16	3	0	12	0	0	79	10	1	**90**
NR	16	3	0	16	1	0	10	0	0	9	1	0	51	5	0	**56**
NW	37	1	1	127	3	2	108	7	1	49	3	0	321	14	4	**339**
RM	10	3	0	11	0	0	4	0	0	6	2	0	31	5	0	**36**
SA	6	0	0	6	1	2	16	3	1	0	0	0	28	4	3	**35**
SO	29	2	0	51	9	0	25	4	0	6	0	0	111	15	0	**126**
SW	33	1	0	43	1	0	10	2	1	8	0	0	94	4	1	**99**
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Canada	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Subtotal:	*178*	*17*	*1*	*353*	*23*	*5*	*247*	*19*	*3*	*124*	*8*	*1*	*902*	*67*	*10*	
Total:	**196**						**269**			**133**			**979**			

Wildland Fires and Acres Burned by State and Agency

(Figures are from the SIT/209 Application)

Alabama

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	55	2,262	3	897	58	3,159
FWS	2	203	1	399	3	602
NPS	2	1	0	0	2	1
ST	1,363	17,216	99	0	1,462	17,216
Totals:	**1,422**	**19,682**	**103**	**1,296**	**1,525**	**20,978**

Alaska

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BLM	36	2,742	104	551,024	140	553,766
DVF	150	769	75	112,540	225	113,308
FS	11	1	1	0	12	1
Totals:	**197**	**3,512**	**180**	**663,564**	**377**	**667,075**

Arizona

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	604	13,674	152	21,590	756	35,264
BLM	129	3,841	104	39,660	233	43,501
DVF	297	31,963	44	46,839	341	78,802
FS	373	36,953	455	85,450	828	122,402
FWS	8	1,341	1	1,422	9	2,763
NPS	11	1	13	256	24	257
Totals:	**1,422**	**87,773**	**769**	**195,217**	**2,191**	**282,989**

Arkansas

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	1,189	23,714	0	0	1,189	23,714
FWS	4	51	0	0	4	51
NPS	26	1,679	0	0	26	1,679
Totals:	**1,219**	**25,444**	**0**	**0**	**1,219**	**25,444**

California

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	48	898	0	0	48	898
BLM	92	10,670	34	2,833	126	13,503
C&L	47	87,337	0	0	47	87,336
CDF	7,075	503,944	12	934	7,087	504,878
FS	688	385,744	224	71,558	912	457,302
FWS	3	8	0	0	3	8
NPS	46	33	35	14,881	81	14,913
USA	6	2,299	0	0	6	2,299

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
USAF	6	6	0	0	6	6
Totals:	**8,011**	**990,939**	**305**	**90,206**	**8,316**	**1,081,144**

Colorado

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	12	56	45	27	57	83
BLM	54	3,944	262	1,703	316	5,647
BOR	1	0	1	0	2	0
C&L	173	11,366	92	4,423	265	15,788
FS	108	16,622	102	8,287	210	24,909
FWS	3	40	1	3	4	43
NPS	7	0	16	133	23	133
USA	14	13,277	2	566	16	13,842
USAF	1	92	0	0	1	92
Totals:	**373**	**45,398**	**521**	**15,142**	**894**	**60,539**

Connecticut

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
ST	356	339	0	0	356	339
Totals:	**356**	**339**	**0**	**0**	**356**	**339**

Delaware

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
ST	23	137	0	0	23	137
Totals:	**23**	**137**	**0**	**0**	**23**	**137**

Florida

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	3	1	0	0	3	1
DOD	0	0	1	833	1	833
FS	69	6,772	11	923	80	7,695
FWS	6	166	4	4,901	10	5,067
NPS	12	818	4	12	16	830
OTHR	11	52	2	1	13	53
ST	1,805	27,430	420	23,709	2,225	51,139
Totals:	**1,906**	**35,239**	**442**	**30,379**	**2,348**	**65,618**

Georgia

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	35	327	2	2	37	329
FWS	1	1	0	0	1	1
NPS	1	10	0	0	1	10
ST	2,453	11,556	0	0	2,453	11,556
Totals:	**2,490**	**11,894**	**2**	**2**	**2,492**	**11,896**

Hawaii

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
C&L	88	74	1	300	89	374
NPS	0	0	1	78	1	78
Totals:	**88**	**74**	**2**	**378**	**90**	**452**

Idaho

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	38	3,074	5	29,020	43	32,094
BLM	138	21,059	91	288,502	229	309,561
BOR	3	8	0	0	3	8
C&L	34	734	2	60	36	794
DOD	0	0	2	142	2	142
FS	94	3,476	407	569,677	501	573,153
FWS	1	0	1	114	2	114
ST	511	42,160	123	38,736	634	80,896
Totals:	**819**	**70,511**	**631**	**926,251**	**1,450**	**996,762**

Illinois

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	39	380	0	0	39	379
FWS	6	15	0	0	6	15
ST	2	47	0	0	2	47
Totals:	**47**	**442**	**0**	**0**	**47**	**441**

Indiana

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	14	42	0	0	14	42
NPS	44	34	0	0	44	34
ST	6	78	0	0	6	78
Totals:	**64**	**154**	**0**	**0**	**64**	**154**

Iowa

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
DNR	355	3,152	0	0	355	3,152
FWS	7	813	0	0	7	813
Totals:	**362**	**3,965**	**0**	**0**	**362**	**3,965**

Kansas

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	12	273	0	0	12	272
C&L	23	21,818	0	0	23	21,818
FWS	5	126	1	1	6	126
Totals:	**40**	**22,217**	**1**	**1**	**41**	**22,217**

Kentucky

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	24	525	0	0	24	525
ST	933	23,923	0	0	933	23,923
Totals:	**957**	**24,448**	**0**	**0**	**957**	**24,448**

Louisiana

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	15	218	3	14	18	232
FWS	0	0	1	2,830	1	2,830
ST	366	5,996	0	0	366	5,996
Totals:	**381**	**6,214**	**4**	**2,844**	**385**	**9,058**

Maine

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
NPS	3	0	0	0	3	0
ST	650	295	0	0	650	295
Totals:	**653**	**295**	**0**	**0**	**653**	**295**

Maryland

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FWS	3	2	0	0	3	2
NPS	5	2	1	0	6	2
ST	163	961	2	0	165	961
Totals:	**171**	**965**	**3**	**0**	**174**	**965**

Massachusetts

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
ST	1,297	4,622	2	0	1,299	4,622
Totals:	**1,297**	**4,622**	**2**	**0**	**1,299**	**4,622**

Michigan

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	13	20	0	0	13	20
DNR	279	1,339	16	102	295	1,441
FS	130	271	5	329	135	600
NPS	0	0	0	0	0	0
ST	4	1	0	0	4	1
Totals:	**426**	**1,631**	**21**	**431**	**447**	**2,062**

Minnesota

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	188	883	0	0	188	883
DNR	890	13,475	0	0	890	13,475

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	33	431	0	0	33	431
FWS	11	335	0	0	11	335
NPS	0	0	1	1	1	1
Totals:	**1,122**	**15,124**	**1**	**1**	**1,123**	**15,125**

Mississippi

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	10	20	0	0	10	20
FS	167	15,672	4	122	171	15,794
FWS	8	25	0	0	8	25
NPS	20	408	0	0	20	408
OTHR	1,591	39,633	0	0	1,591	39,633
Totals:	**1,796**	**55,758**	**4**	**122**	**1,800**	**55,880**

Missouri

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	164	11,607	0	0	164	11,607
NPS	3	58	0	0	3	58
ST	2,637	83,430	0	0	2,637	83,430
Totals:	**2,804**	**95,095**	**0**	**0**	**2,804**	**95,095**

Montana

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	372	9,550	44	2,227	416	11,777
BLM	29	478	65	176,074	94	176,552
C&L	775	45,680	263	57,265	1,038	102,945
FS	243	22,863	269	32,468	512	55,331
FWS	4	123	9	1,797	13	1,920
NPS	2	0	6	30	8	30
ST	157	947	85	2,988	242	3,936
Totals:	**1,582**	**79,641**	**741**	**272,849**	**2,323**	**352,491**

Nebraska

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	6	263	0	0	6	263
DOF	899	101,946	107	10,120	1,006	112,066
FS	2	0	16	1,227	18	1,227
FWS	2	284	2	0	4	284
TNC	1	10	0	0	1	10
Totals:	**910**	**102,503**	**125**	**11,347**	**1,035**	**113,850**

Nevada

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BLM	345	20,169	225	23,263	570	43,432

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BOR	56	5	0	0	56	5
C&L	145	6,397	37	2,893	182	9,289
DOD	2	8,026	1	0	3	8,026
FS	21	10	45	9,067	66	9,076
FWS	2	0	2	98	4	98
NPS	29	4	12	478	41	482
ST	5	1	2	0	7	1
Totals:	**605**	**34,612**	**324**	**35,799**	**929**	**70,410**

New Hampshire

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	3	1	0	0	3	1
ST	123	125	4	1	127	126
Totals:	**126**	**126**	**4**	**1**	**130**	**127**

New Jersey

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FWS	4	25	0	0	4	25
NPS	1	0	0	0	1	0
ST	1,438	12,424	0	0	1,438	12,424
Totals:	**1,443**	**12,449**	**0**	**0**	**1,443**	**12,449**

New Mexico

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	73	8,057	44	17,709	117	25,766
BLM	44	123	36	238	80	361
DOE	1	1	0	0	1	1
FS	95	848	201	47,663	296	48,510
FWS	0	0	2	98	2	98
NPS	2	1	13	1,670	15	1,671
SF	235	2,966	76	3,158	311	6,123
USA	1	0	0	0	1	0
Totals:	**451**	**11,995**	**372**	**70,536**	**823**	**82,531**

New York

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
NPS	3	0	0	0	3	0
ST	119	6,495	3	1	122	6,496
Totals:	**122**	**6,495**	**3**	**1**	**125**	**6,496**

North Carolina

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	13	13	0	0	13	13
FS	40	999	2	2	42	1,001

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FWS	0	227	0	0	0	227
NPS	5	1	0	0	5	1
ST	4,535	15,345	53	361	4,588	15,706
USM	20	1,285	0	0	20	1,285
Totals:	**4,613**	**17,870**	**55**	**363**	**4,668**	**18,233**

North Dakota

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	369	18,810	2	12	371	18,822
BLM	1	145	0	0	1	145
FS	12	9,340	2	42	14	9,382
FWS	10	1,100	0	0	10	1,100
NPS	2	8	2	11	4	19
ST	522	143,732	13	37	535	143,769
Totals:	**916**	**173,135**	**19**	**102**	**935**	**173,237**

Ohio

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	45	48	0	0	45	48
ST	1,054	2,383	8	10	1,062	2,393
Totals:	**1,099**	**2,431**	**8**	**10**	**1,107**	**2,441**

Oklahoma

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	944	70,757	0	0	944	70,757
FWS	3	12,423	0	0	3	12,423
NPS	1	0	0	0	1	0
OTHR	389	3,177	0	0	389	3,177
ST	1,691	295,179	5	1,835	1,696	297,014
TRIBE	8	220	0	0	8	220
Totals:	**3,036**	**381,757**	**5**	**1,835**	**3,041**	**383,592**

Oregon

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	100	857	5	33	105	889
BLM	158	341,534	147	746,161	305	1,087,695
C&L	2	14	3	0	5	14
DOF	780	34,696	218	120,841	998	155,537
FS	299	145,648	500	335,562	799	481,210
FWS	3	1	7	67,157	10	67,158
NPS	3	1	7	5,292	10	5,293
Totals:	**1,345**	**522,751**	**887**	**1,275,046**	**2,232**	**1,797,796**

Pennsylvania

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	7	1	0	0	7	1
NPS	14	628	0	0	14	628
ST	1,423	3,161	4	2	1,427	3,163
Totals:	**1,444**	**3,790**	**4**	**2**	**1,448**	**3,792**

Rhode Island

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
ST	73	75	0	0	73	75
Totals:	**73**	**75**	**0**	**0**	**73**	**75**

South Carolina

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	49	634	1	0	50	634
Totals:	**49**	**634**	**1**	**0**	**50**	**634**

South Dakota

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	379	21,509	39	491	418	22,000
BLM	3	16	1	0	4	16
C&L	30	744	8	9,952	38	10,696
FS	42	53	62	557	104	610
FWS	3	87	0	0	3	87
NPS	1	0	2	1,981	3	1,981
ST	70	315	32	104	102	419
USA	1	0	0	0	1	0
USAF	2	0	0	0	2	0
Totals:	**531**	**22,724**	**144**	**13,085**	**675**	**35,809**

Tennessee

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	31	351	2	60	33	411
NPS	7	55	0	0	7	55
OTHR	523	6,400	10	154	533	6,554
ST	22	750	1	1	23	751
Totals:	**583**	**7,556**	**13**	**215**	**596**	**7,771**

Texas

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BLM	0	0	0	0	0	0
C&L	4,148	14,553	132	1,681	4,280	16,234
FS	41	1,279	1	0	42	1,279
FWS	7	689	1	0	8	689
NPS	34	162	4	13,519	38	13,681
OTHR	4	1	0	0	4	1

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
ST	562	1,277,517	33	5,502	595	1,283,019
Totals:	**4,796**	**1,294,201**	**171**	**20,702**	**4,967**	**1,314,903**

Utah

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	18	5	14	611	32	616
BLM	118	16,787	199	3,882	317	20,669
DOD	9	5,328	0	0	9	5,328
FS	84	39,634	120	17,960	204	57,594
FWS	1	137	0	0	1	137
NPS	3	0	10	46	13	46
ST	514	2,894	121	3,131	635	6,026
Totals:	**747**	**64,786**	**464**	**25,631**	**1,211**	**90,417**

Vermont

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	2	1	1	0	3	1
ST	93	179	1	0	94	179
Totals:	**95**	**180**	**2**	**0**	**97**	**180**

Virginia

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	46	19,701	6	7	52	19,708
FWS	3	0	0	0	3	0
OTHR	0	10,298	0	0	0	10,298
ST	683	26,343	4	23	687	26,366
Totals:	**732**	**56,342**	**10**	**30**	**742**	**56,372**

Washington

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	160	7,719	24	53,793	184	61,512
BLM	45	13,331	6	336	51	13,667
C&L	70	6,443	1	0	71	6,443
DNR	969	58,650	96	8,306	1,065	66,956
FS	129	22,340	103	14,591	232	36,931
FWS	22	972	1	1	23	973
NPS	32	9	11	1,553	43	1,562
ST	135	87,533	0	0	135	87,533
TRIBE	2	15	0	0	2	15
Totals:	**1,564**	**197,012**	**242**	**78,580**	**1,806**	**275,593**

West Virginia

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	20	49	0	0	20	49

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
NPS	11	245	0	0	11	245
ST	1,073	55,015	0	0	1,073	55,015
Totals:	**1,104**	**55,309**	**0**	**0**	**1,104**	**55,309**

Wisconsin

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	6	2	0	0	6	2
DNR	1,106	2,503	31	26	1,137	2,529
FS	16	32	1	26	17	58
FWS	2	8	0	0	2	8
NPS	0	0	0	0	0	0
Totals:	**1,130**	**2,545**	**32**	**52**	**1,162**	**2,597**

Wyoming

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	67	465	21	33,944	88	34,409
BLM	68	7,581	73	46,998	141	54,579
C&L	201	68,602	123	268,769	324	337,371
FS	64	12,753	76	149,213	140	161,966
FWS	0	0	2	18	2	18
NPS	6	3	4	0	10	3
SF	14	4,356	19	27,367	33	31,723
Totals:	**420**	**93,760**	**318**	**526,309**	**738**	**620,069**

NICC Benchmarks

The figures below represent national-level totals for fire activity and numbers of **resources mobilized through the National Interagency Coordination Center**, except for Incident Management Team mobilizations, which are displayed in totality of mobilizations nationwide. Records set during the year of this report are in **bold**.

Category	Record Year	Record	2024 Stats
Wildfires	2006	96,385	64,897
Wildfire Acres Burned	2015	10,125,149	8,924,884
Large Fires	2006	1,801	1,180
Days at Preparedness Level 1&2	2010	365	243
Days at Preparedness Level 4&5	2021	99	96
CIMT Mobilizations (fire & non-fire)	2021	204	150
Dept. of Defense Battalions/Task Forces	1988	8	1
MAFFS (millions of gallons delivered)	1994	5.03	0.87
Tactical Crew Mobilizations	**2024**	**1,839**	**1,839**
Engine Mobilizations	2021	3,149	2,576
Overhead Mobilizations	**2024**	**18,286**	**18,286**
Type 1 Helicopter Mobilizations	2016	334	243
Type 2 Helicopter Mobilizations	2006	323	80
Heavy Airtankers (VLAT/LAT/MAFFS)	2017	2,298	887
Large Transport Flights	1994	552	16
Mobile Food Units	1994	195	124
Shower Units	1994	256	174

Identifier Legend

Interagency Coordination Centers
NICC: National Interagency Coordination Center
NIFC: National Interagency Fire Center
CIIFC: Canadian Interagency Forest Fire Centre
AK: Alaska Area
EA: Eastern Area
GB: Great Basin Area
NO: Northern California Area
NR: Northern Rockies Area
NW: Northwest Area
RM: Rocky Mountain Area
SA: Southern Area
SW: Southwest Area
SO: Southern California Area

Federal Government Agencies
FS: Forest Service
BIA: Bureau of Indian Affairs
BLM: Bureau of Land Management
FWS: Fish and Wildlife Service
NPS: National Park Service
FEMA: Federal Emergency Management Agency
ESF4: Emergency Support Function, Firefighting
NWS: National Weather Service
DOE: Department of Energy
DOD: Department of Defense

International Partners
AU: Australia
CN: Canada
MX: Mexico
NZ: New Zealand

Other Providers/Ownership
CNTY: County
OT: Other
PRI: Private
ST: State
ST/OT: State/Other Combined

Acronyms and Terminology

Air Attack: Light aircraft (airplane or helicopter) that carries the ATGS.

ASM: Aerial Supervision Module, light twin-engine airplane that combines the lead plane function and tactical supervision (pilot and Air Tactical Supervisor - ATS).

IA: Initial Attack.

IMT: Incident Management Team.

Infrared: Aircraft outfitted with infrared sensing equipment.

IROC: Interagency Resource Ordering Capability System.

Large fire: A large fire is defined as 100 acres or greater in timber, 300 acres or greater in grass/brush, or a CIMT, Type 1 or NIMO team is assigned.

LAT: Large Airtanker.

Lead Plane: Twin-engine airplane that guides airtankers over a fire.

MAFFS: Modular Airborne Fire Fighting System (military C-130 aircraft).

NIMO: National Incident Management Organization.

Pax: Passengers.

RAWS: Remote Automated Weather Station.

Starter: Type of portable radio kit.

Repeater: Type of portable radio kit.

Tactical: Type of portable radio kit.

SEAT: Single engine airtanker.

Scooper: The vernacular term for a multi-engine airtanker capable of filling its tanks while skimming over a body of water then dropping the water on a wildland fire.

TFR: Temporary Flight Restriction.

UTF: Unable to Fill resource request (the requested resource couldn’t be filled).

UAS: Unmanned Aircraft Systems.

VLAT: Very Large Airtanker.

National Interagency Coordination Center

Wildland Fire Summary and Statistics Annual Report 2023



Hayden Fire, Idaho

National Interagency Coordination Center

Table of Contents

Preface 1
2023 Fire Environment Summary 2
National Fire Activity Synopsis 7
Structures Destroyed 7
Significant Incidents Over 40,000 Acres 8
Wildfires and Acres 9
- Overall Wildfire Activity Reported to NICC 11
- Wildfires by Geographic Area 11
- Wildfires by Agency 12
- Lightning Fires and Acres by Geographic Area 13
- Human Caused Fires and Acres by Geographic Area 13
- Wildfires and Acres Burned by Agency and GACC – 2023 & prior years 14

National Preparedness Levels 15
Requests Filled Nationally in IROC 17
Requests Processed through the NICC 18
- International Resource Mobilizations 18
- Department of Defense Mobilizations 19
- Incident Management Team Mobilizations 20
- Crew Mobilizations 24
- Engine Mobilizations 26
- Overhead Mobilizations 29
- Helicopter Mobilizations 31
- Fixed Wing Aircraft Mobilizations 33
- Airtanker Mobilizations 34
- Infrared Aircraft Mobilizations 35
- Unmanned Aircraft Systems 38
- Temporary Flight Restrictions 38
- Large Transportation Aircraft 39
- Equipment Services Mobilization 40
- Radio and Weather Equipment Mobilizations 41

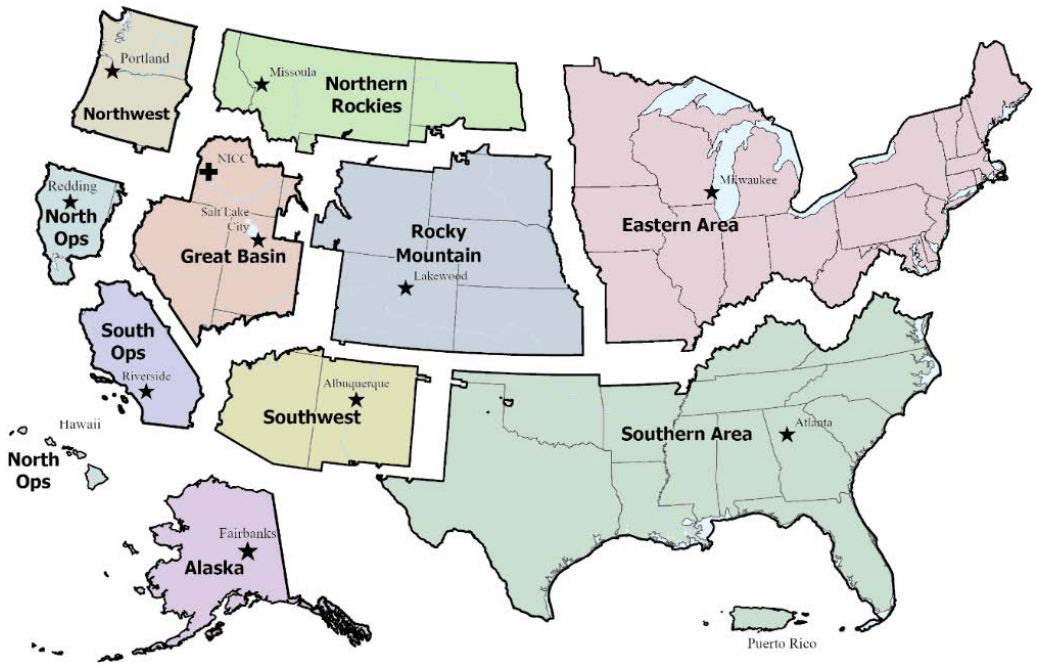
Wildland Fires and Acres Burned by State and Agency 42
NICC Benchmarks 52
Identifier Legend 53
Acronyms and Terminology 54

Preface

Statistics used in this report were gathered from the Situation Report and Incident Status Summary (ICS-209) programs[1]. Previous National Interagency Coordination Center (NICC) annual reports and other sources were also used in this document. The statistics presented here are intended to provide a national perspective of annual fire activity, but they may not reflect official figures for a specific agency. The statistics are delineated by agency and Geographic Area. This document and prior year annual reports are available electronically on the NICC Intelligence web page.

Resource mobilization statistics used in this report were gathered from the Interagency Resource Ordering Capability system (IROC), which tracks aircraft, crews, equipment, overhead, and supplies mobilized nationally. Statistics presented in this report are resources requested by any of the ten Geographic Area Coordination Centers (GACCs) and processed through NICC, apart from Incident Management Teams and Temporary Flight Restrictions[2]. Requests by FEMA are placed to NICC through Emergency Support Function (ESF) #4 (Firefighting). The resource ordering process and procedures may be found in the National Mobilization Guide. The National Mobilization Guide can be found on the NICC Reference Documents web page.

Geographic Area Coordination Centers



[1] Situation Report and ICS-209 data are considered situational and provisional, as they are reported while wildfire activity and incidents are occurring; they do not account for all wildland fires and their final outcomes. Some wildfires, including many that are suppressed solely by private citizens or local fire departments (not by wildland fire management agencies), are never reported to any Dispatch Center that submits Situation Report data. Additionally, ICS-209 reports are not required for the small, short duration wildfires that comprise the vast majority of overall fire occurrence annually. For official data and summary statistics, one must contact each of the individual agencies affected and refer to their final fire reports and other authoritative sources of agency-specific information.

[2] This report only tallies resource requests processed through NICC, with the exceptions of Incident Management Team mobilizations and Temporary Flight Restrictions that are captured nationally. It excludes the substantial number of IROC orders that were placed and filled within the same GACC. It also excludes any resource usage not tracked in IROC, such as local dispatch of initial attack resources.

2023 Fire Environment Summary

January – March

Much of the West was characterized with above normal precipitation and below normal temperatures January through March. Multiple moderate to strong atmospheric rivers brought heavy precipitation to California into the Great Basin and central and southern Rockies through mid-January. While a less active period followed, late February through March had substantial precipitation and below normal temperatures across the West as consistent upper-level trough passages phased with ample Pacific moisture due in part to a historically strong Madden-Julian Oscillation. This led to record setting snowpack and snow water equivalent (SWE) in the Sierra, Nevada, Utah, and Arizona, including multiple stations and ski resorts in California recording more than 700 inches of snow. Snowpack and SWE were mostly well above average through March across the West, but portions of Washington, the northern Rockies, and Alaska were closer to average. Due to the widespread above normal precipitation and near to below normal temperatures, drought improved or was removed across the West except for portions of northern Oregon, eastern Washington, and the Idaho Panhandle into northwest Montana.

Much of the southern and central Plains had below normal precipitation through March, with moderate to exceptional drought occupying most of this territory. Above normal precipitation from eastern Oklahoma into the Upper Mississippi Valley and the Great Lakes in February and March helped alleviate drought in those areas, but drought maintained or worsened across Texas and the southern and central High Plains. The Florida Peninsula received below average precipitation during early 2023 leading to moderate and extreme drought, with drought also developing on portions of the Gulf Coast. Overall, temperatures were above normal for most of the eastern US January through March. Additionally, two late March severe weather events across the Southeast resulted in 26 deaths.

Significant fire activity remained minimal across the US through February, with below average number of fires and only 35% of the 10-year average for acres burned. Fire activity increased in March across the Southern, Southwest, and Rocky Mountain Geographic Areas. Increasingly receptive fuels were noted in the eastern Carolinas into the Mid-Atlantic, on the Florida Peninsula, from Texas onto the southern and central High Plains, and into southern and central New Mexico. Several large wildfires emerged on March 30 in Colorado and New Mexico and on March 31 in Kansas and Oklahoma as strong winds and low relative humidity combined to create critical fire weather conditions. However, the national year-to-date number of fires remained below average while acres burned was far below average at 25% at the end of March.

April – June

Below normal temperatures were widespread across the West, and despite the below average precipitation outside of the Northwest, little snowmelt occurred until the end of April during record setting high temperatures. Record or near record SWE values remained in the Sierra, Nevada, Utah, and Arizona through April. Snowpack and SWE remained above average in May for the southern half to two-thirds of the West, but well above normal temperatures and below normal precipitation caused a precipitous decline in snowpack across Washington, northern Idaho, western Montana, and parts of Wyoming to well below normal by the end of May. Most areas in the West were snow free by the end of June, but basins in the Sierra and portions of the Great Basin held snow much later than normal, especially at higher elevations. By the end of June, most of the drought across the southern half to two-thirds of the West was gone, while drought continued in portions of the northwestern US.

Drought emerged or worsened in Florida during April but record daily rainfall of over 25 inches was recorded in Fort Lauderdale on April 13. Drought was mostly removed in Florida by June after this and other heavy rain events. Widespread above normal precipitation fell on the High Plains, especially the southern and central High Plains in May and June, which improved or removed drought conditions, but areas of extreme to exceptional drought continued in Kansas and Nebraska into the Mid-Mississippi Valley by the end of June. Drought also emerged and worsened in parts of the Midwest and Great Lakes during May and June.

Significant fire activity increased across the Southern, Southwest, Rocky Mountain, and Eastern Geographic Areas in April, but a portion of the Southern Area observed a decrease in significant fire activity at the end of the month due to green-up. Two significant wind events across the central and southern Plains on April 10-13 and April 17-18 resulted in spikes of significant fire activity across New Mexico, Colorado, Nebraska, Iowa, Kansas, and Oklahoma. Very dry and occasionally breezy winds contributed to elevated activity across the Mid-Atlantic into southern New England beginning April 12, with significant fires in Massachusetts, New York, New Jersey, Pennsylvania, and West Virginia. Very dry conditions in eastern North Carolina contributed to the Great Lakes Fire, resulting in the first Complex Incident Management Team deployment of the year. Florida, Arizona, Michigan, and Wisconsin also had short-lived significant fires during the month.

While the steady but modest seasonal increase in fire activity warranted elevating to national Preparedness Level (PL) two (scale one to five) on May 8, significant fire activity remained below normal across the US during May and June. Wildfire activity remained low in much of the Southern Area, with the West observing a gradual increase in activity, but hot and windy conditions at the end of the month saw a marked increase in activity in the Southwest, Colorado, and Texas. By the end of May, fire danger was high in the Lower Mississippi Valley, where the dry conditions and elevated fire potential would persist into fall. However, the nation's first Fuels and Fire Behavior Advisory was issued in mid-June for the western Great Lakes states due to deficient seasonal precipitation. Alaska continued to have a very slow season, one of the slowest on record. At the end of June, national year-to-date acres burned was only 36% of the 10-year average.

In Canada, an unprecedented start to their fire season began in May, with the Canadian Interagency Forest Fire Center (CIFFC) going from PL one to five (i.e., the highest level) in eight days (May 3 to May 11). Numerous large, out of control wildfires were in nearly every province by the end of June, and more than 8 million hectares had burned, eclipsing the annual record for acres burned dating back to 1982. Smoke occasionally drifted into states along the US-Canada border, while abundant smoke poured into the northeast US in early June and significantly deteriorated air quality for multiple days in major cities such as New York and Washington, D.C.

July – September

Significant fire activity increased in July, especially during the latter half, as the national PL increased from two to three on July 21. Much of the significant fire activity was in the Southwest Geographic Area, but the Northern Rockies and Northwest Geographic Areas had multiple long-duration incident management team wildfires on the landscape. Alaska's abnormally slow season finally saw an uptick in activity in the last week of July, when dozens of new wildfires, including several large wildfires, ignited due to prolific lightning and moderately receptive fuels, as noted in a short-lived Fuels and Fire Behavior Advisory issued for the central and eastern Interior and Copper River Basin.

Significant fire activity continued to increase through August, with the national PL increasing from three to four on August 17. Significant fire activity increased across most geographic areas in August, including the Southern Area, but decreased in the Southwest Area, which had escalated to PL four for a short period in early August. A timely significant rainfall event stemming from the remnant of Tropical Storm Hilary over August 20-23 resulted in decreased activity across the Great Basin, Rocky Mountain, and Northern Rockies Geographic Areas for the end of the month. Alaska continued with elevated activity through mid-month before decreasing rapidly at the end of August, while Hawai'i was very active as well.

Significant fire activity generally decreased during September as the national PL dropped from four to three September 7 and from three to two September 26. Rainfall at the end of August and beginning of September across northern California and the northern Intermountain West caused a step down in fire activity, and a season ending rain event along and west of the Cascades from northwest California through western Washington occurred the last week in September. At the end of September, national year-to-date acres burned for the US was well below the 10-year average at just under 40%, with just below average number of fires.

In Hawai'i, Tropical Storm Calvin brought heavy rainfall to the Big Island in July, but overall, a warming and drying trend continued across the islands through July into August as drought expanded across much of the Hawai'ian Islands by the end of August. Driven by winds from the passage of Hurricane Dora to the south and strong upper-level ridging to the north of the islands, respectively, the Lahaina and Upcountry Fires on Maui burned thousands of acres and more than 2,000 structures. With 100 confirmed deaths, the Lahaina fire was the nation's deadliest wildfire in over 100 years. Recent drying and above normal fuel loading coupled with extremely critical fire weather conditions to ignite and spread these wildfires among several others.

Parts of Texas into the Lower Mississippi Valley neared flash drought conditions in July, with accelerating drought in parts of south, west, and central Texas. In August, record breaking temperatures were observed across Texas, the Lower Mississippi Valley, and Gulf Coast as a prolonged heat wave lasted much of August. The conditions were highlighted with a Fuels and Fire Behavior Advisory first issued in mid-August and repeatedly renewed (and shifted eastward) into November as flash drought conditions resulted with much of east Texas and Louisiana in extreme to exceptional drought. While scattered thunderstorms developed over portions of east Texas and the Lower Mississippi Valley at the end of August, any relief was temporary and localized, with lightning-ignited wildfires resulting from thunderstorms as well. Consistent elevated initial attack and large fire occurrence was reported in Texas, Louisiana, Mississippi, and other southeast US states during the summer. Southern Area elevated to PL four on August 24 and then to PL five from August 29 to September 5, due to this significant wildfire activity and Hurricane Idalia, before reverting to PL three on September 17.

Drier than normal conditions were observed across Florida into the Carolinas before Hurricane Idalia moved through Florida, southern Georgia, and the Carolinas at the end August. However, the tropical moisture tracked east of the western Florida Panhandle and central Gulf Coast states, which remained dry. Drought also intensified and expanded in portions of the Ohio Valley and Midwest, but late September rainfall brought some relief. Heavy rain fell on portions of the East Coast due to tropical cyclones or remnants of tropical cyclones, with a developing coastal low producing record setting rainfall in and around New York City September 29.

Warmer and drier than normal conditions developed across the West in July, mostly due to the late arriving and weak North American Monsoon. Record breaking temperatures were observed across the southwestern US into Texas as a prolonged heat wave lasted much of July. Record heat examples included El Paso having more than six consecutive weeks above 100°F, and Phoenix with 30 straight days over 110°F. Phoenix's July average temperature was nearly four degrees above the previous warmest month, and areas in the southwestern US received little to no rainfall marking their driest July on record.

Abnormally dry and drought conditions developed and expanded from the Lower Mississippi Valley through the southwestern US, with intensifying and expanding drought across parts of the Northwest and Northern Rockies July into August. The North American Monsoon arrived in August to the Southwest and Colorado, and it was augmented by tropical cyclones such as Hurricane Hilary as it extended through the Intermountain West. However, two significant dry thunderstorms developed August 14-15 and August 24-25 in northwest California, western Oregon, and western Washington, helping ignite dozens of large wildfires and spurring the elevation to PL four in Northern California and two short periods of PL five in the Northwest. By the third week of August, all ten Geographic Areas had ongoing large fires, as is common at the peak of the summer season, but for the second consecutive year, elevation to national PL five did not occur. The monsoon continued into September with some intrusions farther north across the West, but the Southwest into the Four Corners mostly received near to below normal rainfall for the month. Large fires continued to be active from mid-August to late September in western Washington and northwest California, especially between moisture intrusions, before season ending rains arrived in late September via an atmospheric river.

The unprecedented fire season Canada continued through most of September with CIFFC remaining at PL five for 124 days (May 11 – September 7) and not dropping to PL one until October 6. Nearly two-hundred thousand people were evacuated during the summer and nearly 18.5 million hectares burned, more than two and a half times the previous annual record. Additionally, 142 confirmed pyrocumulonimbus (pyroCb) clouds were observed on fires in Canada, setting a record for most pyroCbs in a year.

October – December

Significant fire activity generally decreased through October as the national PL dropped from two to one on October 13. However, very dry and occasionally windy conditions at the end of the month from California into the greater Four Corners area resulted in a brief uptick in activity across California, the Southwest, and southern Colorado. Moderate initial attack and periodic large fires continued in the Southern Area as well, mainly in the Deep South and southern Appalachians. Fire activity increased in Southern Area during November, with the geographic area increasing to PL three in early November before returning to PL two the last week of November. Large fires were reported in every state of the Southern Area during the month, and multiple complex incident management teams were assigned, with fire activity increasing in the Eastern Area near the Southern Area boundary. Central Appalachia was briefly highlighted with a Fuels and Fire Behavior Advisory jointly issued by Southern and Eastern Areas for the latter half of November.

Extreme and exceptional drought expanded and intensified across east Texas through the Lower Mississippi Valley, with continued warmer and drier than normal conditions in October. Extreme to exceptional drought persisted in Louisiana and Mississippi with other areas in Iowa, Nebraska, and New Mexico as most of the CONUS had below normal precipitation and near to above normal temperatures during November. Southern and Eastern Areas' fire activity increased due

to the multiple passages of dry cold fronts followed by periods of post-frontal dry and breezy conditions in November. Drought improved in Texas, but drought developed or worsened in portions of the Four Corners, Mississippi Valley, Midwest, and the southern and central Appalachians into the Mid-Atlantic during November.

In December, several cold fronts moved from the Plains to the East Coast during the month, but these tended to be drier until they reached the Appalachians, Gulf and East Coasts. However, by late December the pattern turned wetter for the Plains into the Southeast. As a result, drought improved slightly across portions of the Lower Mississippi and Tennessee Valleys as well as portions of the Gulf Coast, and Mid-Atlantic. However, drought worsened over portions of the Mid-Mississippi and Lower Ohio Valleys.

Early and late October precipitation events in the northwestern US continued to slow fire activity, but moderate to extreme drought remained along and west of the Cascades stretching into northern Idaho and northern Montana. Drought improved across much of the northwestern US in November and December due to several atmospheric river events impacting region and down the West Coast. However, most of the West had below normal snowpack and SWE at the end of December, generally 25-75%, with most areas receiving near to below normal precipitation during the three-month period as well. The timely arrival of atmospheric rivers kept fire activity mostly below typical levels across California even during multiple periods of offshore winds.

The Hawai'ian Islands had multiple periods of enhanced trade winds with dry airmasses October - December, including in early November and late December when fire activity increased. However, a strong Kona Low brought widespread heavy rainfall to the islands the last week of November. Periodic frontal passages also helped mitigate fire potential on the islands through the period, with drought improving but remaining in some areas.

Fire activity continued to decrease throughout December across the US, continuing the trend from late November. On December 7, Southern Area reverted to PL one, leaving just the California Geographic Areas at PL two, given the possibility of problematic late-season winds despite otherwise favorable fuels conditions. A limited number of large fires burned briefly across the country in December, mainly in the Eastern, Southern, and Southwest Areas; however, significant fire activity was minimal over the last half of the month. While a large fire was recorded in southern California early in the month due to a Santa Ana wind event, the late-season fire activity in coastal California was unusually light. At the end of the year, annual acres burned for the US in 2023 remained well below the 10-year average at just over 37%, with slightly below average number of fires as well, at 95%.

National Fire Activity Synopsis

Nationally, there were 56,580 wildfires reported in 2023, compared to 68,988 wildfires reported in 2022. Reported wildfires consumed 2,693,910 acres nationally, compared to 7,577,183 acres in 2022.

In 2023, the reported acres burned nationwide was noticeably lower than the 10-year average, while the number of reported wildfires nationwide was only slightly lower than the 10-year average. Eastern Area was the only Geographic Area to see above average (56%) acres burned. All other geographic areas were below their averages for both number of fires and acres burned.

A total of 4,318 structures were reported destroyed by wildfires in 2023, including 3,060 residences, 1,228 minor structures, and 51 commercial/mixed residential structures. In 2023, the majority of structures were destroyed in the Northern California Geographic Area, including the 2,308 residences destroyed in Maui.

Structures Destroyed

GACC	Single Residences	Mixed Commercial-Residential	Multiple Residences	Nonresidential Commercial Property	Other Minor Structures	Total
AK	5	0	0	0	4	**9**
EA	18	0	0	0	76	**94**
GB	4	0	0	1	5	**10**
NO	2,313	0	0	3	1	**2,317**
NR	17	0	0	0	52	**69**
NW	421	0	0	5	459	**885**
RM	7	0	0	3	11	**21**
SA	220	3	24	14	586	**847**
SO	25	0	0	0	17	**42**
SW	6	0	0	1	17	**24**
Total	**3,036**	**3**	**24**	**27**	**1,228**	**4,318**

Significant Incidents Over 40,000 Acres

Name	GACC	State	Start Date	Last Report Date	Size In Acres	Cause*
Smith River Complex	NO	CA	8/16	11/15	95,107	U
York	SO	CA	7/28	8/19	93,078	H
Newell Road	NW	WA	7/21	7/30	60,551	U
Pass	SW	NM	5/21	8/31	59,833	L
Anderson Complex	AK	AK	7/29	8/24	58,933	U
Delta	AK	AK	7/25	8/31	57,395	L
Clear Creek Complex	AK	AK	7/27	8/17	52,966	L
2023 SRF Lightning Complex	NO	CA	8/17	10/24	50,198	U
Pogo Mine Road	AK	AK	7/25	8/23	48,792	L
Cooksley	RM	NE	4/18	4/18	40,000	U

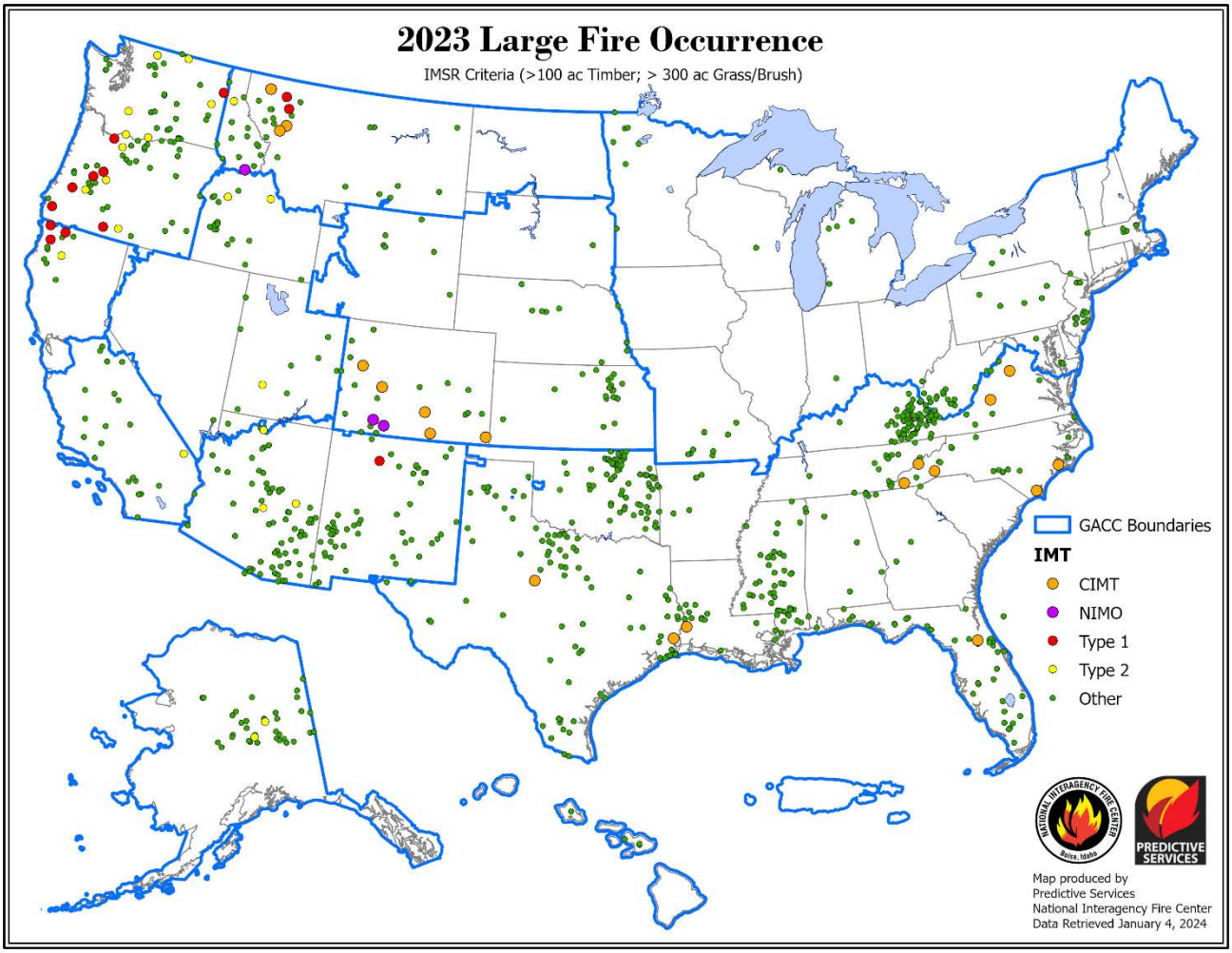
* L = Lightning H – Human U – Undetermined NR – Not Reported

Information in the above table was derived from the Sit/209 Application. This information may not reflect final official figures.

Wildfires and Acres

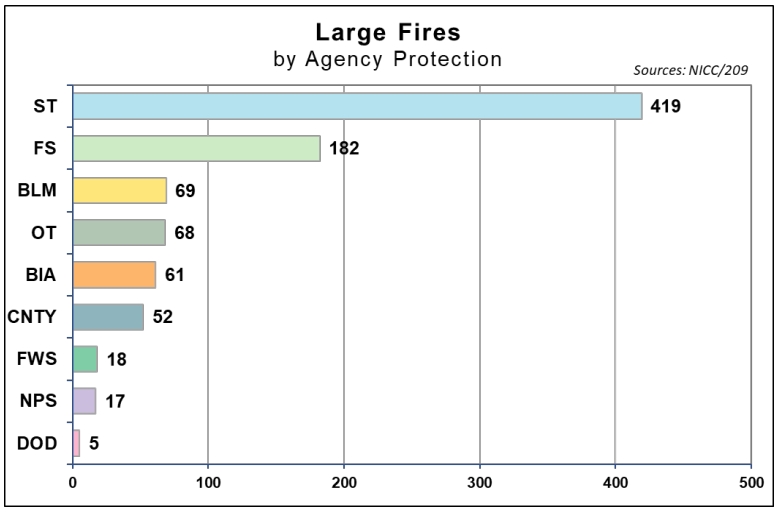
Large fires are defined in the National Mobilization Guide as fires that burn a minimum of 100 acres in timber fuel models or 300 acres in grass and brush fuel models.

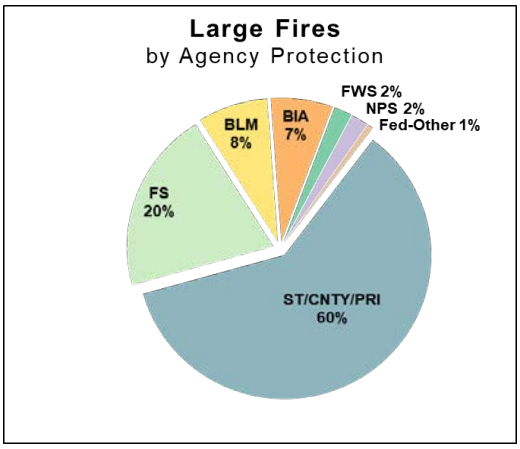
There were 891 large wildfires and complexes reported in 2023 through the SIT/209 application. Large wildfires represented less than 2% of total wildfires reported nationally in 2023.

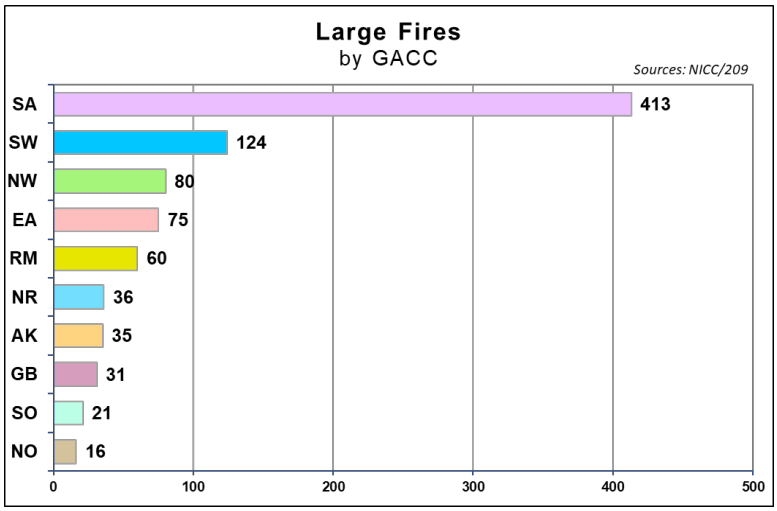


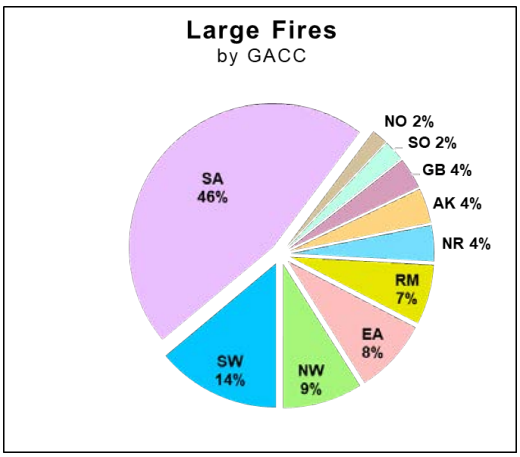
Large Wildfires by Geographic Area and Agency

In 2023, most incidents that met “large fire” criteria occurred in Southern Area and on lands protected at the state-level or other non-federal fire management organizations.



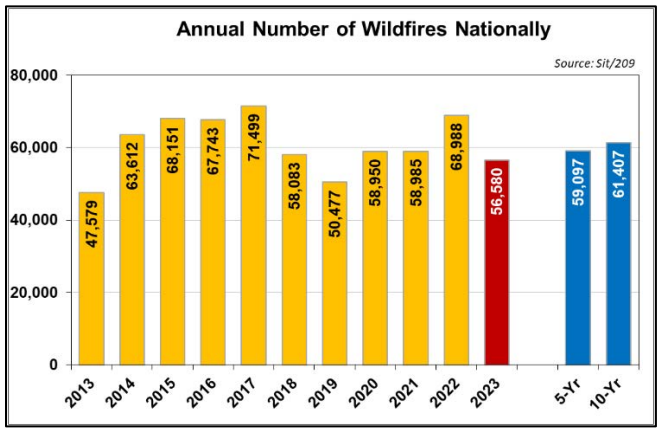


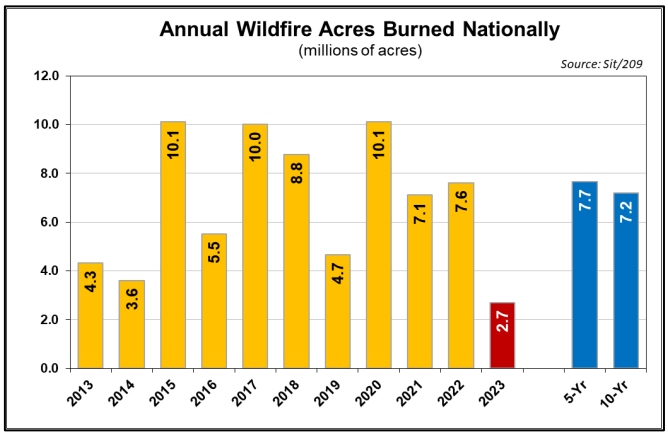




Overall Wildfire Activity Reported to NICC

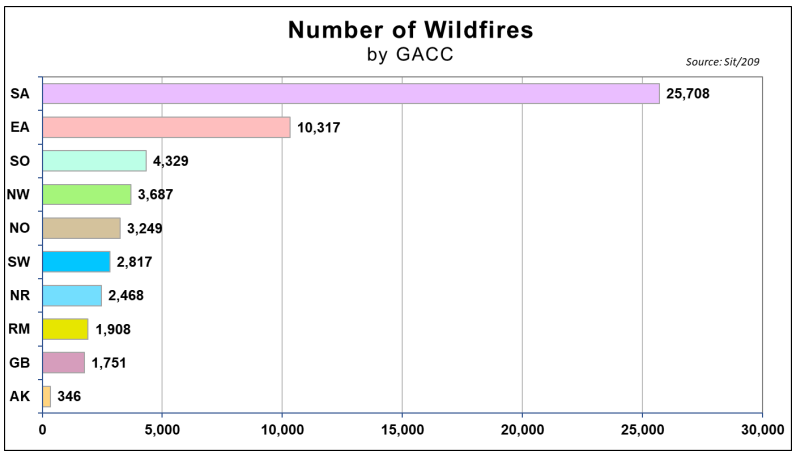
In 2023, there were 56,580 wildfires that burned 2,693,910 acres. The total number of fires and acres burned were both below the five and ten-year averages.

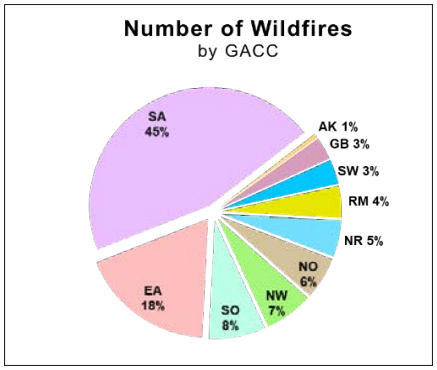


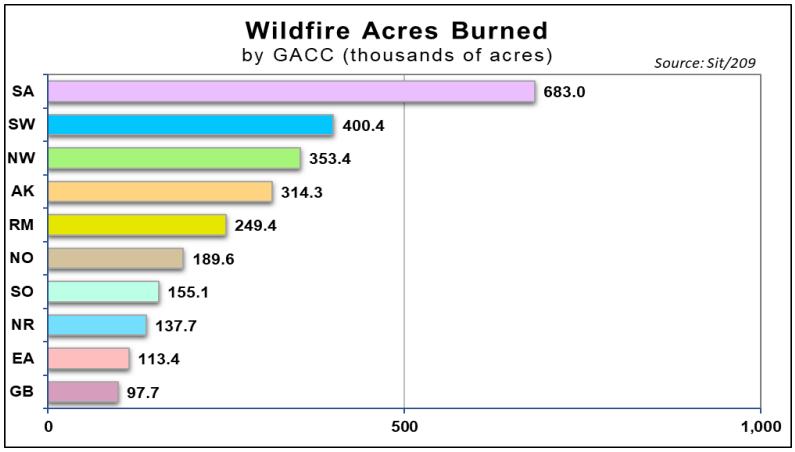


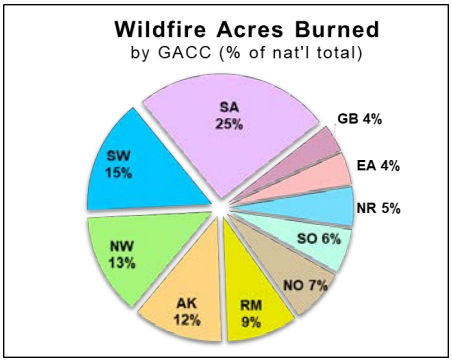
Wildfires by Geographic Area

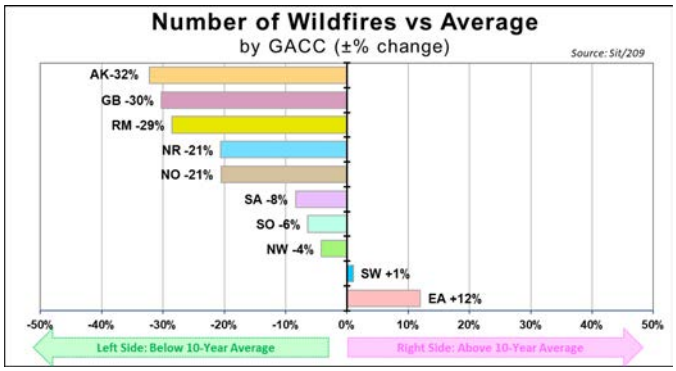
In 2023, the Southern Area accounted for just under half of the overall distribution of wildfires, and the largest proportion of acres burned the United States. The charts below show the 2023 fire activity for each Geographic Area.

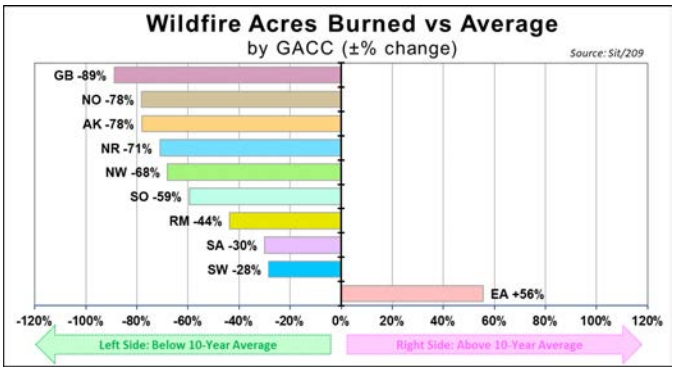






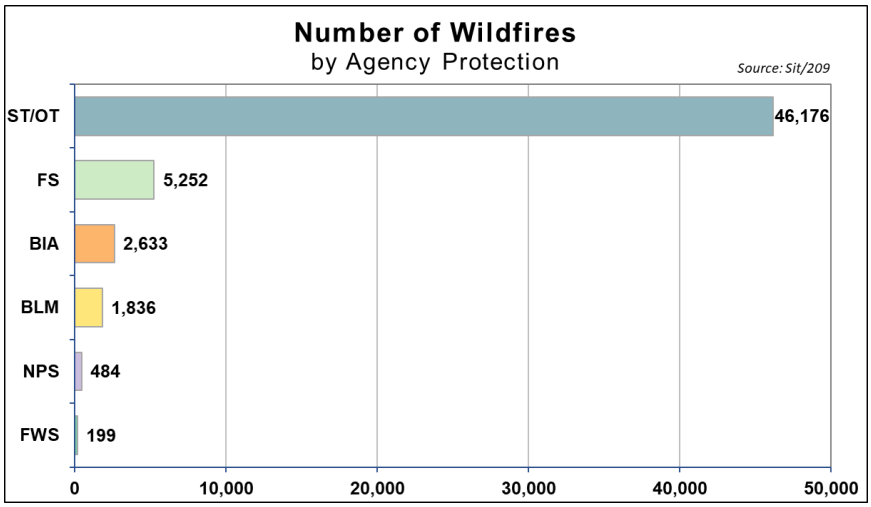


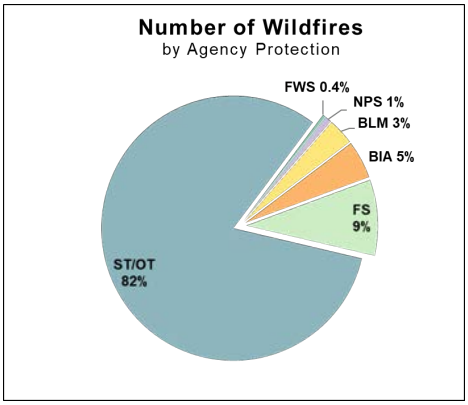


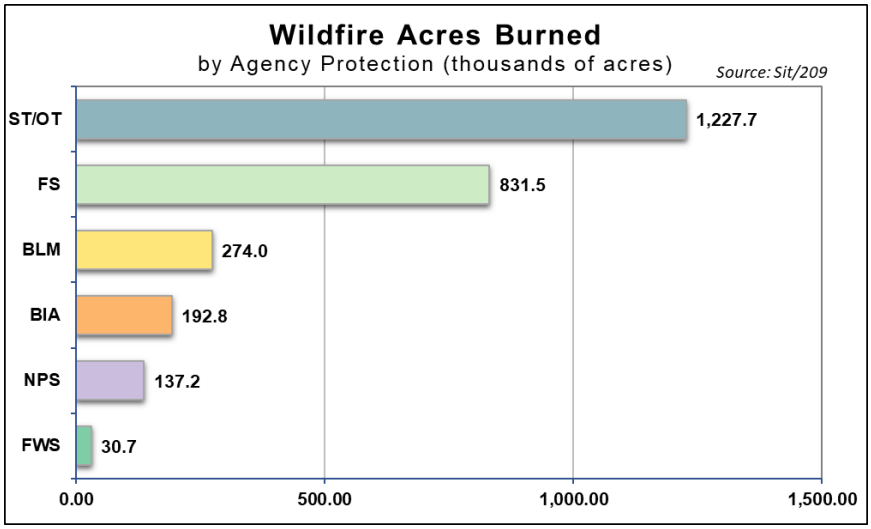


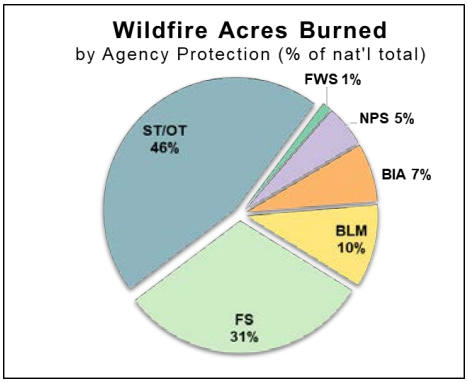
Wildfires by Agency

The distribution of wildfires by protection agency in 2023 was similar to prior years. About one-quarter of the nation's fires occurred on federally protected lands. Most wildfires, however, ignited on private lands or other areas under state or local protection.



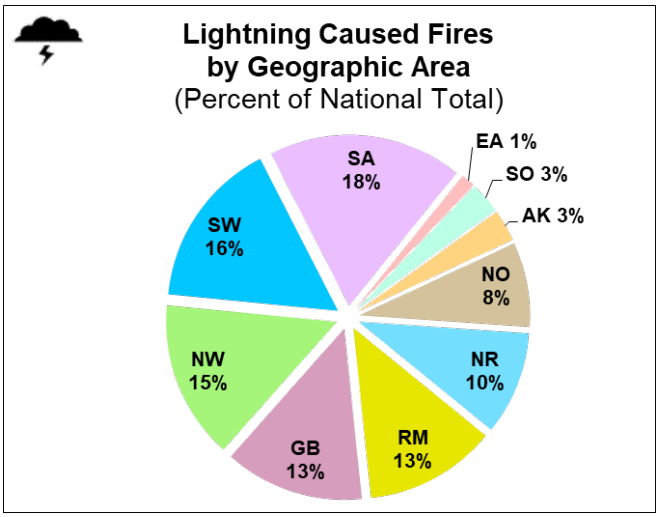


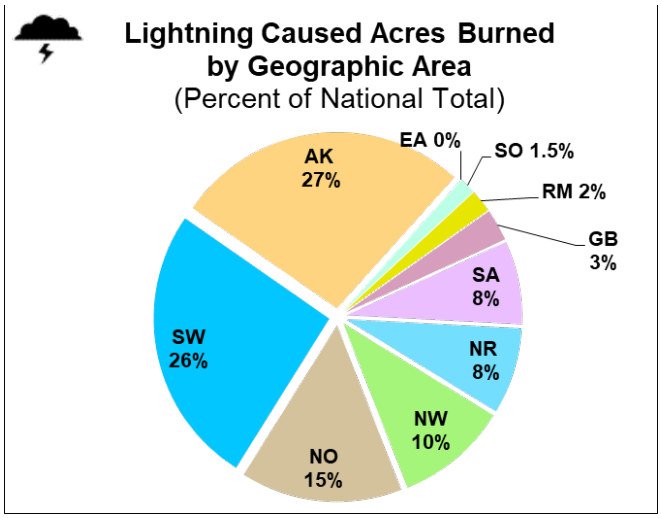




Lightning Fires and Acres by Geographic Area

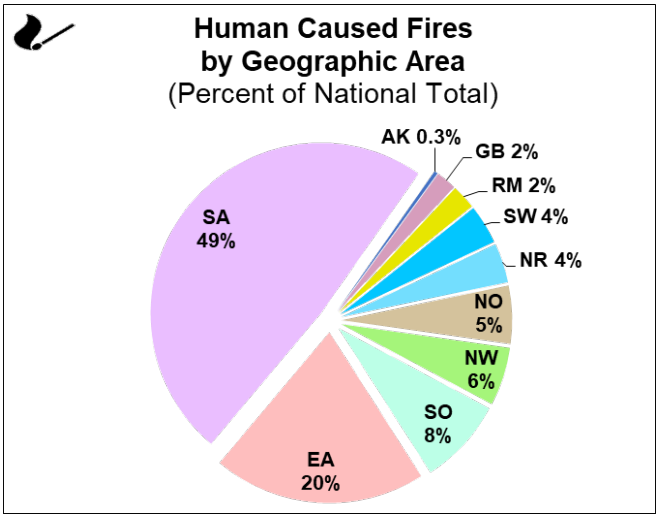
Fires/ Acres	AK	EA	GB	NO	NR	NW	RM	SA	SO	SW	Total
Fires	176	77	777	470	576	882	734	1,081	174	936	5,883
Acres	313,538	351	34,030	172,438	91,949	119,748	24,039	88,765	17,019	298,788	1,160,665

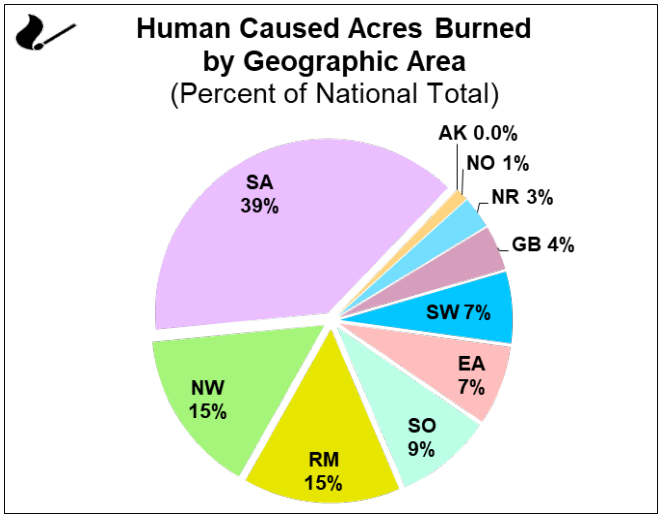




Human Caused Fires and Acres by Geographic Area

Fires/ Acres	AK	EA	GB	NO	NR	NW	RM	SA	SO	SW	Total
Fires	170	10,240	974	2,779	1,892	2,805	1,174	24,627	4,155	1,881	50,697
Acres	737	113,065	63,626	17,209	45,705	233,619	225,324	594,233	138,115	101,612	1,533,245





Wildfires and Acres Burned by Agency and GACC – 2023 & prior years

Agency Fires/Acres	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	5-Yr Avg.	10-Yr Avg.
BIA Fires	3,239	3,377	3,886	4,056	3,843	3,472	2,830	4,740	4,646	3,182	2,633	3,774	3,727
BIA Acres	173,491	327,352	591,644	325,162	306,542	216,118	151,305	923,298	396,433	255,552	192,807	388,541	366,690
BLM Fires	2,628	1,944	2,093	2,105	2,927	2,872	2,046	2,362	2,241	1,934	1,836	2,291	2,315
BLM Acres	1,012,600	871,642	4,770,133	1,183,821	2,711,267	1,905,343	2,024,554	1,131,540	412,155	1,752,793	274,004	1,445,277	1,777,585
FS Fires	7,105	6,755	7,056	5,676	6,617	5,629	5,332	6,738	6,244	5,852	5,252	5,959	6,300
FS Acres	1,365,644	871,876	1,916,302	1,247,906	2,866,031	2,307,439	615,816	4,814,465	4,126,564	1,865,791	831,465	2,746,015	2,199,783
FWS Fires	332	348	194	174	252	162	175	238	307	196	199	216	238
FWS Acres	138,284	17,404	33,897	15,374	206,393	71,137	91,311	52,739	51,264	20,659	30,707	57,422	69,846
NPS Fires	455	389	398	463	314	389	290	304	361	332	484	335	370
NPS Acres	265,755	24,949	74,780	177,901	110,349	121,092	27,533	145,447	131,182	28,615	137,242	90,774	110,760
State/Other Fires	33,820	50,799	54,524	55,269	57,546	45,559	39,804	44,568	45,186	57,492	46,176	46,522	48,457
State/Other Acres	1,363,772	1,482,390	2,738,393	2,559,831	3,825,504	4,146,363	1,753,843	3,054,847	2,008,045	3,653,773	1,227,685	2,923,374	2,658,676
Total Fires:	47,579	63,612	68,151	67,743	71,499	58,083	50,477	58,950	58,985	68,988	56,580	59,097	61,407
Total Acres:	4,319,546	3,595,613	10,125,149	5,509,995	10,026,086	8,767,492	4,664,362	10,122,336	7,125,643	7,577,183	2,693,910	7,651,403	7,183,341

GACC Fires/Acres	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	5-Yr Avg.	10-Yr Avg.
AK Fires	603	384	768	572	364	367	720	349	384	595	346	483	511
AK Acres	1,316,876	233,561	5,111,404	496,467	653,023	410,683	2,498,159	181,169	253,356	3,110,976	314,277	1,290,869	1,426,567
EA Fires	7,110	7,030	11,639	11,270	9,816	6,891	5,750	13,175	10,855	8,592	10,317	9,053	9,213
EA Acres	64,992	54,141	100,294	98,042	41,705	50,734	38,852	63,036	152,669	64,342	113,416	73,927	72,881
GB Fires	2,971	2,250	2,096	2,063	3,127	2,776	2,308	2,958	2,449	2,121	1,751	2,522	2,512
GB Acres	930,795	164,802	505,483	761,622	2,103,788	2,087,922	459,384	948,812	373,165	436,598	97,656	861,176	877,237
NO Fires	5,299	4,082	4,587	3,363	4,173	3,602	3,704	4,678	3,962	3,429	3,249	3,875	4,088
NO Acres	165,194	474,826	594,048	96,706	672,448	1,496,950	214,742	2,779,003	1,945,506	246,990	189,647	1,336,638	868,641
NR Fires	2,773	2,665	3,817	2,700	3,900	2,741	2,309	3,404	4,052	2,710	2,468	3,043	3,107
NR Acres	179,459	143,271	745,947	202,140	1,551,275	147,093	74,042	403,046	1,069,660	223,746	137,654	383,517	473,968
NW Fires	4,389	4,572	4,603	2,519	3,404	3,764	3,690	3,853	4,075	3,611	3,687	3,799	3,848
NW Acres	503,993	1,383,514	1,823,473	513,226	1,121,442	1,336,096	249,476	1,983,970	1,503,026	631,605	353,367	1,140,835	1,104,982
RM Fires	2,621	2,356	2,559	3,289	3,164	2,480	1,684	2,852	3,316	2,392	1,908	2,545	2,671
RM Acres	237,121	78,345	180,822	686,921	754,747	748,956	114,685	1,021,951	336,187	273,503	249,363	499,056	443,324
SA Fires	14,448	34,267	31,594	34,474	35,068	27,721	22,999	18,773	22,164	38,945	25,708	26,120	28,045
SA Acres	182,650	752,694	556,267	1,591,044	1,960,764	1,591,101	498,925	556,902	532,835	1,518,116	682,996	939,576	974,130
SO Fires	4,608	3,786	4,175	3,996	5,389	4,453	4,632	5,419	5,324	4,460	4,329	4,858	4,624
SO Acres	412,481	80,218	304,925	479,207	595,873	348,722	55,092	1,144,214	320,378	87,350	155,134	391,151	382,846
SW Fires	2,757	2,220	2,313	3,497	3,094	3,288	2,681	3,489	2,404	2,133	2,817	2,799	2,788
SW Acres	325,985	230,241	202,486	584,620	571,021	549,235	461,005	1,040,233	638,861	983,957	400,400	734,658	558,764
Total Fires:	47,579	63,612	68,151	67,743	71,499	58,083	50,477	58,950	58,985	68,988	56,580	59,097	61,407
Total Acres:	4,319,546	3,595,613	10,125,149	5,509,995	10,026,086	8,767,492	4,664,362	10,122,336	7,125,643	7,577,183	2,693,910	7,651,403	7,183,341

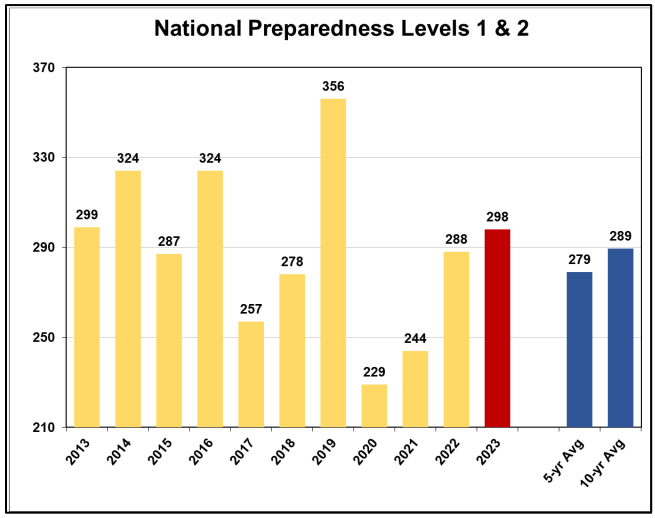
National Preparedness Levels

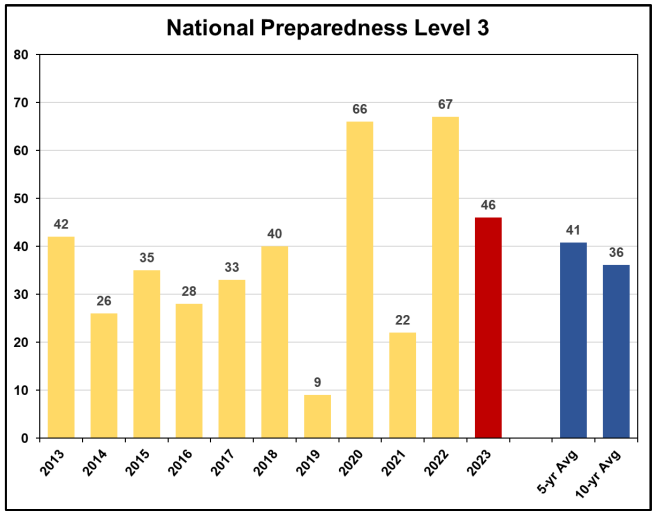
In 2023 the National Preparedness Level (PL) was elevated and decreased accordingly:

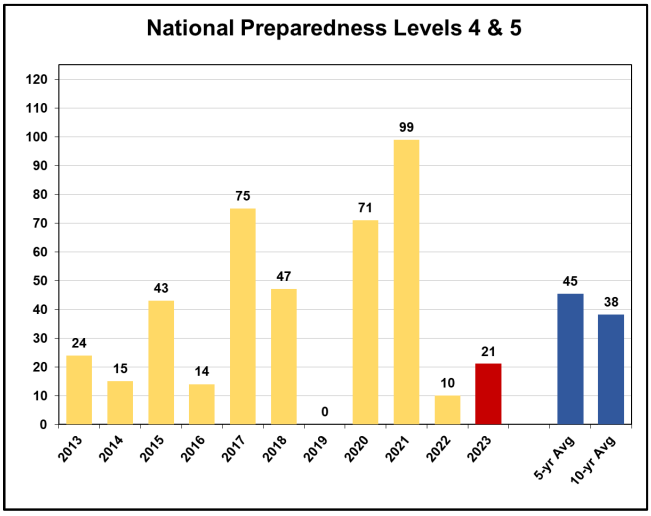
- Elevated from PL 1 to PL 2 on May 9
- Elevated from PL 2 to PL 3 on July 21
- Elevated from PL 3 to PL 4 on August 17
- Decreased from PL 4 to PL 3 on September 7
- Decreased from PL 3 to PL 2 on September 26
- Decreased from PL 2 to PL 1 on October 13

Total Number of Days at Each National Preparedness Level

PL	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1	31	28	31	30	8	0	0	0	0	23	30	31	208
2	0	0	0	0	23	30	20	0	5	8	0	0	90
3	0	0	0	0	0	0	11	16	19	0	0	0	46
4	0	0	0	0	0	0	0	15	6	0	0	0	21
5	0	0	0	0	0	0	0	0	0	0	0	0	0
Total:	**31**	**28**	**31**	**30**	**31**	**30**	**31**	**31**	**30**	**31**	**30**	**31**	**365**







National Preparedness Level Summary

Total Days at National Preparedness Levels

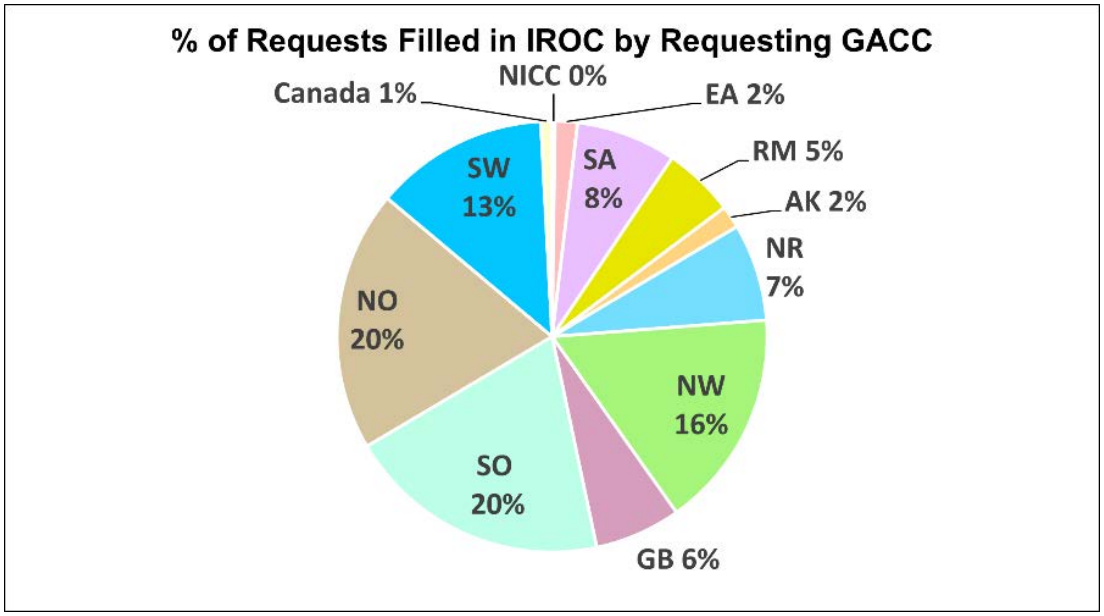
Year	PL 1	PL 2	PL 3	PL 4	PL 5	PL1&2	PL4&5
1990	247	74	31	6	7	321	13
1991	255	103	7	0	0	358	0
1992	278	67	15	6	0	345	6
1993	268	97	0	0	0	365	0
1994	235	26	54	4	46	261	50
1995	254	96	15	0	0	350	0
1996	98	179	60	8	21	277	29
1997	216	149	0	0	0	365	0
1998	157	172	30	6	0	329	6
1999	159	165	33	8	0	324	8
2000	179	73	61	13	40	252	53
2001	188	142	9	10	16	330	26
2002	187	76	14	26	62	263	88
2003	92	155	60	10	48	247	58
2004	249	57	60	0	0	306	0
2005	233	44	47	41	0	277	41
2006	118	137	44	16	50	255	66
2007	212	76	17	21	39	288	60
2008	209	84	15	36	22	293	58
2009	275	62	28	0	0	337	0
2010	231	134	0	0	0	365	0
2011	207	92	59	7	0	299	7
2012	212	49	60	45	0	261	45
2013	253	46	42	17	7	299	24
2014	242	82	26	15	0	324	15
2015	253	34	35	19	24	287	43
2016	251	73	28	14	0	324	14
2017	185	72	33	36	39	257	75
2018	191	87	40	13	34	278	47
2019	241	115	9	0	0	356	0
2020	205	24	66	26	45	229	71
2021	161	83	22	31	68	244	99
2022	152	136	67	10	0	288	10
2023	211	86	46	21	0	298	21

Averages	PL1&2	PL 3	PL4&5
Total Days: 5-yr Avg	*279*	*41*	*45*
Total Days: 10-yr Avg	*289*	*36*	*40*

Requests Filled Nationally in IROC

2023 was another below average year for the wildland firefighter and dispatch community. A little over 334,000 requests were filled nationally in IROC. This is lower than the 385,030 requests filled in 2022. The following data shows the number of requests filled in IROC by Requesting GACC in 2023.

GACC	Aircraft	Crew	Equipment	Overhead	Supply	Total
AK	268	97	746	4,136	397	**5,644**
EA	59	56	806	4,621	98	**5,640**
GB	1,358	293	3,392	16,032	607	**21,682**
NICC	55	17	20	610	23	**725**
NO	6,327	2,558	14,201	40,860	1,500	**65,446**
NR	1,620	465	4,113	16,795	1,422	**24,415**
NW	4,503	1,409	8,378	37,294	3,193	**54,777**
RM	1,501	329	1,864	13,391	805	**17,890**
SA	1,414	169	3,064	19,571	914	**25,132**
SO	6,701	3,131	17,171	38,637	620	**66,260**
SW	2,717	1,116	5,016	32,981	1,803	**43,633**
Canada	7	77	29	2,661	0	**2,774**
Total	**26,530**	**9,717**	**58,800**	**227,589**	**11,382**	**334,018**



**** Disclaimer: Of the 227,589 overhead requests, 177,078 requests were subordinate requests attached to parent aircraft, overhead, crew, engine, and supply requests. Of the 334,018 requests, 2,786 requests were support requests attached to parent aircraft, overhead, crew, and engine requests.*

These statistics are based off an IROC report utilizing the QST1 Request Status Table. Statistics may vary amongst individual Geographic Area annual reports depending on which filters are utilized within the IROC Reports module.

Requests Processed through the NICC

During the 2023 fire season, resource requests to NICC varied compared to the five and ten-year averages. Incident Management Teams ordering was significantly below both averages. Type 1 helicopter orders surpassed the ten-year average, whereas Type 2 helicopter requests fell below it. Airtanker ordering was notably below both the five and ten-year averages. National contract caterer and shower orders were also under the 10-year averages. However, overhead, engines, and crew orders exceeded the 10-year average.

The following statistics show requests processed through the National Interagency Coordination Center, except for Incident Management Teams, which are captured on a national mobilization scale. This data is broken down by requesting Geographic Area and Requesting Agency. Five- and ten-year averages are also provided.

International Resource Mobilizations

In 2023, Canada experienced an unprecedented wildfire season with 6,623 reported wildfires burning over 45 million acres—well beyond the 10-year average of 5,597 fires for 6,798,267 acres. Starting in April, the wildfire activity escalated across all provinces and territories, leading to a National Preparedness Level of PL5 on May 11, which remained until dropping to PL4 on September 8.

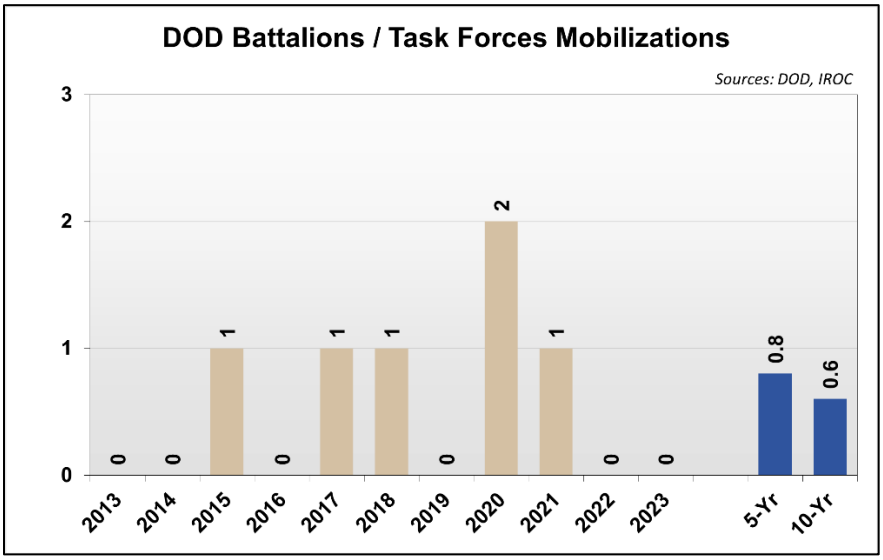
The United States was one of 12 countries that mobilized wildland fire personnel to Canada. Through the NIFC-CIFFC Agreement the US provided resource assistance from May through early September to Alberta, British Columbia, Ontario and Quebec. These resource mobilizations included three smokejumper aircraft (with smokejumper personnel), two Type 2 rappel helicopters (with personnel), 29 engines, 77 hand crews and 25 incident management teams[3]. A total of 2,774 resources were mobilized to Canada.

Additional resource mobilization occurred through state compacts with the northern border states. Most occurred outside of IROC and are not part of the statistics shown. Additionally, there were significant supply requests filled through the National Cache System. These were not requested through IROC and were tracked through the Interagency Cache Business System. Supply requests to Alberta and Quebec included 258 Mark-3 pumps and accessory kits, collapsible water tanks, hundreds of water handling accessories, hose, sprinkler kits, dozens of wildland fire tools, drip torches and other wildland fire supplies.

[3] The incident management team mobilizations to Canada reflect all filled requests for Type 1, Type 2, Type 3 and Complex Incident Management Teams.

Department of Defense Mobilizations

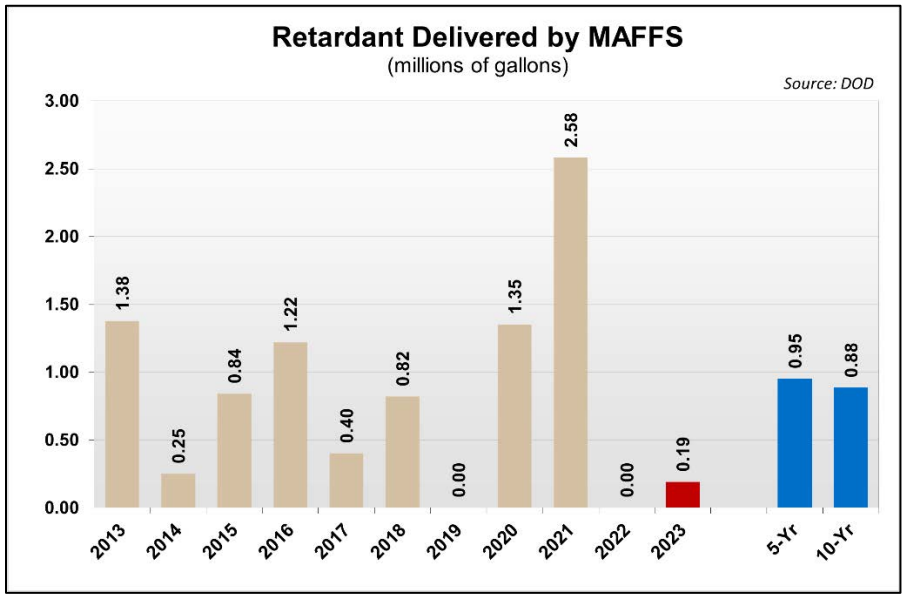
NICC did not process any military requests in 2023. The number of military battalions and task forces requested through NICC and deployed in the last ten years is shown below.



Modular Airborne Fire Fighting Systems (MAFFS)

MAFFS air tankers were activated on August 9 and released on September 6. National statistics for the 35-day activation are listed below:

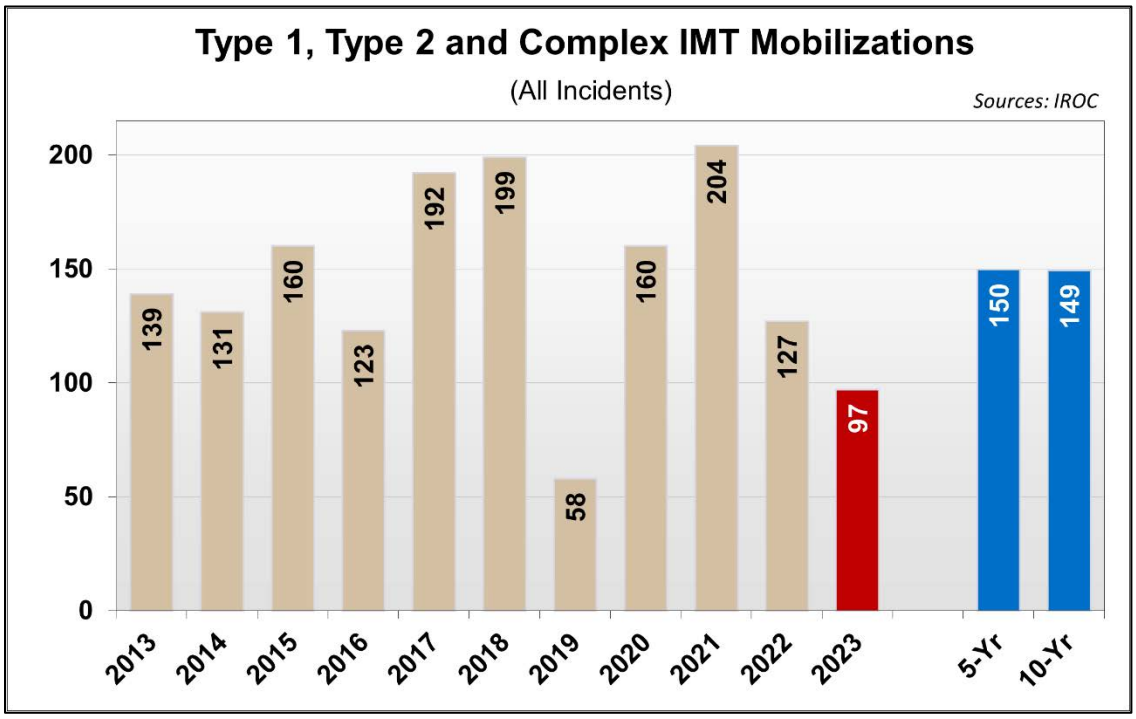
- Total missions: 69
- Total employment hours: 90.3
- Total retardant drops: 73
- Total gallons of retardant dropped: 185,263



Incident Management Team Mobilizations

In 2024, the firefighting community will adopt a new Incident Management Team business model. All federal Type 1 and Type 2 Incident Management Teams (IMTs) will become Complex Incident Management Teams (CIMT). More information about CIMTs can be found at the NWCG Incident Workforce Development Group webpage.

In 2023, all team types were mobilized, and statistics can be found below. The following statistics include the transition from Type 1 and Type 2 IMTs to Complex Incident Management Teams.

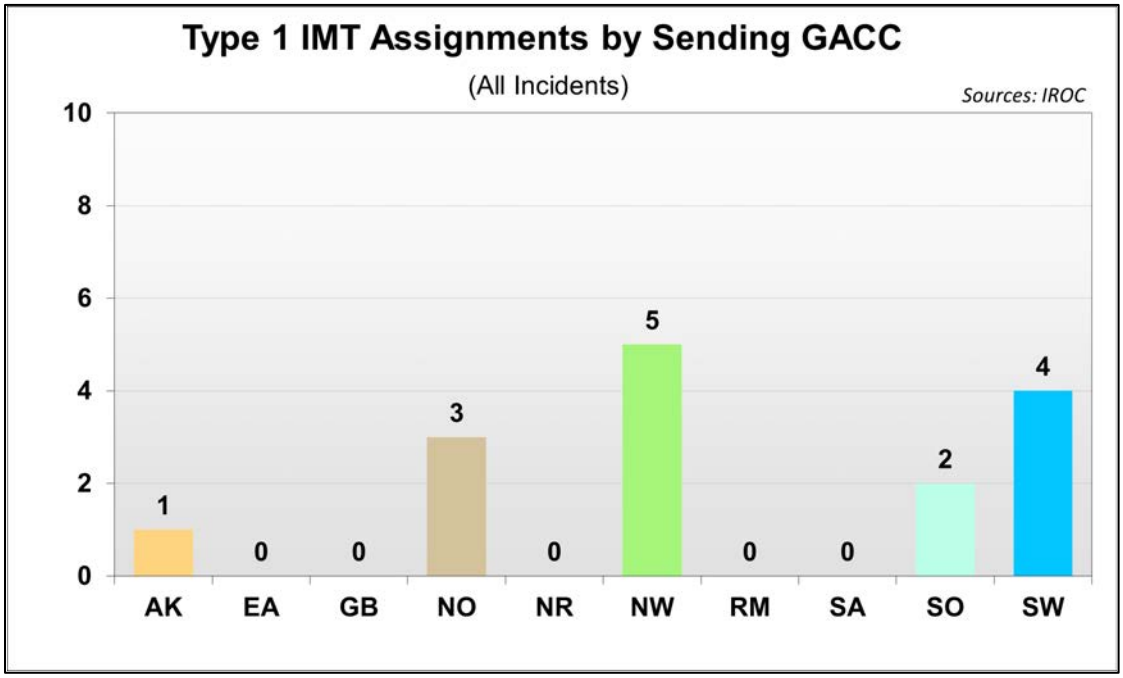


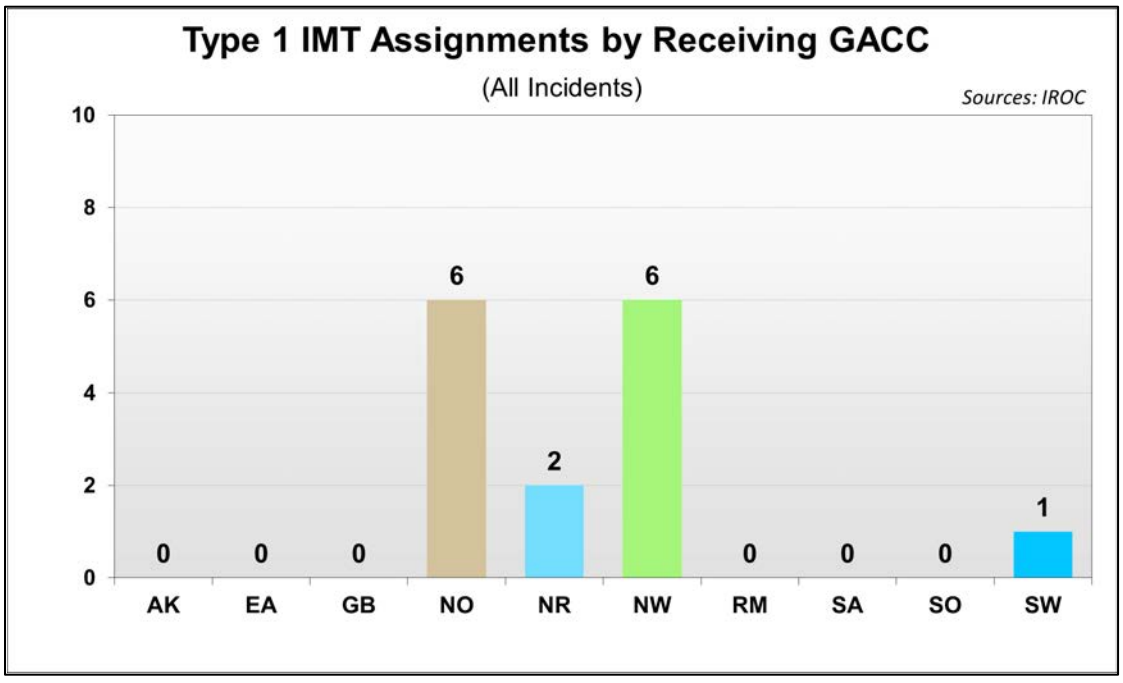
National Incident Management Organization

National Incident Management Organization (NIMO) teams were assigned to five wildfire incidents for a total of 111 days. NIMO teams were also mobilized to three non-wildland fire incidents.

Type 1 Incident Management Teams

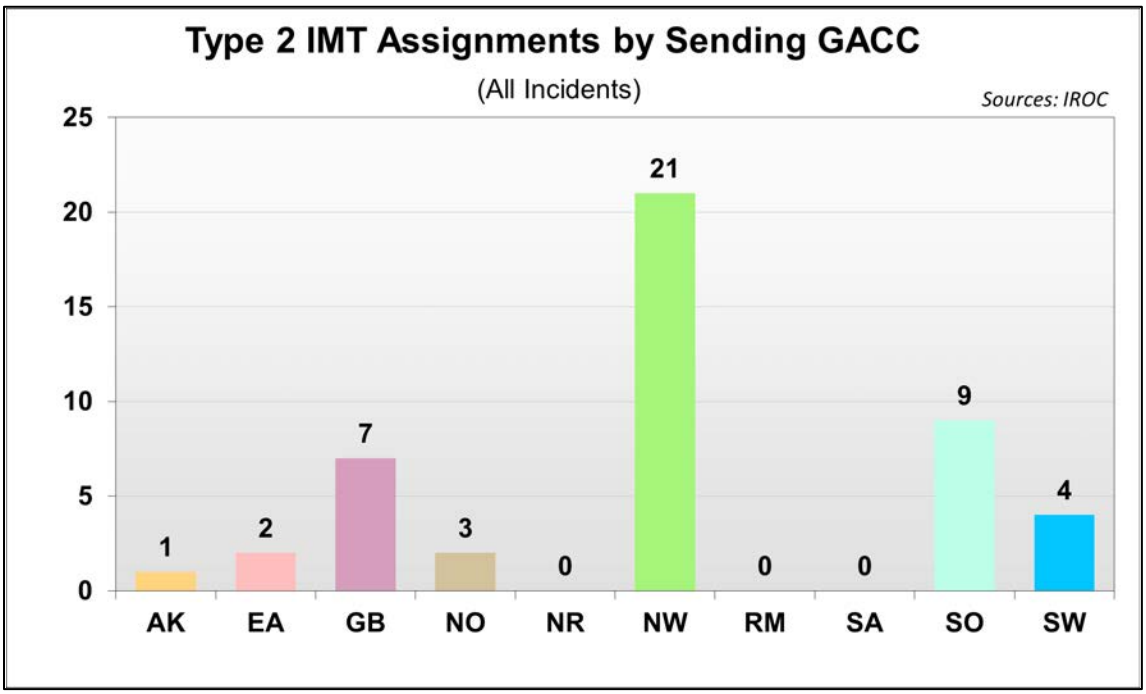
Eight national Type 1 Incident Management Teams were mobilized to 15 incidents in 2023. Type 1 IMTs were assigned for 226 days.

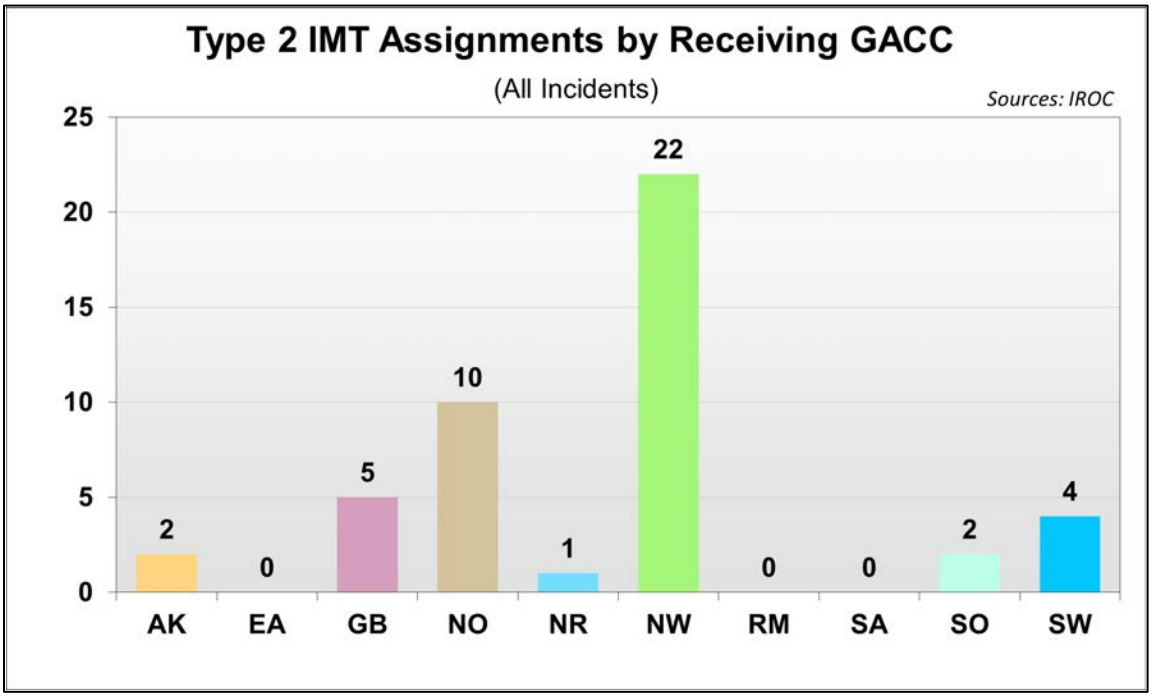




Type 2 Incident Management Teams

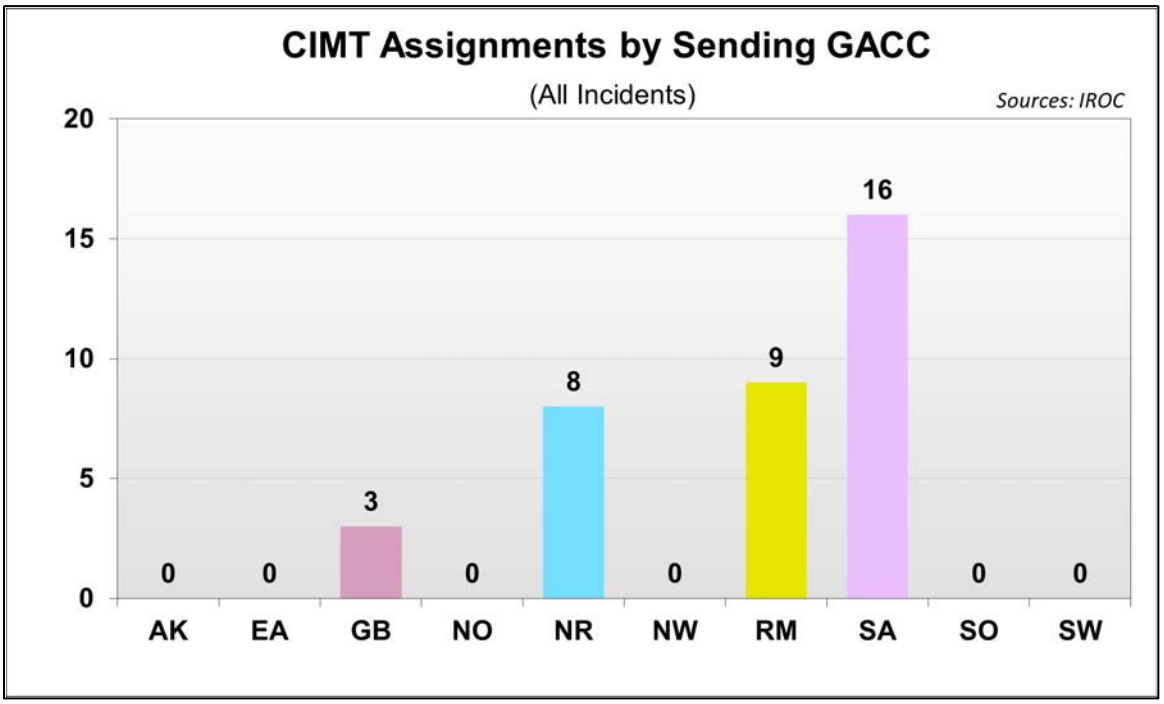
Twenty-five national Type 2 Incident Management Teams were mobilized to 46 incidents. Type 2 IMTs were assigned for 614 days.

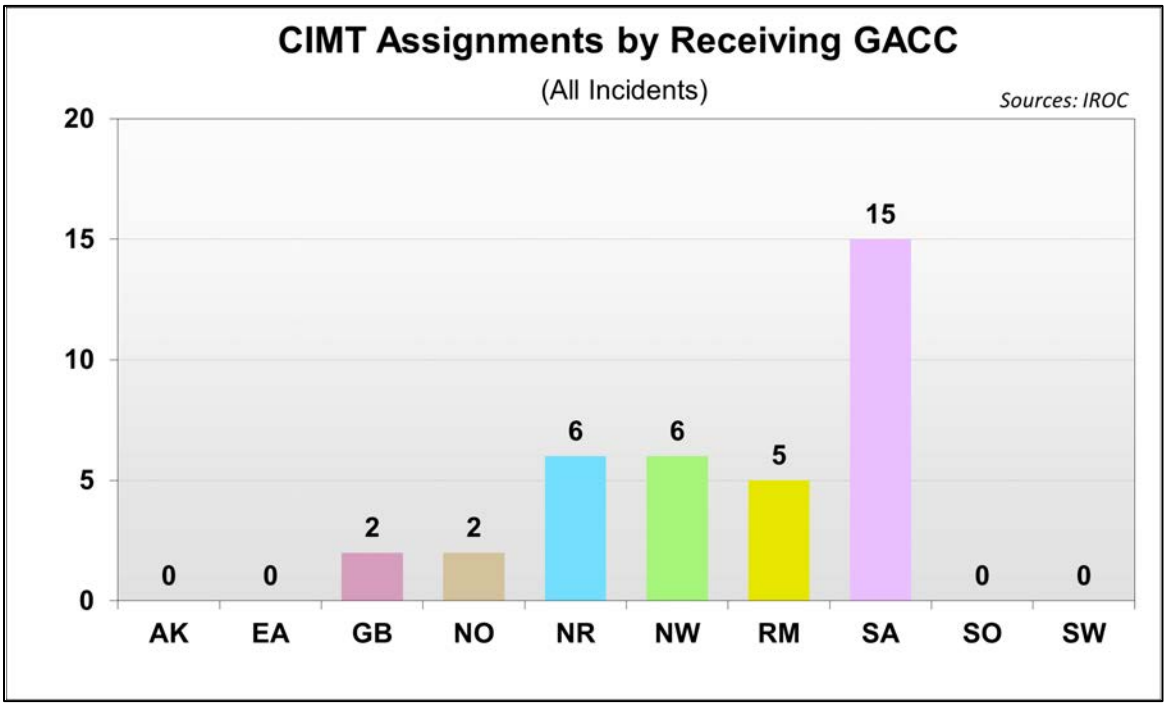




Complex Incident Management Teams

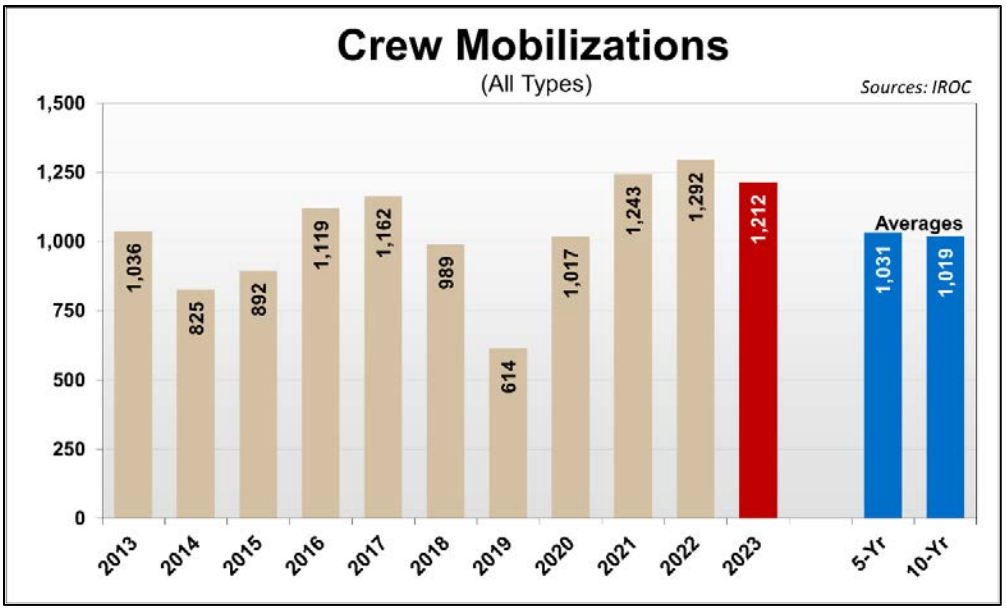
National Complex Incident Management Teams (CIMT) were mobilized to 36 incidents. CIMTs were assigned for 500 days.

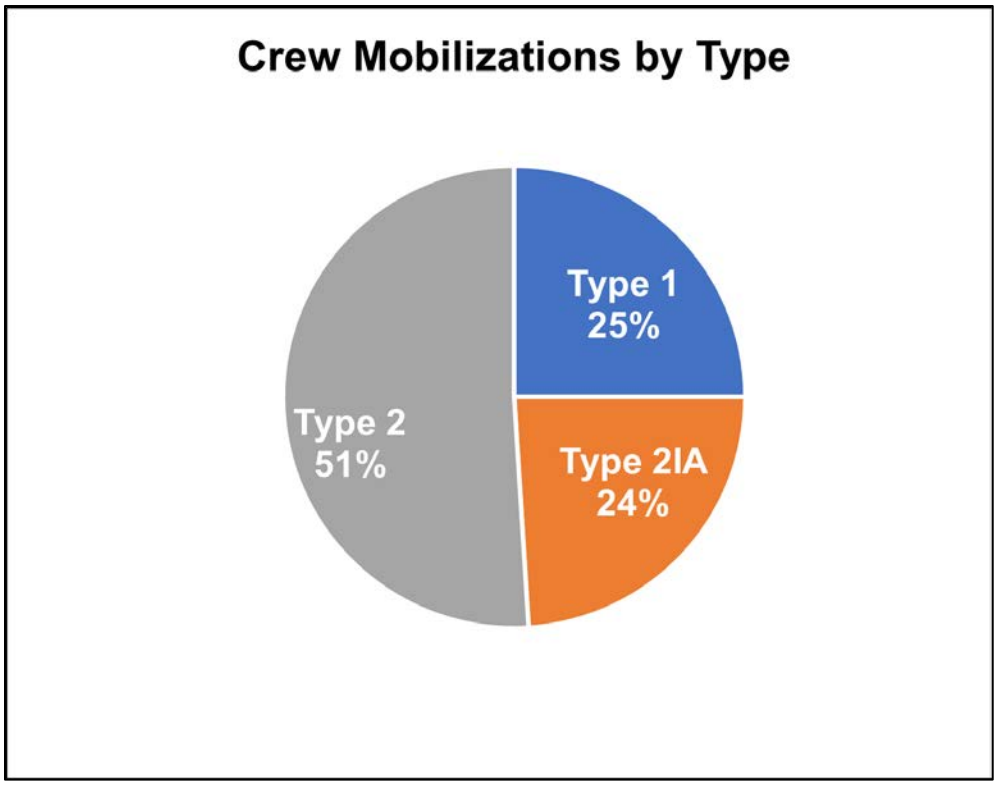




Crew Mobilizations

NICC received 2,022 crew requests in 2023. Of those requests: 1,212 were filled, 260 were canceled and 550 were UTF. The NICC received 860 orders for Type 1 crews, 699 orders for Type 2 crews and 463 orders for Type 2 IA crews. The number of crew mobilizations in 2023 was above both the five and ten-year average.





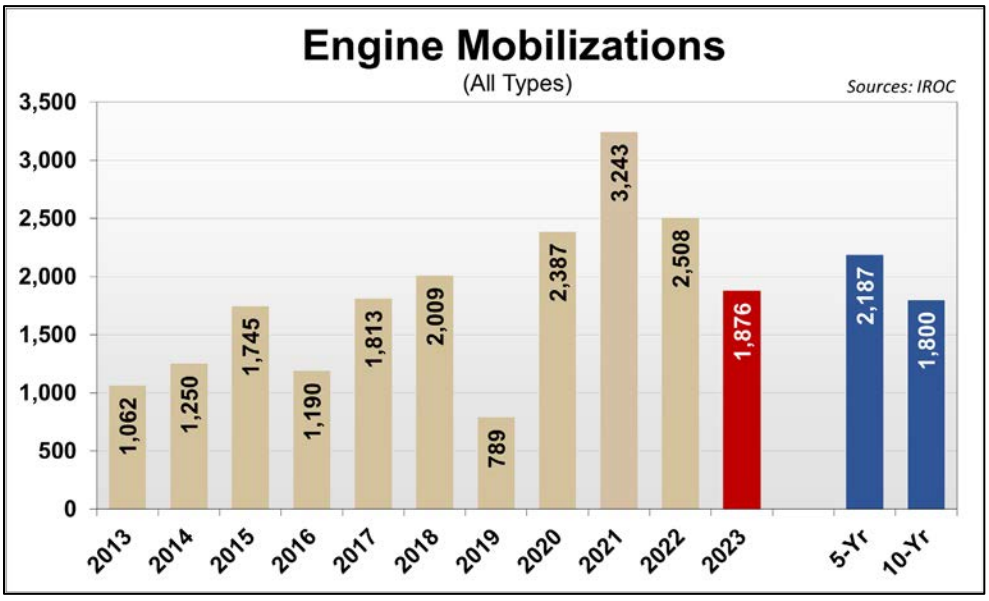
Crew Requests Summary by Requesting Agency and Geographic Area

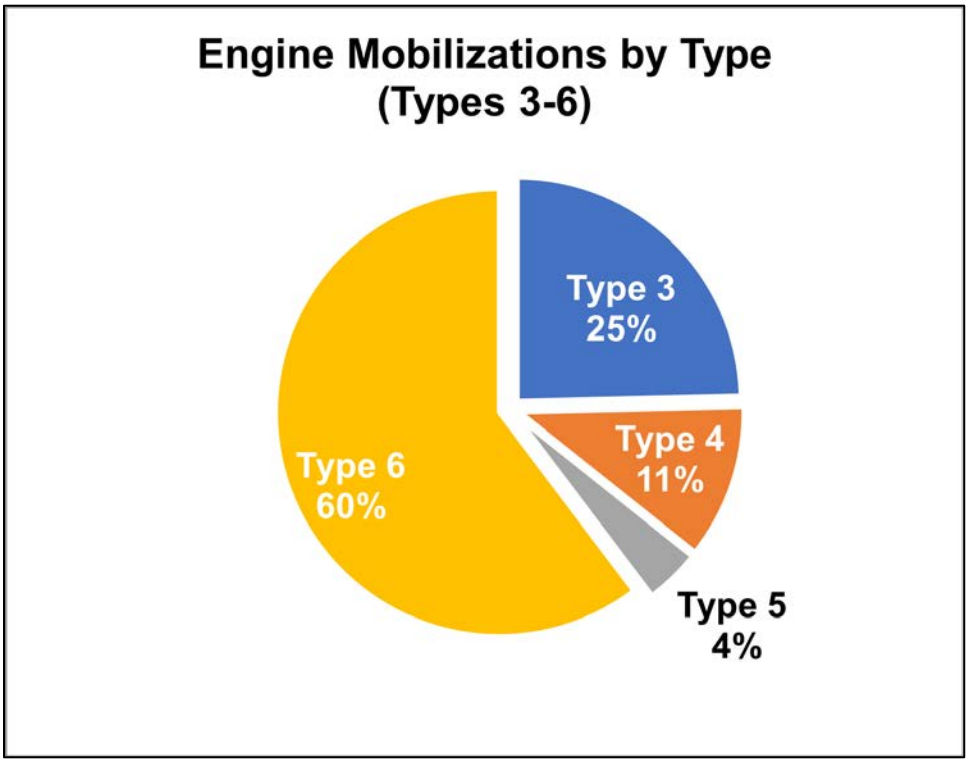
	Type 1 Crew			Type 2 Crew			Type 2-IA Crew			Crew Totals			
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Total
BIA	1	0	0	10	0	0	5	1	2	16	1	2	**19**
BLM	3	5	1	1	3	0	12	2	0	16	10	1	**27**
DOD	0	0	0	0	0	0	0	0	0	0	0	0	**0**
FEMA	0	0	0	0	0	0	0	0	0	0	0	0	**0**
FS	216	135	398	584	35	36	226	64	100	1,026	234	534	**1,794**
FWS	0	0	0	3	0	0	0	0	0	3	0	0	**3**
NPS	3	0	1	1	0	2	6	2	3	10	2	6	**18**
ST	20	8	4	23	1	0	21	1	2	64	10	6	**80**
Other	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Canada	61	3	1	0	0	0	16	0	0	77	3	1	**81**
Subtotal:	*304*	*151*	*405*	*622*	*39*	*38*	*286*	*70*	*107*	*1,212*	*260*	*550*	
Total:	**860**			**699**			**463**			**2,022**			

	Type 1 Crew			Type 2 Crew			Type 2-IA Crew			Crew Totals			
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Total
AK	6	2	2	11	0	0	0	0	0	17	2	2	**21**
EA	11	2	0	0	0	0	6	1	0	17	3	0	**20**
GB	12	4	20	54	1	1	16	2	14	82	7	35	**124**
NICC	7	2	0	8	0	0	5	0	0	20	2	0	**22**
NO	43	78	246	194	14	12	56	25	34	293	117	292	**702**
NR	29	3	29	86	1	4	26	10	26	141	14	59	**214**
NW	47	14	55	169	15	15	44	21	29	260	50	99	**409**
RM	20	12	7	38	3	0	41	8	2	99	23	9	**131**
SA	11	8	3	3	0	1	30	0	0	44	8	4	**56**
SO	8	6	5	8	4	3	5	0	1	21	10	9	**40**
SW	49	17	37	51	1	2	41	3	1	141	21	40	**202**
Other	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Canada	61	3	1	0	0	0	16	0	0	77	3	1	**81**
Subtotal:	*304*	*151*	*405*	*622*	*39*	*38*	*286*	*70*	*107*	*1,212*	*260*	*550*	
Total:	**860**			**699**			**463**			**2,022**			

Engine Mobilizations

NICC received 2,719 engine requests in 2023. Of those requests: 1,876 were filled, 369 were canceled and 474 were UTF. Type 6 engines were the most requested engine with 1,653 requests and 1,131 fills. Type 3 engines were the next most requested with 758 requests and 462 fills. The number of engine mobilizations was below the five-year average, but similar to the ten-year average.





Engine Requests Summary by Requesting Agency

	Type 1 Engine			Type 2 Engine			Type 3 Engine			Type 4 Engine		
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF
BIA	0	0	0	0	0	0	11	1	1	4	0	2
BLM	0	0	0	0	0	0	10	0	0	14	2	5
DOD	0	0	0	0	0	0	0	0	0	0	0	0
FEMA	0	0	0	0	0	0	0	0	0	0	0	0
FS	0	0	0	0	0	0	421	134	153	180	7	3
FWS	0	0	0	0	0	0	2	0	0	0	0	0
NPS	0	0	0	0	0	0	6	0	0	2	0	0
ST	0	0	0	0	0	0	12	1	6	8	0	0
Other	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal:	*0*	*0*	*0*	*0*	*0*	*0*	*462*	*136*	*160*	*208*	*9*	*10*
Total:	**0**			**0**			**758**			**227**		

	Type 5 Engine			Type 6 Engine			Type 7 Engine			Engine Totals			
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	***Total***
BIA	0	0	0	97	11	3	0	0	0	112	12	6	***130***
BLM	2	0	0	19	0	1	0	0	0	45	2	6	***53***
DOD	0	0	0	0	0	0	0	0	0	0	0	0	***0***
FEMA	0	0	0	0	0	0	0	0	0	0	0	0	***0***
FS	62	0	1	816	195	216	0	1	3	1,479	337	376	***2,192***
FWS	0	0	0	3	0	1	0	0	0	5	0	1	***6***
NPS	0	0	0	33	8	25	0	0	0	41	8	25	***74***
ST	11	0	1	163	9	53	0	0	0	194	10	60	***264***
Other	0	0	0	0	0	0	0	0	0	0	0	0	***0***
Subtotal:	*75*	*0*	*2*	*1,131*	*223*	*299*	*0*	*1*	*3*	1,876	369	474	
Total:	**77**			**1,653**			**4**			**2,719**			

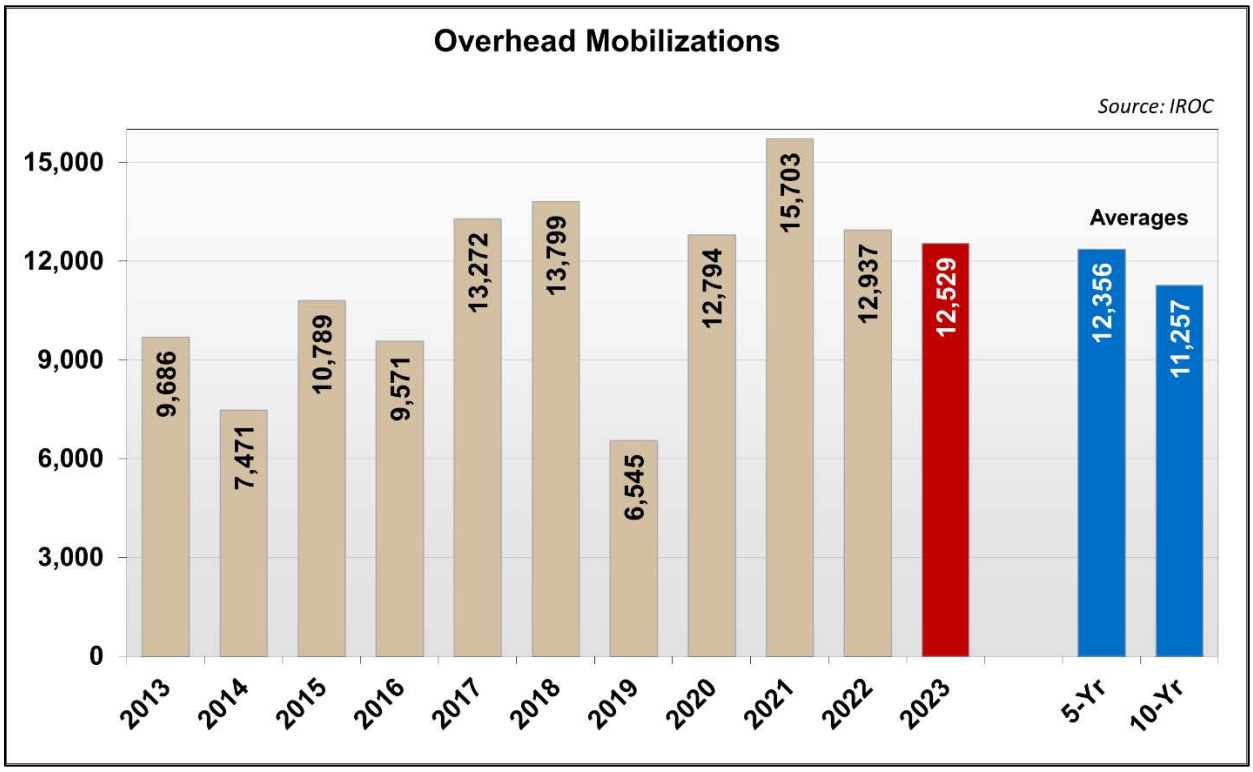
Engine Requests Summary by Requesting Geographic Area

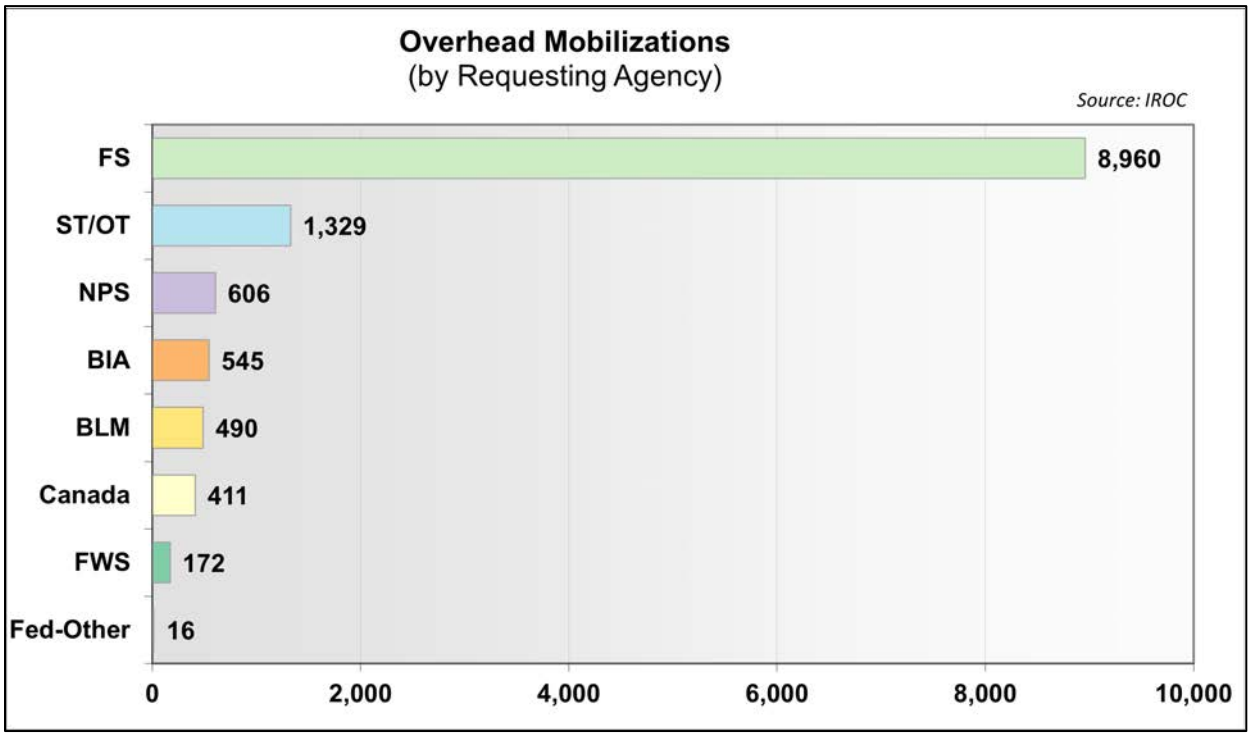
	Type 1 Engine			Type 2 Engine			Type 3 Engine			Type 4 Engine		
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF
AK	0	0	0	0	0	0	0	0	0	0	0	0
EA	0	0	0	0	0	0	13	0	1	7	0	0
GB	0	0	0	0	0	0	4	0	1	3	2	0
NICC	0	0	0	0	0	0	0	0	0	0	0	0
NO	0	0	0	0	0	0	155	69	69	89	0	1
NR	0	0	0	0	0	0	8	0	0	1	0	0
NW	0	0	0	0	0	0	54	3	10	27	0	1
RM	0	0	0	0	0	0	11	2	0	10	7	6
SA	0	0	0	0	0	0	22	5	3	11	0	2
SO	0	0	0	0	0	0	109	31	66	18	0	0
SW	0	0	0	0	0	0	86	26	10	42	0	0
Subtotal:	*0*	*0*	*0*	*0*	*0*	*0*	*462*	*136*	*160*	*208*	*9*	*10*
Total:	**0**			**0**			**758**			**227**		

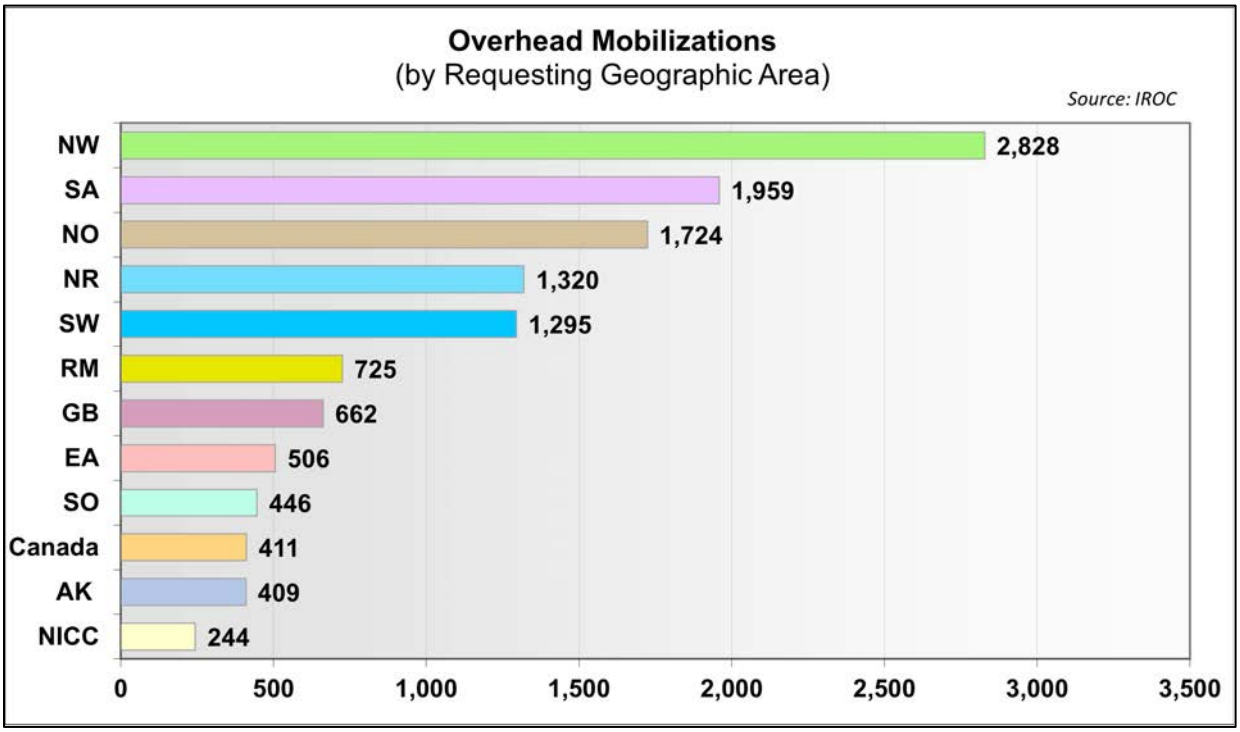
	Type 5 Engine			Type 6 Engine			Type 7 Engine			Engine Totals			
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	***Total***
AK	0	0	0	2	0	0	0	0	0	2	0	0	***2***
EA	2	0	0	78	7	17	0	0	0	100	7	18	***125***
GB	0	0	1	19	6	11	0	0	2	26	8	15	***49***
NICC	0	0	0	0	0	0	0	0	0	0	0	0	***0***
NO	44	0	0	291	24	60	0	0	0	579	93	130	***802***
NR	1	0	0	89	21	19	0	0	0	99	21	19	***139***
NW	9	0	1	97	26	27	0	0	0	187	29	39	***255***
RM	1	0	0	66	26	29	0	0	0	88	35	35	***158***
SA	7	0	0	285	52	95	0	0	0	325	57	100	***482***
SO	10	0	0	57	2	4	0	1	1	194	34	71	***299***
SW	1	0	0	147	59	37	0	0	0	276	85	47	***408***
Subtotal:	*75*	*0*	*2*	*1,131*	*223*	*299*	*0*	*1*	*3*	1,876	369	474	
Total:	**77**			**1,653**			**4**			**2,719**			

Overhead Mobilizations

NICC received 20,977 overhead requests in 2023. Of those requests: 12,529 were filled, 3,402 were canceled, and 5,046 were UTF. The number of overhead mobilizations was just over the five-year average.







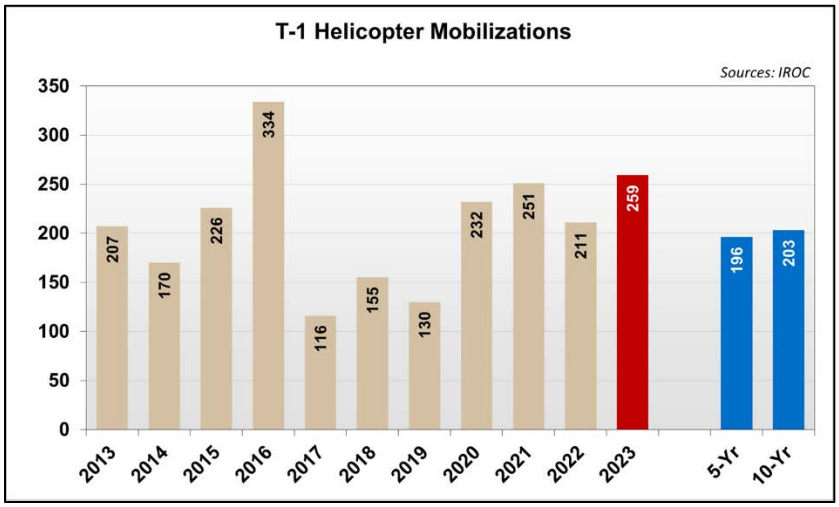
Overhead Requests Summary

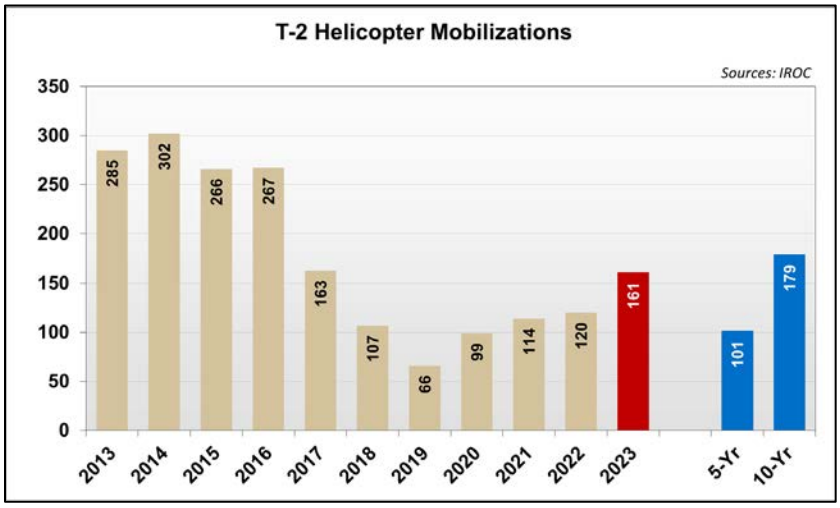
	Individual Overhead			
	Fill	Cancel	UTF	*Total*
BIA	545	72	147	***764***
BLM	490	59	107	***656***
DOD	16	1	0	***17***
FEMA	0	0	0	***0***
FS	8,960	2,503	3,889	***15,352***
FWS	172	4	0	***176***
NPS	606	197	149	***952***
ST	1,298	524	629	***2,451***
Other	31	0	1	***32***
Canada	411	42	124	***577***
Australia	0	0	0	***0***
Subtotal:	*12,529*	*3,402*	*5,046*	
Total:	**20,977**			

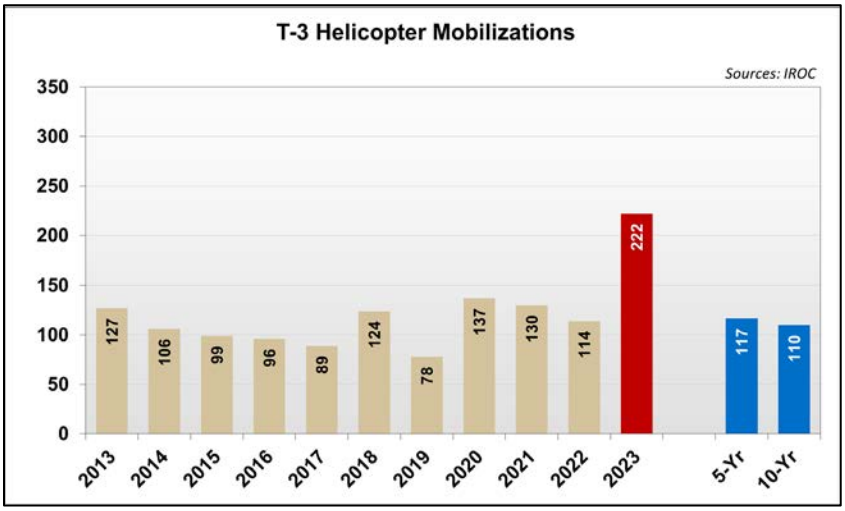
	Individual Overhead			
	Fill	Cancel	UTF	*Total*
AK	409	163	123	***695***
EA	506	60	32	***598***
GB	662	128	172	***962***
NICC	244	11	8	***263***
NO	1,724	702	1,261	***3,687***
NR	1,320	267	723	***2,310***
NW	2,828	925	1,473	***5,226***
RM	725	132	160	***1,017***
SA	1,959	372	437	***2,768***
SO	446	277	234	***957***
SW	1,295	323	299	***1,917***
Other	0	0	0	***0***
Canada	411	42	124	***577***
Australia	0	0	0	***0***
Subtotal:	*12,529*	*3,402*	*5,046*	
Total:	**20,977**			

Helicopter Mobilizations

NICC received 642 orders for Type 1, Type 2, and Type 3 helicopters in 2023. Of those requests: 424 were filled, 106 were canceled and 112 were UTF. Overall, Type 3 mobilizations were well above the five and ten-year averages. Type 1 and Type 2 mobilizations were both above their five-year averages.







Helicopter Requests Summary by Requesting Agency

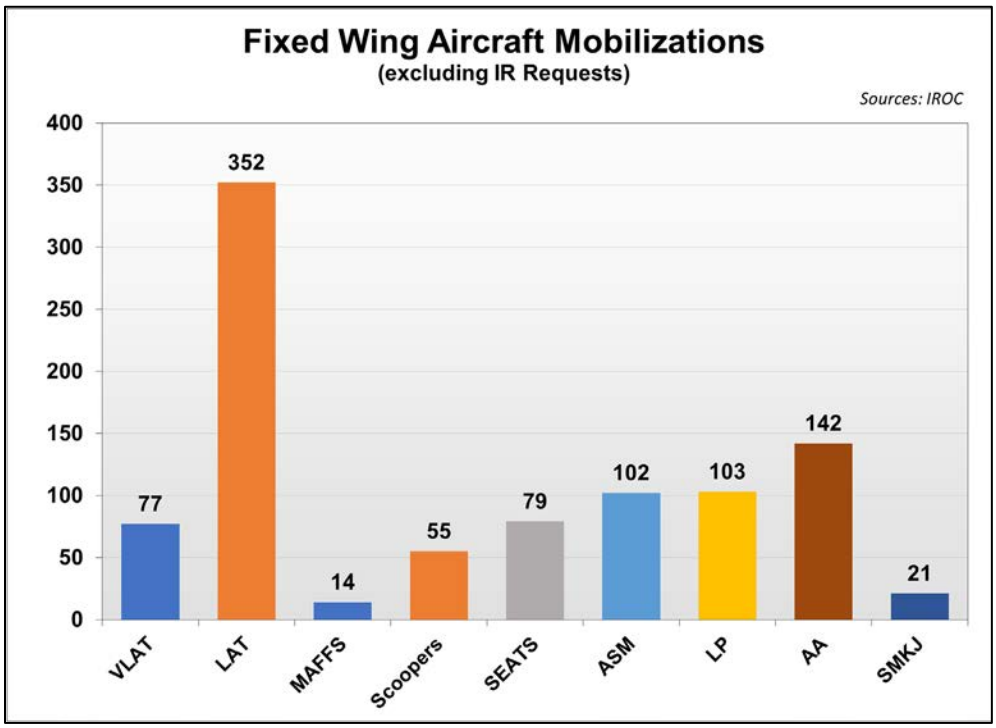
	Type 1			Type 2						Type 3			Helicopter Totals			
				Standard Use			Limited Use									
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Total
BIA	1	3	1	1	3	1	0	0	0	8	1	0	10	7	2	**19**
BLM	2	3	0	1	3	2	0	0	0	5	1	2	8	7	4	**19**
DOD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
FEMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
FS	159	29	29	63	20	34	8	2	7	120	34	32	350	85	102	**537**
FWS	1	0	0	0	0	0	0	0	0	0	1	0	1	1	0	**2**
NPS	8	1	0	3	1	3	2	0	0	7	0	0	20	2	3	**25**
ST	20	2	0	2	0	0	3	0	0	8	2	1	33	4	1	**38**
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Canada	0	0	0	2	0	0	0	0	0	0	0	0	2	0	0	**2**
Subtotal:	*191*	*38*	*30*	*72*	*27*	*40*	*13*	*2*	*7*	*148*	*39*	*35*	*424*	*106*	*112*	
Total:	**259**			**139**			**22**			**222**			**642**			

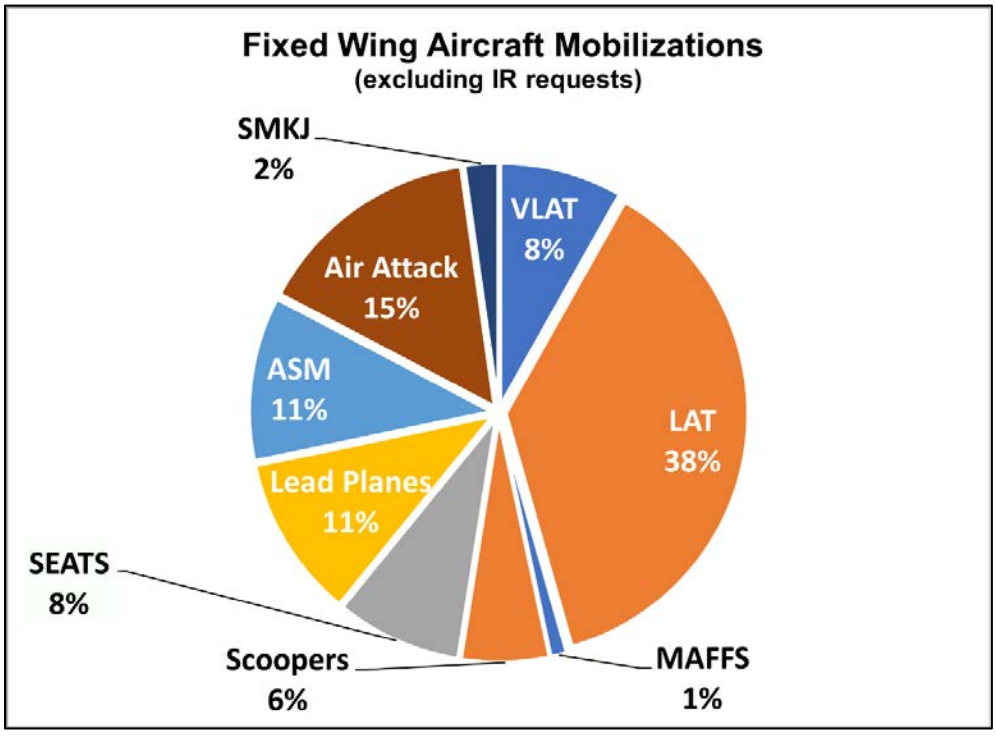
Helicopter Requests Summary by Requesting Geographic Area

	Type 1			Type 2						Type 3			Helicopter Totals			
				Standard Use			Limited Use									
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Total
AK	0	0	0	0	1	1	0	0	0	0	0	1	0	1	2	**3**
EA	5	0	0	1	0	0	0	0	0	7	0	0	13	0	0	**13**
GB	15	1	0	11	1	8	1	0	0	33	4	8	60	6	16	**82**
NICC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
NO	23	18	11	11	10	15	2	1	3	18	15	5	54	44	34	**132**
NR	25	4	8	8	1	6	5	0	3	14	3	11	52	8	28	**88**
NW	38	6	7	15	2	4	2	1	1	25	4	7	80	13	19	**112**
RM	12	2	0	4	0	0	0	0	0	9	3	1	25	5	1	**31**
SA	35	2	1	2	0	1	3	0	0	6	1	1	46	3	3	**52**
SO	19	2	1	8	4	3	0	0	0	2	1	0	29	7	4	**40**
SW	19	3	2	10	8	2	0	0	0	34	8	1	63	19	5	**87**
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Canada	0	0	0	2	0	0	0	0	0	0	0	0	2	0	0	**2**
Subtotal:	*191*	*38*	*30*	*72*	*27*	*40*	*13*	*2*	*7*	*148*	*39*	*35*	*424*	*106*	*112*	
Total:	**259**			**139**			**22**			**222**			**642**			

Fixed Wing Aircraft Mobilizations

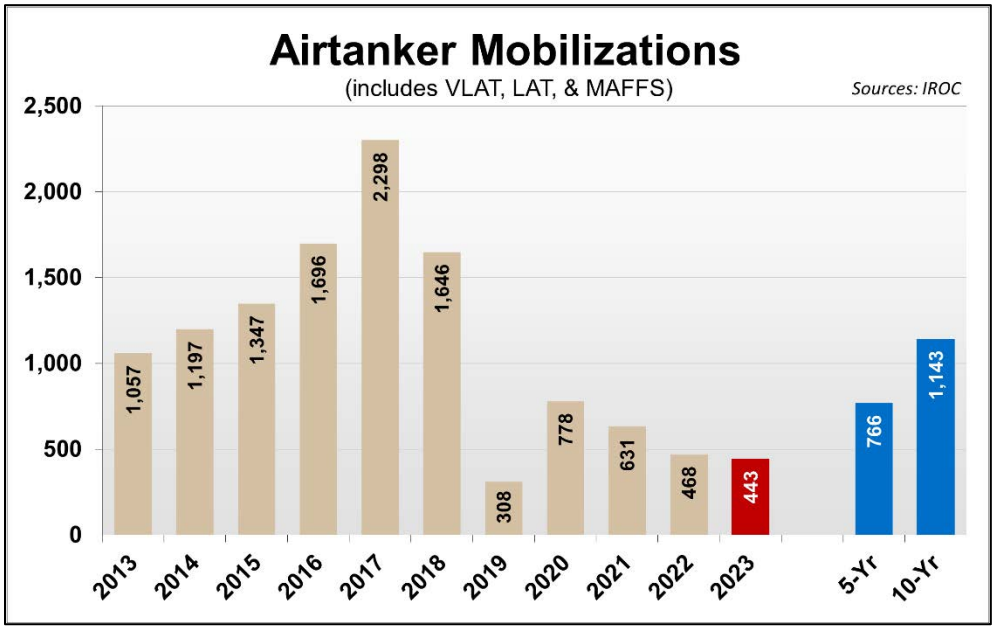
Fixed wing aircraft include very large airtankers (VLAT), large airtankers (LAT), multi-engine airtankers (Scoopers), single engine airtankers (SEATs), lead planes (LP), aerial supervision modules (ASM), air attack (AA), infrared (IR), and smokejumper aircraft (SMKJ). NICC received 3,085 requests for fixed wing aircraft in 2023. Of those requests: 2,112 were filled, 399 were canceled and 574 were UTF.

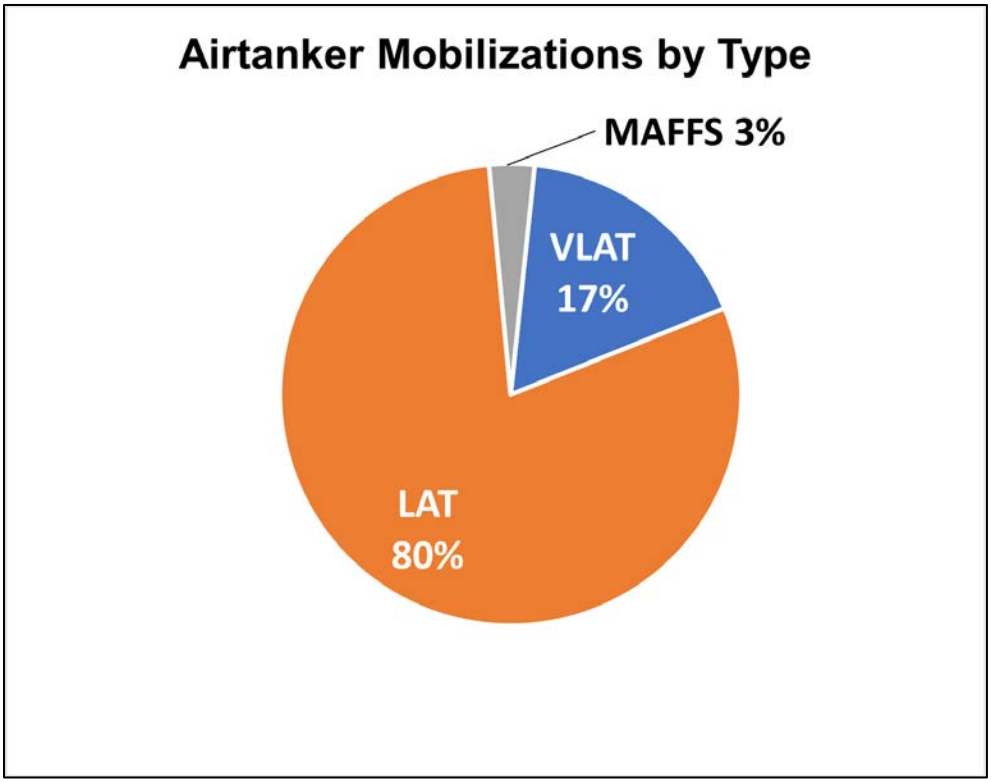




Airtanker Mobilizations

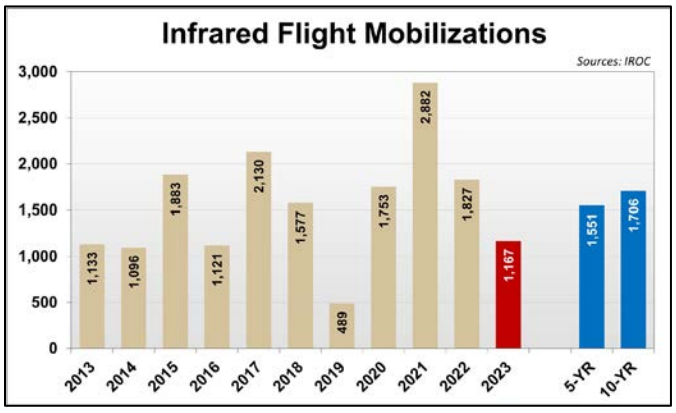
NICC received 569 requests for very large and large airtankers in 2023. Of those requests: 443 were filled, 67 were canceled and 58 were UTF. Airtanker mobilizations were well below the five and ten-year averages.

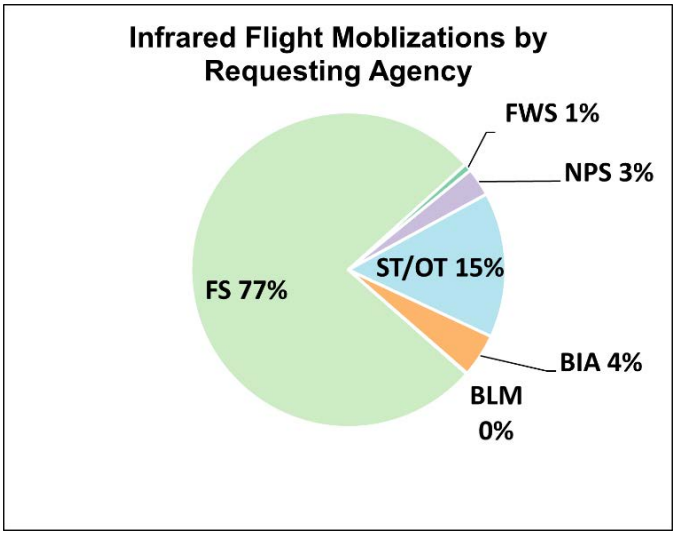


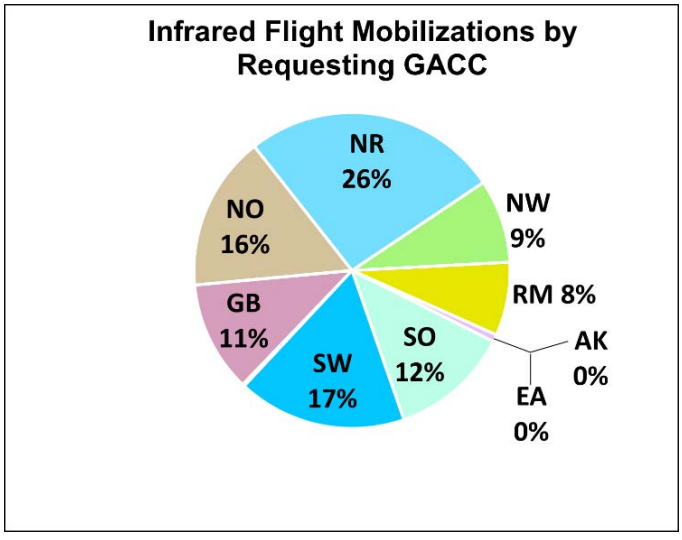


Infrared Aircraft Mobilizations

NICC received 1,828 infrared (IR) aircraft requests. Of those requests: 1,167 were filled, 213 were cancelled and 448 were UTF. IR requests were below the five and ten-year averages.







Fixed Wing Aircraft Requests Summary by Requesting Agency

	Very Large Airtanker (VLAT)			Large Airtanker (LAT)			Modular Airborne Fire Fighting System (MAFFS)			Type 3 Multi-Engine Airtanker (Scoopers)			Single Engine Airtanker (SEAT)			Lead Plane (LP)		
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF
BIA	3	0	1	16	2	2	0	0	0	2	0	2	11	0	0	1	0	1
BLM	4	2	2	41	7	4	0	0	0	4	0	0	34	4	3	6	4	2
DOD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FEMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FS	53	7	3	226	34	28	14	0	0	39	12	20	20	25	8	88	13	3
FWS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NPS	0	1	1	8	1	3	0	0	0	0	0	2	0	2	0	0	0	0
ST	17	2	5	61	11	9	0	0	0	10	0	2	14	1	0	7	2	0
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal:	*77*	*12*	*12*	*352*	*55*	*46*	*14*	*0*	*0*	*55*	*12*	*26*	*79*	*32*	*11*	*102*	*19*	*6*
Total:	**101**			**453**			**14**			**93**			**122**			**127**		

	Aerial Supervision Module (ASM)			Air Attack (AA)			Infrared (IR)			Smokejumper Aircraft (SKMJ)			Fixed Wing Aircraft Total Requests			
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	*Total*
BIA	1	0	0	5	2	0	52	31	11	0	0	0	91	35	17	***143***
BLM	3	0	0	12	3	0	1	2	2	0	0	0	105	22	13	***140***
DOD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	***0***
FEMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	***0***
FS	93	12	4	109	28	20	897	123	364	16	3	1	1,555	257	451	***2,263***
FWS	0	0	0	0	0	0	9	4	12	0	0	0	9	4	12	***25***
NPS	0	0	0	3	1	0	34	7	16	0	0	0	45	12	22	***79***
ST	6	3	0	13	3	0	174	46	43	0	0	0	302	68	59	***429***
Other	0	0	0	0	0	0	0	0	0	5	1	0	5	1	0	***6***
Subtotal:	*103*	*15*	*4*	*142*	*37*	*20*	*1,167*	*213*	*448*	*21*	*4*	*1*	*2,112*	*399*	*574*	
Total:	**122**			**199**			**1,828**			**26**			**3,085**			

Fixed Wing Aircraft Requests Summary by Requesting Geographic Area

	Very Large Airtanker (VLAT)			Large Airtanker (LAT)			Modular Airborne Fire Fighting System (MAFFS)			Type 3 Multi-Engine Airtanker (Scoopers)			Single Engine Airtanker (SEAT)			Lead Plane (LP)		
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF
AK	0	0	0	0	1	0	0	0	0	2	0	0	2	0	0	2	0	0
EA	0	0	0	1	0	0	0	0	0	4	0	0	7	0	0	0	0	0
GB	4	0	0	59	5	3	0	0	0	10	2	2	19	2	0	13	3	1
NICC	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	15	1	0
NO	13	2	1	22	9	12	6	0	0	2	0	0	6	0	0	3	3	0
NR	13	1	0	33	4	6	0	0	0	14	2	2	2	13	6	5	0	1
NW	14	3	6	51	7	13	8	0	0	19	6	20	22	4	5	28	3	0
RM	10	2	1	51	4	7	0	0	0	0	0	0	4	5	0	8	3	3
SA	1	2	2	10	4	0	0	0	0	4	0	2	4	2	0	4	3	1
SO	6	1	1	37	2	2	0	0	0	0	0	0	0	0	0	3	1	0
SW	16	1	1	85	19	3	0	0	0	0	2	0	13	6	0	21	2	0
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Canada	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal:	*77*	*12*	*12*	*352*	*55*	*46*	*14*	*0*	*0*	*55*	*12*	*26*	*79*	*32*	*11*	*102*	*19*	*6*
Total:	**101**			**453**			**14**			**93**			**122**			**127**		

	Aerial Supervision Module (ASM)			Air Attack (AA)			Infrared (IR)			Smokejumper Aircraft (SMKJ)			Fixed Wing Aircraft Total Requests			
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	*Total*
AK	4	0	0	1	0	0	0	0	0	0	0	0	11	1	0	***12***
EA	0	0	0	5	0	0	3	2	0	0	0	0	20	2	0	***22***
GB	2	0	0	9	2	3	46	3	45	1	0	0	163	17	54	***234***
NICC	3	0	0	3	0	0	0	0	0	0	0	0	24	1	0	***25***
NO	1	2	0	14	15	3	154	28	64	4	2	0	225	61	80	***366***
NR	2	1	0	15	2	2	215	86	91	1	0	0	300	109	108	***517***
NW	12	2	2	25	3	2	355	37	155	7	1	0	541	66	203	***810***
RM	6	0	0	19	7	4	116	6	21	1	0	0	215	27	36	***278***
SA	14	5	0	15	3	0	102	21	32	0	0	0	154	40	37	***231***
SO	21	3	0	2	1	0	10	2	0	0	0	0	79	10	3	***92***
SW	38	2	2	34	4	6	166	28	40	2	0	1	375	64	53	***492***
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	***0***
Canada	0	0	0	0	0	0	0	0	0	5	1	0	5	1	0	***6***
Subtotal:	*103*	*15*	*4*	*142*	*37*	*20*	*1,167*	*213*	*448*	*21*	*4*	*1*	*2,112*	*399*	*574*	
Total:	**122**			**199**			**1,828**			**26**			**3,085**			

Unmanned Aircraft Systems

The NICC received 141 requests for UAS resources in 2023. Of those requests: 65 were filled, 37 were cancelled, and 39 were UTF.

	Fixed Wing			Rotor Wing			UAS Totals			
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Total
BIA	0	0	0	0	0	0	0	0	0	**0**
BLM	0	0	0	0	2	0	0	2	0	**2**
DOD	0	0	0	0	0	0	0	0	0	**0**
FEMA	0	0	0	0	0	0	0	0	0	**0**
FS	3	0	0	58	34	37	61	34	37	**132**
FWS	0	0	0	2	0	0	2	0	0	**2**
NPS	0	0	0	1	0	2	1	0	2	**3**
ST	0	0	0	1	1	0	1	1	0	**2**
Other	0	0	0	0	0	0	0	0	0	**0**
Canada	0	0	0	0	0	0	0	0	0	**0**
Subtotal:	*3*	*0*	*0*	*62*	*37*	*39*	*65*	*37*	*39*	
Total:	**3**			**138**			**141**			

	Fixed Wing			Rotor Wing			UAS Totals			
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Total
AK	0	0	0	0	0	0	0	0	0	**0**
EA	0	0	0	1	2	6	1	2	6	**9**
GB	0	0	0	4	2	2	4	2	2	**8**
NICC	0	0	0	1	0	0	1	0	0	**1**
NO	2	0	0	9	7	8	11	7	8	**26**
NR	0	0	0	12	1	7	12	1	7	**20**
NW	1	0	0	8	7	9	9	7	9	**25**
RM	0	0	0	3	1	0	3	1	0	**4**
SA	0	0	0	10	0	0	10	0	0	**10**
SO	0	0	0	1	2	2	1	2	2	**5**
SW	0	0	0	13	15	5	13	15	5	**33**
Other	0	0	0	0	0	0	0	0	0	**0**
Canada	0	0	0	0	0	0	0	0	0	**0**
Subtotal:	*3*	*0*	*0*	*62*	*37*	*39*	*65*	*37*	*39*	
Total:	**3**			**138**			**141**			

Temporary Flight Restrictions

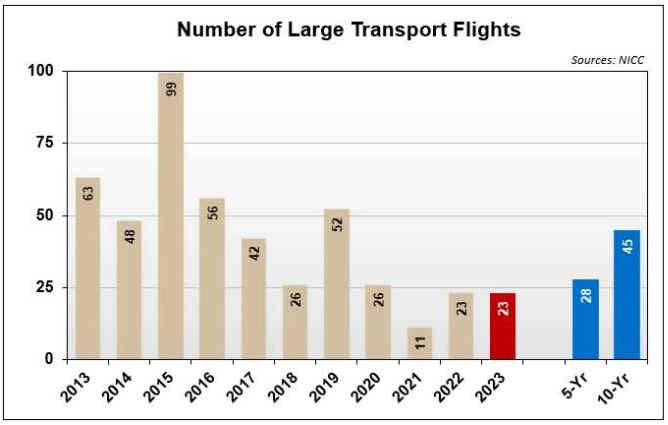
There were 777 Temporary Flight Restrictions (TFR) requests in 2023.

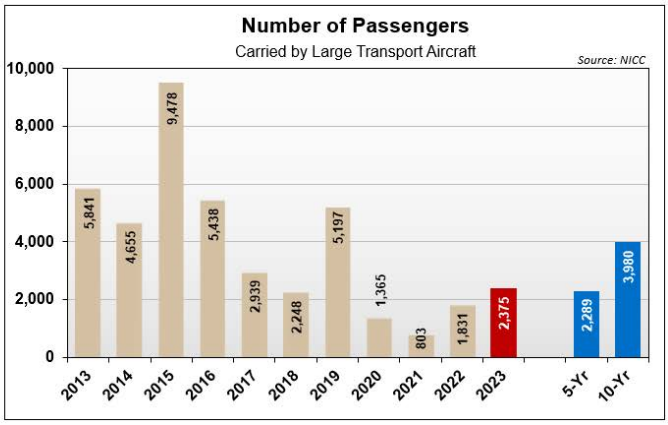
Agency	BIA	BLM	DOD	FEMA	FS	FWS	NPS	ST	Other
Filled	46	58	0	0	416	3	34	220	0

GACC	AK	EA	GB	NICC	NO	NR	NW	RM	SA	SO	SW
Filled	41	2	42	0	56	96	193	40	80	31	196

Large Transportation Aircraft

In 2023, there was one exclusive use contract for large transportation aircraft. The contract was filled with a B737-2T4 jet aircraft. This exclusive use jet flew 23 logistical missions, transporting a total of 2,375 passengers.





Exclusive Use and Charter Large Transport Requests Summary by Destination Agency and Geographic Area

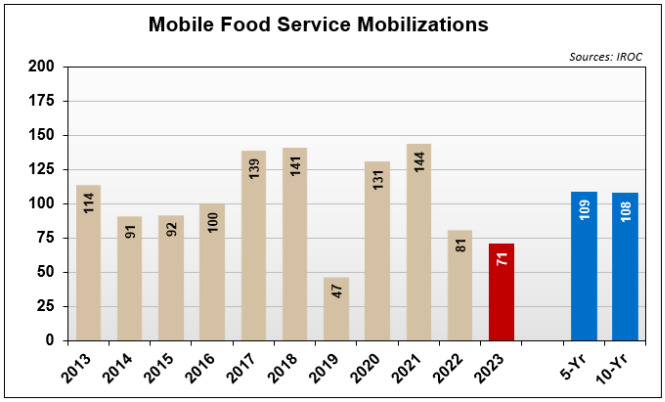
	Exclusive Use Aircraft		Charter Aircraft		Large Trans. Totals	
	Flights	Pax	Flights	Pax	**Flights**	**Pax**
BIA	0	0	0	0	**0**	**0**
BLM	10	1,609	0	0	**10**	**1,609**
DOD	0	0	0	0	**0**	**0**
FEMA	0	0	0	0	**0**	**0**
FS	0	0	0	0	**0**	**0**
FWS	0	0	0	0	**0**	**0**
NPS	0	0	0	0	**0**	**0**
ST	0	0	0	0	**0**	**0**
Other	0	0	0	0	**0**	**0**
Canada	13	766	0	0	**13**	**766**
Total:	**23**	**2,375**	**0**	**0**	**23**	**2,375**

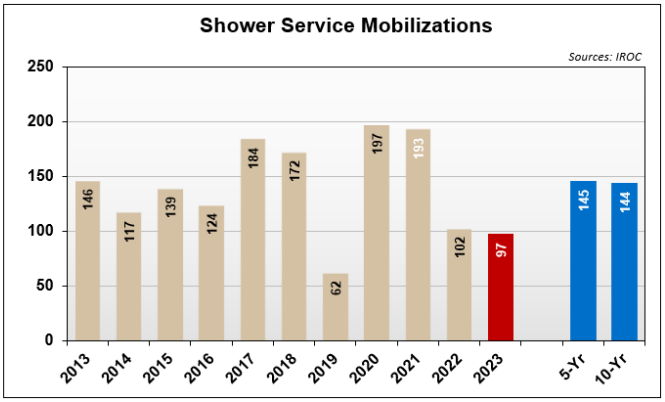
	Exclusive Use Aircraft		Charter Aircraft		Large Trans. Totals	
	Flights	Pax	Flights	Pax	**Flights**	**Pax**
AK	10	1,609	0	0	**10**	**1,609**
EA	0	0	0	0	**0**	**0**
GB	0	0	0	0	**0**	**0**
NICC	0	0	0	0	**0**	**0**
NO	0	0	0	0	**0**	**0**
NR	0	0	0	0	**0**	**0**
NW	0	0	0	0	**0**	**0**
RM	0	0	0	0	**0**	**0**
SA	0	0	0	0	**0**	**0**
SO	0	0	0	0	**0**	**0**
SW	0	0	0	0	**0**	**0**
Other	0	0	0	0	**0**	**0**
Canada	13	766	0	0	**13**	**766**
Total:	**23**	**2,375**	**0**	**0**	**23**	**2,375**

Equipment Services Mobilization

NICC received 71 requests for mobile food services in 2023. Of those requests: 66 were filled, five were canceled and zero were UTF. The number of mobilizations was well below the five and ten-year averages.

NICC received 97 requests for mobile shower services in 2023. Of those requests: 89 were filled, seven were canceled and one was UTF. The number of mobilizations was well below the five and ten-year averages.





Equipment Services Requests Summary by Requesting Agency and Geographic Area

	Mobile Food			Showers			Equipment Services Totals			
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Total
BIA	5	0	0	6	0	0	11	0	0	**11**
BLM	1	1	0	1	0	0	2	1	0	**3**
DOD	0	0	0	0	0	0	0	0	0	**0**
FEMA	0	0	0	0	0	0	0	0	0	**0**
FS	50	4	0	75	7	1	125	11	1	**137**
FWS	0	0	0	0	0	0	0	0	0	**0**
NPS	2	0	0	1	0	0	3	0	0	**3**
ST	8	0	0	6	0	0	14	0	0	**14**
Other	0	0	0	0	0	0	0	0	0	**0**
Canada	0	0	0	0	0	0	0	0	0	**0**
Subtotal:	*66*	*5*	*0*	*89*	*7*	*1*	*155*	*12*	*1*	
Total:	**71**			**97**			**168**			

	Mobile Food			Showers			Equipment Services Totals			
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Total
AK	0	0	0	0	0	0	0	0	0	**0**
EA	0	0	0	0	0	0	0	0	0	**0**
GB	5	0	0	6	0	0	11	0	0	**11**
NICC	0	0	0	0	0	0	0	0	0	**0**
NO	11	0	0	16	1	0	27	1	0	**28**
NR	11	1	0	15	0	0	26	1	0	**27**
NW	19	4	0	32	3	1	51	7	1	**59**
RM	4	0	0	5	2	0	9	2	0	**11**
SA	0	0	0	0	0	0	0	0	0	**0**
SO	2	0	0	2	0	0	4	0	0	**4**
SW	14	0	0	13	1	0	27	1	0	**28**
Other	0	0	0	0	0	0	0	0	0	**0**
Canada	0	0	0	0	0	0	0	0	0	**0**
Subtotal:	*66*	*5*	*0*	*89*	*7*	*1*	*155*	*12*	*1*	
Total:	**71**			**97**			**168**			

Radio and Weather Equipment Mobilizations

NICC received 531 requests for radio kits and weather equipment in 2023. Of those requests: 506 were filled, 24 were canceled, and one was UTF.

Radio and Weather Equipment Request Summary by Requesting Agency and Requesting Geographic Area

	4390 Starter			4312 Repeater			4381 Tactical			5869 RAWS			Equipment Totals			
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Total
BIA	3	0	0	10	0	0	2	0	0	3	0	0	18	0	0	**18**
BLM	4	0	0	7	1	0	7	0	0	0	0	0	18	1	0	**19**
DOD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
FEMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
FS	108	3	1	145	6	0	84	1	0	60	7	0	397	17	1	**415**
FWS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
NPS	2	0	0	4	1	0	2	0	0	3	1	0	11	2	0	**13**
ST	15	0	0	23	0	0	13	0	0	11	4	0	62	4	0	**66**
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Canada	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Subtotal:	*132*	*3*	*1*	*189*	*8*	*0*	*108*	*1*	*0*	*77*	*12*	*0*	*506*	*24*	*1*	
Total:	**136**			**197**			**109**			**89**			**531**			

	4390 Starter			4312 Repeater			4381 Tactical			5869 RAWS			Equipment Totals			
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Total
AK	6	0	0	12	0	0	7	0	0	0	0	0	25	0	0	**25**
EA	4	0	0	1	0	0	0	0	0	0	0	0	5	0	0	**5**
GB	4	0	0	12	0	0	11	1	0	10	0	0	37	1	0	**38**
NICC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
NO	13	0	0	30	0	0	18	0	0	7	0	0	68	0	0	**68**
NR	19	0	0	21	1	0	17	0	0	10	1	0	67	2	0	**69**
NW	26	1	0	45	2	0	35	0	0	31	8	0	137	11	0	**148**
RM	12	0	0	9	3	0	4	0	0	14	0	0	39	3	0	**42**
SA	12	2	0	12	0	0	6	0	0	0	0	0	30	2	0	**32**
SO	5	0	1	5	0	0	2	0	0	1	3	0	13	3	1	**17**
SW	31	0	0	42	2	0	1	0	0	4	0	0	78	2	0	**80**
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Canada	0	0	0	0	0	0	7	0	0	0	0	0	7	0	0	**7**
Subtotal:	*132*	*3*	*1*	*189*	*8*	*0*	*108*	*1*	*0*	*77*	*12*	*0*	*506*	*24*	*1*	
Total:	**136**			**197**			**109**			**89**			**531**			

Wildland Fires and Acres Burned by State and Agency

(Figures are from the SIT/209 Application)

Alabama

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	40	1,522	1	8	41	1,530
FWS	3	1	0	0	3	1
NPS	2	161	0	0	2	161
OTHR	2	16	0	0	2	16
ST	1,793	16,524	15	103	1,808	16,627
Totals:	**1,840**	**18,224**	**16**	**111**	**1,856**	**18,335**

Alaska

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BLM	10	97	104	167,941	114	168,037
DVF	151	631	72	145,598	223	146,229
FS	9	10	0	0	9	9
Totals:	**170**	**738**	**176**	**313,539**	**346**	**314,276**

Arizona

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	366	2,340	97	20,187	463	22,526
BLM	131	2,100	62	5,389	193	7,489
DVF	361	48,334	48	20,618	409	68,952
FS	428	22,783	304	63,227	732	86,010
FWS	6	168	2	3,056	8	3,224
NPS	14	98	18	183	32	281
Totals:	**1,306**	**75,823**	**531**	**112,660**	**1,837**	**188,483**

Arkansas

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	59	1,149	9	1,139	68	2,288
FWS	1	20	0	0	1	20
NPS	23	1,926	0	0	23	1,925
OTHR	55	1,425	0	0	55	1,425
Totals:	**138**	**4,520**	**9**	**1,139**	**147**	**5,659**

California

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	63	83	2	118	65	201
BLM	66	1,507	16	50	82	1,557
BOR	1	0	0	0	1	0
C&L	11	15,195	0	0	11	15,195
CDF	6,006	32,914	78	672	6,084	33,586
FS	536	2,032	486	185,224	1,022	187,255
FWS	8	8	0	0	8	8
NPS	48	86,858	36	3,394	84	90,251
DOD	7	4,668	0	0	7	4,667
Totals:	**6,746**	**143,265**	**618**	**189,458**	**7,364**	**332,722**

Colorado

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	8	2	46	140	54	142
BLM	84	5,807	241	6,377	325	12,184
BOR	1	3	0	0	1	3
C&L	100	15,580	87	1,531	187	17,111
FS	128	1,398	133	11,046	261	12,444
FWS	2	8	0	0	2	8
NPS	5	0	26	25	31	25
Totals:	**328**	**22,798**	**533**	**19,119**	**861**	**41,917**

Connecticut

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
ST	499	297	0	0	499	297
Totals:	**499**	**297**	**0**	**0**	**499**	**297**

Delaware

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
NPS	1	0	0	0	1	0
Totals:	**1**	**0**	**0**	**0**	**1**	**0**

Florida

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	5	10	2	128	7	138
FS	63	4,169	11	6,414	74	10,583
FWS	16	1,686	8	173	24	1,859
NPS	21	10,712	22	21,212	43	31,924
OTHR	112	1,642	28	200	140	1,842
ST	1,918	36,652	521	15,508	2,439	52,160
USAF	3	1,136	0	0	3	1,136
Totals:	**2,138**	**56,007**	**592**	**43,635**	**2,730**	**99,642**

Georgia

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	25	209	3	14	28	223
FWS	1	0	0	0	1	0
NPS	1	0	0	0	1	0
OTHR	3	27	0	0	3	27
ST	2,353	10,080	0	0	2,353	10,080
Totals:	**2,383**	**10,316**	**3**	**14**	**2,386**	**10,330**

Hawaii

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
C&L	183	10,363	26	0	209	10,363
FWS	1	1,696	0	0	1	1,696
NPS	4	0	0	0	4	0
Totals:	**188**	**12,059**	**26**	**0**	**214**	**12,059**

Idaho

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	25	48	2	13	27	61
BLM	115	18,277	40	8,857	155	27,134
C&L	12	43	5	41	17	84
DOD	2	5	0	0	2	5
FS	71	43,904	166	13,131	237	57,035
ST	366	3,075	88	407	454	3,482
Totals:	**591**	**65,352**	**301**	**22,449**	**892**	**87,801**

Illinois

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	20	100	0	0	20	100
FWS	1	1	0	0	1	1
ST	1	10	0	0	1	10
Totals:	**22**	**111**	**0**	**0**	**22**	**111**

Indiana

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
DOD	1	5	0	0	1	5
FS	25	200	0	0	25	199
NPS	14	7	0	0	14	7
ST	7	310	0	0	7	310
Totals:	**47**	**522**	**0**	**0**	**47**	**521**

Iowa

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	2	5	0	0	2	5
FWS	4	1	0	0	4	1
Totals:	**6**	**6**	**0**	**0**	**6**	**6**

Kansas

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
C&L	29	17,525	0	0	29	17,525
NPS	0	0	1	3	1	3
FWS	3	36	0	0	3	36
BIA	16	399	0	0	16	399
Totals:	**48**	**17,960**	**1**	**3**	**49**	**17,963**

Kentucky

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	9	70	0	0	9	70
Totals:	**9**	**70**	**0**	**0**	**9**	**70**

Louisiana

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	55	6,159	6	36	61	6,194
OTHR	29	303	0	0	29	303
ST	1,377	15,606	0	0	1,377	15,606
Totals:	**1,461**	**22,068**	**6**	**36**	**1,467**	**22,103**

Maine

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
NPS	2	1	0	0	2	1
ST	473	317	18	7	491	324
Totals:	**475**	**318**	**18**	**7**	**493**	**325**

Maryland

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
DOD	9	3	0	0	9	3
FWS	1	0	1	5	2	5
NPS	2	1	0	0	2	1
ST	174	4,422	9	55	183	4,477
Totals:	**186**	**4,426**	**10**	**60**	**196**	**4,486**

Massachusetts

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
ST	1,074	1,468	5	0	1,079	1,468
Totals:	**1,074**	**1,468**	**5**	**0**	**1,079**	**1,468**

Michigan

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	12	11	0	0	12	11
FS	163	453	5	152	168	605
NPS	8	15	2	1	10	16
ST	266	3,636	10	19	276	3,655
Totals:	**449**	**4,115**	**17**	**172**	**466**	**4,287**

Minnesota

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	173	1,103	0	0	173	1,103
FS	21	36	8	6	29	42
FWS	19	2,750	0	0	19	2,750
NPS	3	1	0	0	3	1
ST	612	5,520	0	0	612	5,520
Totals:	**828**	**9,410**	**8**	**6**	**836**	**9,416**

Mississippi

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	15	22	0	0	15	22
FS	183	21,104	11	557	194	21,660
NPS	22	582	0	0	22	582
OTHR	2,091	29,085	0	0	2,091	29,085
ST	61	1,159	0	0	61	1,159
Totals:	**2,372**	**51,952**	**11**	**557**	**2,383**	**52,508**

Missouri

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	125	6,881	0	0	125	6,881
FWS	2	2,618	0	0	2	2,618
Totals:	**127**	**9,499**	**0**	**0**	**127**	**9,499**

Montana

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	326	7,665	26	42,959	352	50,624
BLM	14	1,357	39	620	53	1,977
C&L	639	8,761	105	5,949	744	14,710
FS	163	16,394	169	30,401	332	46,795
FWS	2	6	4	256	6	262
NPS	0	0	12	3	12	3
ST	114	1,570	49	7,192	163	8,762
Totals:	**1,258**	**35,753**	**404**	**87,380**	**1,662**	**123,133**

Nebraska

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
DOF	505	177,236	55	1,799	560	179,035
FS	5	1,475	3	1	8	1,476
FWS	1	222	0	0	1	222
Totals:	**511**	**178,933**	**58**	**1,800**	**569**	**180,733**

Nevada

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BLM	102	26	105	346	207	371
BOR	5	469	0	0	5	469
C&L	56	110	21	49	77	159
DOD	1	0	0	0	1	0
FS	16	216	34	81	50	297
FWS	5	0	0	0	5	0
NPS	22	3	5	0	27	3
OTHR	1	0	0	0	1	0
ST	1	0	1	0	2	0
Totals:	**209**	**824**	**166**	**476**	**375**	**1,300**

New Hampshire

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	3	0	0	0	3	0
ST	49	58	0	0	49	58
Totals:	**52**	**58**	**0**	**0**	**52**	**58**

New Jersey

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FWS	3	18	0	0	3	18
NPS	1	0	0	0	1	0
ST	1,190	18,015	0	0	1,190	18,015
Totals:	**1,194**	**18,033**	**0**	**0**	**1,194**	**18,033**

New Mexico

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	59	50	23	29	82	79
BLM	70	1,754	64	5,020	134	6,774
DOE	0	0	1	0	1	0
FS	109	799	194	157,520	303	158,319
FWS	3	2	2	39	5	41
NPS	0	0	22	1,516	22	1,515
SF	346	23,259	126	22,390	472	45,648
Totals:	**587**	**25,864**	**432**	**186,514**	**1,019**	**212,378**

New York

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FWS	1	0	0	0	1	0
NPS	3	1	0	0	3	1
ST	143	1,371	3	11	146	1,382
Totals:	**147**	**1,372**	**3**	**11**	**150**	**1,383**

North Carolina

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	25	21	0	0	25	21
FS	43	39,087	4	5,530	47	44,616
FWS	6	3,854	0	0	6	3,854
NPS	3	1	0	0	3	1
ST	5,057	18,583	35	159	5,092	18,742
USM	41	6,718	0	0	41	6,718
Totals:	**5,175**	**68,264**	**39**	**5,689**	**5,214**	**73,953**

North Dakota

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	218	930	5	4	223	934
FS	5	117	0	0	5	117
FWS	7	212	0	0	7	212
NPS	4	2	25	22	29	24
ST	200	2,859	7	37	207	2,896
Totals:	**434**	**4,120**	**37**	**63**	**471**	**4,183**

Ohio

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	39	421	0	0	39	421
ST	844	2,048	0	0	844	2,048
Totals:	**883**	**2,469**	**0**	**0**	**883**	**2,469**

Oklahoma

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	650	109,700	0	0	650	109,699
FWS	25	1,468	0	0	25	1,468
NPS	1	5	0	0	1	5
OTHR	368	4,095	0	0	368	4,094
ST	536	47,222	0	0	536	47,222
Totals:	**1,580**	**162,490**	**0**	**0**	**1,580**	**162,489**

Oregon

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	97	2,955	4	5	101	2,959
BLM	120	10,295	102	9,760	222	20,055
C&L	15	16,821	0	0	15	16,821
DL	2	1,142	0	0	2	1,141
DOF	819	6,397	183	10,818	1,002	17,215
FS	337	68,739	278	72,602	615	141,340
FWS	2	2,500	1	0	3	2,500
NPS	2	0	17	3	19	3
Totals:	**1,394**	**108,848**	**585**	**93,188**	**1,979**	**202,035**

Pennsylvania

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	7	432	0	0	7	432
FWS	2	14	0	0	2	14
NPS	4	0	0	0	4	0
ST	1,886	9,177	11	5	1,897	9,182
Totals:	**1,899**	**9,623**	**11**	**5**	**1,910**	**9,628**

Rhode Island

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
ST	78	582	0	0	78	582
Totals:	**78**	**582**	**0**	**0**	**78**	**582**

South Carolina

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	15	483	1	2	16	485
FWS	0	0	1	105	1	105
USA	5	1	0	0	5	1
Totals:	**20**	**484**	**2**	**107**	**22**	**591**

South Dakota

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	65	259	5	27	70	286
BLM	1	7	0	0	1	7
C&L	8	438	4	2	12	440
FS	14	1	33	69	47	70
NPS	1	0	1	1	2	1
ST	34	126	11	15	45	141
Totals:	**123**	**831**	**54**	**114**	**177**	**945**

Tennessee

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	46	1,967	2	1	48	1,968
NPS	5	9	0	0	5	9
OTHR	685	6,278	6	185	691	6,463
ST	28	6,954	0	0	28	6,954
Totals:	**764**	**15,208**	**8**	**186**	**772**	**15,394**

Texas

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BLM	2	0	0	0	2	0
C&L	5,487	44,240	209	15,424	5,696	59,664
FS	91	1,922	8	1,260	99	3,182
FWS	21	4,440	0	0	21	4,440
NPS	18	118	4	481	22	599
OTHR	6	6	0	0	6	6
ST	1,083	121,824	173	20,549	1,256	142,373
Totals:	**6,708**	**172,550**	**394**	**37,714**	**7,102**	**210,264**

Utah

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	4	471	21	3	25	474
BLM	69	1,889	167	3,598	236	5,487
DOD	0	0	1	0	1	0
FS	48	9	89	9,757	137	9,766
NPS	3	2	14	178	17	180
ST	250	928	116	1,274	366	2,202
Totals:	**374**	**3,299**	**408**	**14,810**	**782**	**18,109**

Vermont

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	4	4	0	0	4	4
ST	63	58	0	0	63	58
Totals:	**67**	**62**	**0**	**0**	**67**	**62**

Virginia

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	35	12,062	2	7	37	12,069
FWS	2	16	1	0	3	16
NPS	3	0	0	0	3	0
Totals:	**40**	**12,078**	**3**	**7**	**43**	**12,085**

Washington

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	189	2,198	25	824	214	3,022
BLM	51	20,563	8	471	59	21,034
C&L	9	1,060	1	0	10	1,060
DNR	983	90,374	123	1,505	1,106	91,878
FS	147	704	116	15,738	263	16,442
FWS	24	5,246	1	14	25	5,260
NPS	5	1	21	7,467	26	7,468
ST	3	4,626	1	526	4	5,152
Totals:	**1,411**	**124,772**	**296**	**26,545**	**1,707**	**151,316**

West Virginia

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	7	0	0	0	7	0
NPS	8	2,249	0	0	8	2,249
ST	1,105	43,365	4	65	1,109	43,430
Totals:	**1,120**	**45,614**	**4**	**65**	**1,124**	**45,679**

Wisconsin

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	28	18	0	0	28	18
FS	30	94	0	0	30	94
FWS	4	68	0	0	4	68
ST	1,023	4,678	1	25	1,024	4,703
Totals:	**1,085**	**4,858**	**1**	**25**	**1,086**	**4,883**

Wyoming

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	27	80	2	0	29	80
BLM	30	1,048	23	848	53	1,896
BOR	1	4	0	0	1	4
C&L	66	3,186	38	1,729	104	4,915
FS	27	391	25	47	52	438
FWS	1	0	1	0	2	0
NPS	0	0	5	0	5	0
ST	0	223	3	378	3	601
Totals:	**152**	**4,932**	**97**	**3,002**	**249**	**7,934**

NICC Benchmarks

The figures below represent national-level totals for fire activity and numbers of **resources mobilized through the National Interagency Coordination Center**, except for Incident Management Team mobilizations, which are displayed in totality of mobilizations nationwide. Records set during the year of this report are in **bold**.

Category	Record Year	Record	2023 Stats
Wildfires	2006	96,385	56,580
Wildfire Acres Burned	2015	10,125,149	2,693,910
Significant Fires	2006	1,801	891
Days at Preparedness Level 1&2	2010	365	298
Days at Preparedness Level 4&5	2021	99	21
Days at Preparedness Level 5	2021	68	0
Type 1 IMT Mobilizations (fire & non-fire)	2002	85	15
Type 2 IMT Mobilizations (fire & non-fire)	2021	138	46
Dept. of Defense Battalions/Task Forces	1988	8	0
MAFFS (millions of gallons delivered)	1994	5.03	0.19
Tactical Crew Mobilizations	2003	1,796	1,212
Engine Mobilizations	2021	3,149	1,876
Overhead Mobilizations	2000	17,898	12,529
Type 1 Helicopter Mobilizations	2016	334	259
Type 2 Helicopter Mobilizations	2006	323	161
Heavy Airtankers (VLAT/LAT/MAFFS)	2017	2,298	443
Large Transport Flights	1994	552	23
Mobile Food Units	1994	195	71
Shower Units	1994	256	97

Identifier Legend

Interagency Coordination Centers
NICC: National Interagency Coordination Center
NIFC: National Interagency Fire Center
CIIFC: Canadian Interagency Forest Fire Centre
AK: Alaska Area
EA: Eastern Area
GB: Great Basin Area
NO: Northern California Area
NR: Northern Rockies Area
NW: Northwest Area
RM: Rocky Mountain Area
SA: Southern Area
SW: Southwest Area
SO: Southern California Area

Federal Government Agencies
FS: Forest Service
BIA: Bureau of Indian Affairs
BLM: Bureau of Land Management
FWS: Fish and Wildlife Service
NPS: National Park Service
FEMA: Federal Emergency Management Agency
ESF4: Emergency Support Function, Firefighting
NWS: National Weather Service
DOE: Department of Energy
DOD: Department of Defense

International Partners
AU: Australia
CN: Canada
MX: Mexico
NZ: New Zealand

Other Providers/Ownership
CNTY: County
OT: Other
PRI: Private
ST: State
ST/OT: State/Other Combined

Acronyms and Terminology

Air Attack: Light aircraft (airplane or helicopter) that carries the ATGS.

ASM: Aerial Supervision Module, light twin-engine airplane that combines the lead plane function and tactical supervision (pilot and Air Tactical Supervisor - ATS).

IA: Initial attack**.**

IMT: Incident Management Team.

Infrared: Aircraft outfitted with infrared sensing equipment.

IROC: Interagency Resource Ordering Capability System.

Large fire: A large fire is defined as 100 acres or greater in timber, 300 acres or greater in grass/brush, or a Type 1, Type 2 or NIMO team is assigned.

LAT: Large Airtanker.

Lead Plane: Twin-engine airplane that guides airtankers over a fire.

MAFFS: Modular Airborne Fire Fighting System (military C-130 aircraft).

NIMO: National Incident Management Organization.

Pax: Passengers.

RAWS: Remote Automated Weather Station.

Starter: Type of portable radio kit.

Repeater: Type of portable radio kit.

Tactical: Type of portable radio kit.

SEAT: Single engine airtanker.

Scooper: The vernacular term for a multi-engine airtanker capable of filling its tanks while skimming over a body of water then dropping the water on a wildland fire.

TFR: Temporary Flight Restriction.

UTF: Unable to Fill resource request (the requested resource couldn't be filled).

UAS: Unmanned aircraft systems.

VLAT: Very Large Airtanker.

National Interagency Coordination Center

Wildland Fire Summary and Statistics Annual Report 2022



Six Rivers Lightning Complex, California

National Interagency Coordination Center

Table of Contents

Preface 1
2022 Fire Environment Summary 2
National Fire Activity Synopsis 6
Significant Incidents Over 40,000 Acres 7
Wildfires and Acres 8
National Preparedness Levels 14
Requests Created Nationally in IROC 16
Requests Processed through the NICC 17
- Department of Defense Mobilizations 17
- International Resource Mobilizations 18
- Incident Management Team Mobilizations 18
- Crew Mobilizations 21
- Engine and Tactical Water Tender Mobilizations 23
- Overhead Mobilizations 26
- Helicopter Mobilizations 27
- Fixed Wing Aircraft Mobilizations 29
- Unmanned Aircraft Systems 32
- Temporary Flight Restrictions 33
- Large Transportation Aircraft 34
- Equipment Services Mobilization 35
- Radio and Weather Equipment Mobilizations 36

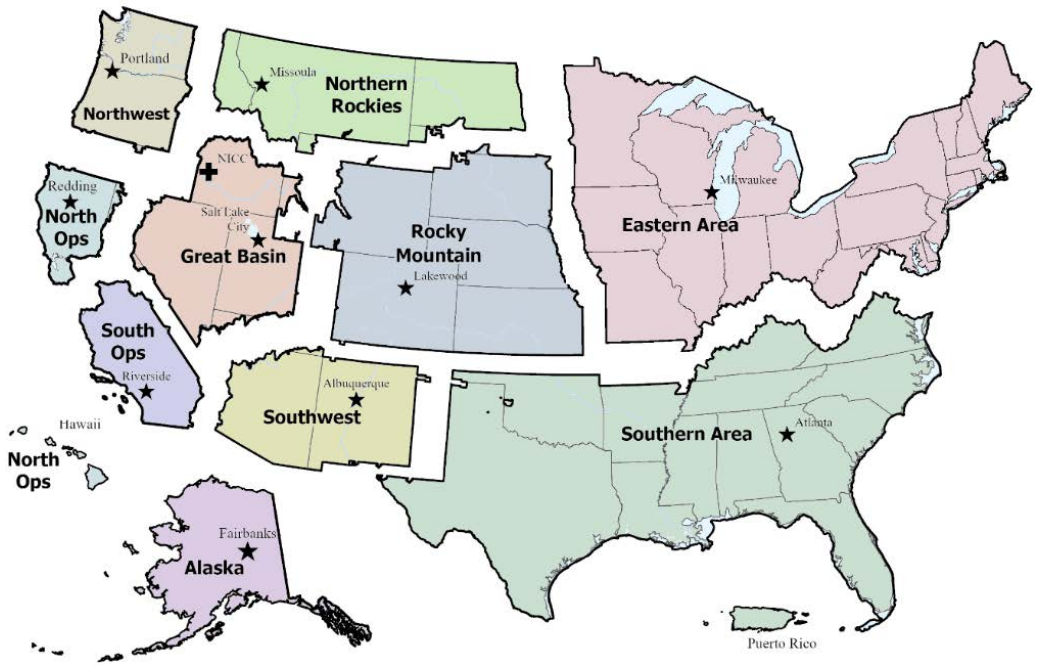
Wildland Fires and Acres Burned by State and Agency 37
NICC Benchmarks 47
Identifier Legend 48
Acronyms and Terminology 49

Preface

Statistics used in this report were gathered from the Situation Report and Incident Status Summary (ICS-209) programs[1]. Previous National Interagency Coordination Center (NICC) annual reports and other sources were also used in this document. The statistics presented here are intended to provide a national perspective of annual fire activity, but they may not reflect official figures for a specific agency. The statistics are delineated by agency and Geographic Area. This document and prior year annual reports are available electronically on NICC's Intelligence web page: https://www.predictiveservices.nifc.gov/intelligence/intelligence.htm

Resource mobilization statistics used in this report were gathered from the Interagency Resource Ordering Capability system (IROC), which tracks aircraft, crews, equipment, overhead, and supplies mobilized nationally. Statistics presented in this report are resources requested by any of the ten Geographic Area Coordination Centers (GACCs) and processed through NICC, apart from Incident Management Teams and Temporary Flight Restrictions[2]. Requests by FEMA are placed to NICC through Emergency Support Function (ESF) #4 (Firefighting). The resource ordering process and procedures may be found in the National Mobilization Guide. The National Mobilization Guide can be found on the NICC web site (https://www.nifc.gov/nicc/) under reference materials.

Geographic Area Coordination Centers



[1] Situation Report and ICS-209 data are considered situational and provisional, as they are reported while wildfire activity and incidents are occurring, plus they do not account for all wildland fires and their final outcomes. Some wildfires, including many that are suppressed solely by private citizens or local fire departments (not by wildland fire management agencies), are never reported to any Dispatch Center that submits Situation Report data. Additionally, ICS-209 reports are not required for the small, short duration wildfires that comprise the vast majority of overall fire occurrence annually. For official data and summary statistics, one must contact each of the individual agencies affected and refer to their final fire reports and other authoritative sources of agency-specific information.

[2] This report only tallies resource requests processed through NICC, with the exceptions of Incident Management Team mobilizations and Temporary Flight Restrictions that are captured nationally. It excludes the substantial number of IROC orders that were placed and filled within the same GACC. It also excludes any resource usage not tracked in IROC, such as local dispatch of initial attack resources.

2022 Fire Environment Summary

January – March
Well below normal precipitation was observed across much of the western United States (US), into the Plains in January through March, except for small areas of above normal precipitation along the Front Range and in eastern Colorado. According to the National Centers for Environmental Information (NCEI), California recorded its driest January through March period on record, while Reno, Nevada observed no precipitation in January for the first time in recorded history. Temperatures averaged above normal across much of the West during the first quarter of 2022 as well, except for areas of near normal temperatures in the greater Four Corners region. Temperatures averaged below normal for the quarter from the Plains to the Mississippi Valley January through March, with the coldest period in February when numerous Arctic outbreaks occurred across the northern Plains, Minnesota, and northern Great Lakes. After a cold start to the year in January from the Appalachians to the East Coast, February and March warmed to above normal. US precipitation east of the Mississippi River was near to above normal except for areas near the Gulf Coast, Southeast coast, and Florida Peninsula where precipitation was below normal. Alaska observed above normal temperatures and precipitation to begin the year, with an abundant snowpack developing across the Interior.

By the end of March, snow water equivalent (SWE) across much of the West was below normal, with SWE across several basins of southwest California and Oregon less than 50% of average according to data from the National Resources Conservation Service (NRCS). However, SWE across Interior Alaska was nearly 200% of normal, with the remainder of Alaska above normal as well. Most areas in the Southwest and Colorado Rockies had near average SWE and snowpack in the higher elevations, but mid to lower elevation SWE was well below normal. Drought expanded and intensified across the West and Plains in early 2022 due to the observed well below normal precipitation, with areas of exceptional drought observed across portions of central Oregon, southern Nevada, eastern New Mexico, western Oklahoma, and Texas.

Large fire activity was minimal in the West in January, with isolated large fire activity in the Southern Area and on portions of the northern and southern High Plains. Fire activity began to increase across California, the Southwest, Rocky Mountain, and Southern Geographic Areas in February. Wind-driven large fires became more frequent toward the end of February from eastern New Mexico into Kansas, Oklahoma, and Texas, with periodic large fires observed along the Gulf Coast as well. A strong north wind event across the Mojave and Sonoran Deserts February 16 resulted in the Airport Fire near Bishop, California.

Large fire activity increased across the US in March, especially in Southern, Rocky Mountain, and Southwest Geographic Areas. Dry and windy conditions led to frequent short duration wind-driven large fires across these areas through March. Windy conditions became more frequent across the Southwest and southern and central Plains at the end of the month as the storm track shifted southward, with numerous large fires observed during an exceptionally windy day on March 29.

April – June
Fire activity increased markedly in the Southwest into the southern and central Plains April into May, while fire activity gradually increased in California, the Great Basin, Eastern, and Rocky Mountain Areas. Except for the southern Plains, which remained active, the remainder of the Southern Area peaked in activity in early April, followed by a decrease in fire activity due to timely

precipitation events. Frequent windy and dry conditions occurred across the Southwest into the southern Plains, with the most intense critical fire weather conditions of the spring observed on April 22 resulting in numerous significant fires across New Mexico, Colorado, Nebraska, Kansas, Oklahoma, and Texas. Much above normal temperatures and very dry conditions resulted in several days of extreme fire behavior on significant fires in New Mexico as well. Numerous long-duration significant fires were burning across New Mexico by the end of May, including the Black and Hermits Peak Fires.

Much of the Southwest, Great Basin, and southern and central Plains received below normal precipitation in April and May. No precipitation was recorded in portions of the Southwest and west Texas in April, with much of the Mojave and Sonoran Deserts receiving no rainfall during May. A pattern change brought much wetter conditions to the northwestern US in April and May, with precipitation near normal for large swaths of the eastern US. Temperatures were cooler than average across the northwestern US for the two months, but above normal across the southern tier of the US from California to the Gulf Coast.

As a result of the pattern change across the West, snowpack changed little through April before slowly melting off across the Northwest and northern Rockies in May. However, snowpack melted very rapidly in the Southwest, southern Great Basin, and southern Colorado, with very low to zero SWE by the end of April. A slower melt occurred across California, but little snow remained there by mid-May as well. Alaska's snowpack melted during April with the remaining snowpack melting by mid-May as above normal temperatures were observed throughout the state. Overall, drought intensified across the Plains, California, Arizona, and New Mexico due to the persistent extremely dry conditions in April and May.

Well above normal temperatures continued across Alaska in June along with periodic episodes of lightning, first across southwest Alaska, then across much of the Interior and Brooks Range. As a result, fire activity increased rapidly across Alaska during June, with dozens of significant fires burning across the state by the end of the month. Air quality was extremely poor across portions of Alaska, especially across the Interior where visibility was reduced to less than a mile for days.

In the Southwest, fire activity continued through mid-June before a rapid and robust onset of the North American Monsoon occurred. Fire activity rapidly waned the latter half of June as much above normal precipitation was observed across the Southwest, southern Colorado, southern Utah, and portions of southeast California. Much of the southern and central Plains remained dry with occasional significant fire activity. However, wind events were less frequent and not as strong as in April and May.

Fire activity increased very gradually across the remainder of the West as above normal precipitation and cooler than normal temperatures persisted into June. A late season atmospheric river event affected the Northwest into the northern Rockies June 10-13. Coupled with rapid snow melt, record flooding was observed along with catastrophic damage to Yellowstone National Park and portions of south-central Montana. With the above normal precipitation across the Northwest and northern Great Basin during the spring, grass growth was above normal across the lower elevations, but remained green through much of June. While drought continued over nearly 80% of the West by the end of June, improvement occurred across much of the Northwest and northern Rockies.

Precipitation across much of the eastern US was below normal from the Plains to the East Coast during June. Rapid onset drought occurred across portions of southern New England and New Jersey during the month, with periods of abnormally dry and windy conditions. Fire activity increased through the end of the month in this portion of the Eastern Area, with two significant fires in New Jersey, including the Mullica River Fire.

July – September

Fire activity began to wane in Alaska during the last half of July as consistent cooler and wetter conditions spread across the state. However, fire activity continued and increased across Texas, Oklahoma, and Arkansas. Significant fire activity was slow to increase across the West, but large fire activity did start during late July in central Idaho along with a couple large wildfires near Yosemite National Park. Additionally, very hot and dry conditions preceding mixed wet and dry thunderstorms led to an increase of significant fire activity in far northern California, central Idaho, central Oregon, and Montana the last week of July.

Significant fire activity emerged across Texas, Oklahoma, and into Arkansas from July through mid-August as drought rapidly intensified and expanded across Oklahoma, Arkansas, the Ozarks, portions of Texas, and into the Lower Mississippi Valley due to very hot and dry conditions. However, heavy rainfall during the second half of August led to a rapid decrease in fire activity. Additionally, flash drought developed in New England during August, but above normal rainfall in September reduced drought and fire potential.

The North American Monsoon was robust across the Southwest, much of the greater Four Corners region, and periodically moved into portions of California, the northern Great Basin, northern Rockies, and Pacific Northwest. Tropical Storm Kay also provided widespread wetting rain across southern California into the Southwest and southern Great Basin. Significant fire activity continued to slowly increase across the West away from the consistent, robust monsoon into mid-August, before remaining steady through the end of the month. Large fires were active across California, Oregon, Washington, Idaho, and Montana at the end of August. The monsoon improved drought conditions in Arizona, New Mexico, Colorado, and Utah, while remaining active into late August. Drought encompassed much of the West through September, including more than 70% at the end of July.

A historically strong heatwave developed across the West, especially on the West Coast and northern Intermountain West, in early September as daily, monthly, and all-time record temperatures were observed. Hot, dry, unstable, and windy periods early in the month led to significant fire growth in California, the Northwest, Northern Rockies, and northern Great Basin. Additionally, dry thunderstorms helped ignite large fires across most of these areas. September 6 featured hot, dry, unstable, and windy conditions coincident with dry thunderstorms from northern California through the Pacific Northwest, Northern Rockies, and northern Great Basin, representing the peak of the western fire season. Strong offshore winds also affected the Cascades late in the second week of September, which fueled fire growth. Precipitation events reduced fire activity mid to late September across these areas, although fire activity did continue in portions of the Pacific Northwest, Idaho, and western Montana during elevated and critical fire weather.

Devastating and deadly flooding transpired in eastern Kentucky during late July, claiming the lives of more than 40 people. Hurricane Ian also made landfall near Fort Myers, FL on September 28 as a category four hurricane, with 144 deaths attributed to it. Heavy rain stretched from the

Florida Peninsula to along and east of the southern and central Appalachians to the southeast Atlantic coast. Away from this swath of heavy rain, fire activity increased in Southern Area.

October – December

Significant fire activity continued across the Northwest into mid-October before waning, with gradually decreasing activity from the northern Rockies through the Great Basin into California during the month. Very warm conditions continued across the West through mid-October, especially in the Pacific Northwest where an offshore wind event on October 15-16 increased fire activity in Washington. A pattern change occurred late in the month, starting with a significant precipitation event across the northwestern US October 21-22 that resulted in a significant decrease of fire activity. Occasional precipitation events continued across the Northwest through the end of the month as well.

It was much drier than normal from the Plains to the Appalachians during October, with fire activity increasing across the central and southern Plains, Mid-Mississippi and Lower Ohio Valleys, and Southeast. Significant fires ignited in Kansas, Nebraska, Iowa, and Missouri during a wind event on October 22-23. Drought expanded and intensified in much of the Southeast, Appalachians, Mississippi Valley, and Lower Ohio Valley, and by the end of October, nearly two-thirds of the CONUS was in drought.

Significant fire activity decreased across the West in November, while activity increased across portions of the Southern and Eastern Areas through mid-month before waning. Heavy rain and mountain snow the first week of November across the West effectively ended fire season there except across portions of southern California and the Southwest. However, it remained dry across much of the central and southern High Plains with occasional significant fires.

Fire activity was minimal across the US during December as consistent upper-level trough passages with precipitation limited significant fire potential. However, it remained dry across much of the central and southern High Plains into the Rio Grande Valley, with occasional elevated fire weather conditions.

Although modest reductions in drought occurred across the US in November and December, drought continues in about half of the CONUS. The most intense drought continues on portions of the southern and central Plains, which had another month of below normal precipitation, including some areas receiving none. However, most of the US had near to below normal temperatures, including record low temperatures behind a strong Arctic cold front just before Christmas.

Multiple moderate to strong atmospheric rivers brought precipitation to the West Coast and across much of the Intermountain West in December. Snowpack is near to above normal across the West at the end of the year, except for portions of the southern Rockies, and some basins have received approximately 200% of normal for snow water equivalent in and around the Sierra. Snowpack and snow cover are also near to above normal across Alaska, while Juneau, AK set a new annual precipitation record this year. A historically strong winter storm affected along and east of the Rockies across the CONUS in late December, including record low temperatures and precipitous temperature drops associated with the Arctic cold front. Blizzard conditions affected portions of the northern Plains, Great Lakes, and Northeast for multiple days. More than 60 people died in eight states, including 39 people in Erie County, NY, due to this storm.

National Fire Activity Synopsis

Nationally, there were 68,988 wildfires reported in 2022, compared to 58,985 wildfires reported in 2021. Reported wildfires consumed 7,577,183 acres nationally, compared to 7,125,643 acres in 2021.

In 2022, the reported number of wildfires nationwide was noticeably higher than the 10-year average, while acres burned nationwide varied little from the 10-year average. However, there was considerable variation among the Geographic Areas. Alaska and Southern Areas are two Geographic Areas that sometimes account for large percentages of the nation's total acres burned. These Geographic Areas saw an increase in the number of fires when compared to their average fire statistics and burned significantly more acreage. Alaska Area burned over 170% of their average acres. Southwest Area was 25% below its average number of fires while burning over 90% more acres than average. All other geographic areas were below their averages for both number of fires and acres burned.

When compared to their 10-year average fire occurrences, Alaska and Southern Areas saw a significant increase in 2022. Southern California and Northwest Areas were near their 10-year average for numbers of fires, while the six remaining Geographic Areas were noticeably lower than their 10-year averages for fire occurrences. While three geographic areas saw a substantial increase in acres burned, the total acres burned was remarkably close to the 10-year average due to well below average acres burned in all other geographic areas.

A total of 2,717 structures were reported destroyed by wildfires in 2022, including 1,261 residences, 1,294 minor structures, and 91 commercial/mixed residential structures. In 2022, California accounted for the highest number of structures lost in one state: 492 residences, 11 nonresidential commercial properties, two mixed commercial residences and 252 minor structures.

Requests for firefighting resources placed with NICC during the 2022 fire season were generally at or above the 10-year averages. Ordering for Type 1 and Type 2 Incident Management Teams were slightly below the 10-year average. Type 1 and Type 2 helicopter ordering was below the 10-year average. This rang true for airtanker orders as well. National contract caterer and shower orders were slightly below the 10-year average. Ordering was up from the 10-year average for overhead, engines and crews.

Significant Incidents Over 40,000 Acres

Name	GACC	State	Start Date	Last Report Date	Size In Acres	Cause*	Estimated Cost
Lime Complex	AK	AK	6/15	7/26	865,625	U	$12,726,992
Hermits Peak	SW	NM	4/7	10/20	341,735	H	$330,100,293
Black	SW	NM	5/13	11/10	325,136	H	$60,190,000
Paradise Complex	AK	AK	7/7	8/11	275,703	U	$2,782,896
Tatlawiksuk	AK	AK	6/5	7/22	229,439	L	$75,965
NC HPAI 2022	SA	NC	4/11	4/19	212,865	U	$484,012
Bean Complex	AK	AK	6/25	8/06	212,504	U	$11,656,365
Koktuli River	AK	AK	6/8	6/12	205,862	L	NR
Hog Butte	AK	AK	6/5	7/06	204,145	L	$628,717
Double Creek	NW	OR	8/30	10/21	171,532	L	$39,500,000
East Fork	AK	AK	6/2	7/27	166,760	L	$6,150,000
Poorman Complex	AK	AK	6/28	9/07	140,355	U	NR
Moose	GB	ID	7/17	11/10	130,205	H	$98,200,000
Cedar Creek	NW	OR	8/4	11/24	127,311	L	$133,750,000
Aghaluk Mountain	AK	AK	6/6	6/14	115,030	L	$12,726,992
Door Mountain	AK	AK	6/9	6/10	114,294	L	$500
Chitanana	AK	AK	6/19	6/23	100,246	L	$1,148,818
Dalton Highway Complex	AK	AK	7/1	8/4	91,679	U	$6,971,097
Pike Creek	AK	AK	6/8	7/29	88,108	L	$76,037
Swift River	AK	AK	6/8	6/12	85,073	L	NR
Apoon Pass	AK	AK	6/9	6/30	84,138	L	NR
Mosquito	NO	CA	9/6	10/23	76,788	H	$181,100,000
Clear	AK	AK	6/21	9/8	73,284	L	$2,363,465
Bitzshitini	AK	AK	6/19	6/23	71,266	L	$216,545
Camp Creek	AK	AK	6/27	6/27	69,006	L	$45,000
Donut	AK	AK	6/21	6/23	68,348	L	$45,000
Middle Tanana Complex	AK	AK	7/3	9/8	62,861	U	$3,434,457
North Fork	AK	AK	6/21	7/21	60,750	L	NR
McKinney	NO	CA	7/29	11/7	60,138	U	$96,580,000
Cooks Peak	SW	NM	4/17	5/31	59,359	U	$12,500,000
Lansing Creek	AK	AK	6/21	7/21	56,371	L	NR
Eastland Complex	SA	TX	3/17	4/6	54,513	U	$7
Door Creek	AK	AK	6/13	6/13	54,006	L	NR
Schilling Creek	AK	AK	6/17	7/21	53,526	L	$50,000
Titnuk Creek	AK	AK	6/9	6/11	53,291	L	NR
Borrega	SA	TX	3/30	4/4	51,566	H	NR
Fourth of July Creek	AK	AK	6/8	7/22	51,146	L	$70,912
Radio Creek	AK	AK	6/21	7/27	45,801	L	$75,000
Kiknik	AK	AK	6/9	6/11	45,734	L	$3,033
Cerro Pelado	SW	NM	4/22	7/11	45,605	H	$46,800,000

Name	GACC	State	Start Date	Last Report Date	Size In Acres	Cause*	Estimated Cost
Road 702	RM	NE	4/22	4/30	44,024	L	$1,800,000
Iowithla River	AK	AK	6/8	7/22	42,880	L	$200,852
2022 SRF Lightning Complex	NO	CA	8/5	11/1	41,600	U	$102,118,922
Stony River	AK	AK	6/6	6/12	40,419	L	$960
Willow Creek	NW	OR	6/28	7/4	40,274	H	$285,000

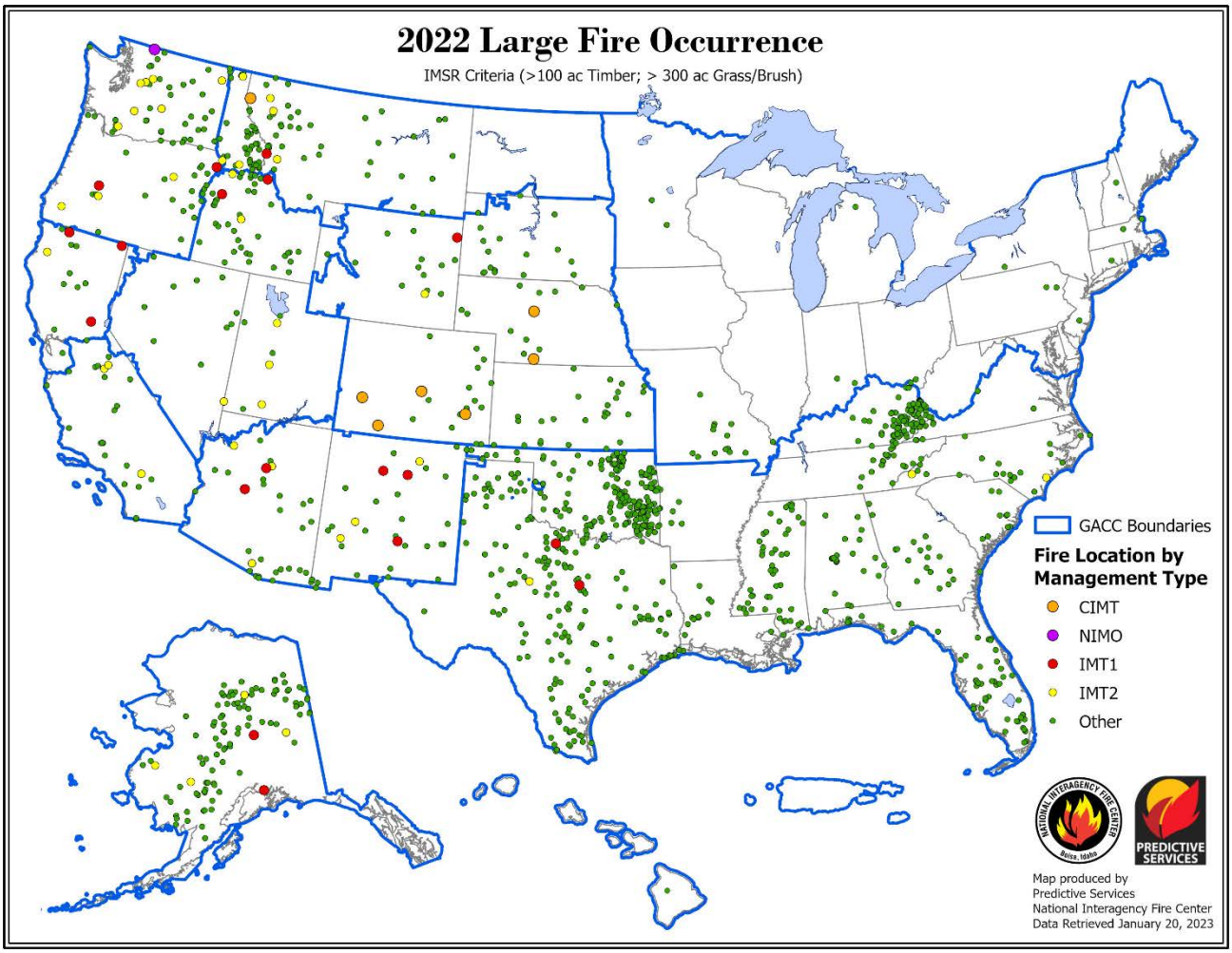
* L = Lightning H – Human U – Undetermined NR – Not Reported

Information in the above table was derived from the Sit/209 Application. This information may not reflect final official figures.

Wildfires and Acres

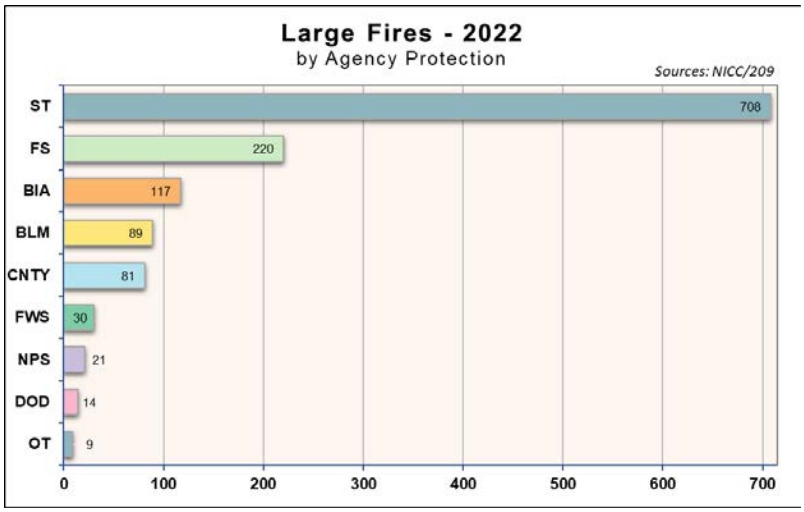
Large fires are defined in the National Mobilization Guide as fires that burn a minimum of 100 acres in timber fuel models or 300 acres in grass and brush fuel models.

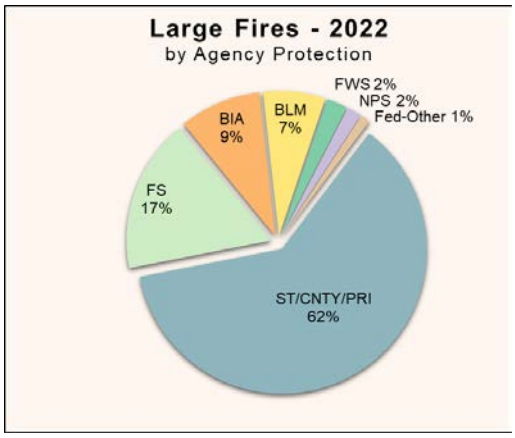
There were 1,289 large wildfires and complexes reported in 2022 through the SIT/209 application. Large wildfires represented less than 2% of total wildfires reported nationally in 2022.

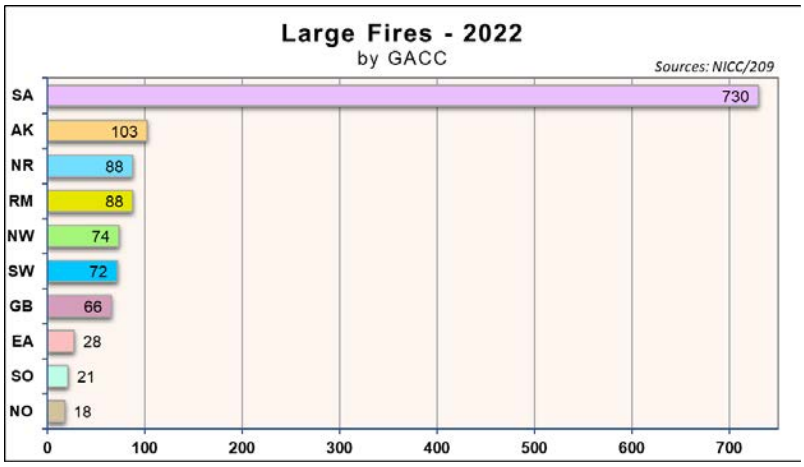


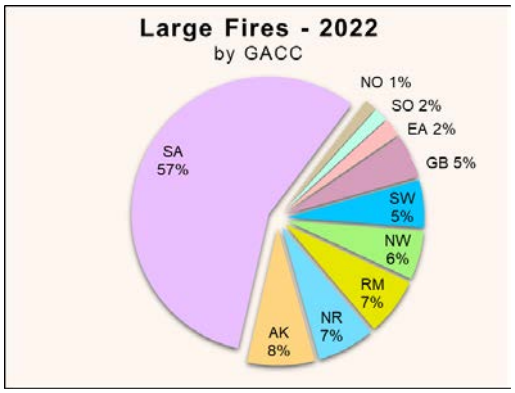
Large Wildfires by Geographic Area and Agency

In 2022, over half of the incidents that met “large fire” criteria occurred in Southern Area and on lands protected by a state-level or other non-federal fire management organization.



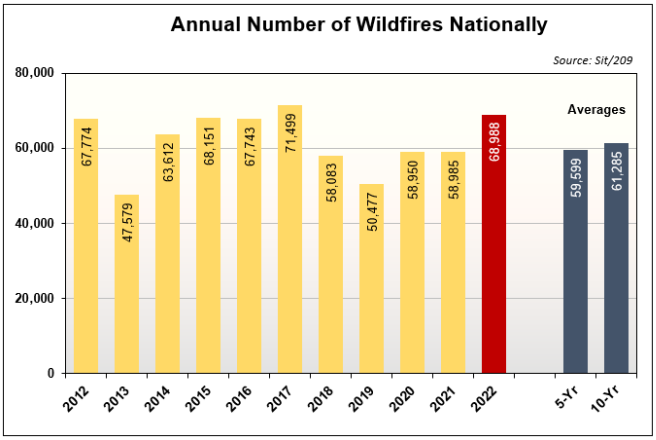


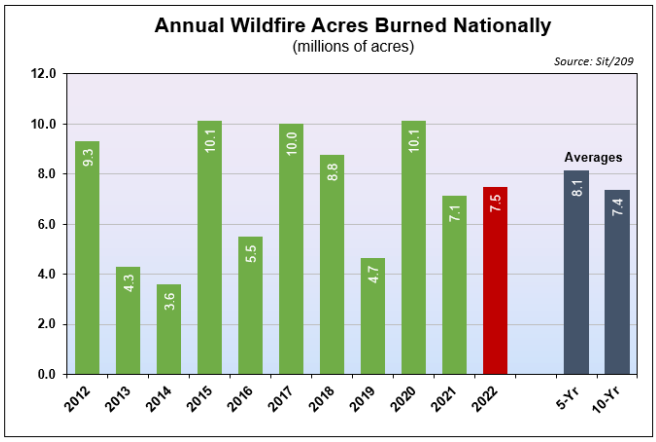




Overall Wildfire Activity Reported to NICC

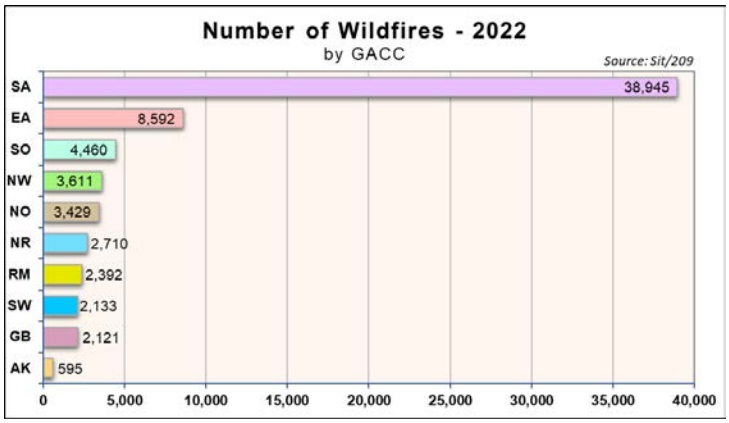
In 2022, there were 68,988 wildfires that burned 7,577,183 acres. The total number of fires were above the five and ten-year averages. The total acres burned in 2022 were similar to both the five and ten-year national averages.

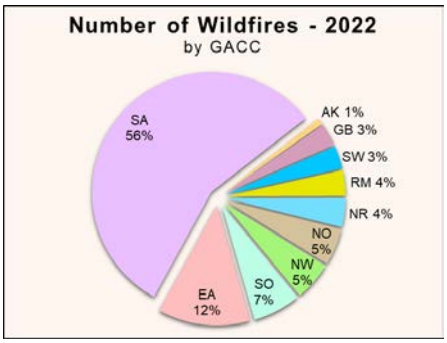


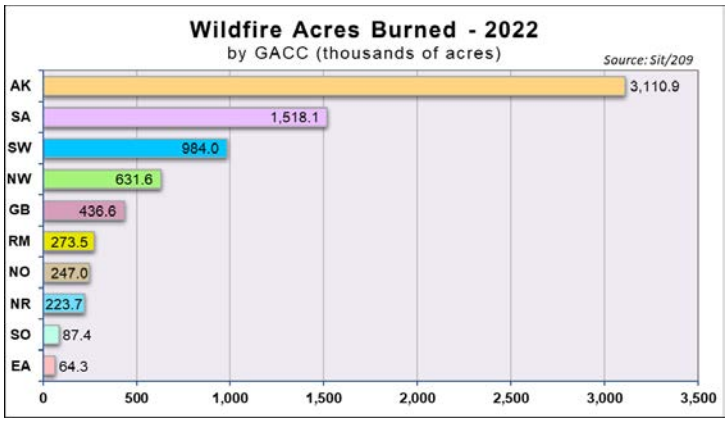


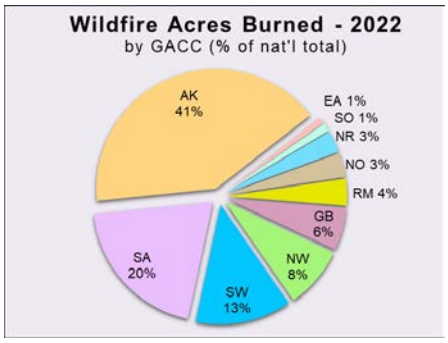
Wildfires by Geographic Area

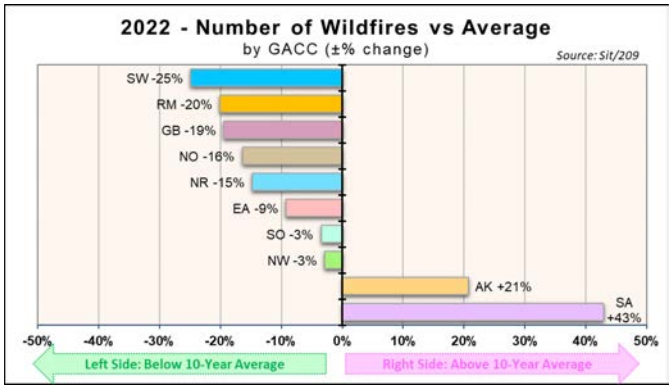
In 2022, Southern Area accounted for over half of the overall distribution of wildfires in the United States. The charts below show the 2022 fire activity for each Geographic Area.

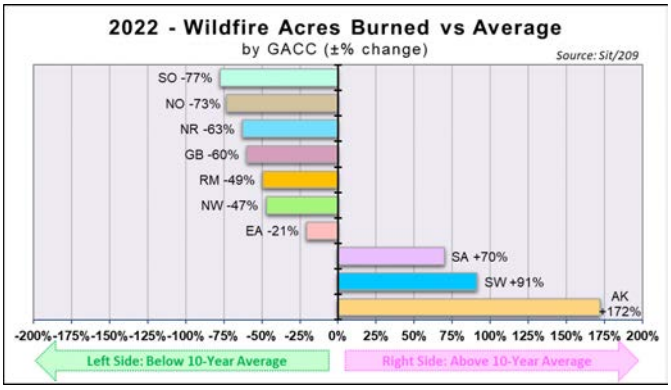






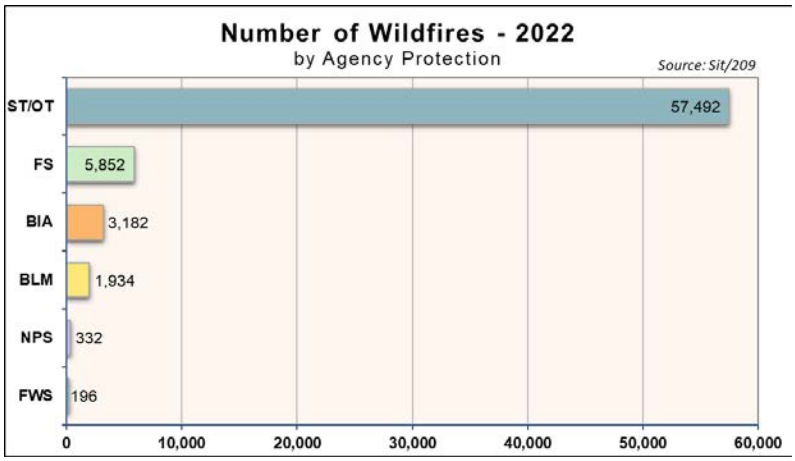


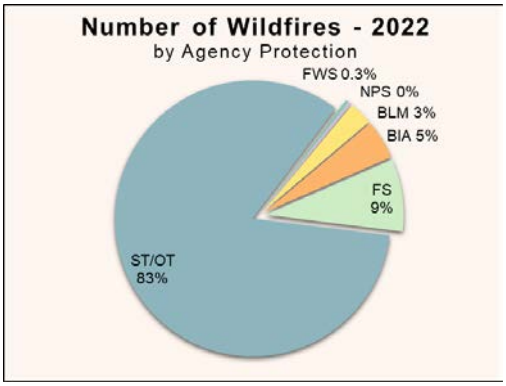


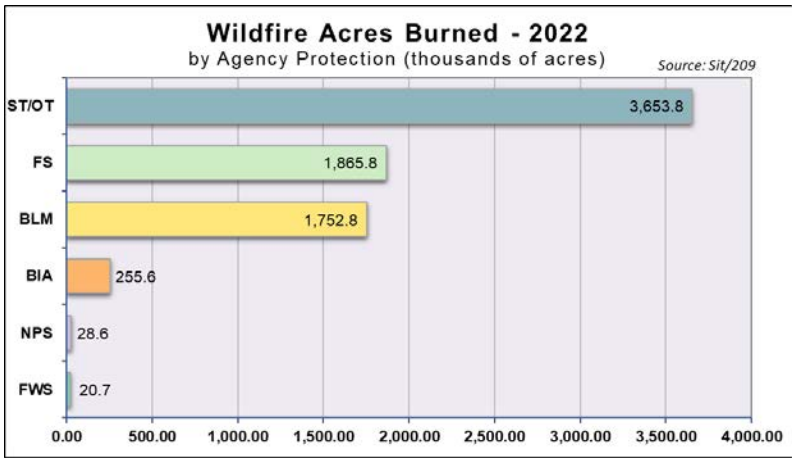


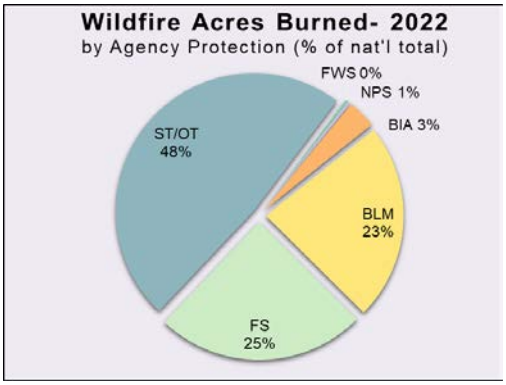
Wildfires by Agency

The distribution of wildfires by protection agency in 2022 was like prior years. About one-quarter of the nation's fires occurred on federally protected lands. Most wildfires, however, ignited on private lands or other areas under state or local protection.



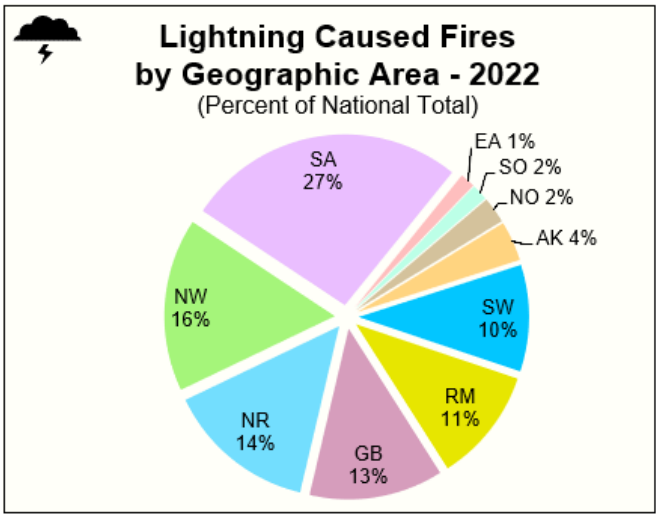


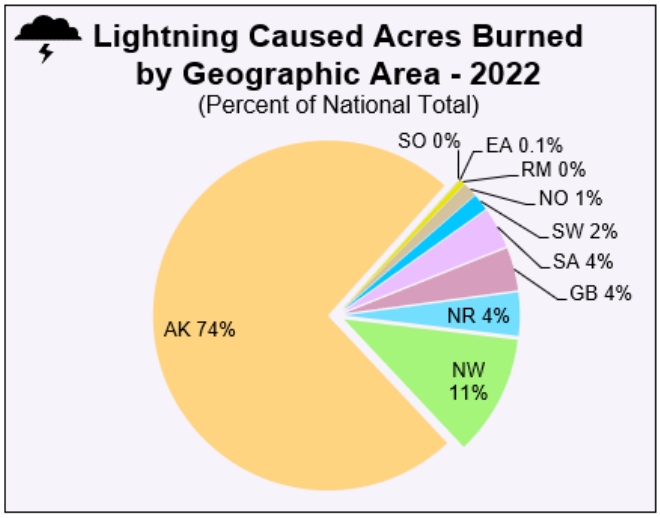




Lightning Fires and Acres by Geographic Area

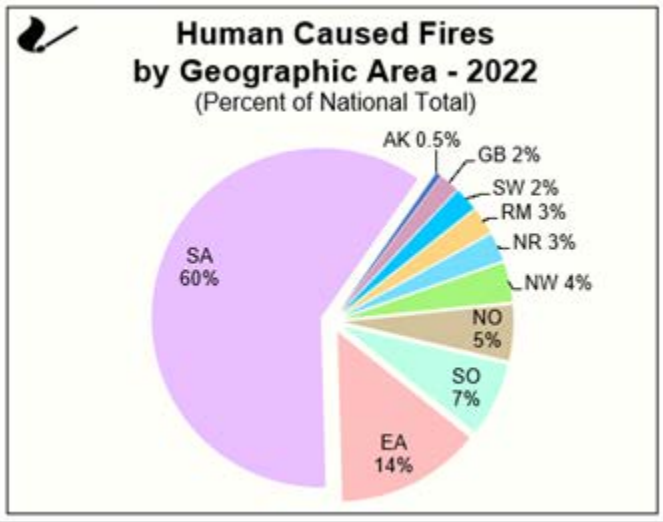
Year: 2022	AK	EA	GB	NO	NR	NW	RM	SA	SO	SW	Total
Fires	282	107	949	185	1,061	1,225	808	1,981	115	754	7,467
Acres	3,099,133	3,355	166,266	56,221	167,700	467,980	20,906	157,570	2,676	65,153	4,206,960

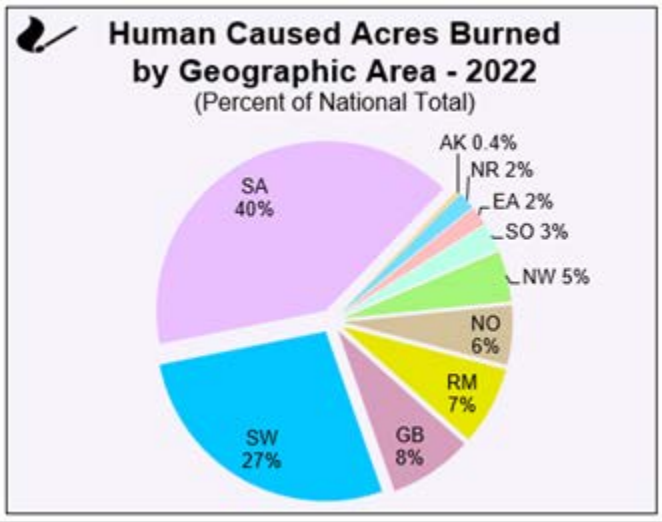




Human Caused Fires and Acres by Geographic Area

Year: 2022	AK	EA	GB	NO	NR	NW	RM	SA	SO	SW	Total
Fires	313	8,485	1,171	3,244	1,649	2,295	1,584	36,964	4,345	1,379	61,429
Acres	11,843	60,986	270,330	190,768	56,045	163,580	252,596	1,360,545	84,673	918,803	3,370,169





Wildfires and Acres Burned by Agency and GACC – 2022 & prior years

AgeOcy		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	5-Yr Avg.	10-Yr Avg.
BIA	Fires	5,753	3,239	3,377	3,886	4,056	3,843	3,472	2,830	4,740	4,646	3,182	*3,906*	*3,984*
	Acres	866,444	173,491	327,352	591,644	325,162	306,542	216,118	151,305	923,298	396,433	255,552	*398,739*	*427,779*
BLM	Fires	3,031	2,628	1,944	2,093	2,105	2,927	2,872	2,046	2,362	2,241	1,934	*2,490*	*2,425*
	Acres	3,331,273	1,012,600	871,642	4,770,133	1,183,821	2,711,267	1,905,343	2,024,554	1,131,540	412,155	1,752,793	*1,636,972*	*1,935,433*
FS	Fires	7,098	7,105	6,755	7,056	5,676	6,617	5,629	5,332	6,738	6,244	5,852	*6,112*	*6,425*
	Acres	2,680,233	1,365,644	871,876	1,916,302	1,247,906	2,866,031	2,307,439	615,816	4,814,465	4,126,564	1,865,791	*2,946,063*	*2,281,228*
FWS	Fires	394	332	348	194	174	252	162	175	238	307	196	*227*	*258*
	Acres	101,752	138,284	17,404	33,897	15,374	206,393	71,137	91,311	52,739	51,264	20,659	*94,569*	*77,956*
NPS	Fires	369	455	389	398	463	314	389	290	304	361	332	*332*	*373*
	Acres	140,807	265,755	24,949	74,780	177,901	110,349	121,092	27,533	145,447	131,182	28,615	*107,121*	*121,980*
State/ Other	Fires	51,129	33,820	50,799	54,524	55,269	57,546	45,559	39,804	44,568	45,186	57,492	*46,533*	*47,820*
	Acres	2,205,729	1,363,772	1,482,390	2,738,393	2,559,831	3,825,504	4,146,363	1,753,843	3,054,847	2,008,045	3,653,773	*2,957,720*	*2,513,872*
Totals:	**Fires**	**67,774**	**47,579**	**63,612**	**68,151**	**67,743**	**71,499**	**58,083**	**50,477**	**58,950**	**58,985**	**68,988**	***59,599***	***61,285***
	Acres	**9,326,238**	**4,319,546**	**3,595,613**	**10,125,149**	**5,509,995**	**10,026,086**	**8,767,492**	**4,664,362**	**10,122,336**	**7,125,643**	**7,577,183**	***8,141,184***	***7,358,246***

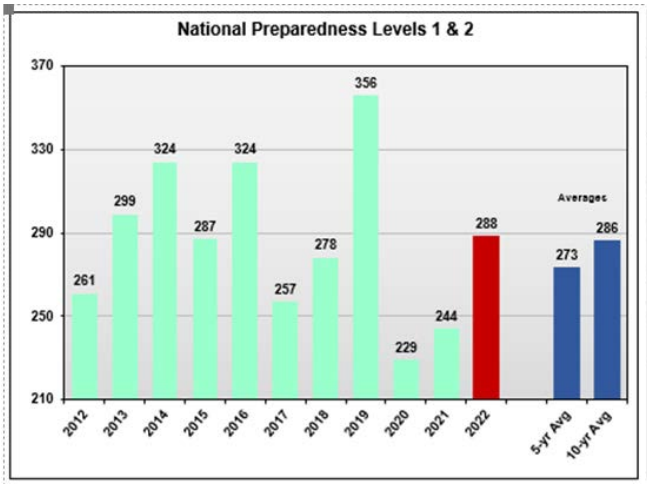
GACC		2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	5-Yr Avg.	10-Yr Avg.
AK	Fires	416	603	384	768	572	364	367	720	349	384	595	*437*	*493*
	Acres	286,887	1,316,876	233,561	5,111,404	496,467	653,023	410,683	2,498,159	181,169	253,356	3,110,976	*799,278*	*1,144,159*
EA	Fires	11,147	7,110	7,030	11,639	11,270	9,816	6,891	5,750	13,175	10,855	8,592	*9,297*	*9,468*
	Acres	146,208	64,992	54,141	100,294	98,042	41,705	50,734	38,852	63,036	152,669	64,342	*69,399*	*81,067*
GB	Fires	3,343	2,971	2,250	2,096	2,063	3,127	2,776	2,308	2,958	2,449	2,121	*2,724*	*2,634*
	Acres	2,502,018	930,795	164,802	505,483	761,622	2,103,788	2,087,922	459,384	948,812	373,165	436,598	*1,194,614*	*1,083,779*
NO	Fires	3,536	5,299	4,082	4,587	3,363	4,173	3,602	3,704	4,678	3,962	3,429	*4,024*	*4,099*
	Acres	771,486	165,194	474,826	594,048	96,706	672,448	1,496,950	214,742	2,779,003	1,945,506	246,990	*1,421,730*	*921,091*
NR	Fires	3,433	2,773	2,665	3,817	2,700	3,900	2,741	2,309	3,404	4,052	2,710	*3,281*	*3,179*
	Acres	1,497,972	179,459	143,271	745,947	202,140	1,551,275	147,093	74,042	403,046	1,069,660	223,746	*649,023*	*601,391*
NW	Fires	2,305	4,389	4,572	4,603	2,519	3,404	3,764	3,690	3,853	4,075	3,611	*3,757*	*3,717*
	Acres	1,515,596	503,993	1,383,514	1,823,473	513,226	1,121,442	1,336,096	249,476	1,983,970	1,503,026	631,605	*1,238,802*	*1,193,381*
RM	Fires	5,584	2,621	2,356	2,559	3,289	3,164	2,480	1,684	2,852	3,316	2,392	*2,699*	*2,991*
	Acres	1,244,073	237,121	78,345	180,822	686,921	754,747	748,956	114,685	1,021,951	336,187	273,503	*595,305*	*540,381*
SA	Fires	30,964	14,448	34,267	31,594	34,474	35,068	27,721	22,999	18,773	22,164	38,945	*25,345*	*27,247*
	Acres	718,624	182,650	752,694	556,267	1,591,044	1,960,764	1,591,101	498,925	556,902	532,835	1,518,116	*1,028,105*	*894,181*
SO	Fires	4,412	4,608	3,786	4,175	3,996	5,389	4,453	4,632	5,419	5,324	4,460	*5,043*	*4,619*
	Acres	99,914	412,481	80,218	304,925	479,207	595,873	348,722	55,092	1,144,214	320,378	87,350	*492,856*	*384,102*
SW	Fires	2,634	2,757	2,220	2,313	3,497	3,094	3,288	2,681	3,489	2,404	2,133	*2,991*	*2,838*
	Acres	543,460	325,985	230,241	202,486	584,620	571,021	549,235	461,005	1,040,233	638,861	983,957	*652,071*	*514,715*
Totals:	**Fires**	**67,774**	**47,579**	**63,612**	**68,151**	**67,743**	**71,499**	**58,083**	**50,477**	**58,950**	**58,985**	**68,988**	***59,599***	***61,285***
	Acres	**9,326,238**	**4,319,546**	**3,595,613**	**10,125,149**	**5,509,995**	**10,026,086**	**8,767,492**	**4,664,362**	**10,122,336**	**7,125,643**	**7,577,183**	***8,141,184***	***7,358,246***

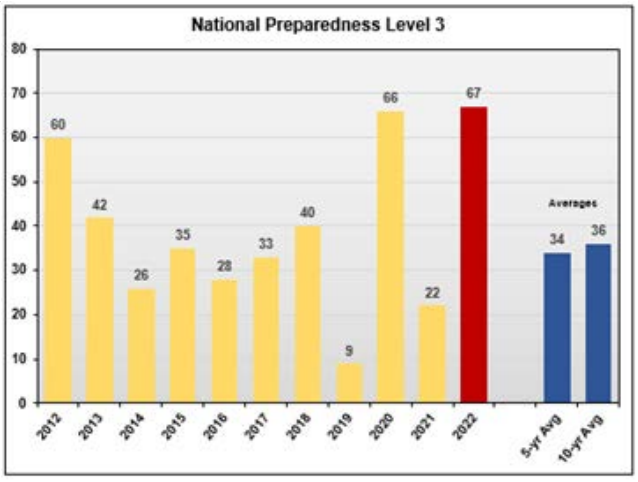
National Preparedness Levels

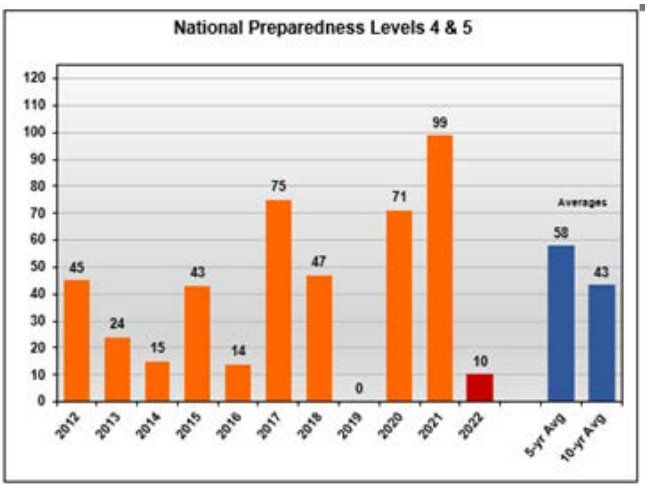
In 2022 the National Preparedness Level (PL) was elevated and decreased accordingly:

- Elevated from PL 1 to PL 2 on March 29
- Elevated from PL 2 to PL 3 on July 12
- Elevated from PL 3 to PL 4 on September 6
- Decreased from PL 4 to PL 3 on September 16
- Decreased from PL 3 to PL 2 on September 27
- Decreased from PL 2 to PL 1 on October 28

2022 - Total Number of Days at Each National Preparedness Level													
PL	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1	31	28	28	0	0	0	0	0	0	4	30	31	152
2	0	0	3	30	31	30	11	0	4	27	0	0	136
3	0	0	0	0	0	0	20	31	16	0	0	0	67
4	0	0	0	0	0	0	0	0	10	0	0	0	10
5	0	0	0	0	0	0	0	0	0	0	0	0	0
Total:	31	28	31	30	31	30	31	31	30	31	30	31	365







National Preparedness Level Summary

Total Days at National Preparedness Levels

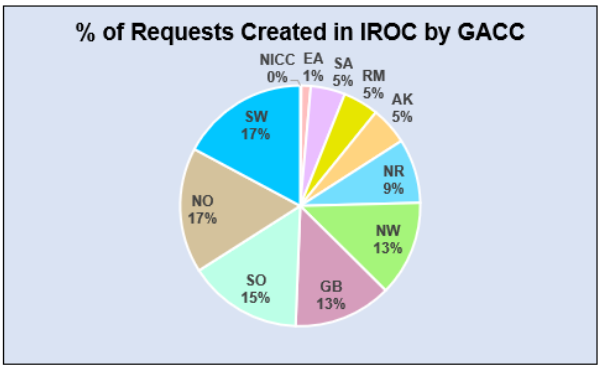
Year	PL 1	PL 2	PL 3	PL 4	PL 5	PL1&2	PL4&5
1990	247	74	31	6	7	321	13
1991	255	103	7	0	0	358	0
1992	278	67	15	6	0	345	6
1993	268	97	0	0	0	365	0
1994	235	26	54	4	46	261	50
1995	254	96	15	0	0	350	0
1996	98	179	60	8	21	277	29
1997	216	149	0	0	0	365	0
1998	157	172	30	6	0	329	6
1999	159	165	33	8	0	324	8
2000	179	73	61	13	40	252	53
2001	188	142	9	10	16	330	26
2002	187	76	14	26	62	263	88
2003	92	155	60	10	48	247	58
2004	249	57	60	0	0	306	0
2005	233	44	47	41	0	277	41
2006	118	137	44	16	50	255	66
2007	212	76	17	21	39	288	60
2008	209	84	15	36	22	293	58
2009	275	62	28	0	0	337	0
2010	231	134	0	0	0	365	0
2011	207	92	59	7	0	299	7
2012	212	49	60	45	0	261	45
2013	253	46	42	17	7	299	24
2014	242	82	26	15	0	324	15
2015	253	34	35	19	24	287	43
2016	251	73	28	14	0	324	14
2017	185	72	33	36	39	257	75
2018	191	87	40	13	34	278	47
2019	241	115	9	0	0	356	0
2020	205	24	66	26	45	229	71
2021	161	83	22	31	68	244	99
2022	152	136	67	10	0	288	10

Averages	PL1&2	PL 3	PL4&5
Total Days: 5-yr Avg	*273*	*34*	*58*
Total Days: 10-yr Avg	*286*	*36*	*43*

Requests Created Nationally in IROC

A little over 385,000 requests were created nationally in IROC. Which is significantly lower than the 600,000 requests created in 2021, and the 547,000 requests created in 2020. These statistics include requests that were filled, cancelled, or unable to fill.

	Aircraft	Crew	Equipment	Overhead	Supply	Total
AK	716	206	1,161	9,963	7,560	**19,606**
EA	85	6	269	1,953	2,565	**4,878**
GB	2,839	637	4,525	25,663	17,218	**50,882**
NICC	74	8	2	416	61	**561**
NO	6,078	2,352	17,385	28,314	10,680	**64,809**
NR	1,875	386	3,074	15,461	12,557	**33,353**
NW	3,353	884	5,318	21,597	18,175	**49,327**
RM	1,280	230	1,415	10,809	4,723	**18,457**
SA	741	80	1,711	12,423	2,889	**17,844**
SO	6,254	2,718	15,741	25,716	8,708	**59,137**
SW	2,767	1,183	5,974	32,101	24,151	**66,176**
Total	**26,062**	**8,690**	**56,575**	**184,416**	**109,287**	**385,030**



**** Disclaimer: Of the 184,416 overhead requests, 143,986 requests were subordinate requests attached to parent aircraft, overhead, crew, engine, and supply requests. Of the 385,030 requests, 4,923 requests were support requests attached to parent aircraft, overhead, crew, and engine requests.*

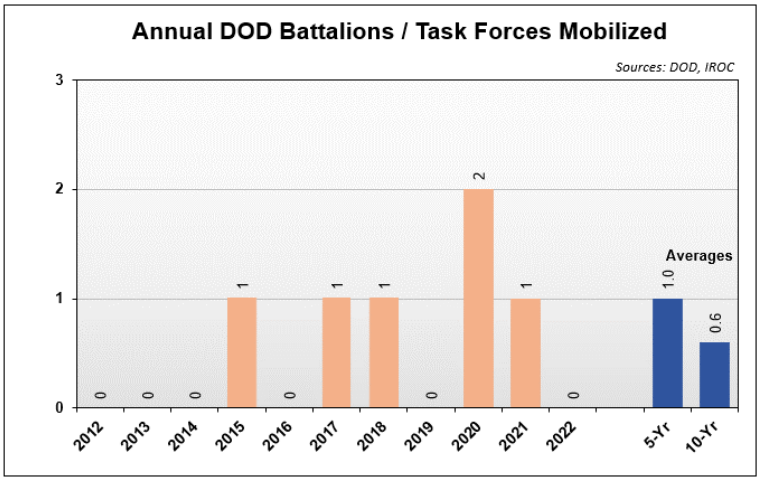
These statistics are based off an IROC report utilizing the QST1 Request Status Table. Statistics may vary amongst individual Geographic Area annual reports depending on which filters are utilized within the IROC Reports module.

Requests Processed through the NICC

The following statistics pertain to requests processed through the National Interagency Coordination Center, except for Incident Management Teams, which are captured on a national mobilization scale. They are broken down by requesting Geographic Area and Requesting Agency. Five- and ten-year averages are also provided.

Department of Defense Mobilizations

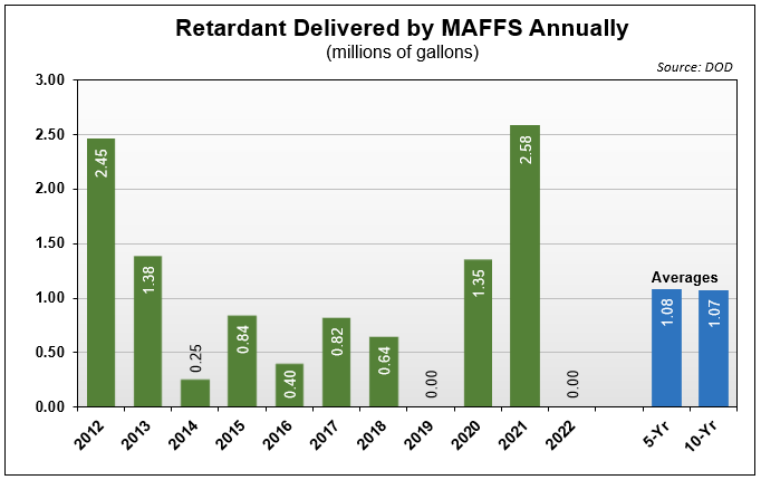
In 2022, NICC did not process any military requests. The number of military battalions and task forces requested through NICC and deployed in the last ten years is shown below.



Modular Airborne Fire Fighting Systems (MAFFS)

NICC processed three requests for MAFFS in 2022. MAFFS were activated on September 9th and released on September 16th[th]. National statistics are listed below:

- Total missions: 8
- Total employment hours: 7
- Total retardant drops: 9
- Total gallons of retardant dropped: 16,700



Distributed Real-Time Infrared (DRTI)

Two RC-26 aircraft with DRTI capability were activated on June 20th and released on September 30th. National statistics are listed below:

- Total missions: 137
- Total employment hours: 471
- Total fires reported to dispatch: 205
- Total fires mapped: 202
- Total days activated: 103

International Resource Mobilizations

International assistance to the United States: Australia sent one 737 airtanker to provide national support.

Incident Management Team Mobilizations

Starting in April 2024, the firefighting community will adopt a new Incident Management Team business model. All federal Type 1 and Type 2 Incident Management Teams will become Complex Incident Management Teams. In 2022, the Rocky Mountain Area participated in a Complex Incident Management Team pilot program with three incident management teams. Due to the lack of fire activity, they were not mobilized frequently, and those team mobilizations were folded into the following Type 1 and Type 2 Incident Management Team statistics based on the qualification of the Incident Commander. A complete picture of the Complex Incident Management Team business model can be found here: https://www.nwcg.gov/partners/iwdg

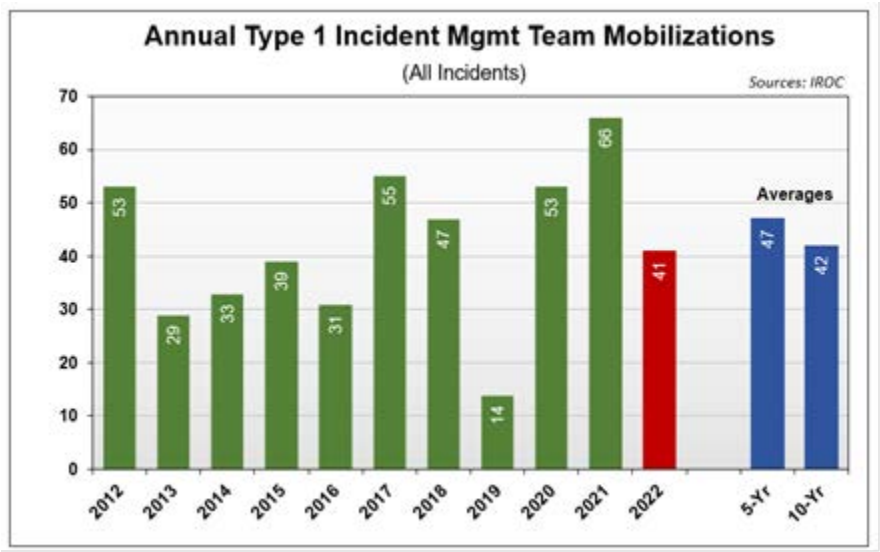
National Incident Management Organization and Area Command Teams

National Incident Management Organization (NIMO) teams were assigned to four wildfire incidents for a total of 79 days.

No Area Command Teams were assigned to incidents.

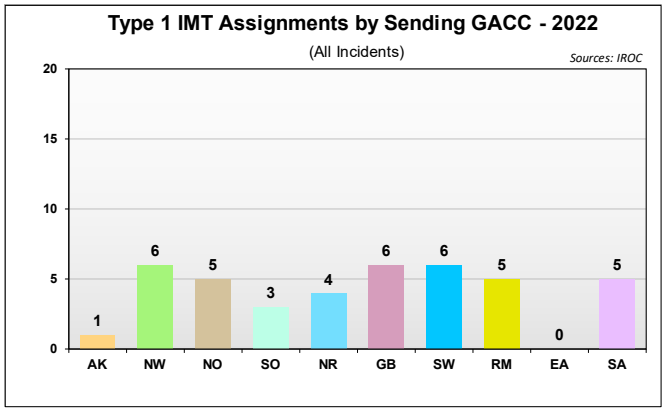
Type 1 Incident Management Teams

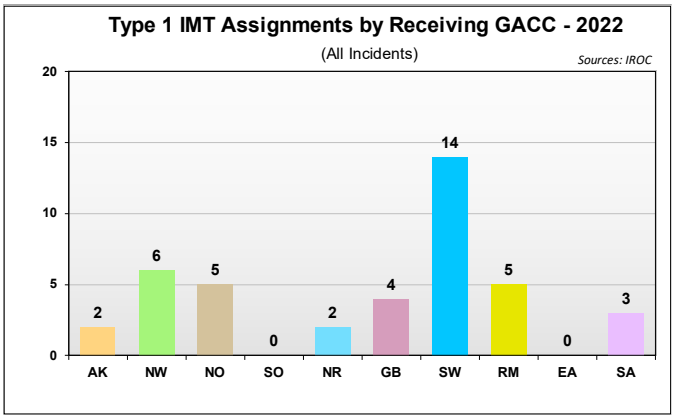
Sixteen national Type 1 Incident Management Teams (IMTs) were available in 2022 and were mobilized to 41 incidents. Of those assignments, 38 were to wildland fires and 3 were to non-wildland fire incidents. Type 1 IMTs were assigned for 556 days.



Type 1 IMT Assignments by Geographic Area

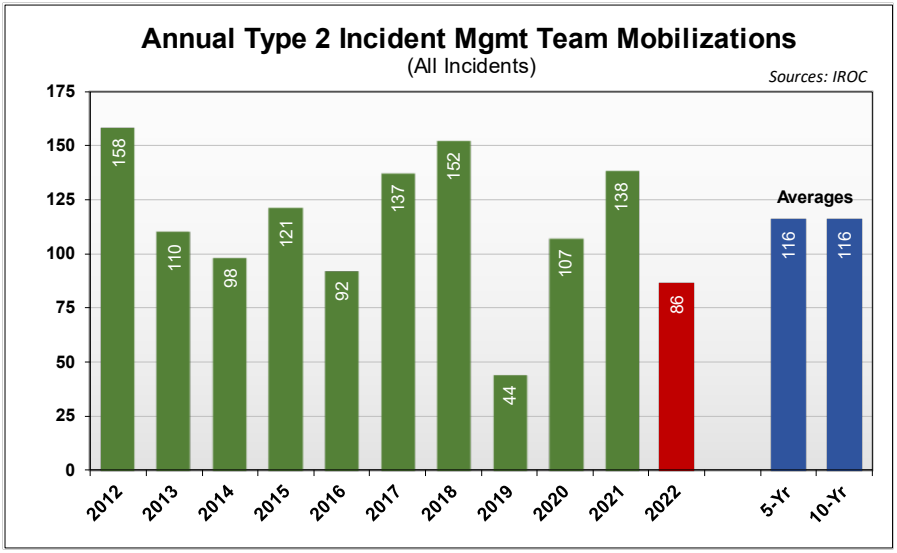
The following charts depict the mobilization of Type 1 IMTs by sending and receiving Geographic Area.





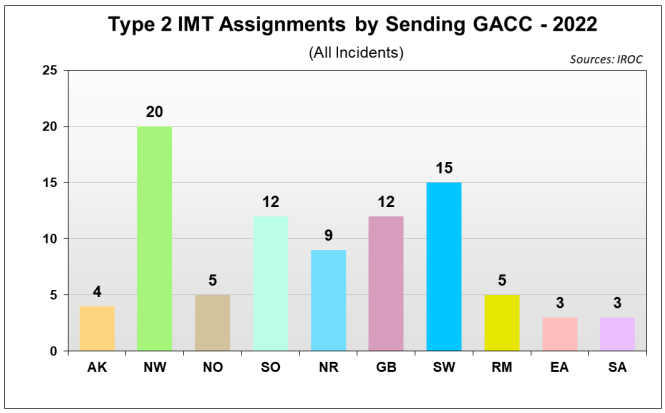
Type 2 Incident Management Teams

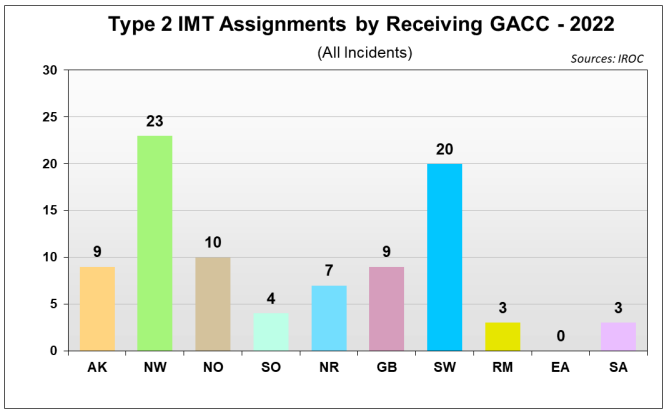
Thirty-three Type 2 Incident Management Teams (IMTs) were available in 2022. Type 2 IMTs were mobilized to 86 incidents and assigned for 1,152 days.



Type 2 IMT Assignments by Geographic Area

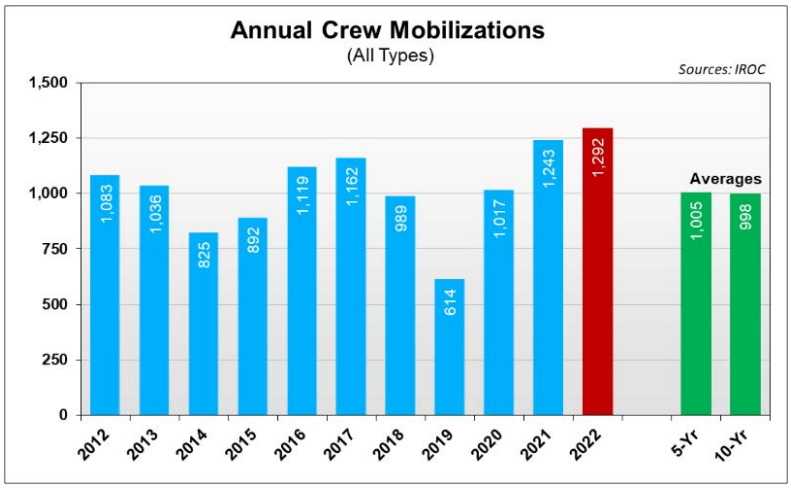
The following charts depict the mobilization of Type 2 IMTs by sending and receiving Geographic Area.

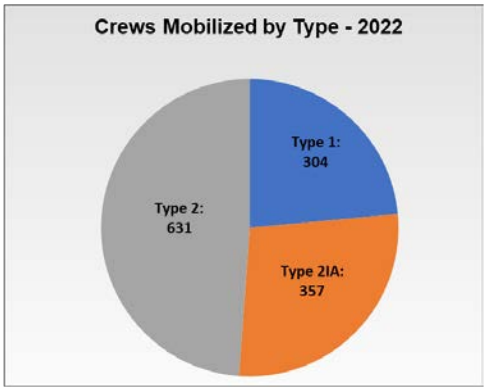




Crew Mobilizations

The NICC received 1,909 crew requests in 2022. Of those requests: 1,292 were filled, 302 were canceled and 315 were UTF. The NICC received 650 orders for Type 1 crews, 731 orders for Type 2 crews and 528 orders for Type 2 IA crews.





Crew Requests Summary by Requesting Agency and Geographic Area

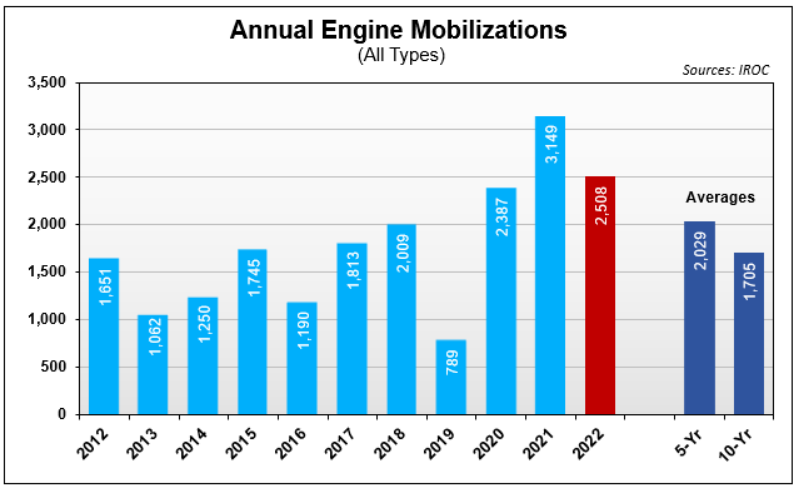
Requesting Agency	Type 1 Crew			Type 2 Crew			Type 2-IA Crew			Crew Totals			
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Total
BIA	4	2	3	4	0	0	3	4	0	11	6	3	20
BLM	35	0	0	10	9	0	19	11	0	64	20	0	84
DOD	0	0	0	0	0	0	0	0	0	0	0	0	0
FEMA	1	0	0	0	0	0	9	4	0	10	4	0	14
FS	242	83	234	546	73	7	287	68	64	1,075	224	305	1,604
FWS	0	0	0	0	0	0	0	2	0	0	2	0	2
NPS	2	3	0	5	0	0	5	2	0	12	5	0	17
ST	20	18	3	66	10	1	34	13	3	120	41	7	168
Other	0	0	0	0	0	0	0	0	0	0	0	0	0
Canada	0	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal:	*304*	*106*	*240*	*631*	*92*	*8*	*357*	*104*	*67*	*1,292*	*302*	*315*	
Total:		**650**			**731**			**528**			**1,909**		

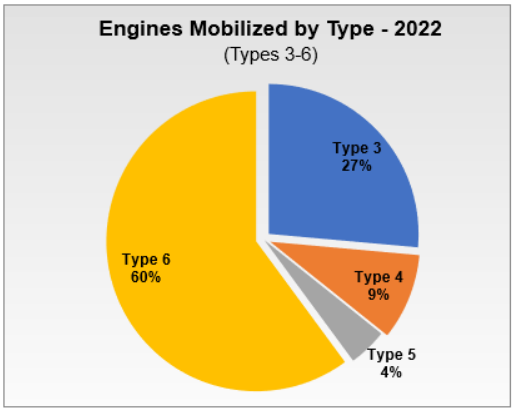
Requesting GACC	Type 1 Crew			Type 2 Crew			Type 2-IA Crew			Crew Totals			
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Total
AK	27	0	0	0	0	0	18	5	0	45	5	0	50
EA	1	0	1	0	0	0	1	2	0	2	2	1	5
GB	56	10	28	54	4	0	48	10	7	158	24	35	217
NICC	6	1	0	0	0	0	2	0	0	8	1	0	9
NO	43	40	162	134	64	6	45	19	16	222	123	184	529
NR	17	4	7	39	1	1	23	10	5	79	15	13	107
NW	33	8	24	144	16	1	40	20	23	217	44	48	309
RM	15	11	5	15	1	0	32	7	2	62	19	7	88
SA	10	4	1	0	0	0	23	4	1	33	8	2	43
SO	8	20	5	36	3	0	12	16	0	56	39	5	100
SW	88	8	7	209	3	0	113	11	13	410	22	20	452
Other	0	0	0	0	0	0	0	0	0	0	0	0	0
Canada	0	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal:	*304*	*106*	*240*	*631*	*92*	*8*	*357*	*104*	*67*	*1,292*	*302*	*315*	
Total:		**650**			**731**			**528**			**1,909**		

Engine and Tactical Water Tender Mobilizations

The NICC received 2,951 engine requests in 2022. Of those requests: 2,412 were filled, 233 were canceled and 306 were UTF.

The NICC also received 166 requests for tactical water tenders. Of those requests: 96 were filled, 19 were canceled and 51 were UTF.





Engine and Tactical Water Tender Requests Summary by Requesting Agency

Requesting Agency	Type 1 Engine			Type 2 Engine			Type 3 Engine			Type 4 Engine			Type 5 Engine		
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF
BIA	8	0	0	0	0	0	7	1	1	2	0	0	1	0	0
BLM	0	0	0	0	0	0	14	6	9	23	2	2	0	0	0
DOD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FEMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FS	0	0	0	0	0	0	527	74	162	177	14	8	70	3	0
FWS	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0
NPS	0	0	0	0	0	0	3	2	3	3	0	0	1	0	0
ST	0	1	0	0	0	0	81	8	9	16	1	0	28	0	0
Other	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
Subtotal:	*8*	*1*	*0*	*0*	*0*	*0*	*634*	*91*	*184*	*223*	*17*	*10*	*100*	*3*	*0*
Total:	**9**			**0**			**909**			**250**			**103**		

Requesting Agency	Type 6 Engine			Type 7 Engine			Tactical Water Tender			Engine/TWT Totals			
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	*Total*
BIA	127	25	10	5	0	0	4	0	0	154	26	11	***191***
BLM	46	0	0	0	0	0	0	0	0	83	8	11	***102***
DOD	0	0	0	0	0	0	0	0	0	0	0	0	***0***
FEMA	0	0	0	0	0	0	0	0	0	0	0	0	***0***
FS	1,001	84	69	0	0	0	80	19	49	1,855	194	288	***2,337***
FWS	4	0	0	0	0	0	0	0	0	6	0	0	***6***
NPS	30	7	4	0	0	0	0	0	0	37	9	7	***53***
ST	227	2	27	0	0	0	12	.0	2	364	12	38	***414***
Other	7	3	2	0	0	0	0	0	0	9	3	2	***14***
Subtotal:	*1,442*	*121*	*112*	*5*	*0*	*0*	*96*	*19*	*51*	2,508	252	357	
Total:	**1,675**			**5**			**166**			**3,117**			

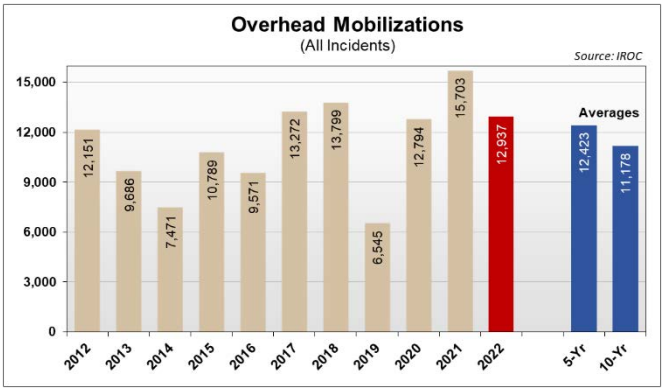
Engine and Tactical Water Tender Requests Summary by Requesting Geographic Area

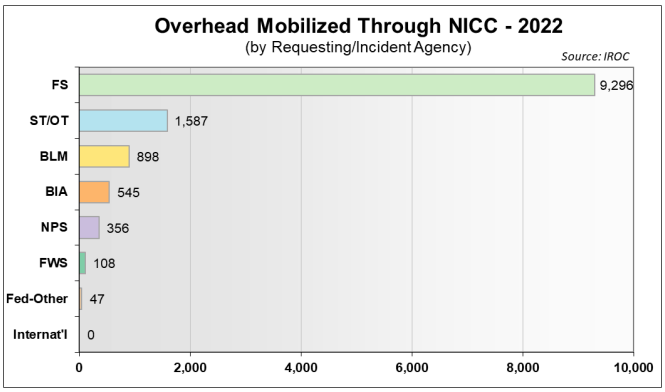
Requesting GACC	Type 1 Engine			Type 2 Engine			Type 3 Engine			Type 4 Engine			Type 5 Engine		
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF
AK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EA	0	0	0	0	0	0	4	2	4	3	0	0	0	0	0
GB	0	0	0	0	0	0	29	7	2	17	1	4	1	1	0
NICC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NO	0	0	0	0	0	0	182	18	96	62	0	3	45	0	0
NR	0	0	0	0	0	0	20	8	10	9	0	0	4	2	0
NW	0	0	0	0	0	0	24	5	9	16	4	0	2	0	0
RM	0	0	0	0	0	0	25	6	6	11	2	2	8	0	0
SA	0	0	0	0	0	0	72	2	6	11	2	0	8	0	0
SO	0	0	0	0	0	0	59	13	40	21	0	0	7	0	0
SW	8	1	0	0	0	0	219	30	11	73	8	1	25	0	0
Subtotal:	*8*	*1*	*0*	*0*	*0*	*0*	*634*	*91*	*184*	*223*	*17*	*10*	*100*	*3*	*0*
Total:	**9**			**0**			**909**			**250**			**103**		

Requesting GACC	Type 6 Engine			Type 7 Engine			Tactical Water Tender			Engine/TWT Totals			
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	*Total*
AK	0	0	0	0	0	0	0	0	0	0	0	0	***0***
EA	36	10	12	1	0	0	0	0	0	44	12	16	***72***
GB	66	2	7	0	0	0	2	0	0	115	11	13	***139***
NICC	0	0	0	0	0	0	0	0	0	0	0	0	***0***
NO	261	5	1	0	0	0	24	0	9	574	23	109	***706***
NR	118	11	5	1	0	0	4	0	0	156	21	15	***192***
NW	82	7	10	0	0	0	8	0	0	132	16	19	***167***
RM	66	18	8	0	0	0	3	0	2	113	26	18	***157***
SA	318	32	45	3	0	0	2	0	0	414	36	51	***501***
SO	99	0	4	0	0	0	1	0	2	187	13	46	***246***
SW	396	36	20	0	0	0	52	19	38	773	94	70	***937***
Subtotal:	*1,442*	*121*	*112*	*5*	*0*	*0*	*96*	*19*	*51*	2,508	252	357	
Total:	**1,675**			**5**			**166**			**3,117**			

Overhead Mobilizations

The NICC received 22,138 overhead requests in 2022. Of those requests: 12,937 were filled, 3,231 were canceled, and 5,970 were UTF.





Overhead Requests Summary

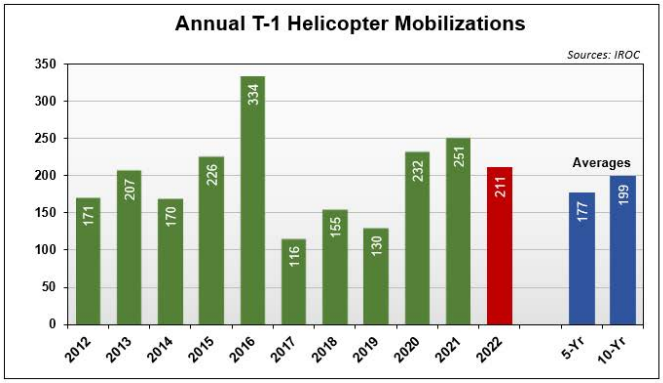
Requesting Agency	Individual Overhead			
	Fill	Cancel	UTF	Total
BIA	545	95	70	710
BLM	898	183	218	1,299
DOD	16	6	2	24
FEMA	31	13	4	48
FS	9,396	2,363	4,851	16,610
FWS	108	9	0	117
NPS	356	105	77	538
ST	1,564	448	744	2,756
Other	23	9	4	36
Canada	0	0	0	0
Australia	0	0	0	0
Subtotal:	12,937	3,231	5,970	
Total:	22,138			

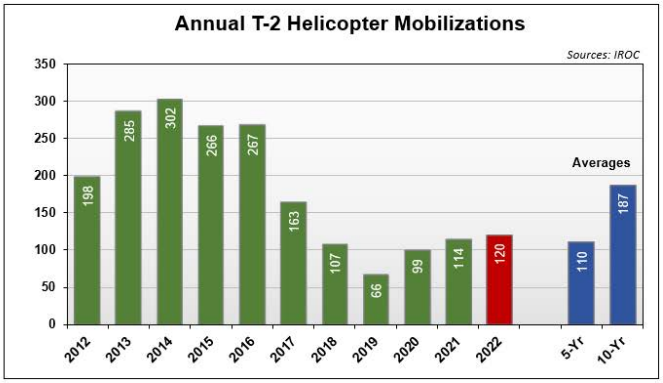
Requesting GACC	Individual Overhead			
	Fill	Cancel	UTF	Total
AK	1,201	126	312	1,639
EA	305	33	31	369
GB	1,187	301	534	2,022
NICC	253	25	7	285
NO	1,143	411	1,005	2,559
NR	876	270	388	1,534
NW	2,035	620	1,117	3,772
RM	633	204	262	1,099
SA	1,493	201	279	1,973
SO	359	200	226	785
SW	3,452	840	1,809	6,101
Other	0	0	0	0
Canada	0	0	0	0
Australia	0	0	0	0
Subtotal:	12,937	3,231	5,970	
Total:	22,138			

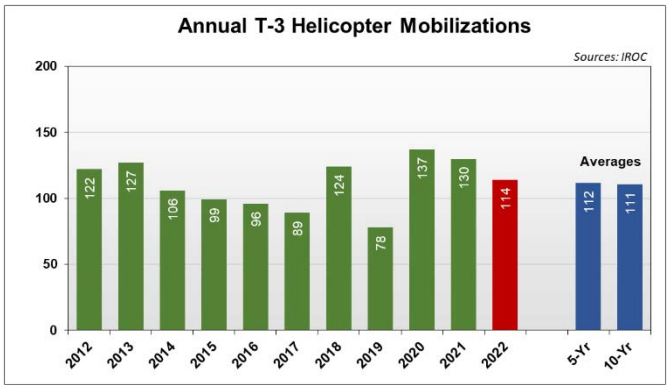
Helicopter Mobilizations

NICC received 677 orders for Type 1, 2, and 3 helicopters in 2022. Of those requests: 445 were filled, 87 were canceled and 145 were UTF. Individual statistics are listed below:

- Type 1 Helicopter requests: NICC received 288 requests - 211 were filled, 32 were canceled, and 45 were UTF.
- Type 2 Helicopter requests: NICC received 209 requests - 120 were filled, 30 were canceled, and 59 were UTF.
- Type 3 Helicopter requests: NICC received 180 requests - 114 were filled, 25 were canceled, and 41 were UTF.







Helicopter Requests Summary by Requesting Agency

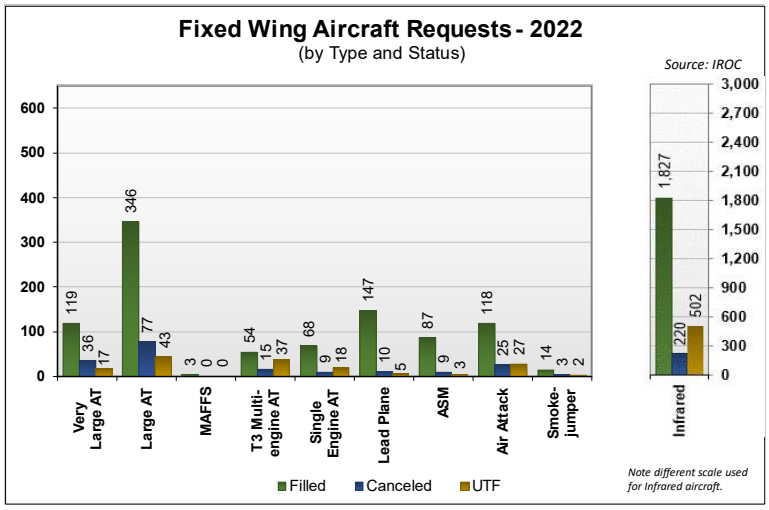
Requesting Agency	Type 1				Type 2								Type 3				Helicopter Totals				
					Standard Use				Limited Use												
	Fill		Cancel	UTF	Fill		Cancel	UTF	Fill		Cancel	UTF	Fill		Cancel	UTF	Fill		Cancel	UTF	Total
	CWN	EXCL			CWN	EXCL			CWN	EXCL			CWN	EXCL			CWN	EXCL			
BIA	4	0	0	3	0	1	0	0	0	0	0	0	0	9	2	1	4	10	2	4	**20**
BLM	3	0	2	0	0	15	1	4	0	0	0	0	3	13	2	4	6	28	5	8	**47**
DOD	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
FEMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
FS	192	0	29	39	9	57	24	46	21	2	1	3	27	52	15	29	249	111	69	117	**546**
FWS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
NPS	2	0	0	0	0	2	0	3	0	0	0	0	2	2	0	3	4	4	0	6	**14**
ST	9	0	0	3	3	8	3	3	2	0	1	0	3	3	6	4	17	11	10	10	**48**
Other	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	**2**
Canada	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Subtotal:	*211*	*0*	*32*	*45*	*12*	*83*	*28*	*56*	*23*	*2*	*2*	*3*	*35*	*79*	*25*	*41*	*281*	*164*	*87*	*145*	
	211				*95*				*25*				*114*				*445*				
Total:	**288**				**179**				**30**				**180**				**677**				

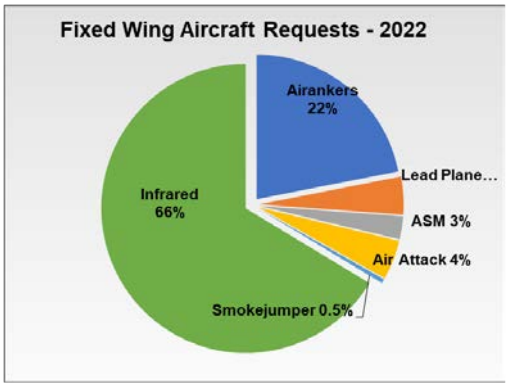
Helicopter Requests Summary by Requesting Geographic Area

Requesting GACC	Type 1				Type 2								Type 3				Helicopter Totals				
					Standard Use				Limited Use												
	Fill		Cancel	UTF	Fill		Cancel	UTF	Fill		Cancel	UTF	Fill		Cancel	UTF	Fill		Cancel	UTF	Total
	CWN	EXCL			CWN	EXCL			CWN	EXCL			CWN	EXCL			CWN	EXCL			
AK	0	0	0	0	2	9	0	4	0	0	0	0	1	9	2	1	3	18	2	5	**28**
EA	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	**1**
GB	39	0	6	2	3	17	4	10	3	1	2	0	7	15	4	7	52	33	16	19	**120**
NICC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
NO	16	0	7	8	3	11	8	16	0	0	0	0	5	10	2	4	24	21	17	28	**90**
NR	20	0	3	9	0	9	4	11	11	1	0	1	4	3	5	4	35	13	12	25	**85**
NW	46	0	4	17	0	7	4	7	4	0	0	0	7	14	5	18	57	21	13	42	**133**
RM	10	0	0	1	0	2	1	2	1	0	0	1	1	5	1	0	12	7	2	4	**25**
SA	11	0	1	0	2	1	0	0	0	0	0	0	1	4	0	0	14	5	1	0	**20**
SO	32	0	7	6	2	12	2	4	1	0	0	1	4	4	2	0	39	16	11	11	**77**
SW	37	0	4	2	0	15	5	2	3	0	0	0	4	15	4	7	44	30	13	11	**98**
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Canada	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Subtotal:	*211*	*0*	*32*	*45*	*12*	*83*	*28*	*56*	*23*	*2*	*2*	*3*	*35*	*79*	*25*	*41*	*281*	*164*	*87*	*145*	
	211				*95*				*25*				*114*				*445*				
Total:	**288**				**179**				**30**				**180**				**677**				

Fixed Wing Aircraft Mobilizations

Fixed wing aircraft include heavy airtankers, multi-engine airtankers (CL-215/415), single-engine airtankers (SEATs), lead planes, aerial supervision modules (ASM), air attack, infrared, and smokejumper aircraft. NICC received 3,841 requests for fixed wing aircraft in 2022. Of those requests: 2,783 were filled, 404 were canceled, and 654 were UTF.

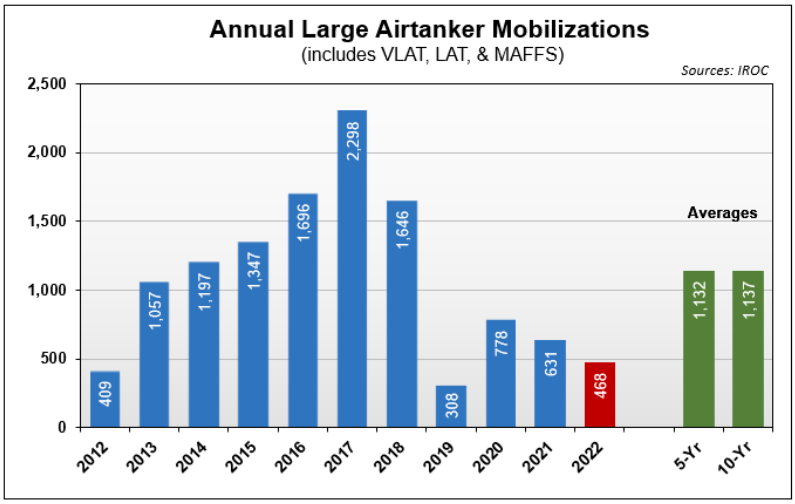


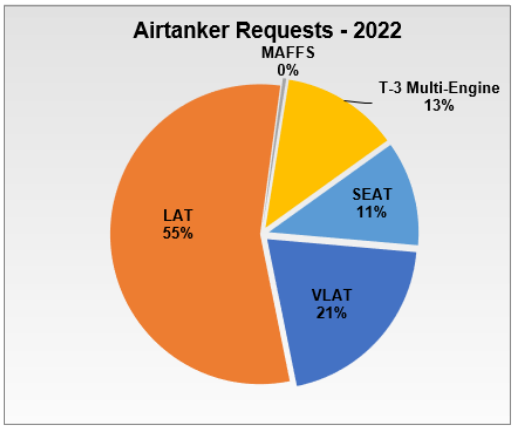


Airtanker Mobilizations

NICC received 638 requests for very large and heavy airtankers in 2022. Of those requests: 465 were filled, 113 were canceled and 60 were UTF.

NICC received 201 requests for multi-engine and single engine airtankers. Of those requests: 122 were filled, 24 were canceled, and 55 were UTF.





Fixed Wing Aircraft Requests Summary by Requesting Agency

Requesting Agency	Very Large Airtanker (VLAT)			Large Airtanker (LAT)			Modular Airborne Fire Fighting System (MAFFS)			Type 3 Multi-Engine Airtanker			Single Engine Airtanker (SEAT)			Lead Plane		
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF
BIA	10	4	2	19	4	7	0	0	0	8	0	0	8	0	0	0	2	0
BLM	7	1	1	38	14	3	2	0	0	8	0	0	25	6	0	11	0	0
DOD	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	1	0	0
FEMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FS	77	18	9	231	29	19	1	0	0	36	11	37	24	1	18	117	3	4
FWS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
NPS	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
ST	25	12	4	54	29	13	0	0	0	2	4	0	9	2	0	18	5	1
Other	0	1	1	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0
Subtotal:	*119*	*36*	*17*	*346*	*77*	*43*	*3*	*0*	*0*	*54*	*15*	*37*	*68*	*9*	*18*	*147*	*10*	*5*
Total:	**172**			**466**			**3**			**106**			**95**			**162**		

Requesting Agency	Aerial Supervision Module (ASM)			Air Attack			Infrared			Smokejumper Aircraft			Fixed Wing Aircraft Total Requests			
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	*Total*
BIA	3	0	0	4	1	0	52	6	14	0	0	0	104	17	23	***144***
BLM	3	0	0	14	2	0	78	7	35	4	1	1	190	31	40	***261***
DOD	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	***3***
FEMA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	***0***
FS	76	8	2	82	18	23	1,454	171	383	10	2	1	2,108	261	496	***2,865***
FWS	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	***1***
NPS	0	0	0	0	0	0	47	5	11	0	0	0	48	6	12	***66***
ST	5	1	1	17	4	4	196	30	59	0	0	0	326	87	82	***495***
Other	0	0	0	1	0	0	0	0	0	0	0	0	4	1	1	***6***
Subtotal:	*87*	*9*	*3*	*118*	*25*	*27*	*1,827*	*220*	*502*	*14*	*3*	*2*	*2,783*	*404*	*654*	
Total:	**99**			**170**			**2,549**			**19**			**3,841**			

Fixed Wing Aircraft Requests Summary by Requesting Geographic Area

Requesting GACC	Very Large Airtanker (VLAT)			Large Airtanker (LAT)			Modular Airborne Fire Fighting System (MAFFS)			Type 3 Multi-Engine Airtanker			Single Engine Airtanker (SEAT)			Lead Plane		
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF
AK	0	0	0	2	0	0	0	0	0	8	0	0	4	0	0	4	0	0
EA	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0
GB	24	14	1	81	15	4	1	0	0	9	4	2	10	0	4	22	0	0
NICC	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	9	0	0
NO	12	7	3	20	4	5	0	0	0	11	0	0	2	2	0	7	1	1
NR	10	1	4	55	15	11	0	0	0	8	3	1	14	3	14	12	3	0
NW	16	4	2	44	15	8	2	0	0	7	6	32	14	0	0	25	3	2
RM	15	1	0	44	6	5	0	0	0	0	0	0	8	0	0	11	2	0
SA	3	3	1	3	0	0	0	0	0	0	0	0	6	0	0	0	0	0
SO	17	1	2	40	14	5	0	0	0	0	2	0	0	0	0	2	0	1
SW	22	5	4	56	8	5	0	0	0	11	0	2	6	4	0	55	1	1
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Canada	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal:	119	36	17	346	77	43	3	0	0	54	15	37	68	9	18	147	10	5
Total:	**172**			**466**			**3**			**106**			**95**			**162**		

Requesting GACC	Aerial Supervision Module (ASM)			Air Attack			Infrared			Smokejumper Aircraft			Fixed Wing Aircraft Total Requests			
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	*Total*
AK	1	0	0	9	2	1	52	10	33	1	0	1	81	12	35	***128***
EA	0	0	0	1	1	0	0	0	0	0	0	0	5	1	0	***6***
GB	10	0	0	22	4	2	422	54	98	1	0	0	602	91	111	***804***
NICC	0	0	0	0	0	0	52	5	0	0	0	0	62	5	0	***67***
NO	4	0	0	3	3	2	132	9	6	3	0	1	194	26	18	***238***
NR	16	2	0	6	1	1	330	59	132	1	0	0	452	87	163	***702***
NW	9	1	0	19	8	9	511	58	173	6	3	0	653	98	226	***977***
RM	4	2	0	18	1	2	17	4	4	1	0	0	118	16	11	***145***
SA	3	1	0	7	0	0	14	1	2	0	0	0	36	5	3	***44***
SO	18	3	1	4	2	0	42	7	4	0	0	0	123	29	13	***165***
SW	22	0	2	29	3	10	255	13	50	1	0	0	457	34	74	***565***
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	***0***
Canada	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	***0***
Subtotal:	*87*	*9*	*3*	*118*	*25*	*27*	*1,827*	*220*	*502*	*14*	*3*	*2*	*2,783*	*404*	*654*	
Total:	**99**			**170**			**2,549**			**19**			**3,841**			

Unmanned Aircraft Systems

Over the years, requests for Unmanned Aircraft Systems (UAS) have increased significantly. Several land management agencies have their own UAS programs and UAS statistics will be included in this annual report moving forward.

In 2022, the NICC received 131 requests for UAS resources. Of those requests: 51 were filled, 21 were cancelled, and 59 were UTF.

Requesting	Fixed Wing			Rotor Wing			UAS Totals			
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Total
BIA	0	0	0	0	0	0	0	0	0	**0**
BLM	0	0	0	4	0	3	4	0	3	**7**
DOD	0	0	0	0	0	0	0	0	0	**0**
FEMA	0	0	0	0	0	0	0	0	0	**0**
FS	6	3	8	39	17	46	45	20	54	**119**
FWS	0	0	0	0	0	0	0	0	0	**0**
NPS	0	0	0	1	1	0	1	1	0	**2**
ST	0	0	0	1	0	2	1	0	2	**3**
Other	0	0	0	0	0	0	0	0	0	**0**
Canada	0	0	0	0	0	0	0	0	0	**0**
Subtotal:	*6*	*3*	*8*	*45*	*18*	*51*	*51*	*21*	*59*	
Total:	**17**			**114**			**131**			

Requesting	Fixed Wing			Rotor Wing			UAS Totals			
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Total
AK	0	0	0	2	0	0	2	0	0	**2**
EA	0	0	0	2	1	3	2	1	3	**6**
GB	0	0	0	9	4	8	9	4	8	**21**
NICC	1	0	0	0	0	0	1	0	0	**1**
NO	2	2	0	5	3	12	7	5	12	**24**
NR	0	0	0	6	4	7	6	4	7	**17**
NW	2	0	3	7	2	10	9	2	13	**24**
RM	0	0	0	0	1	0	0	1	0	**1**
SA	0	0	0	9	1	3	9	1	3	**13**
SO	0	0	0	1	2	0	1	2	0	**3**
SW	1	1	5	4	0	8	5	1	13	**19**
Other	0	0	0	0	0	0	0	0	0	**0**
Canada	0	0	0	0	0	0	0	0	0	**0**
Subtotal:	*6*	*3*	*8*	*45*	*18*	*51*	*51*	*21*	*59*	
Total:	**17**			**114**			**131**			

Temporary Flight Restrictions

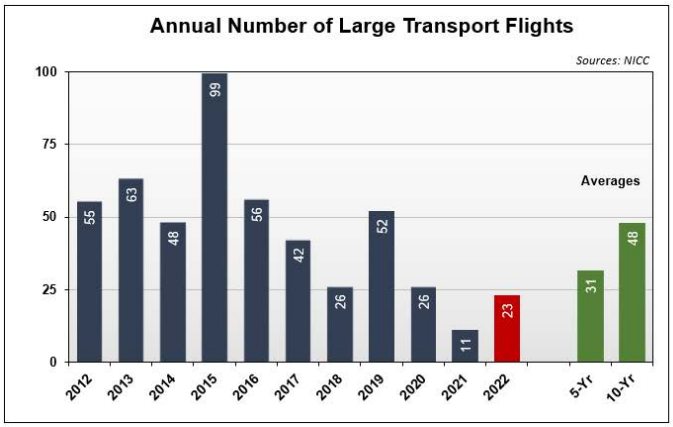
The National Airspace Coordination Program became part of the NICC in 2019. Temporary Flight Restrictions created nationally will be included in this annual report moving forward.

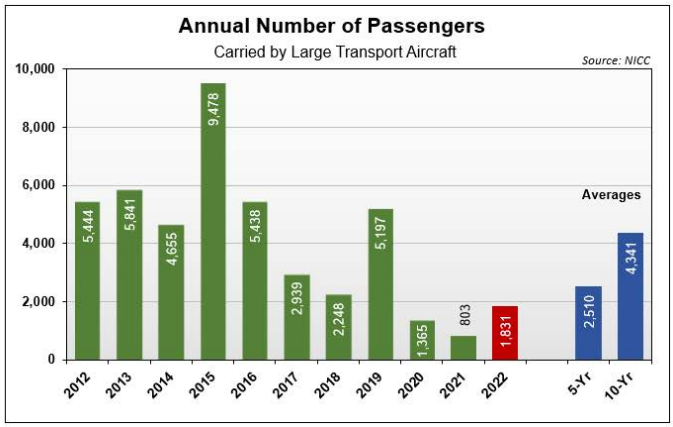
TFR Requests by Agency									
	BIA	BLM	DOD	FEMA	FS	FWS	NPS	ST	Other
Filled	39	68	2	0	462	0	32	265	4
Total:	872								

TFR Requests by GACC											
	AK	EA	GB	NICC	NO	NR	NW	RM	SA	SO	SW
Filled	47	4	123	0	65	109	173	56	29	81	185
Total:	872										

Large Transportation Aircraft

In 2022, there was one exclusive-use contract for large transportation aircraft. The contract was filled with a B737-2T4 jet aircraft. This exclusive-use jet flew 13 times. There were also 10 additional large aircraft charter flights arranged by NICC.





Exclusive-Use and Charter Large Transport Requests Summary by Destination Agency and Geographic Area

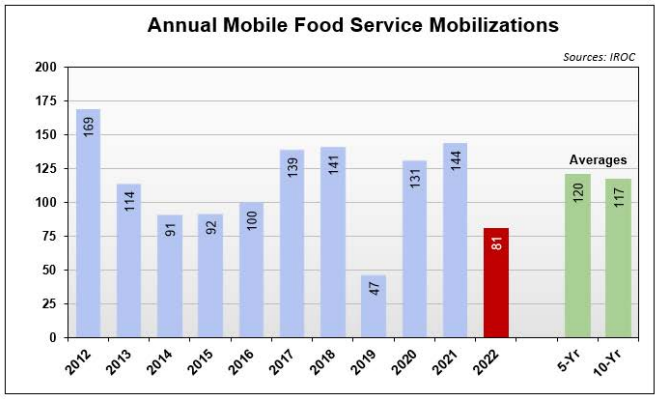
Requesting Agency	Exclusive-Use Aircraft		Charter Aircraft		Large Trans. Totals	
	Flights	Pax	Flights	Pax	Flights	Pax
BIA	0	0	0	0	0	0
BLM	13	1016	10	815	23	1,831
DOD	0	0	0	0	0	0
FEMA	0	0	0	0	0	0
FS	0	0	0	0	0	0
FWS	0	0	0	0	0	0
NPS	0	0	0	0	0	0
ST	0	0	0	0	0	0
Other	0	0	0	0	0	0
Canada	0	0	0	0	0	0
Total:	13	1,016	10	815	23	1,831

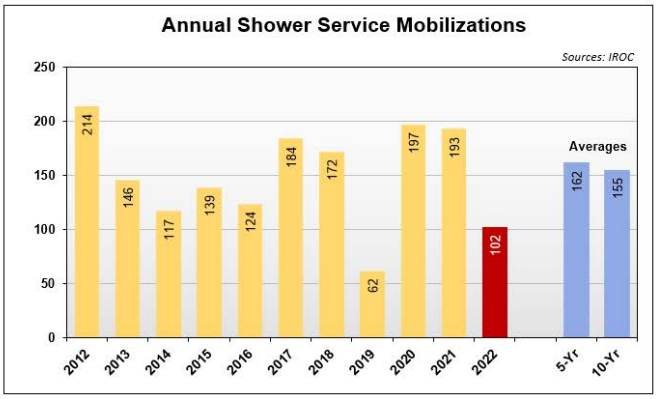
Requesting GACC	Exclusive-Use Aircraft		Charter Aircraft		Large Trans. Totals	
	Flights	Pax	Flights	Pax	Flights	Pax
AK	12	996	10	815	22	1,811
EA	0	0	0	0	0	0
GB	0	0	0	0	0	0
NICC	0	0	0	0	0	0
NO	0	0	0	0	0	0
NR	0	0	0	0	0	0
NW	1	20	0	0	1	20
RM	0	0	0	0	0	0
SA	0	0	0	0	0	0
SO	0	0	0	0	0	0
SW	0	0	0	0	0	0
Other	0	0	0	0	0	0
Canada	0	0	0	0	0	0
Total:	13	1,016	10	815	23	1,831

Equipment Services Mobilization

NICC received 87 requests for mobile food services in 2022. Of those requests: 81 were filled, five were canceled and one was UTF.

NICC received 111 requests for mobile shower services in 2022. Of those requests: 102 were filled, six were canceled and three were UTF.





Equipment Services Requests Summary by Requesting Agency and Geographic Area

Requesting Agency	Mobile Food			Showers			Equipment Services Totals			
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Total
BIA	5	0	0	5	0	0	10	0	0	10
BLM	5	0	0	3	1	0	8	1	0	9
DOD	0	0	0	0	0	0	0	0	0	0
FEMA	0	0	0	0	0	0	0	0	0	0
FS	58	3	1	82	3	2	140	6	3	149
FWS	0	0	0	0	0	0	0	0	0	0
NPS	2	1	0	4	0	0	6	1	0	7
ST	11	1	0	8	2	1	19	3	1	23
Other	0	0	0	0	0	0	0	0	0	0
Canada	0	0	0	0	0	0	0	0	0	0
Subtotal:	*81*	*5*	*1*	*102*	*6*	*3*	*183*	*11*	*4*	
Total:		**87**			**111**			**198**		

Requesting GACC	Mobile Food			Showers			Equipment Services Totals			
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Total
AK	0	0	0	0	0	0	0	0	0	0
EA	0	0	0	0	0	0	0	0	0	0
GB	16	1	0	16	1	2	32	2	2	36
NICC	0	0	0	0	0	0	0	0	0	0
NO	7	0	0	16	0	0	23	0	0	23
NR	10	0	0	10	1	0	20	1	0	21
NW	13	0	1	22	0	0	35	0	1	36
RM	9	1	0	6	2	1	15	3	1	19
SA	1	0	0	0	0	0	1	0	0	1
SO	5	1	0	6	0	0	11	1	0	12
SW	20	2	0	26	2	0	46	4	0	50
Other	0	0	0	0	0	0	0	0	0	0
Canada	0	0	0	0	0	0	0	0	0	0
Subtotal:	*81*	*5*	*1*	*102*	*6*	*3*	*183*	*11*	*4*	
Total:		**87**			**111**			**198**		

Radio and Weather Equipment Mobilizations

NICC received 598 requests for radio kits and weather equipment in 2022. Of those requests: 569 were filled, 25 were canceled, and four were UTF.

Radio and Weather Equipment Request Summary by Requesting Agency and Requesting Geographic Area

Requesting Agency	4390 Starter			4312 Repeater			4381 Tactical			5869 RAWS			Equipment Totals			
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Total
BIA	0	0	0	1	0	0	1	0	0	2	0		4	0	0	4
BLM	16	1	0	23	1	0	5	0	0	7	0		51	2	0	53
DOD	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0
FEMA	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0
FS	74	7	1	130	3	1	129	6	2	70	1		403	17	4	424
FWS	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0
NPS	0	0	0	10	0	0	2	0	0	3	0		15	0	0	15
ST	15	0	0	41	1	0	18	0	0	15	4		89	5	0	94
Other	0	0	0	4	1	0	3	0	0	0	0		7	1	0	8
Canada	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0
Subtotal:	*105*	*8*	*1*	*209*	*6*	*1*	*158*	*6*	*2*	*97*	*5*	*0*	*569*	*25*	*4*	
Total:	**114**			**216**			**166**			**102**			**598**			

Requesting GACC	4390 Starter			4312 Repeater			4381 Tactical			5869 RAWS			Equipment Totals			
	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Fill	Cancel	UTF	Total
AK	10	1	0	28	0	0	5	0	0	6	3	0	49	4	0	53
EA	4	0	0	0	1	0	0	0	0	0	0	0	4	1	0	5
GB	8	0	0	21	3	1	19	0	1	23	0	0	71	3	2	76
NICC	0	0	0	4	1	0	2	0	0	0	0	0	6	1	0	7
NO	13	2	1	23	0	0	28	1	0	9	0	0	73	3	1	77
NR	8	0	0	9	0	0	1	0	0	6	0	0	24	0	0	24
NW	18	4	0	37	1	0	42	0	0	20	0	0	117	5	0	122
RM	13	0	0	3	0	0	0	0	0	2	2	0	18	2	0	20
SA	0	0	0	7	0	0	7	0	0	0	0	0	14	0	0	14
SO	12	1	0	22	0	0	7	0	0	5	0	0	46	1	0	47
SW	19	0	0	55	0	0	47	5	1	26	0	0	147	5	1	153
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Canada	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal:	*105*	*8*	*1*	*209*	*6*	*1*	*158*	*6*	*2*	*97*	*5*	*0*	*569*	*25*	*4*	
Total:	**114**			**216**			**166**			**102**			**598**			

Wildland Fires and Acres Burned by State and Agency

(Figures are from the SIT/209 Application)

Alabama

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	37	6,402	2	320	39	6,722
FWS	1	1	0	0	1	1
NPS	3	7	0	0	3	7
ST	1,875	33,173	792	1,072	2,667	34,245
Totals:	**1,916**	**39,583**	**794**	**1,392**	**2,710**	**40,975**

Alaska

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BLM	29	136	171	1,535,427	200	1,535,563
DVF	256	11,698	108	1,563,706	364	1,575,404
FS	28	9	3	0	31	9
Totals:	**313**	**11,843**	**282**	**3,099,133**	**595**	**3,110,976**

Arizona

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	256	8,040	67	31,889	323	39,929
BLM	100	928	44	1,789	144	2,717
DVF	247	25,478	32	2,378	279	27,856
FS	329	37,077	327	13,846	656	50,924
FWS	2	0	4	16	6	16
NPS	5	11	19	2,710	24	2,721
Totals:	**939**	**71,535**	**493**	**52,629**	**1,432**	**124,165**

Arkansas

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	167	4,040	22	277	189	4,317
FWS	2	28	0	0	2	28
NPS	25	1,355	0	0	25	1,355
OTHR	1,687	33,328	0	0	1,687	33,328
Totals:	**1,881**	**38,751**	**22**	**277**	**1,903**	**39,028**

California

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	35	156	1	0	36	156
BLM	60	3,118	19	122	79	3,240
C&L	18	4,501	0	0	18	4,501
CDF	6,710	82,820	44	410	6,754	83,230
FS	712	154,277	222	56,824	934	211,101
FWS	13	193	0	0	13	193
NPS	37	5,328	13	1,536	50	6,864
Totals:	**7,585**	**250,394**	**299**	**58,892**	**7,884**	**309,287**

Colorado

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	17	103	59	37	76	140
BLM	31	1,362	252	587	283	1,949
C&L	149	36,403	97	422	246	36,825
FS	92	1,004	100	2,221	192	3,225
FWS	6	3	1	0	7	3
NPS	2	265	22	340	24	605
USA	5	1,330	2	1,655	7	2,985
Totals:	**302**	**40,470**	**533**	**5,262**	**835**	**45,732**

Connecticut

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
ST	150	347	0	0	150	347
Totals:	**150**	**347**	**0**	**0**	**150**	**347**

Delaware

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FWS	1	0	0	0	1	0
ST	6	79	0	0	6	79
Totals:	**7**	**79**	**0**	**0**	**7**	**79**

Florida

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	11	4,002	2	1	13	4,003
DOD	5	2,039	1	1,100	6	3,139
FS	82	2,386	19	13	101	2,399
FWS	6	336	2	2	8	338
NPS	15	877	19	371	34	1,248
OTHR	46	40	1	55	47	95
ST	2,052	80,225	489	61,760	2,541	141,985
USAF	34	11,567	0	0	34	11,567
Totals:	**2,251**	**101,472**	**533**	**63,302**	**2,784**	**164,774**

Georgia

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
DOD	1	0	0	0	1	0
FS	42	1,474	2	97	44	1,571
NPS	1	3	0	0	1	3
OTHR	59	389	0	120	59	509
ST	3,514	20,489	2	2,445	3,516	22,934
Totals:	**3,617**	**22,355**	**4**	**2,662**	**3,621**	**25,017**

Hawaii

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
DOD	1	25,000	0	0	1	25,000
FWS	2	5	0	0	2	5
NPS	1	43	1	5	2	48
Totals:	**4**	**25,048**	**1**	**5**	**5**	**25,053**

Idaho

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	20	8,519	2	86	22	8,605
BLM	125	54,384	50	15,487	175	69,871
BOR	1	0	0	0	1	0
C&L	51	33,029	4	15	55	33,044
FS	86	132,920	371	189,649	457	322,569
FWS	1	58	0	0	1	58
ST	225	1,988	152	597	377	2,585
Totals:	**509**	**230,898**	**579**	**205,834**	**1,088**	**436,733**

Illinois

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	21	109	0	0	21	109
FWS	3	2	0	0	3	2
ST	8	187	0	0	8	187
Totals:	**32**	**298**	**0**	**0**	**32**	**298**

Indiana

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	36	95	0	0	36	95
FWS	3	1,326	0	0	3	1,326
NPS	6	2	0	0	6	2
ST	4	220	0	0	4	220
Totals:	**49**	**1,643**	**0**	**0**	**49**	**1,643**

Iowa

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FWS	7	288	0	0	7	288
Totals:	**7**	**288**	**0**	**0**	**7**	**288**

Kansas

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	14	641	0	0	14	641
C&L	47	79,371	3	3,926	50	83,297
FWS	3	77	0	0	3	77
Totals:	**64**	**80,089**	**3**	**3,926**	**67**	**84,015**

Kentucky

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	51	1,162	2	1	53	1,163
NPS	2	9	0	0	2	9
ST	1,225	58,027	0	0	1,225	58,027
Totals:	**1,278**	**59,198**	**2**	**1**	**1,280**	**59,199**

Louisiana

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	80	9,352	4	26	84	9,378
ST	1,175	15,097	0	0	1,175	15,097
Totals:	**1,255**	**24,449**	**4**	**26**	**1,259**	**24,475**

Maine

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
ST	709	409	21	16	730	425
Totals:	**709**	**409**	**21**	**16**	**730**	**425**

Maryland

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FWS	2	18	0	0	2	18
ST	108	2,881	7	240	115	3,121
Totals:	**110**	**2,899**	**7**	**240**	**117**	**3,139**

Massachusetts

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
ST	1,180	1,749	12	7	1,192	1,756
Totals:	**1,180**	**1,749**	**12**	**7**	**1,192**	**1,756**

Michigan

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	7	7	0	0	7	7
FS	133	94	5	1	138	95
NPS	1	5	0	0	1	5
ST	217	653	13	2,762	230	3,415
Totals:	**358**	**759**	**18**	**2,763**	**376**	**3,522**

Minnesota

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	114	264	0	0	114	264
FS	60	45	3	9	63	54
FWS	10	373	0	0	10	373
NPS	1	0	0	0	1	0
ST	524	3,023	1	1	525	3,024
Totals:	**709**	**3,705**	**4**	**10**	**713**	**3,715**

Mississippi

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	2	8	0	0	2	8
FS	139	8,919	3	13	142	8,933
NPS	7	1	0	0	7	1
OTHR	1,829	44,228	0	0	1,829	44,228
Totals:	**1,977**	**53,156**	**3**	**13**	**1,980**	**53,170**

Missouri

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	134	4,958.1	0	0	134	4,958
NPS	2	10	0	0	2	10
Totals:	**136**	**4,968.1**	**0**	**0**	**136**	**4,968**

Montana

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	427	28,654	59	2,171	486	30,825
BLM	10	7	27	137	37	144
C&L	604	18,285	144	21,462	748	39,747
FS	171	1,393	284	60,800	455	62,193
FWS	0	0	5	366	5	366
NPS	1	1	8	1,707	9	1,708
ST	182	2,242	165	284	347	2,526
Totals:	**1,395**	**50,582**	**692**	**86,927**	**2,087**	**137,509**

Nebraska

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	1	545	0	0	1	545
DOF	519	69,856	15	75	534	69,931
FS	6	666	24	5,338	30	6,004
FWS	3	54	0	0	3	54
Totals:	**529**	**71,121**	**39**	**5,413**	**568**	**76,534**

Nevada

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	1	0	1	0	2	0
BLM	131	18,092	145	14,640	276	32,733
BOR	5	2	0	0	5	2
C&L	101	2,770	21	667	122	3,438
FS	37	55	31	22,172	68	22,227
FWS	5	0	0	0	5	0
NPS	21	1	3	0	24	1
ST	4	0	0	0	4	0
Totals:	**305**	**20,921**	**201**	**37,480**	**506**	**58,402**

New Hampshire

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	28	155	9	10	37	165
ST	61	215	5	1	66	216
Totals:	**89**	**370**	**14**	**11**	**103**	**381**

New Jersey

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FWS	1	1	0	0	1	1
ST	1,164	15,531	0	0	1,164	15,531
Totals:	**1,165**	**15,532**	**0**	**0**	**1,165**	**15,532**

New Mexico

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	69	239	38	46	107	285
BLM	62	6,102	43	4,732	105	10,834
DOD	1	12	0	0	1	12
DOE	0	203	0	0	0	203
FS	84	707,839	148	5,109	232	712,948
FWS	1	0	1	0	2	0
NPS	2	3	6	3	8	6
OTHR	20	1,086	16	983	36	2,069
SF	214	131,799	43	1,749	257	133,548
Totals:	**453**	**847,283**	**295**	**12,622**	**748**	**859,906**

New York

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
ST	152	1,086	10	227	162	1,313
Totals:	**152**	**1,086**	**10**	**227**	**162**	**1,313**

North Carolina

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	17	28	0	0	17	28
FS	34	2,562	0	0	34	2,562
FWS	3	18	0	0	3	18
NPS	5	27	0	0	5	27
ST	6,033	18,670	56	1,448	6,089	20,118
USM	74	6,098	0	0	74	6,098
Totals:	**6,166**	**27,403**	**56**	**1,448**	**6,222**	**28,851**

North Dakota

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	98	885	0	0	98	885
FS	7	85	2	0	9	85
FWS	4	539	0	0	4	539
Totals:	**109**	**1,509**	**2**	**0**	**111**	**1,509**

Ohio

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	84	163	0	0	84	163
ST	640	2,900	0	0	640	2,900
Totals:	**724**	**3,063**	**0**	**0**	**724**	**3,063**

Oklahoma

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	1,195	135,893	2	37	1,197	135,930
FWS	15	104	0	0	15	104
OTHR	305	3,556	1	146	306	3,702
ST	1,292	244,397	1	1,000	1,293	245,397
Totals:	**2,807**	**383,950**	**4**	**1,183**	**2,811**	**385,133**

Oregon

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	73	794	5	43	78	838
BLM	116	42,861	229	33,282	345	76,144
C&L	13	6	15	12	28	18
DL	3	96	0	0	3	96
DOF	672	12,034	225	32,825	897	44,859
FS	258	404	482	333,467	740	333,871
FWS	3	4	5	247	8	251
NPS	5	0	13	3	18	3
Totals:	**1,143**	**56,201**	**974**	**399,881**	**2,117**	**456,082**

Pennsylvania

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	4	6	0	0	4	6
ST	939	2,543	8	39	947	2,582
Totals:	**943**	**2,549**	**8**	**39**	**951**	**2,588**

Rhode Island

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
ST	76	44	0	0	76	44
Totals:	**76**	**44**	**0**	**0**	**76**	**44**

South Carolina

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	21	663	1	14	22	677
Totals:	**21**	**663**	**1**	**14**	**22**	**677**

South Dakota

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	302	27,847	20	231	322	28,078
BLM	0	0	1	0	1	0
C&L	44	8,012	12	582	56	8,594
FS	33	3,464	41	20	74	3,484
FWS	2	9	0	0	2	9
NPS	2	114	1	2	3	116
ST	54	1,615	14	41	68	1,656
USA	0	0	1	211	1	211
Totals:	**437**	**41,061**	**90**	**1,087**	**527**	**42,148**

Tennessee

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	35	367	0	0	35	367
NPS	14	981	0	0	14	981
OTHR	1,150	13,114	8	52	1,158	13,166
ST	18	545	0	0	18	545
Totals:	**1,217**	**15,007**	**8**	**52**	**1,225**	**15,059**

Texas

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BLM	4	70	1	23	5	93
C&L	10,111	95,558	264	6,544	10,375	102,102
FS	69	1,263	20	902	89	2,165
FWS	16	2,690	21	13,334	37	16,024
NPS	7	317	2	5	9	322
OTHR	9	13	0	0	9	13
ST	1,815	484,780	232	66,301	2,047	551,081
Totals:	**12,031**	**584,691**	**540**	**87,109**	**12,571**	**671,800**

Utah

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	8	12	16	66	24	78
BLM	38	319	119	520	157	839
DOI	22	291	88	1,965	110	2,256
FS	45	16,331	103	42	148	16,373
NPS	4	0	9	18	13	18
ST	359	7,328	134	353	493	7,681
Totals:	**476**	**24,281**	**469**	**2,964**	**945**	**27,245**

Vermont

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	6	11	9	0	15	11
ST	71	72	0	0	71	72
Totals:	**77**	**83**	**9**	**0**	**86**	**83**

Virginia

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	32	806	0	0	32	806
FWS	6	113	0	0	6	113
ST	509	8,946	11	91	520	9,037
Totals:	**547**	**9,865**	**11**	**91**	**558**	**9,956**

Washington

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	175	1,578	29	32	204	1,610
BLM	52	13,897	5	51	57	13,948
DNR	749	52,646	100	1,708	849	54,354
FS	187	16,437	114	54,005	301	70,442
FWS	34	454	1	0	35	454
NPS	14	1	23	12,313	37	12,314
ST	9	20,537	0	0	9	20,537
Totals:	**1,220**	**105,550**	**272**	**68,109**	**1,492**	**173,659**

West Virginia

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	6	9	0	0	6	9
NPS	2	200	1	40	3	240
ST	881	20,024	3	2	884	20,026
Totals:	**889**	**20,233**	**4**	**42**	**893**	**20,275**

Wisconsin

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
FS	30	22	0	0	30	22
ST	893	859	0	0	893	859
Totals:	**923**	**881**	**0**	**0**	**923**	**881**

Wyoming

Agency	Fires - Human	Acres - Human	Fires – Lightning	Acres – Lightning	Fires – Total	Acres - Total
BIA	39	2,694	0	0	39	2,694
BLM	33	4,275	37	442	70	4,717
BOR	2	2	0	0	2	2
C&L	131	8,776	74	3,912	205	12,688
FS	49	2,876	44	709	93	3,585
FWS	0	0	1	0	1	0
NPS	1	0	6	0	7	0
SF	12	1,263	14	817	26	2,080
Totals:	**267**	**19,886**	**176**	**5,880**	**443**	**25,766**

NICC Benchmarks

The figures below represent national-level totals for fire activity and numbers of **resources mobilized through the National Interagency Coordination Center**, except for Incident Management Team mobilizations, which are displayed in totality of mobilizations nationwide. Records set during the year of this report are in **bold**.

Category	Record Year	Record	2022 Stats
Wildfires	2006	96,385	68,988
Wildfire Acres Burned	2015	10,125,149	7,577,183
Significant Fires	2006	1,801	1,289
Days at Preparedness Level 1&2	2010	365	288
Days at Preparedness Level 4&5	2021	99	10
Days at Preparedness Level 5	2021	68	0
Type 1 IMT Mobilizations (fire & non-fire)	2002	85	41
Type 2 IMT Mobilizations (fire & non-fire)	2021	138	86
Dept. of Defense Battalions/Task Forces	1988	8	0
MAFFS (millions of gallons delivered)	1994	5.03	0.16
Tactical Crew Mobilizations	2003	1,796	1,292
Engine Mobilizations	2021	3,149	2,508
Overhead Mobilizations	2000	17,898	12,937
Type 1 Helicopter Mobilizations	2016	334	211
Type 2 Helicopter Mobilizations	2006	323	120
Heavy Airtankers (VLAT/LAT/MAFFS)	2017	2,298	468
Large Transport Flights	1994	552	23
Mobile Food Units	1994	195	81
Shower Units	1994	256	102

Identifier Legend

Interagency Coordination Centers
NICC: National Interagency Coordination Center
NIFC: National Interagency Fire Center
CIIFC: Canadian Interagency Forest Fire Centre
AK: Alaska Area
EA: Eastern Area
GB: Great Basin Area
NO: Northern California Area
NR: Northern Rockies Area
NW: Northwest Area
RM: Rocky Mountain Area
SA: Southern Area
SW: Southwest Area
SO: Southern California Area

Federal Government Agencies
FS: Forest Service
BIA: Bureau of Indian Affairs
BLM: Bureau of Land Management
FWS: Fish and Wildlife Service
NPS: National Park Service
FEMA: Federal Emergency Management Agency
ESF4: Emergency Support Function, Firefighting
NWS: National Weather Service
DOE: Department of Energy
DOD: Department of Defense

International Partners
AU: Australia
CN: Canada
MX: Mexico
NZ: New Zealand

Other Providers/Ownership
CNTY: County
OT: Other
PRI: Private
ST: State
ST/OT: State/Other Combined

Acronyms and Terminology

Air Attack: Light aircraft (airplane or helicopter) that carries the ATGS.

ASM: Aerial Supervision Module, light twin-engine airplane that combines the lead plane function and tactical supervision (pilot and Air Tactical Supervisor - ATS).

CWN: Call When Needed, refers to aircraft that have a call when needed contract.

DRTI: Distributed Real-Time Infrared aircraft (operated by DOD).

EXCL: Exclusive-Use Contract. Refers to aircraft that have an exclusive-use contact with an agency.

IA: Initial attack**.**

IMT: Incident Management Team.

Infrared: Aircraft outfitted with infrared sensing equipment.

IROC: Interagency Resource Ordering Capability System.

Large fire: A large fire is defined as 100 acres or greater in timber, 300 acres or greater in grass/brush, or a Type 1, Type 2 or NIMO team is assigned.

LAT: Large Airtanker.

Lead Plane: Twin-engine airplane that guides airtankers over a fire.

MAFFS: Modular Airborne Fire Fighting System (military C-130 aircraft).

NIMO: National Incident Management Organization.

Pax: Passengers.

RAWS: Remote Automated Weather Station.

Starter: Type of portable radio kit.

Repeater: Type of portable radio kit.

Tactical: Type of portable radio kit.

SEAT: Single engine airtanker.

TFR: Temporary Flight Restriction.

UTF: Unable to Fill resource request (the requested resource couldn’t be filled).

UAS: Unmanned aircraft systems.

VLAT: Very Large Airtanker.

Are major natural disasters increasing?

Nine out of the 10 years with the highest number of natural disasters occurred in the last decade.

Updated September 5, 2024 by USAFacts team

The number of natural weather disasters with damages of more than a billion dollars has increased over the last forty years, from an average 3.3 per year in the 1980s to 17+ from 2014–2023.

The National Centers for Environmental Information has kept track of billion-dollar natural disasters since 1980 and cites increased exposure, vulnerability, and climate change as reasons for the increase.

Are billion-dollar natural disasters becoming more frequent?

Of the 10 years with the most natural disasters, nine were in the last decade.

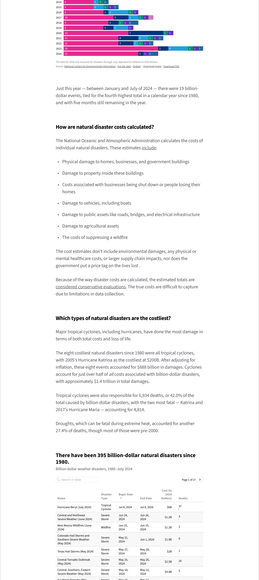
Since 1980, there have been 395 natural weather disasters in the US with total costs over $1 billion[1] in 2024 dollars, including 201 severe storms, 63 tropical cyclones (or hurricanes), 44 floods, 31 droughts, 26 winter storms, 23 wildfires, and nine freezes. In total, these disasters cost $2.77 trillion (adjusted for inflation) and took the lives of nearly 16,500 people.

The bulk of these events happened post-1990. In the 1980s, there were a total of 33 billion-dollar natural disaster events, with 2,294 deaths. In the last 10 full years (2014–2023), this number rose to 192, resulting in 5,872 deaths. All told, nearly 40% of the billion-dollar climate events that have hit the US since 1980 happened between 2017 and the present day.

Subscribe to stay informed about DOGE and federal spending

2023 had the most billion-dollar natural disaster events of any year to date.

Frequency of billion-dollar natural weather disasters, 1980–2024



Thresholds for total costs, accounts for disasters through 2023, adjusted for inflation to 2024 dollars.
Source: National Centers for Environmental Information · See the data · Embed · Download data

Just this year — between January and July of 2024 — there were 19 billion-dollar events, tied for the fourth-highest total in a calendar year since 1980, and with five months still remaining in the year.

How are natural disaster costs calculated?

The National Oceanic and Atmospheric Administration calculates the costs of individual natural disasters. These estimates include:

- Physical damage to homes, businesses, and government buildings
- Damage to property inside these buildings
- Costs associated with businesses being shut down or people losing their homes
- Damage to vehicles, including boats
- Damage to public assets like roads, bridges, and electrical infrastructure
- Damage to agricultural assets
- The costs of suppressing a wildfire

The cost estimates don't include environmental damages, any physical or mental healthcare costs, or larger supply chain impacts, nor does the government put a price tag on the lives lost.

Because of the way disaster costs are calculated, the estimated totals are considered conservative evaluations. The true costs are difficult to capture due to limitations in data collection.

Which types of natural disasters are the costliest?

Major tropical cyclones, including hurricanes, have done the most damage in terms of both total costs and loss of life.

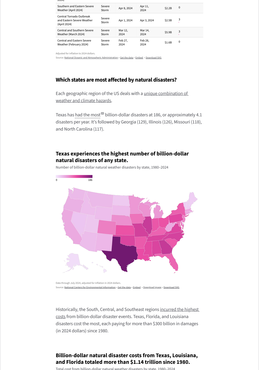
The eight costliest natural disasters since 1980 were all tropical cyclones, with 2005's Hurricane Katrina as the costliest at $200B. After adjusting for inflation, these eight events accounted for $885 billion in damages. Cyclones account for just over half of all costs associated with billion-dollar disasters, with approximately $1.4 trillion in total damages.

Tropical cyclones were also responsible for 5,554 deaths, or 42.0% of the total caused by billion-dollar disasters, with the two most fatal — Katrina and 2017's Hurricane Maria — accounting for 4,614.

Droughts, which can be fatal during extreme heat, accounted for another 27.4% of deaths, though most of those were pre-2000.

There have been 395 billion-dollar natural disasters since 1980.

Billion-dollar weather disasters, 1980–July 2024



Source: National Oceanic and Atmospheric Administration · See the data · Embed · Download data

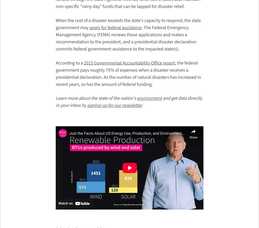
Which states are most affected by natural disasters?

Each geographic region of the US deals with a unique combination of weather and climate hazards.

Texas has had the most[2] billion-dollar disasters at 186, or approximately 4.1 disasters per year. It's followed by Georgia (129), Illinois (126), Missouri (116), and North Carolina (117).

Texas experiences the highest number of billion-dollar natural disasters of any state.

Number of billion-dollar natural weather disasters by state, 1980–2024

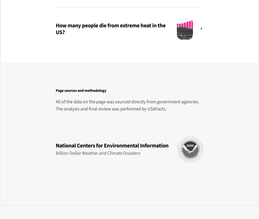


Hold through July 2024, adjusted for inflation to 2024 dollars.
Source: National Centers for Environmental Information · See the data · Embed · Download data · Download CSV

Historically, the South, Central, and Southeast regions incurred the highest costs from billion-dollar disaster events. Texas, Florida, and Louisiana disasters cost the most each, paying for more than $300 billion in damages (in 2024 dollars) since 1980.

Billion-dollar natural disaster costs from Texas, Louisiana, and Florida totaled more than $1.14 trillion since 1980.

Total cost from billion-dollar natural weather disasters by state, 1980–2024



Hold through July 2024 and adjusted for inflation to 2024 dollars.
Source: National Centers for Environmental Information · See the data · Embed · Download data · Download CSV

How are disaster relief efforts funded?

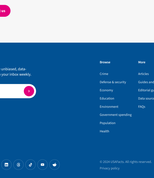
Funding for natural disasters comes from all levels of government. Local and tribal governments are the first line of defense and are expected to manage the immediate impacts of emergencies. When necessary, federal disaster funding supports local disaster response.

Each state has its own way of managing disaster funding. Some establish statewide disaster accounts, specialized funds that provide monies to counties, cities, and towns for disaster costs. These accounts are typically funded through the state's general revenue fund. Some states also maintain non-specific "rainy day" funds that can be tapped for disaster relief.

When the cost of a disaster exceeds the state's capacity to respond, the state government may apply for federal assistance. The Federal Emergency Management Agency (FEMA) reviews these applications and makes a recommendation to the president, and a presidential disaster declaration commits federal government assistance to the impacted state(s).

According to a 2015 Governmental Accountability Office report, the federal government pays roughly 75% of expenses when a disaster receives a presidential declaration. As the number of federal disasters has increased in recent years, so has the amount of federal funding.

Learn more about the state of the nation's environment and get data directly in your inbox by signing up for our newsletter.



Related environment articles

Read data analyses written by the USAFacts team.

Is home insurance getting more expensive? ›

How much land do wildfires burn in the US? ›

How many people die from extreme heat in the US? ›

Page sources and methodology

All of the data on the page was sourced directly from government agencies. The analyses and final review was performed by USAFacts.

National Centers for Environmental Information

Billion-Dollar Weather and Climate Disasters

USAFACTS

USAFacts is a not-for-profit, nonpartisan civic initiative making government data easy for all.

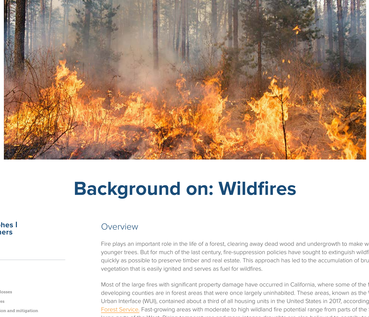
Learn more about us

Subscribe
Subscribe to get more unbiased, data-driven insights sent to your inbox weekly.
Email
Subscribe

Browse
Crime
Defense & security
Economy
Education
Environment
Government spending
Population
Health

More
Articles
Guides and reports
Editorial guidelines
Data sources
FAQs
About

© 2024 USAFacts. All rights reserved. Terms of service
Privacy policy



Background on: Wildfires

Catastrophes | Homeowners

April 4, 2018

IN THIS ARTICLE

Overview
Insured wildfire losses
Causes of wildfires
Wildfire prevention and mitigation
Properties at risk for wildfires
Charts and graphs
Homes At Risk For Extreme Wildfires, By State, 2024
Natural Catastrophe Losses In The United States By Peril, 2014 (1)
Top 10 States For Wildfires Ranked By Number Of Fires And By Number Of Acres Burned, 2023
Top 10 Costliest Wildland Fires In The United States (1)
Additional resources

SHARE THIS

DOWNLOAD TO PDF

SPONSORED BY

Helmsman Management Services LLC®

With you. All the way.
Providing claims capabilities that support, solve, and succeed.

Learn more

Overview

Fire plays an important role in the life of a forest, clearing away dead wood and undergrowth to make way for younger trees. But for much of the last century, fire-suppression policies have sought to extinguish wildfires as quickly as possible to preserve timber and real estate. This approach has led to the accumulation of brush and other vegetation that is easily ignited and serves as fuel for wildfires.

Most of the large fires with significant property damage have occurred in California, where some of the fastest developing counties are in forest areas that were once largely uninhabited. These areas, known as the Wildland-Urban Interface (WUI), contained about a third of all housing units in the United States in 2017, according to the U.S. Forest Service. Fast-growing areas with moderate to high wildland fire potential range from parts of the South to large parts of the West. Rising temperatures and more intense droughts are also believed to contribute to large, destructive blazes. Warmer weather contributes to wildfire conditions in many ways: dryer and more combustible vegetation, more frequent lightning strikes, an extended fire season, more intense winds and earlier spring snowmelt in mountainous areas leading to dry vegetation earlier in the wildfire season. A typical wildfire season would run from mid-summer to early autumn, but with the changing conditions wildfires are becoming a year-round occurrence.

Insured wildfire losses

Damage caused by fire and smoke are covered under standard homeowners, renters and business owners insurance policies and under the comprehensive portion of an auto insurance policy. Water or other damage caused by fire fighters to extinguish the fire is also covered under these policies. In California, the California FAIR Plan covers residential and commercial properties located in brush and wildfire areas. Properties in those areas are subject to higher rates due to increased risk of fire

Causes of wildfires

As many as 90 percent of wildland fires in the United States are caused by humans, according to the U.S. Department of Interior. Some human-caused fires result from campfires left unattended, the burning of debris, downed power lines, negligently discarded cigarettes and intentional acts of arson. The remaining 10 percent are started by lightning or lava.

Wildfire prevention and mitigation

Researchers are discovering that embers blown by the wind during wildfires cause most of the fires that burn homes. Also, homes that are less than 15 feet apart are more likely to burn in clusters. In such cases, fire is often spread by combustible fences and decks connected to houses, a study by the Insurance Institute for Business & Home Safety (IBHS) found.

Among the preventive features recommended in the IBHS study were noncombustible siding, decking and roofing materials; covered vents; and fences not connected directly to the house. In addition, combustible structures in the yard such as playground equipment should be at least 30 feet away from the house and vegetation 100 feet away.

Properties at risk for wildfires

FireLine®, Verisk's wildfire risk management tool, assesses wildfire risk at the address level using advanced remote sensing and digital mapping technology. The three primary factors considered in analyzing wildfire risk are distribution of vegetative fuel, steepness of slope and degree of access for firefighting equipment. FireLine assigns a wildfire hazard score for each factor plus a cumulative score, on a scale from negligible to extreme risk. The following chart from CoreLogic® ranks the most wildfire-prone western U.S. states by top to extreme wildfire risk as of 2024. In California, there were more than 2 million properties at high to extreme wildfire risk in 2024, the largest number of properties of any U.S. state.

Charts and graphs

Homes At Risk For Extreme Wildfires, By State, 2024

Rank	State	Number of housing units
1	California	1,258,748
2	Colorado	321,294
3	Texas	244,617
4	Oregon	129,567
5	Arizona	124,603
6	New Mexico	120,093
7	Idaho	104,752
8	Montana	88,102
9	Utah	67,023
10	Washington	59,503
11	South Dakota	26,697
12	Nevada	22,768
13	Wyoming	16,215
14	Oklahoma	1,524

Source: CoreLogic®, a property data and analytics company

View Archived Tables

Natural Catastrophe Losses In The United States By Peril, 2024 (1)

($ millions)

Peril	Number of events	Fatalities	Economic losses (2)	Insured losses (3)
Tropical cyclone	5	328	$121,555	$43,717
Severe convective storm	49	99	68,579	53,967
Wildfire, drought, heatwave	9	1,033	10,519	5,548
Winter weather	6	89	6,809	4,020
Flooding	12	27	10,189	5,323
Total	**81**	**1,576**	**$217,651**	**$112,575**

(1 Natural disasters that cause at least $25 million in insured losses, or 10 deaths, or 50 people injured, or 2,000 filed claims or homes and structures damaged. Includes Puerto Rico and the U.S. Virgin Islands.
(2) Includes any direct property damage or direct net loss business interruption costs.
(3) Includes losses paid privately and losses from insurers and government-sponsored programs such as the National Flood Insurance Program. Subject to change as loss estimates are further developed. As of January 2025.

Source: Aon.

View Archived Tables

Top 10 States For Wildfires Ranked By Number Of Fires And By Number Of Acres Burned, 2023

Rank	State	Number of fires	Rank	State	Number of acres burned
1	California	7,964	1	California	332,722
2	Texas	7,102	2	Alaska	314,276
3	North Carolina	5,214	3	New Mexico	212,378
4	Florida	2,730	4	Texas	210,264
5	Georgia	2,386	5	Oregon	202,035
6	Mississippi	2,383	6	Arizona	186,483
7	Oregon	1,979	7	Nebraska	180,733
8	Pennsylvania	1,910	8	Oklahoma	162,489
9	Alabama	1,856	9	Washington	151,316
10	Arizona	1,837	10	Montana	123,133

Source: National Interagency Fire Center.

View Archived Tables

Top 10 Costliest Wildland Fires In The United States (1)

($ millions)

			Estimated insured loss	
Rank	Year	Name	Dollars when occurred	In 2024 dollars (2)
1	2018	Camp Fire	$10,000	$12,524
2	2017	Tubbs Fire	8,700	11,134
3	2018	Woolsey Fire	4,200	5,260
4	2023	Maui Wildfire (Hawaii)	4,300	4,421
5	1991	Oakland Fire (Tunnel)	1,700	3,906
6	2017	Atlas Fire	3,000	3,839
7	2020	Glass Fire	2,950	3,578
8	2020	CZU Lightning Complex Fire	2,500	3,032
9	2017	Thomas Fire	2,250	2,881
10	2021	Marshall Fire (Colorado)	2,500	2,831

(1 Includes losses sustained by private insurers and government-sponsored programs such as the National Flood Insurance Program. All fires on this list occurred in California unless otherwise noted. Includes Puerto Rico and the U.S. Virgin Islands. Subject to change as loss estimates are further developed. As of January 2025.
(2) Adjusted for inflation by Aon using the U.S. Consumer Price Index.

Source: Aon.

View Archived Tables

Additional resources

Verisk Insurance Solutions' FireLine State Risk Report

National Interagency Fire Center

Headwaters Economics - The Rising Cost of Wildfire Protection

Insurance Institute for Business & Home Safety – Wildfire resources

National Fire Prevention Administration - Wildfire safety tips

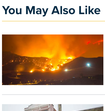
Wildfire Hazard Potential Map

Cal Fire's ReadyforWildfire.org

© Insurance Information Institute, Inc. - ALL RIGHTS RESERVED

Back to top

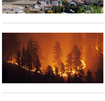
You May Also Like



CATASTROPHES
Facts + Statistics: Wildfires



CATASTROPHES | HOMEOWNERS
Facts + Statistics: Fire



DISASTERS - PREPAREDNESS
Five Steps to preparing an effective evacuation plan



DISASTERS - PREPAREDNESS
Insurance for wildfires



CATASTROPHES
Fighting wildfires with innovation

© Copyright 2025, Insurance Information Institute, Inc.
All Rights Reserved.

An official website of the United States government. Here's how you know

Climate Change Indicators

View the Indicators
- Greenhouse Gases
- Weather and Climate
- Oceans
- Snow and Ice
- Health and Society
- Ecosystems
  - Wildfires
  - Streamflow
  - Stream Temperature
  - Tribal Connection: Trends in Stream Temperature in the Snake River
  - Lake Temperature
  - Great Lakes Water Levels and Temperatures
  - Bird Wintering Ranges
  - A Closer Look: The Black Guillemots of Cooper Island
  - Marine Species Distribution
  - Leaf and Bloom Dates
  - Community Connection: Cherry Blossom Bloom Dates in Washington, D.C.

Dig into the Data

Indicator Stories

About the Indicators

Contact Us About Climate Indicators

Climate Change Indicators: Wildfires

This indicator tracks the frequency, extent, and severity of wildfires in the United States.

Figure 1. Wildfire Frequency | **Figure 2.** Wildfire Extent | **Figure 3.** Wildfire Damage
Figure 4. Burned Area by State | **Figure 5.** Change in Burned Area by State | **Figure 6.** Change in Burned Area, U.S.
Figure 7. Change in Burned Area, West vs. East U.S.

Figure 1. Wildfire Frequency in the United States, 1983–2022



Key Points | Background | About the Indicator | About the Data | Technical Documentation

Key Points

- Since 1983, the National Interagency Fire Center has documented an average of approximately 70,000 wildfires per year (Figure 1). Compiled data from the Forest Service suggest that the actual total may be even higher for the first few years of nationwide data collection that can be compared. The data do not show an obvious trend during this time.
- The extent of area burned by wildfires per year appears to have increased since the 1980s. According to National Interagency Fire Center data, of the 10 years with the largest acreage burned, all have occurred since 2004, including the peak years in 2015 and 2020 (Figure 2). This period coincides with many of the warmest years on record nationwide (see the U.S. and Global Temperature indicator). The largest increases have occurred in the western United States.[1,2,3,4,5,6,7,8,9,10,11]
- Of the total area burned each year from 1984 to 2021, the proportion of burned land suffering severe damage has ranged from 5 to 22 percent (see the "high" category in Figure 3).
- Land area burned by wildfires varies by state. Fires burn more land in the western United States than in the East, and parts of the West have experienced more than 50 percent increases in burned acreage between the first half of the period of record in Figures 4 and 5 (1984–2002) and the second half (2003–2021) (Figure 5). Burned acreage in the West has increased noticeably in nearly every month of the year (Figure 7).
- The peak of the U.S. wildfire season is occurring earlier (Figure 6). In 1984–2002, burned area peaked in August. More recently, it has peaked in July. An average of 1.8 million acres burned in July of each year from 2003 to 2021.

Background

Together, forests, shrubland, and grassland cover more than half of the land area in the United States.[1] These ecosystems are important resources, both environmentally and economically. Wildfires occur naturally and play a long-term role in the health of these ecosystems, changing wildfire patterns threaten to upset the status quo. Human activities have been found to change areas already led to an increase in wildfire season length, wildfire frequency, and burned area.[2,3] The wildfire season has lengthened in many areas due to factors including warmer springs, longer summer dry seasons, and drier soils and vegetation.[4] Similarly, climate change threatens to increase the frequency, extent, and severity of fires through increased temperatures and drought (see the U.S. and Global Temperature and Drought indicators).[5] Earlier spring melting and reduced snowpack (see the Snowpack indicator) result in decreased water availability during hot summer conditions, which in turn contributes to an increased wildfire risk. Lightning strikes, which start more easily and burn hotter. These trends of longer wildfire seasons and larger wildfire size are predicted to continue as more frequent and severe droughts occur.[6] In addition to climate change, other factors—land use, large-scale insect infestation, fuel availability (including invasive species such as highly flammable grasses), and management practices, including fire suppression—play an important role in wildfire frequency and intensity. All of these factors influence wildfires differently from region to region and over time, as do precipitation, wind, temperature, and topography. Nevertheless, overall trends and the understanding changes in fire characteristics requires long-term records, a regional perspective, and consideration of many factors.[7]

Wildfires have the potential to harm property, livelihoods, and human health. Fire-related threats are increasing, especially as more people live in and near forests, grasslands, and other natural areas.[8] According to the National Oceanic and Atmospheric Administration, between 1980 and 2023 the United States had 22 wildfire events that exceeded a billion dollars (when adjusted for inflation) in damage; 18 of those have occurred since 2000.[9] Over the past few decades, the United States has routinely spent more than $1 billion per year on wildfires, including $3.5 billion in 2022.[10] These efforts have resulted in the deaths of hundreds of firefighters.[11] Even in communities far downwind, wildfire smoke has been directly linked to poor air quality that can lead to significant health effects and costs to society (emergency department visits, hospital admissions, and deaths, often due to respiratory ailments).[9,12]

Beyond the human and societal impacts, wildfires also affect the Earth's climate. Forests in particular store large amounts of carbon. When they burn, they immediately release carbon dioxide into the atmosphere, which contributes to climate change. During that burning, forests also release carbon dioxide more gradually through decomposition.

About the Indicator

This indicator defines a wildfire as "a wildland fire originating from an unplanned ignition, such as lightning, volcanoes, unauthorized and accidental human-caused fires, and prescribed fires that are declared wildfires."[13] This indicator tracks four aspects of wildfires over time: the total number of fires (frequency), the total land area burned (extent), the degree of change that fires cause to the landscape (severity), and the acreage burned by fires starting in each month of the year (seasonal patterns).

The total area and total number of fires in the National Interagency Fire Center, which compiles reports from local, state, and federal agencies that are involved in fighting wildfires. The U.S. Forest Service tracked similar data using a different reporting system until 1997. Those data have been added to this indicator for comparison. Data collected over the entire period of record are available for each state from the Monitoring Trends in Burn Severity (MTBS) project, which provides the location, ignition date, size, and other statistics for every individual wildfire that meets certain size criteria (≥ 1,000 acres in the western United States or ≥ 500 acres in the eastern United States). MTBS compares the "greenness" of satellite images taken before and after a fire to classify how severely the land has been burned. Burn severity provides an indication of the ecological damage and how long the effects of wildfires are likely to last.

Although some nationwide fire data have been collected since the early 1900s, this indicator starts in 1983 (Figures 1 and 2) and 1984 (Figures 3 through 7), when nationwide data collection became more complete and standardized. EPA divided the United States into Forest Service Regions 5, 6, and 7 into two roughly equal halves to compare changes in wildfire characteristics over time.

About the Data

Indicator Notes

Many environmental impacts associated with climate change can affect the severity and timing of the wildfire season, including changes in temperature, precipitation, and drought. Short-term weather conditions (dryness, temperature, wind, lightning) influence the likelihood of ignition, where and how quickly fires spread, and how they behave. Long-term climate patterns also play a role by creating conditions that may be conducive to wildfire (for example, a multi-year regional drought). Human activities and land management practices also affect wildfire activity, and preferred practices in wildfire management have evolved over time. Past practices that favored complete wildfire prevention to more recent policies of wildland fire use to suppress and control burns. Resources available to fight and manage wildfires can also impact the amount of area burned over time.

While this indicator is limited to "wildland" fires, it includes fires that encroach on—or perhaps started in—developed areas. Increased development in previously wild lands could also contribute to wildfire frequency and extent. The total number of fires may also vary due to reporting irregularities, as fires that split or merge together across jurisdictional lines may be counted differently.

Along with the influence of ongoing climate change, wildfire patterns can be influenced by natural climate cycles that tend to shift every few decades. Thus, with less than four decades of data shown here, it might be challenging to draw conclusions about long-term trends. While a longer record would be ideal, data from before 1983 are not consistent or detailed enough nationally to be included in this indicator.

Data Sources

The full set of wildfire frequency and burned acreage data in Figures 1 and 2 comes from the National Interagency Fire Center (NIFC), which compiles data from several federal, state, and federal entities that are involved in fighting fires. These data are available online at: www.nifc.gov/fire-information/statistics. Additional data were provided by the U.S. Forest Service based on a different set of records, referred to as Smoke Bear Reports. Burn severity data, state-by-state acreage totals, and monthly acreage data in Figures 3 through 7 come from the MTBS multi-agency project, which maintains a database of wildfire events across the United States. These data are publicly available at: www.mtbs.gov/direct-download.

Technical Documentation

- Download related technical information (pdf)

References

[1] NIFC (Multi-Resolution Land Characteristics) Consortium. (2019). *National Land Cover Database 2016 (NLCD2016) statistics for 2016*. www.mrlc.gov/data/statistics/national-land-cover-database-2016-nlcd2016-statistics-2016

[2] Dobrja, S. M., Crimmins, A. R., Byron, R. G., East, A. E., Winslow, M., O'Neill, S. M., Peterson, D. L., Pierce, J. R., Raymond, C., Trugeli, A., & Vaidyanathan, A. (2023). Focus on western wildfires. In *USGCRP (5.5). Global Change Research Program), Fifth National Climate Assessment*. https://doi.org/10.7930/NCA5.2023.CF

[3] Westerling, A. L. (2016). Increasing western US forest wildfire activity: Sensitivity to changes in the timing of spring. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *371*(1696), 20150178. https://doi.org/10.1098/rstb.2015.0178

[4] Stein, S. M., Menakis, J., Carr, M. A., Comas, S. J., Stewart, S. I., Cleveland, H., Bramwell, L., & Radeloff, V. C. (2013). *Wildfire, wildlands, and people: Understanding and preparing for wildfire in the wildland-urban interface* (General Technical Report RMRS-GTR-299). United States Department of Agriculture. www.fs.usda.gov/research/treesearch/43916

[5] National Association of State Foresters. (2020). *Quadrennial fire review*. www.forestsandrangelands.gov/documents/strategy/foundational/qfr2020final.pdf

[6] NOAA (National Oceanic and Atmospheric Administration). (2022). *Billion-dollar weather and climate disasters*. Retrieved June 1, 2022, from www.ncei.noaa.gov/access/billions

[7] DAFC (National Interagency Fire Center). (2022). *Historical wildland fire information Federal firefighting costs: Suppression only (1985–2020)* [Data set]. Retrieved June 1, 2022, from www.nifc.gov/fire-information/statistics/suppression-costs

[8] NWCG (National Wildfire Coordinating Group). (2017). *NWCG report on wildland firefighter fatalities in the United States: 2007–2016*. www.nwcg.gov/publications/pms841

[9] Johnston, J. M., Henderson, S. B., Chen, Y., Randerson, J. T., Marlier, M., DeFries, R. S., Kinney, P., Bowman, D. M. J. S., & Brauer, M. (2012). Estimated global mortality attributable to smoke from landscape fires. *Environmental Health Perspectives*, *120*(5), 695–701. https://doi.org/10.1289/ehp.1104422

[10] Favre, N., Brennan, T., Dolwick, P., Gamble, J. L., Kacpura, S., Kolb, L., Nolte, C. G., Spero, T. L., & Zoha, L. (2016). Chapter 3: Air quality impacts. In USGCRP (U.S. Global Change Research Program), *The impacts of climate change on human health in the United States: A scientific assessment* (pp. 69–98). https://doi.org/10.7930/J0ZG6QNB

[11] Youssouf, H., Liousse, C., Roblou, L., Assamoi, E. M., Salonen, R., Maesano, C., Banerjee, S., & Annesi-Maesano, I. (2014). Non-accidental health impacts of wildfire smoke. *International Journal of Environmental Research and Public Health*, *11*(11), 11772–11804. https://doi.org/10.3390/ijerph111111772

[12] Jones, R. A., & Berrens, R. P. (2017). Application of an original wildfire smoke health cost benefits transfer protocol to the western U.S., 2005–2015. *Environmental Management*, *60*(5), 809–823. https://doi.org/10.1007/s00267-017-0918-4

[13] Favre, N., Ahman, B., Broome, R. A., Morgan, G. G., Johnston, F. H., Poulsé, G., & Rappold, A. G. (2018). The health impacts and economic value of wildland fire episodes in the U.S.: 2008–2012. *Science of the Total Environment*, *610–611*, 802–809. https://doi.org/10.1016/j.scitotenv.2017.08.024

[14] NWCG (National Wildfire Coordinating Group). (2020). *Glossary of wildfire terminology*. www.nwcg.gov/publications/pms205

[15] Peterson, W. T., & Schwing, F. B. (2003). A new climate regime in northeast Pacific ecosystems. *Geophysical Research Letters*, *30*(17). 2003GL017528. https://doi.org/10.1029/2003GL017528

[16] Kitzberger, T., Brown, P. M., Heyerdahl, E. K., Swetnam, T. W., & Veblen, T. T. (2007). Contingent Pacific–Atlantic Ocean influence on multicentury wildfire synchrony over western North America. *Proceedings of the National Academy of Sciences*, *104*(2), 543–548. https://doi.org/10.1073/pnas.0606078104

[17] NIFC (National Interagency Fire Center). (2024). *Total wildland fires and acres (1983–2023)* [Data set]. Retrieved February 21, 2024, from www.nifc.gov/fireInfo/fireInfo_stats_totalFires.html

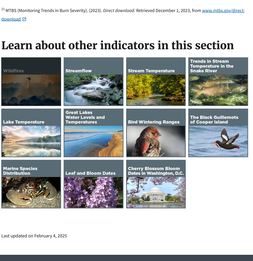
[18] USDA (U.S. Department of Agriculture) Forest Service. (2014). *1992–1997 wildland fire statistics* (prepared by USDA Forest Service, State and Private Forestry, Fire and Aviation Management staff, and supplemented with historical records provided by Forest Service staff, April 2014) [Data set].

[19] Short, K. C. (2015). Sources and implications of bias and uncertainty in a century of US wildfire activity data. *International Journal of Wildland Fire*, *24*(7), 883–891. https://doi.org/10.1071/WF14190

[20] MTBS (Monitoring Trends in Burn Severity). (2024). *Direct download*. Retrieved February 1, 2024, from www.mtbs.gov/direct-download

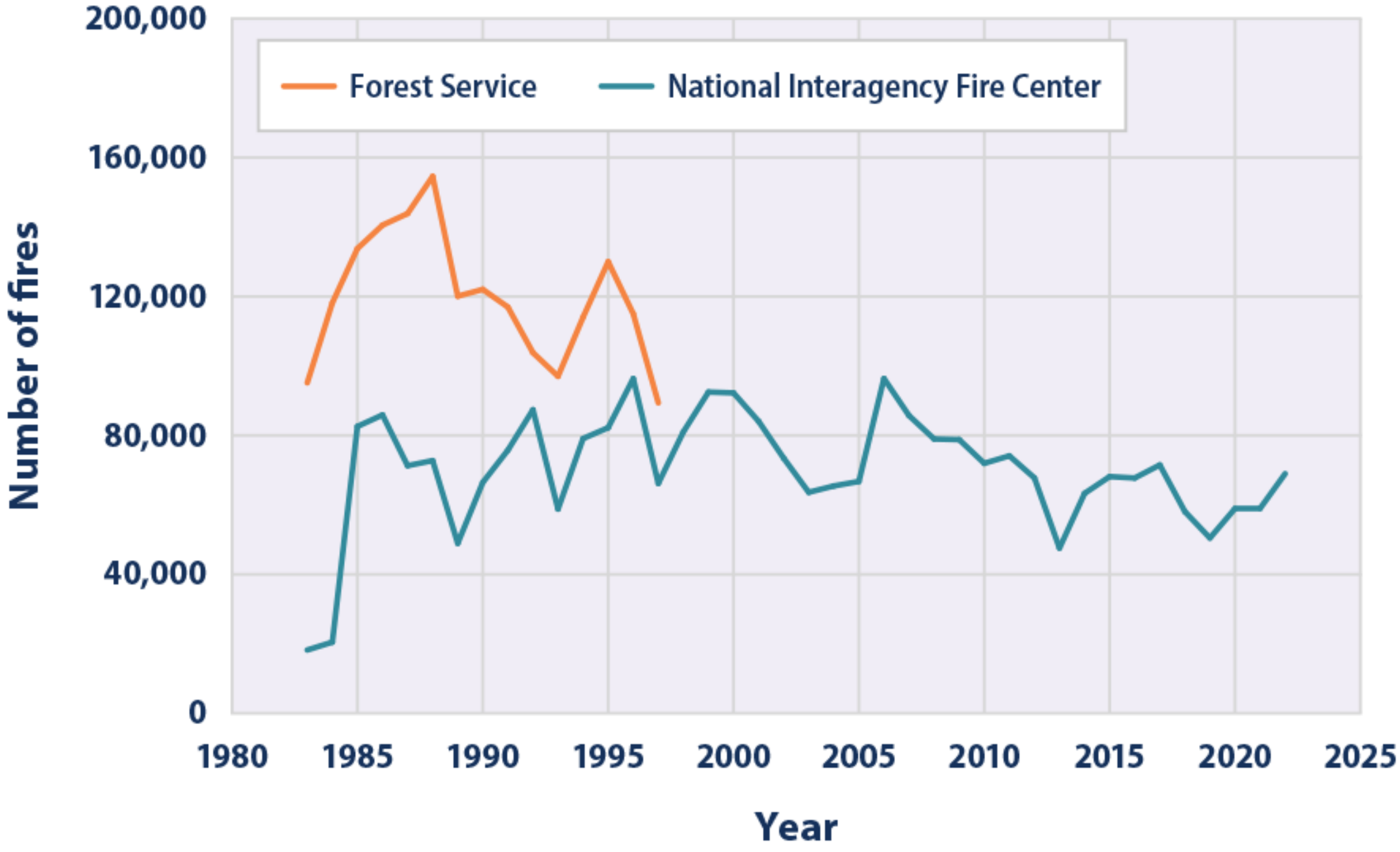
[21] MTBS (Monitoring Trends in Burn Severity). (2023). *Direct download*. Retrieved December 1, 2023, from www.mtbs.gov/direct-download

Learn about other indicators in this section



Last updated on February 4, 2025

Wildfire Frequency in the United States, 1983–2022

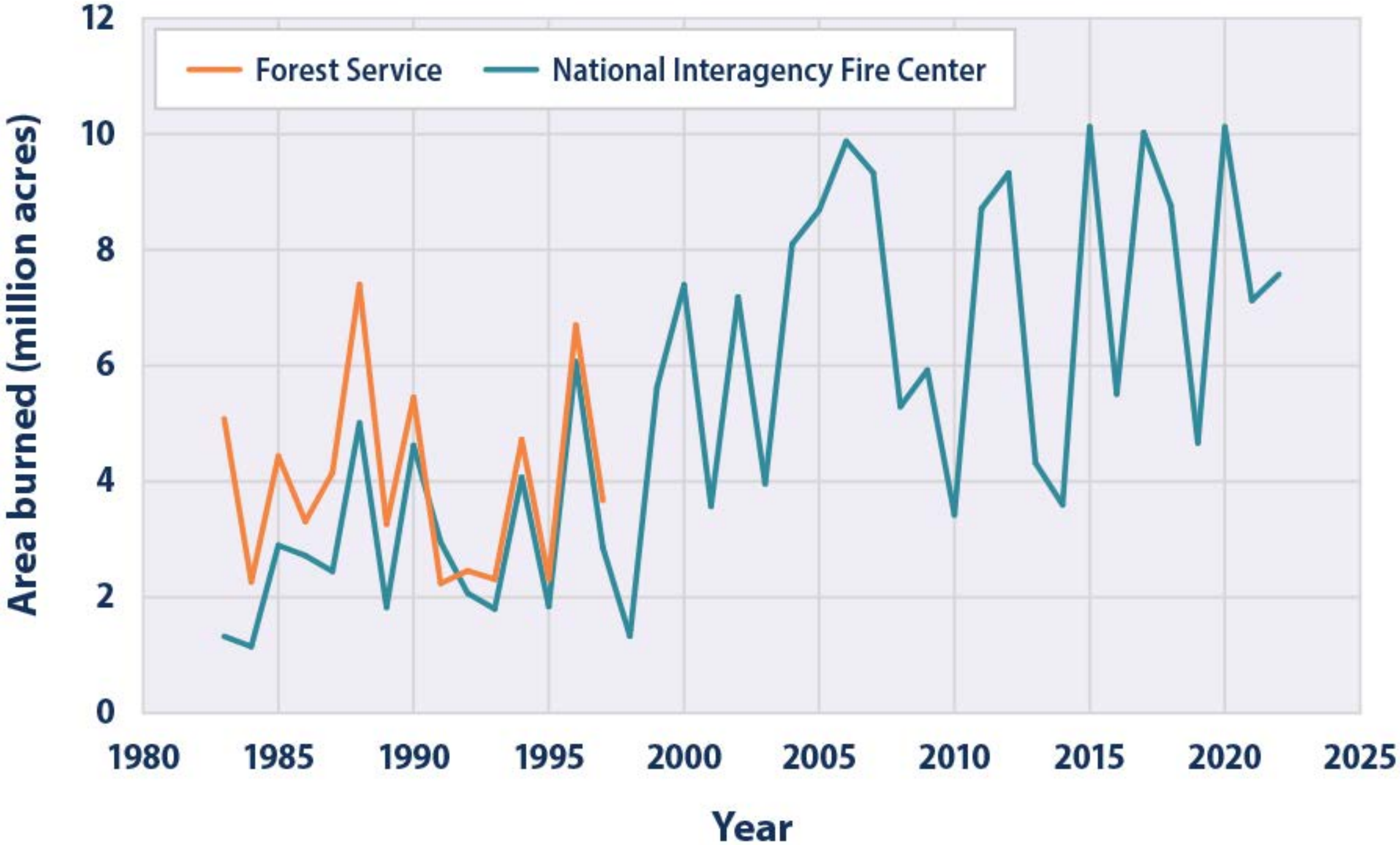


Data sources:

- NIFC (National Interagency Fire Center). (2024). *Total wildland fires and acres (1983–2023)* [Data set]. Retrieved February 21, 2024, from www.nifc.gov/fireInfo/fireInfo_stats_totalFires.html
- USDA (U.S. Department of Agriculture) Forest Service. (2014). *1991–1997 wildland fire statistics* (prepared by USDA Forest Service, State and Private Forestry, Fire and Aviation Management staff, and supplemented with historical records provided by Forest Service staff, April 2014) [Data set].

For more information, visit U.S. EPA's "Climate Change Indicators in the United States" at www.epa.gov/climate-indicators.

Wildfire Extent in the United States, 1983–2022



Data sources:

- NIFC (National Interagency Fire Center). (2024). *Total wildland fires and acres (1983–2023).* [Data set]. Retrieved February 21, 2024, from www.nifc.gov/fireInfo/fireInfo_stats_totalFires.html
- Short, K. C. (2015). Sources and implications of bias and uncertainty in a century of US wildfire activity data. *International Journal of Wildland Fire*, *24*(7), 883–891. https://doi.org/10.1071/WF14190

For more information, visit U.S. EPA's "Climate Change Indicators in the United States" at www.epa.gov/climate-indicators.

An official website of the United States government. Here's how you know

Climate Change Indicators

View the Indicators
- Greenhouse Gases
- Weather and Climate
- Oceans
- Snow and Ice
- Health and Society
- Ecosystems
  - Wildfires
  - Streamflow
  - Stream Temperature
  - Tribal Connection Trends in Stream Temperature in the Snake River
  - Lake Temperature
  - Great Lakes Water Levels and Temperatures
  - Bird Wintering Ranges
  - A Closer Look: The Black Guillemots of Cooper Island
  - Marine Species Distribution
  - Leaf and Bloom Dates
  - Community Connection: Cherry Blossom Bloom Dates in Washington, D.C.

Dig into the Data

Indicator Stories

About the Indicators

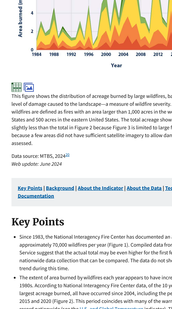
Contact Us About Climate Indicators

Climate Change Indicators: Wildfires

This indicator tracks the frequency, extent, and severity of wildfires in the United States.



Figure 3. Damage Caused by Wildfires in the United States, 1984–2021



This figure shows the distribution of acreage burned by large wildfires, based on the level of damage caused to the landscape—a measure of wildfire severity. Large wildfires are defined as fires with an area larger than 1,000 acres in the western United States and 300 acres in the eastern United States. The amount of acreage burned in this figure is slightly less than the total in Figure 2 because Figure 3 is limited to large fires and because a few areas did not have sufficient satellite imagery to allow damage to be assessed.

Data source: MTBS, 2022[1]
Web update: June 2024

Key Points | Background | About the Indicator | About the Data | Technical Documentation

Key Points

- Since 1983, the National Interagency Fire Center has documented an average of approximately 70,000 wildfires per year (Figure 1). Compiled data from the Forest Service suggest that the actual total may be even higher for the first few years of nationwide data collection that can be compared. The data do not show an obvious trend during this time.
- The extent of area burned by wildfires each year appears to have increased since the 1980s. According to National Interagency Fire Center data, 11 of the 20 years with the largest acreage burned, all but one occurred since 2004, including the peak years in 2015 and 2020 (Figure 2). This period coincides with many of the warmest years on record nationwide (see the U.S. and Global Temperature indicator). The largest increases occurred in western states and forested ecosystems (Figure 4).
- The late 1990s were a period of transition in certain climate cycles that tend to shift every few decades.[2] This shift—combined with other ongoing changes in temperature, drought, and snowmelt—may have contributed to warmer, drier conditions that have fueled wildfires in parts of the western United States.[3,4]
- Of the total area burned each year from 1984 to 2021, the proportion of severely land suffering severe damage has ranged from 5 to 22 percent (see the "high" category in Figure 3).
- Land area burned by wildfires varies by state. Fires burn more land in the western United States than in the East, and parts of the West and Southwest show the largest increase in burned acreage between the first half of the period (as reflected in Figures 4 and 5 (1984–2002) and the second half (2003–2021) (Figure 5). Burned acreage in the West has increased noticeably in nearly every year of the record (Figure 7).
- The peak of the U.S. wildfire season is occurring earlier (Figure 6). In 1984–2002, burned area peaked in August. More recently, it has peaked in July. An average of 1.8 million acres burned in July of each year from 2003 to 2021.

Background

Together, forests, shrubland, and grassland cover more than half of the land area in the United States.[5] These ecosystems are important resources, both environmentally and economically. Wildfires naturally occur naturally and play a long-term role in the health of these ecosystems, changing wildfire patterns threaten to upset the status quo. Wildfires can also pose risks that climate change has already led to an increase in wildfire season length, wildfire frequency, and burned area.[2,3] The wildfire season has lengthened in many areas due to factors including warmer springs, longer summer dry seasons, and drier soils and vegetation.[2] Similarly, climate change threatens to increase the frequency, duration, and severity of droughts in many regions nationwide and drought (see the U.S. and Global Temperature and Drought indicators).[2] Earlier spring melting and reduced snowpack (see the Snowpack indicator) result in increased water availability during hot summer conditions, which in turn contributes to an increased wildfire risk, allowing fires to start more easily and burn hotter. These trends of longer wildfire seasons and larger wildfire areas are predicted to continue as more frequent and longer droughts occur.[2] In addition to climate change, other factors—land use, large-scale insect infestations, fuel availability (including unusual species such as highly flammable cheatgrass), and management practices, including fire suppression—play an important role in wildfire frequency and intensity. All of these factors influencing wildfires vary greatly by region and over time, as do precipitation, wind, temperature, vegetation types, and landscape features. Therefore, understanding changes in fire characteristics requires long-term records, a regional perspective, and consideration of many factors.[3]

Wildfires have the potential to harm property, livelihoods, and human health. Fire-related threats are increasing, especially as more people live in and near forests, grasslands, and other natural areas.[3] According to the National Oceanic and Atmospheric Administration, between 1980 and 2021 the United States had 22 wildfire events that individually caused more than $1 billion in damage; 18 of those have occurred since 2000.[6] Over the past few decades, the United States has routinely spent more than $1 billion per year to fight wildfires, including $3.5 billion in 2022.[7] These efforts have resulted in the deaths of hundreds of firefighters.[8] Even in communities far downwind, wildfire smoke has been directly linked to poor air quality that can lead to significant health effects and costs to society (emergency department visits, hospital admissions, and deaths, often due to respiratory problems).[9,10]

Beyond the human and societal impacts, wildfires also affect the Earth's climate. Forests in particular store large amounts of carbon. When they burn, they immediately release carbon dioxide into the atmosphere, which in turn contributes to climate change. Wildfires can also release smaller particles that can reduce visibility through decomposition.

About the Indicator

This indicator defines a wildfire as "a wildland fire originating from an unplanned ignition, such as lightning, volcanoes, unauthorized and accidental human actions, and prescribed fires that are declared wildfires."[11] This indicator tracks four aspects of wildfires over time: the total number of fires (frequency), the total area burned (extent), the degree of damage that fires cause to the landscape (severity), and the amount of money that the federal government spends on wildfire suppression.

While this indicator is limited to "wildland" fires, it includes fires that encroach on—or perhaps started in—developed areas. Increased development in previously wild lands could also influence trends in the characteristics required to report fires. The total number of fires may also vary due to reporting irregularities, as fires that split or merge together across jurisdictional lines may be counted differently.

Along with the influence of ongoing climate change, wildfire patterns are influenced by natural climate cycles that tend to shift every few decades. Thus, with less than four decades of data shown here, it might be challenging to draw conclusions about long-term trends. While a longer record exists for some areas, data from before 1983 are not consistent or detailed enough nationally to be included in this indicator.

About the Data

Indicator Notes

Many environmental impacts associated with climate change can affect the severity and timing of the wildfire season, including changes in temperature, precipitation, and drought. Short-term weather conditions (dryness, temperature, wind, lightning) influence the likelihood of ignition, where and how long a fire spreads, and how big it gets. Longer-term climate patterns also play a role by creating conditions that may be conducive to wildfire (for example, a multi-year regional drought). Human activities and land management practices also affect wildfire severity, and preferred practices in wildfire management have evolved over time, from older policies that favored complete wildfire prevention to more recent policies that allow some managed and controlled burns. Resources available to fight and manage wildfires can also influence the amount of area burned over time.

While this indicator is limited to "wildland" fires, it includes fires that encroach on—or perhaps started in—developed areas. Increased development in previously wild lands could also influence trends in the characteristics required to report fires. The total number of fires may also vary due to reporting irregularities, as fires that split or merge together across jurisdictional lines may be counted differently.

Along with the influence of ongoing climate change, wildfire patterns are influenced by natural climate cycles that tend to shift every few decades. Thus, with less than four decades of data shown here, it might be challenging to draw conclusions about long-term trends. While a longer record exists for some areas, data from before 1983 are not consistent or detailed enough nationally to be included in this indicator.

Data Sources

The full set of wildfire frequency and burned acreage data in Figures 1 and 2 comes from the National Interagency Fire Center, which compiles wildfire reports sent from local, state, and federal entities that are involved in fighting fires. These data are available online at: www.nifc.gov/fire-information/statistics [2]. Additional data were provided by the U.S. Forest Service based on a different set of records, referred to as Smokey Bear Reports. Burn severity data by state (Figure 4) and ecoregion (Figure 5) for acreage data in Figures 3 through 7 come from the MTBS multi-agency project, which maintains a database of wildfire events across the United States. Data are available at: www.mtbs.gov/direct-download [1].

Technical Documentation

- Download related technical information (pdf)

References

1 MRLC (Multi-Resolution Land Characteristics) Consortium. (2019). *National Land Cover Database 2016 (NLCD2016) statistics for 2016.* www.mrlc.gov/data-statistics/national-land-cover-database-2016-nlcd2016-statistics-2016 [2]

2 Dodgy, S. M., Crimmins, A. R., Byron, K. G., East, A. E., Mindrup, M., O'Neill, S. M., Peterson, D. L., Pierce, J. R., Raymond, C., Rupp, T. A., & Vadyvaloo, A. (2022). Focus on extremes. In *USGCRP (U.S. Global Change Research Program), Fifth National Climate Assessment.* https://doi.org/10.7930/NCA5.2023.F3 [2]

3 Westerling, A. L. (2016). Increasing western US forest wildfire activity: Sensitivity to changes in the timing of spring. *Philosophical Transactions of the Royal Society B: Biological Sciences, 371*(1696), 20150178. https://doi.org/10.1098/rstb.2015.0178 [2]

4 Stein, S. M., Menakis, J., Carr, M. A., Comas, S. J., Stewart, S. I., Cleveland, H., Bramwell, L., & Radeloff, V. C. (2012). *Wildfire, wildlands, and people: Understanding and preparing for wildfire in the wildland-urban interface* (General Technical Report RMRS-GTR-299). United States Department of Agriculture. www.fs.usda.gov/research/treesearch/43016 [2]

5 National Association of State Foresters. (2006). *Quadrennial fire review.* www.forestsandrangelands.gov/documents/strategy/QuadrennialFireReview.pdf [2]

6 NOAA (National Oceanic and Atmospheric Administration). (2022). *Billion-dollar weather and climate disasters.* Retrieved June 1, 2022, from www.ncei.noaa.gov/access/billions [2]

7 NIFC (National Interagency Fire Center). (2022). *Historical wildland fire information: Federal firefighting costs: Suppression only (1985–2020)* [Data set]. Retrieved June 1, 2022, from www.nifc.gov/fire-information/statistics/suppression-costs [2]

8 NWCG (National Wildfire Coordinating Group). (2017). *NWCG report on wildland fire fatalities in the United States: 2007–2016.* www.nwcg.gov/publications/pms841 [2]

9 Johnston, F. H., Henderson, S. B., Chen, Y., Randerson, J. T., Marlier, M., DeFries, R. S., Kinney, P., Bowman, D. M. J. S., & Brauer, M. (2012). Estimated global mortality attributable to smoke from landscape fires. *Environmental Health Perspectives, 120*(5), 695–701. https://doi.org/10.1289/ehp.1104422 [2]

10 Fann, N., Brennan, T., Dolwick, P., Gamble, J. L., Ilacqua, V., Kolb, L., Nolte, C. G., Spero, T. L., & Ziska, L. (2016). Chapter 3: Air quality impacts. In *USGCRP (U.S. Global Change Research Program), The impacts of climate change on human health in the United States: A scientific assessment* (pp. 69–98). https://doi.org/10.7930/J0GQ9B4K [2]

11 Youssouf, H., Liousse, C., Roblou, L., Assamoi, E.-M., Salonen, R., Maesano, C., Banerjee, S., & Annesi-Maesano, I. (2014). Non-accidental health impacts of wildfire smoke. *International Journal of Environmental Research and Public Health, 11*(11), 11772–11804. https://doi.org/10.3390/ijerph111111772 [2]

12 Jones, B. A., & Berrens, R. P. (2017). Application of an original wildfire smoke health cost benefits transfer protocol to the western U.S., 2005–2013. *Environmental Management, 60*(5), 809–822. https://doi.org/10.1007/s00267-017-0898-4 [2]

13 Fann, N., Alman, B., Broome, R. A., Morgan, G. G., Johnston, F. H., Pouliot, G., & Rappold, A. G. (2018). The health impacts and economic value of wildfire emissions. *Science of the Total Environment, 610–611*, 802–809. https://doi.org/10.1016/j.scitotenv.2017.08.024 [2]

14 NWCG (National Wildfire Coordinating Group). (2020). *Glossary of wildland fire terminology.* www.nwcg.gov/publications/pms205 [2]

15 Peterson, M. T., & Schaeg, C. B. (2002). A new climate regime in northeast Pacific ecosystems. *Geophysical Research Letters, 30*(17), 2005(6):ESC7526. https://doi.org/10.1029/2002GL015526 [2]

16 Kitzberger, T., Brown, P. M., Heyerdahl, E. K., Swetnam, T. W., & Veblen, T. T. (2007). Contingent Pacific-Atlantic Ocean influence on multicentury wildfire synchrony over western North America. *Proceedings of the National Academy of Sciences, 104*(2), 543–548. https://doi.org/10.1073/pnas.0606078104 [2]

17 INTC (National Interagency Fire Center). (2024). *Total wildland fires and acres (1983–2023)* [Data set]. Retrieved February 13, 2024, from www.nifc.gov/fireInfo/fireInfo_stats_totalFires.html [2]

18 USDA (U.S. Department of Agriculture) Forest Service. (2014). *1992–1997 wildland fire statistics* (prepared by USDA Forest Service, State and Private Forestry, Fire and Aviation Management staff, and supplemented with historical records provided by Forest Service staff, April 2014) [Data set].

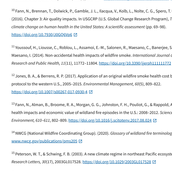
19 Short, K. C. (2015). Sources and implications of bias and uncertainty in a century of US wildfire activity data. *International Journal of Wildland Fire, 24*(7), 883–893. https://doi.org/10.1071/WF14128 [2]

20 MTBS (Monitoring Trends in Burn Severity). (2024). *Direct download.* Retrieved February 1, 2024, from www.mtbs.gov/direct-download [2]

21 MTBS (Monitoring Trends in Burn Severity). (2023). *Direct download.* Retrieved December 1, 2023, from www.mtbs.gov/direct-download [2]

Key Points | Background | About the Indicator | About the Data | Technical Documentation

Learn about other indicators in this section



Last updated on February 6, 2025

Assistance | Spanish | Arabic | Chinese (simplified) | Chinese (traditional) | French | Haitian Creole | Korean | Portuguese | Russian | Tagalog | Vietnamese

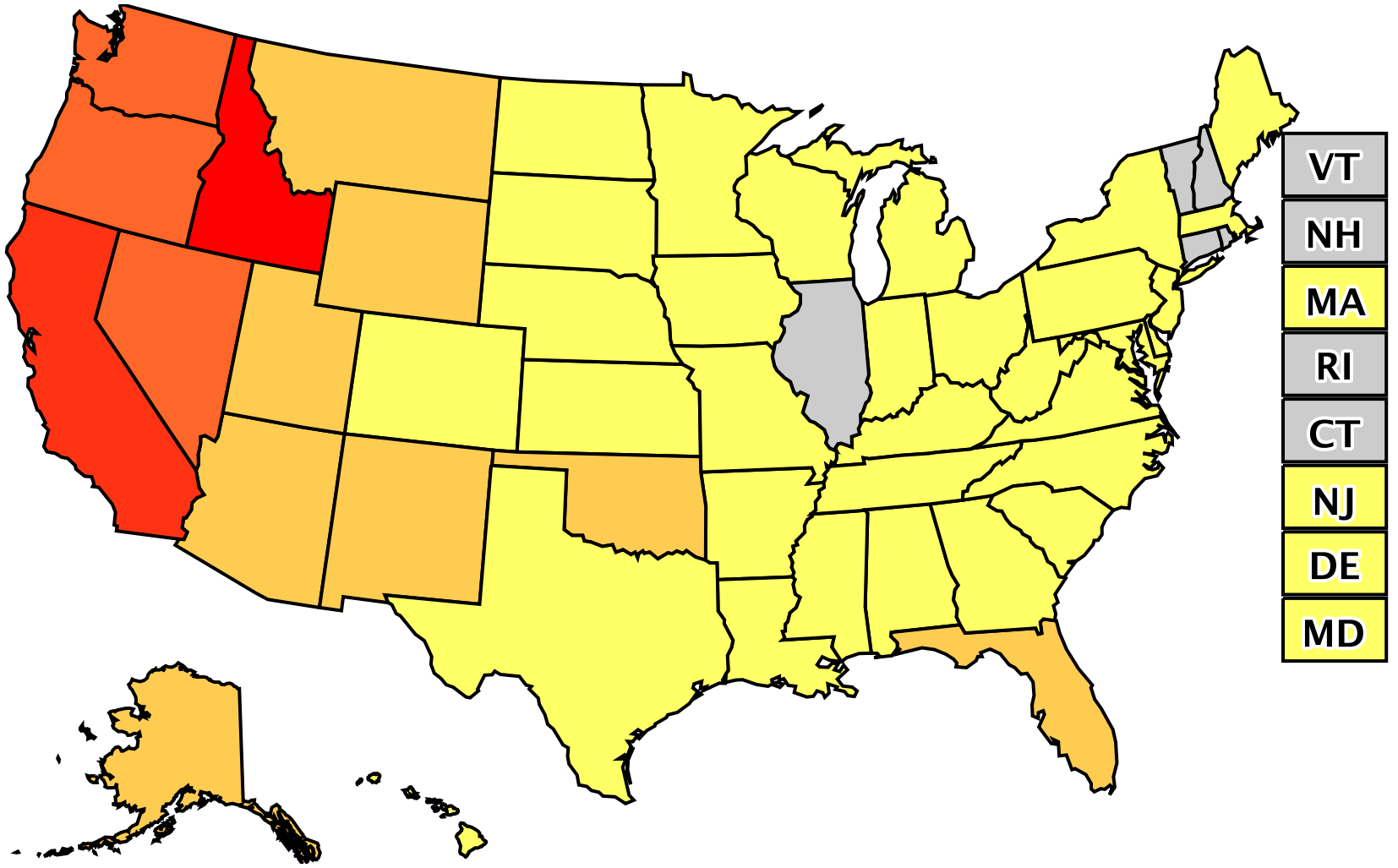
Discover.
Accessibility Statement
Budget & Performance
Contracting
EPA www Web Snapshot
Grants
No FEAR Act Data
Plain Writing
Privacy
Privacy and Security Notice

Connect.
Data
Inspector General
Jobs
Newsroom
Regulations.gov
Subscribe
USA.gov
White House

Ask.
Contact EPA
EPA Disclaimers
Hotlines
FOIA Requests
Frequent Questions
Site Feedback

Follow.

Average Annual Burned Acreage by State, 1984–2021



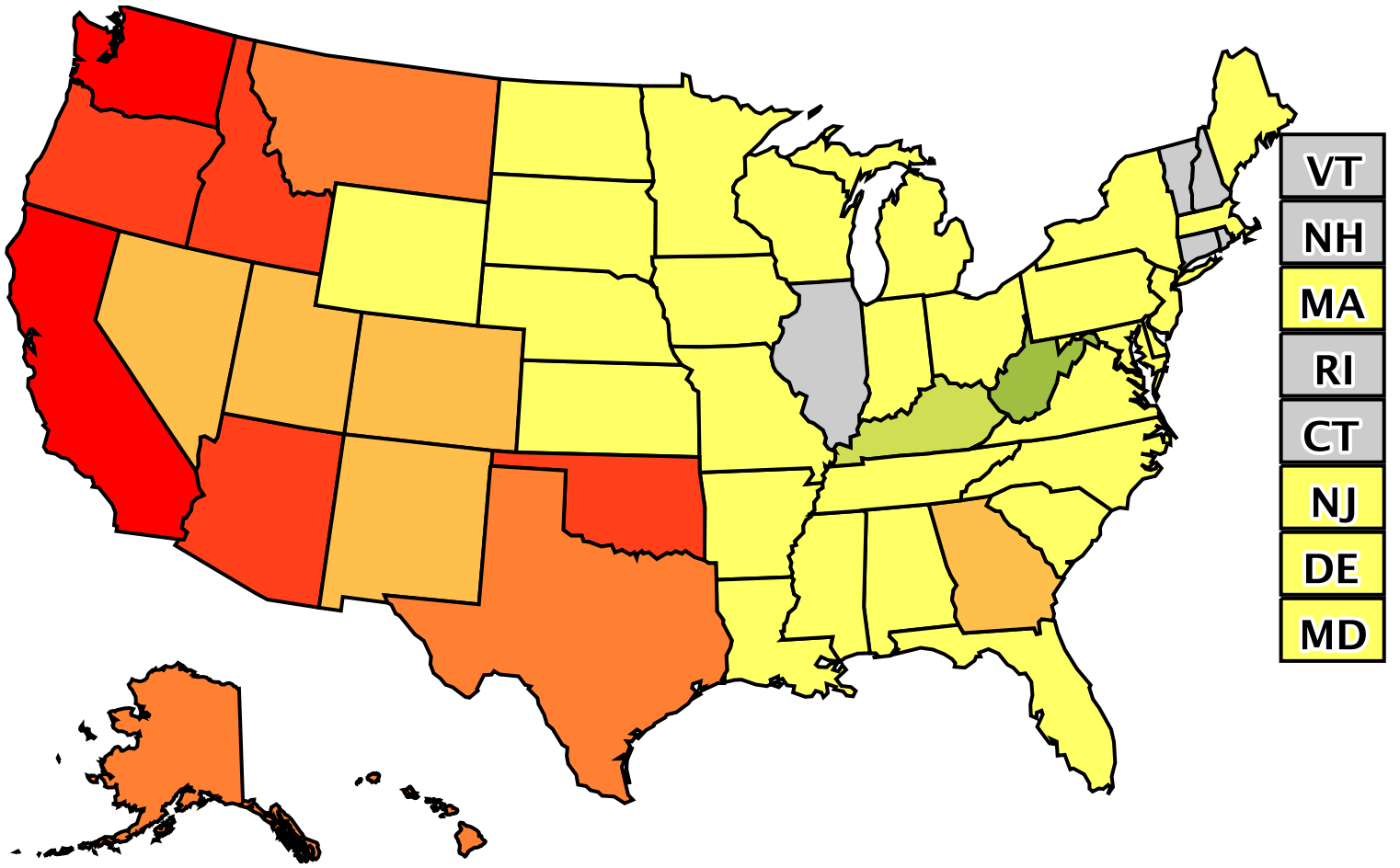
Average annual burned acres per square mile of land area:

0 1 2 3 4 5 6

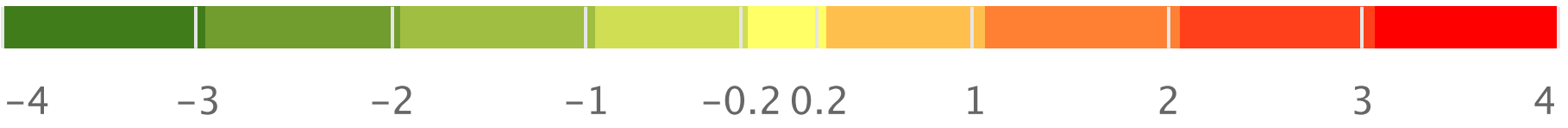
Data source: MTBS (Monitoring Trends in Burn Severity). 2024. Direct download. Retrieved February 1, 2024. www.mtbs.gov/direct-download.

For more information, visit www.epa.gov/climate-indicators.

Change in Annual Burned Acreage by State Between 1984–2002 and 2003–2021



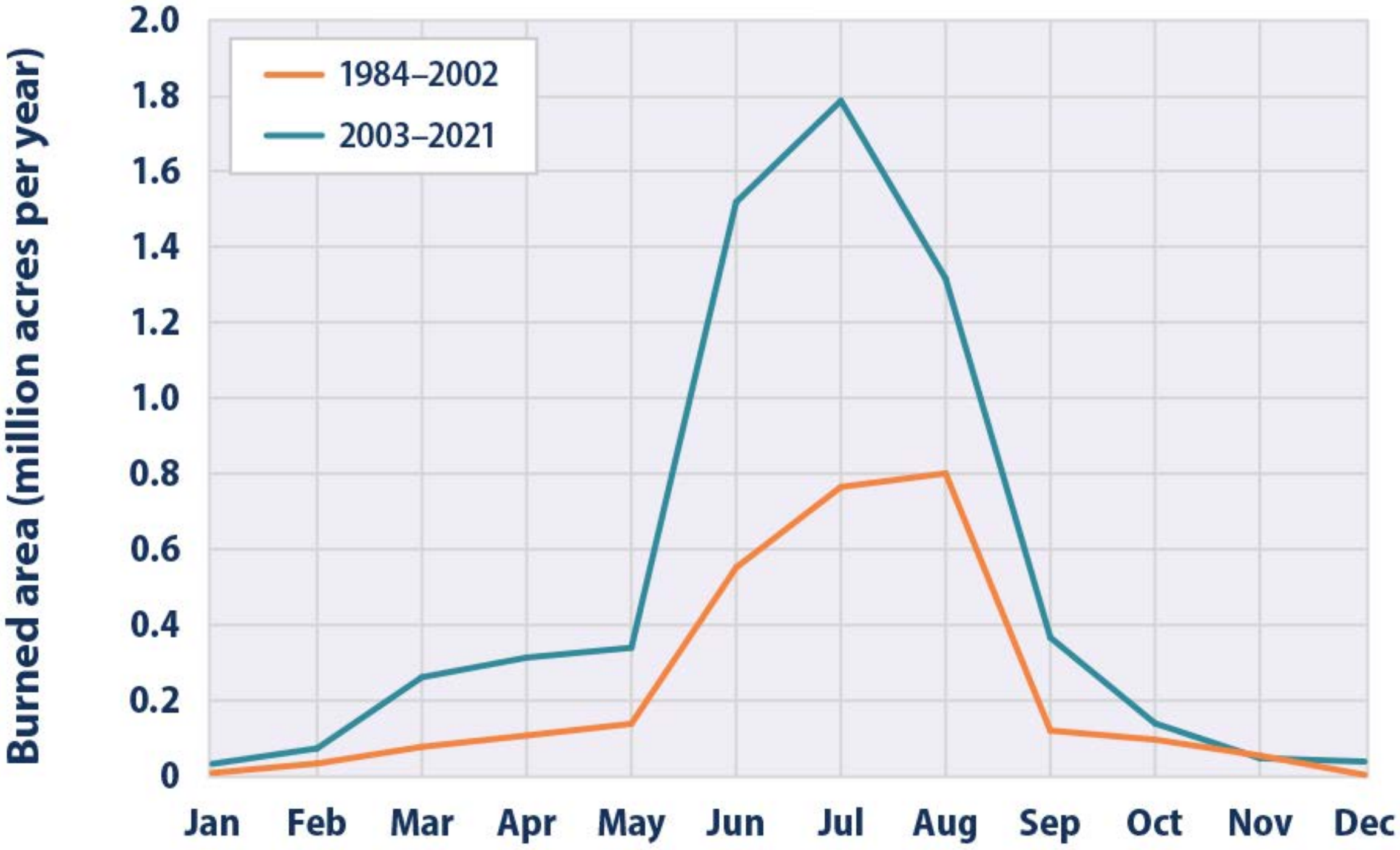
Change in burned acres per square mile of land area:



Data source: MTBS (Monitoring Trends in Burn Severity). 2024. Direct download. Retrieved February 1, 2024. www.mtbs.gov/direct-download.

For more information, visit www.epa.gov/climate-indicators.

Comparison of Monthly Burned Area Due to Wildfires in the United States Between 1984–2002 and 2003–2021



Data source: MTBS (Monitoring Trends in Burn Severity). (2023). *Direct download*. Retrieved December 1, 2023, from www.mtbs.gov/direct-download

For more information, visit U.S. EPA's "Climate Change Indicators in the United States" at www.epa.gov/climate-indicators.

Comparison of Monthly Burned Area Due to Wildfires in the Eastern and Western United States Between 1984–2002 and 2003–2021



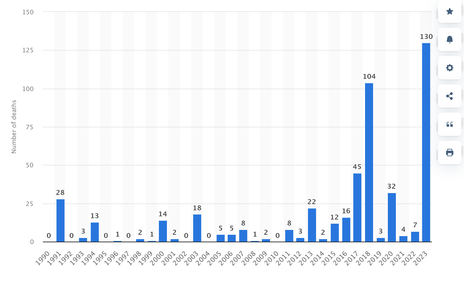
Data source: MTBS (Monitoring Trends in Burn Severity). (2023). *Direct download*. Retrieved December 1, 2023, from www.mtbs.gov/direct-download

For more information, visit U.S. EPA's "Climate Change Indicators in the United States" at www.epa.gov/climate-indicators.



PREMIUM

Number of deaths due to wildfires in the United States from 1990 to 2023



© Statista 2025

Additional Information

Show source

DOWNLOAD

PDF | XLS | PNG | PPT

Sources
- Show sources information
- Show publisher information
- Use Ask Statista Research Service

Release date
2024

Region
United States

Survey time period
1990 to 2023

Citation formats
- View options

Number of deaths caused by wildfires in the U.S. 1990-2023

Published by Erick Burgueño Salas, Dec 2, 2024

Wildfires resulted in 130 deaths in the United States in 2023. This has been the highest figure since 1990, mostly related to the Maui wildfires in Hawaii. There have been more than 500 wildfire-related deaths in the U.S. since 1990.

OTHER STATISTICS ON THE TOPIC

→ Wildfires in the U.S.

GEOGRAPHY & NATURE
Ten countries with most forest area 2022

CLIMATE AND WEATHER
Area burned by wildfires in the U.S. 2024, by state

CLIMATE AND WEATHER
Global number of deaths caused by wildfires 1990-2023

CLIMATE AND WEATHER
Area burned by wildfires in the U.S. 1983-2024

Access all statistics starting from **$2,388 USD** yearly *

* For commercial use only

BASIC ACCOUNT
For single users
$0 USD
Always free
Access limited to **Free Statistics**. Premium Statistics are not included.
✓ Free Statistics

Based on your interests

STARTER ACCOUNT
For single users
$199 USD
per month, billed annually [1]
Buy now
✓ Free Statistics
✓ Premium Statistics
The statistic on this page is a **Premium Statistic** and is **included in this account.**

PROFESSIONAL ACCOUNT
For teams of up to 5 people
$1,299 USD
per month, billed annually [1]
Buy now
✓ Free + Premium Statistics
✓ Reports
✓ Market Insights

[1] All prices do not include sales tax. The account requires an annual contract and will renew after one year to the regular list price.

Compare accounts ›

Leading companies trust Statista: PayPal Google Adobe P&G SAMSUNG T-Mobile

Related reports: Available to download in PDF or PPTX format

ALL DATA IN ONE FORMAT

Wildfires in the U.S.
27 page/s | English | PPTX | Detailed references
Everything on "Wildfires in the U.S." in one document: edited and divided into chapters, including detailed references.
Go to report

I think of Statista as Google for researchers. Statista provides you with the information you search for right away.

Dr. Horst Stipp
EVP, Research & Innovation, Advertising Research Foundation

Statistics on " Wildfires in the U.S. "

- Overview
- Scale
- Effects

The most important statistics
- Economic impact caused by wildfires in the U.S. 1991-2022
- Suppression costs of wildfires in the U.S. 1985-2023
- Structures burned by wildfires in the U.S. 2017-2024
- Number of deaths caused by wildfires in the U.S. 1990-2023
- Wildfires with the highest death tolls in U.S. history 2024
- Number of displacements caused by wildfires in the U.S. 2008-2023
- Number of people left homeless from wildfires in the U.S. 1991-2023

Discover Statista

Find statistics, forecasts and reports

Statista Search

Need help with using Statista for your research? Tutorials and first steps

Further Content: You might find this interesting as well

TOPICS
- Wildfires in the U.S.
- Global climate change
- Wildfires
- Global warming
- Climate change effects

Do you have any questions about our business solutions?

We provide you with detailed information about our Professional Account.

Contact us now



Facts + Statistics: Wildfires

Catastrophes

IN THIS FACTS + STATISTICS

Key Facts
Annual Number of Acres Burned in Wildland Fires, 1980-2024
Wildfires By State, 2023
Homes at Risk For Extreme Wildfires, By State, 2024
Top 10 States For Wildfires Ranked By Number Of Fires And By Number Of Acres Burned, 2023
Top 10 Costliest Wildland Fires In The United States (1)
Top 10 Largest California Wildfires (1)
Top 10 Most Destructive California Wildfires (1)
Top 10 Deadliest California Wildfires (1)

SHARE THIS

DOWNLOAD TO PDF

SPONSORED BY

Key Facts

- According to federal data cited by the National Park Service, humans cause about 85 percent of all wildfires yearly in the United States.
- The Annual 2022 Wildfires Report from the National Centers for Environmental Information indicates that over 7.5 million acres of wildland were consumed by fire that year.
- According to the National Interagency Fire Center, California leads the country with the most wildfires and the most acres burned. California-specific charts below on the Top 10 largest, most destructive, and deadliest wildfires.

Annual Number of Acres Burned in Wildland Fires, 1980-2023



Source: National Interagency Fire Center.

View Archived Graphs

Wildfires By State, 2023

State	Number of fires	Number of acres burned
Alabama	1,856	18,335
Alaska	646	314,276
Arizona	1,837	188,483
Arkansas	147	5,659
California	7,064	332,722
Colorado	861	41,917
Connecticut	499	297
Delaware	1	3
District of Columbia	0	0
Florida	2,730	99,642
Georgia	2,386	10,330
Hawaii	214	12,059
Idaho	892	87,801
Illinois	221	91
Indiana	47	521
Iowa	6	6
Kansas	49	17,963
Kentucky	11	39
Louisiana	1,467	22,103
Maine	493	225
Maryland	196	4,466
Massachusetts	1,079	1,468
Michigan	466	4,287
Minnesota	836	9,410
Mississippi	2,383	52,508

(1) Includes Puerto Rico. Totals for the United States do not match totals shown elsewhere by the National Interagency Fire Center due to the use of different exhibits.

Source: National Interagency Fire Center.

View Archived Tables

Homes At Risk For Extreme Wildfires, By State, 2024

Rank	State	Number of housing units
1	California	1,258,748
2	Colorado	321,294
3	Texas	244,617
4	Oregon	129,567
5	Arizona	124,603
6	New Mexico	120,093
7	Idaho	104,782
8	Montana	89,152
9	Utah	67,023
10	Washington	59,563
11	South Dakota	26,697
12	Nevada	22,768
13	Wyoming	16,215
14	Oklahoma	1,624

Source: CoreLogic®, a property data and analytics company.

View Archived Tables

Top 10 States For Wildfires Ranked By Number Of Fires And By Number Of Acres Burned, 2023

Rank	State	Number of fires	Rank	State	Number of acres burned
1	California	7,064	1	California	332,722
2	Texas	7,102	2	Alaska	314,276
3	North Carolina	5,214	3	New Mexico	212,378
4	Florida	2,730	4	Texas	210,264
5	Georgia	2,386	5	Oregon	202,035
6	Mississippi	2,383	6	Arizona	188,483
7	Oregon	1,979	7	Nebraska	180,733
8	Pennsylvania	1,910	8	Oklahoma	162,489
9	Alabama	1,856	9	Washington	151,216
10	Arizona	1,837	10	Montana	123,133

Source: National Interagency Fire Center.

View Archived Tables

Top 10 Costliest Wildland Fires In The United States (1)

($ millions)

Rank	Year	Name	Estimated insured loss	
			Dollars when occurred	In 2024 dollars (2)
1	2018	Camp Fire	$10,000	$12,524
2	2017	Tubbs Fire	8,700	11,134
3	2018	Woolsey Fire	4,200	5,260
4	2023	Maui Wildfire (Hawaii)	4,300	4,421
5	1991	Oakland Fire (Tunnel)	1,700	3,906
6	2017	Atlas Fire	3,000	3,839
7	2020	Glass Fire	2,950	3,578
8	2020	CZU Lightning Complex Fire	2,500	3,032
9	2017	Thomas Fire	2,250	2,881
10	2021	Marshall Fire (Colorado)	2,500	2,831

(1) Includes losses sustained by private insurers and government-sponsored programs such as the National Flood Insurance Program. All fires on this list occurred in California unless otherwise noted. Includes Puerto Rico and the U.S. Virgin Islands. Subject to change as loss estimates are further developed. As of January 2025. (2) Adjusted for inflation by Bell using the U.S. Consumer Price Index.

Source: Aon.

View Archived Tables

Top 10 Largest California Wildfires (1)

Rank	Fire name (cause)	Date	County	Acres	Str.
1	August Complex (Lightning)	August 2020	Mendocino, Humboldt, Trinity, Tehama, Glenn, Lake, & Colusa	1,032,648	
2	Dixie (Powerlines)	July 2021	Butte, Plumas, Lassen, Shasta & Tehama	963,309	
3	Mendocino Complex (Human Related)	July 2018	Colusa, Lake, Mendocino & Glenn	459,123	
4	Park Fire (Arson)	July 2024	Butte, Plumas, Shasta & Tehama	429,603	
5	SCU Lightning Complex (Lightning)	August 2020	Stanislaus, Santa Clara, Alameda, Contra Costa, & San Joaquin	396,625	
6	Creek (Undetermined)	September 2020	Fresno & Madera	379,895	
7	LNU Lightning Complex (Lightning/Arson)	August 2020	Napa, Solano, Sonoma, Yolo, Lake, & Colusa	363,220	
8	North Complex (Lightning)	August 2020	Butte, Plumas, & Yuba	318,935	
9	Thomas (Powerlines)	December 2017	Ventura & Santa Barbara	281,893	
10	Cedar (Human Related)	October 2003	San Diego	273,246	

(1) As of October 2024.

Source: Cal fire.

View Archived Tables

Top 10 Most Destructive California Wildfires (1)

Rank	Fire name and cause	Date	County	Acres	Structures (2)	Deaths
1	Camp Fire (Powerlines)	November 2018	Butte	153,336	18,804	85
2	Tubbs (Electrical)	October 2017	Napa & Sonoma	36,807	5,636	22
3	Palisades (3)	January 2025	Los Angeles	20,438	5,316	3
4	Eaton (3)	January 2025	Los Angeles	13,690	5,000+	2
5	Tunnel - Oakland Hills (Rekindle)	October 1991	Alameda	1,600	2,900	25
6	Cedar (Human related)	October 2003	San Diego	273,246	2,820	15
7	North Complex (Lightning)	August 2020	Butte, Plumas, & Yuba	318,935	2,352	15
8	Valley (Electrical)	September 2015	Lake, Napa and Sonoma	76,067	1,958	4
9	Witch (Powerlines)	October 2007	San Diego	197,990	1,650	2
10	Woolsey (Electrical)	November	Ventura	96,949	1,643	3

(1) As of January 2025.
(2) "Structures" includes homes, outbuildings (barns, garages, sheds, etc) and commercial properties destroyed. This list does not include fire suppression. There are the Top 20 regardless of whether they were state, federal, or local responsibility.
(3) Under investigation.

Source: Cal fire.

View Archived Tables

Top 10 Deadliest California Wildfires (1)

Rank	Fire name and cause	Date	County	Acres	Structures	Deaths
tbd	Camp Fire (Power lines)	November 2018	Butte	153,336	18,804	85
2	Griffith Park (Unknown)	October 1933	Los Angeles	47	0	29
3	Tunnel - Oakland Hills (Rekindle)	October 1991	Alameda	1,600	2,900	25
4	Tubbs (Electrical)	October 2017	Napa & Sonoma	36,807	5,643	22
5	North Complex (Lightning)	August 2020	Butte, Plumas, & Yuba	318,935	2,352	15
6	Cedar (Human related)	October 2003	San Diego	273,246	2,820	15
7	Rattlesnake (Arson)	July 1953	Glenn	1,340	0	15
8	Loop (Unknown)	November 1966	Los Angeles	2,028	0	12
9	Hauser Creek (Human related)	October 1943	San Diego	12,145	0	11
10	Inaja (Human related)	November 1956	San Diego	43,904	0	11

(1) As of January 2024.

Source: Cal fire.

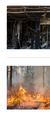
View Archived Tables

Back to top

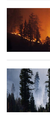
You May Also Like



CATASTROPHES
Spotlight on: Catastrophes - Insurance Issues



CATASTROPHES | HOMEOWNERS
Background on: Wildfires



DISASTERS + PREPAREDNESS
Insurance for wildfires



DISASTERS + PREPAREDNESS
Wildfires: insurance and recovery resources

© Copyright 2025, Insurance Information Institute, Inc.
All Rights Reserved.

The Latest Data Confirms: Forest Fires Are Getting Worse

August 13, 2019 By Jessica Mud'ony, Jessica Richter-Jacobs, Mikaela Weisse and Nancy Harris Email
Image by Sunny Sadowski Illustrations

Finding

Tags: Forests

Also on
[Afrikaans](#)
[Français](#)
[Português](#)
[Bahasa Indonesia](#)

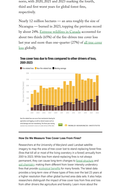
Portugues Français Español Bahasa Indonesia

The latest data are in: forest fires continue what we've long known to be an increasing scare widespread, burning at least twice as much tree cover today as they did two decades ago.

Using [new](#) forest researchers at the University of Maryland, Global Forest Watch updated its recent data for 2001 to 2018, we calculated that the area burned by forest fires around the world in 2001 was 2.9 million hectares. By 2018, that annual area burned had grown to more than 4.3 million hectares – an increase of 48 percent.

This is also making a larger share of global tree cover loss, which includes harvesting and storm damage, than it was in 2001. In that year, forest fires made up 23 percent of all tree cover loss. By 2018, they accounted for nearly 35%.

Nearly 10 million hectares — an area roughly the size of Nicaragua — burned in 2015, topping the previous record set in 2003. Fires burned more than 12 million hectares in 2016, more than double the 2001 total. Fire activity has since fallen back but year and more than one-quarter (27%) of all [tree cover](#) loss globally.



Tree cover loss by fires compared to other drivers of loss, 2001-2018



This increase in fire activity has been widely visible in recent years, including [record](#) burn [data](#) set [burning](#) in the years, with 2020, 2021 and 2023 ranking the fourth, third and second most years for tree cover loss, respectively.

Nearly 10 million hectares — an area roughly the size of Nicaragua — burned in 2015, topping the previous record set in 2003. Fires burned more than 12 million hectares in 2016, more than double the 2001 total. Fire activity has since fallen back but year and more than one-quarter (27%) of all [tree cover](#) loss globally.

How Can We Measure Tree Cover Loss From Fires?

Mapping the extent of forest fires is complicated and the frequency of the fires can make it difficult to detect. Fires that kill all or most of the living canopies is a broad-canopy loss event, but fires that burn through the forest understory sometimes they can cause long-term changes to [ecosystems](#) without [forest](#) affected from tree- [canopy](#) cover. Fires can also [burn](#) through [peatlands](#) underground and smolder for months, releasing [carbon](#) dioxide and [particulate](#) matter into the atmosphere. Further exacerbating climate change and contributing to more fires as part of a "[fire-climate feedback loop](#)."

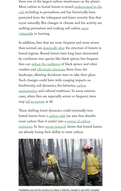


Climate Change Is Making Fires Worse

Climate change is one of the major drivers behind [increased](#) forest fires in the Canadian boreal forest, [more likely](#) today than they were 1700 years ago and [more](#) than [double](#) the [area](#) burned in the past 30 years. Scientists have [linked](#) the [increase](#) in [drivers](#) of [landscape](#) and [fires](#) to the [earlier](#) [snowmelt](#) and [longer](#) [warm](#) [frequent](#) [fires](#).

When forests burn, they release carbon that is stored in the trunks, branches and leaves, as well as in carbon stored underground in the soil. As forest fires become more frequent and intense, they release more carbon, further exacerbating climate change and contributing to more fires as part of a "[fire-climate feedback loop](#)."

This and Its Climate Feedback Loop



This feedback loop, combined with the expansion of human activities into forested areas, is driving much of the increase in fire activity we see today. As climate-linked forest fires burn longer areas, they affect more people and damage more property.

Here's a look at some of the places most impacted by increasing forest fires based on the latest data.

Mounting Temperatures Are Fueling More Severe Fires in Boreal Forests

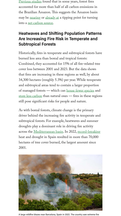
The [Arctic](#) region — roughly 70% — of all the [colossal](#) [forests](#) on Earth, [store](#) [more](#) [carbon](#) than [any](#) [other](#) [terrestrial](#) [ecosystem](#). Though this is a [natural](#) part of how boreal forests [function](#) ecologically, fire-related tree cover loss in these forests has increased by 29% since 2001. Canada [accounted](#) [for](#) [nearly](#) [one](#) [year](#) [over](#) [the](#) [last](#) [21](#) [years](#). That's about half the total global increase between 2001 and 2021.

Climate change is the main cause of increasing fire activity in boreal forests, with [warmer](#) [temperatures](#) [are](#) [increasing](#) [a](#) [longer](#) [fire](#) [season](#) [and](#) [the](#) [degree](#) [to](#) [which](#) [conditions](#) [to](#) [burn](#) [the](#) [moisture](#) [given](#) [the](#) [frequency](#) [and](#) [severity](#) and huge [human](#) [costs](#).

Annual tree cover loss due to fires by climate biomes, 2001-2021



In 2021, for example, Russia saw [1.3 million hectares](#) of fire-related tree cover loss, the most recorded for that country in any year since 2001. Canada saw its second-[worst](#) [year](#) [on](#) [record](#) [for](#) [forest](#) [fires](#) [and](#) [smoke](#) [pollution](#) [in](#) [2023](#), [with](#) [more](#) [than](#) [18](#) [million](#) [hectares](#) [burned](#) [and](#) [more](#) [than](#) [2,000](#) [fires](#) [reported](#) [in](#) [Quebec](#) [alone](#). [The](#) [amount](#) [of](#) [carbon](#) [that](#) [fuels](#) [the](#) [world's](#) [boreal](#) [forests](#) [contained](#) [from](#) [fossil](#) [fuel](#) [use](#) [in](#) [2021](#). [Those](#) [fires](#) [released](#) [more](#) [than](#) [1.76](#) [billion](#) [metric](#) [tons](#) [of](#) [carbon](#) [dioxide](#), [nearly](#) [double](#) [the](#) [annual](#) [emissions](#) [from](#) [all](#) [of](#) [Canada's](#) [fossil](#) [fuel](#) [use](#) [in](#) [2021](#).





This trend is worrying for several reasons. Boreal forests [store](#) more [carbon](#) [per](#) [hectare](#) than any other forest biome, and those [rates](#) of the largest carbon [stockpiles](#) on the planet. Most carbon is found [frozen](#) in [stored](#) [underground](#) in the [soil](#), [including](#) in [permafrost](#) [peatlands](#) that have been [protected](#) from the [subsequent](#) and [forest](#) [severity](#) [fires](#) that [can](#) [release](#) [centuries](#) [or](#) [millennia](#) [of](#) [stored](#) [carbon](#) [when](#) [they](#) [burn](#). [Fires](#) [can](#) [also](#) [damage](#) [soil](#) [structure](#), [making](#) [it](#) [more](#) [vulnerable](#) to [burning](#).

In addition, fires that are more frequent and more severe than normal can [drastically](#) [alter](#) the structure of forests in ways that [can](#) [be](#) [difficult](#) [to](#) [recover](#) [from](#). [Forests](#) [can](#) [be](#) [transformed](#) [from](#) [conifer](#) [to](#) [deciduous](#) [dominated](#) [forests](#) [after](#) [the](#) [black](#) [spruce](#) [has](#) [been](#) [destroyed](#). [For](#) [example](#), [when](#) [fires](#) [reduce](#) [the](#) [number](#) [of](#) [black](#) [spruce](#) [and](#) [other](#) [conifers](#) [and](#) [allow](#) [for](#) [more](#) [sun](#) [to](#) [reach](#) [the](#) [forest](#) [floor](#), [the](#) [landscape](#) [allowing](#) [deciduous](#) [trees](#) [to](#) [take](#) [their](#) [place](#). [Such](#) [changes](#) [can](#) [affect](#) [the](#) [habitat](#) [for](#) [species](#) [that](#) [depend](#) [on](#) [coniferous](#) [forests](#), [including](#) [caribou](#), [moose](#), [and](#) [lynx](#).

In addition, fires that are more frequent and more severe than normal can [drastically](#) [alter](#) the structure of forests in ways that [can](#) [be](#) [difficult](#) [to](#) [recover](#) [from](#). [Forests](#) [can](#) [be](#) [transformed](#) [from](#) [conifer](#) [to](#) [deciduous](#) [dominated](#) [forests](#) [after](#) [the](#) [black](#) [spruce](#) [has](#) [been](#) [destroyed](#). [For](#) [example](#), [when](#) [fires](#) [reduce](#) [the](#) [number](#) [of](#) [black](#) [spruce](#) [and](#) [other](#) [conifers](#) [and](#) [allow](#) [for](#) [more](#) [sun](#) [to](#) [reach](#) [the](#) [forest](#) [floor](#), [the](#) [landscape](#) [allowing](#) [deciduous](#) [trees](#) [to](#) [take](#) [their](#) [place](#). [Such](#) [changes](#) [can](#) [affect](#) [the](#) [habitat](#) [for](#) [species](#) [that](#) [depend](#) [on](#) [coniferous](#) [forests](#), [including](#) [caribou](#), [moose](#), [and](#) [lynx](#).



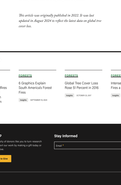
Another [threat](#) [to](#) [boreal](#) [forests](#) [is](#) [increasing](#) [tree](#) [cover](#) [loss](#) [due](#) [to](#) [fires](#) [in](#) [the](#) [tropics](#) [is](#) [causing](#) [higher](#) [carbon](#) [emissions](#). [Previous](#) [studies](#) [have](#) [found](#) [that](#) [forests](#) [have](#) [been](#) [accounted](#) [for](#) [more](#) [than](#) [half](#) [of](#) [all](#) [carbon](#) [emissions](#) [in](#) [the](#) [tropics](#) [in](#) [2021](#), [and](#) [that](#) [the](#) [tropics](#) [have](#) [been](#) [the](#) [source](#) [of](#) [almost](#) [a](#) [tripling](#) [of](#) [carbon](#) [dioxide](#) [emissions](#) [since](#) [the](#) [early](#) [2000s](#).

Agricultural Expansion and Forest Degradation Are Making Fires in Tropical Forests

In contrast to boreal forests, [most](#) [studying](#) [fires](#) [are](#) [not](#) [a](#) [natural](#) [part](#) [of](#) [the](#) [ecosystem](#) [in](#) [tropical](#) [forests](#). [Most](#) [fires](#) [are](#) [occurring](#) [in](#) [this](#) [region](#) [as](#) [well](#). [Over](#) [the](#) [last](#) [21](#) [years](#), [the](#) [related](#) [tree](#) [cover](#) [loss](#) [in](#) [the](#) [tropics](#) [increased](#) [at](#) [a](#) [rate](#) [of](#) [about](#) [20%](#) [faster](#) [than](#) [the](#) [overall](#) [rate](#) [of](#) [tree](#) [cover](#) [loss](#) [in](#) [the](#) [tropics](#), [which](#) [increased](#) [by](#) [roughly](#) [10%](#) [of](#) [the](#) [total](#) [global](#) [increase](#) [in](#) [tree](#) [cover](#) [loss](#) [from](#) [fires](#) [in](#) [the](#) [tropics](#).

Though fires are responsible for less than 10% of all tree cover loss in the tropics, [deforestation](#) [and](#) [other](#) [human-driven](#) [commodity-driven](#) [deforestation](#) [and](#) [shifting](#) [agriculture](#) [make](#) [tropical](#) [forests](#) [less](#) [resilient](#) [and](#) [more](#) [susceptible](#) [to](#) [fires](#). [Logging](#) [roads](#) [and](#) [forest](#) [degradation](#) [have](#) [also](#) [opened](#) [up](#) [previously](#) [untouched](#) [forests](#) [to](#) [human](#) [activity](#) [and](#) [fragmented](#) [and](#) [fire-prone](#) [ecosystems](#), [making](#) [them](#) [more](#) [flammable](#) [and](#) [vulnerable](#) to [burning](#).

In addition, fires that are more frequent and more severe than normal can [drastically](#) [alter](#) the structure of forests in ways that [can](#) [be](#) [difficult](#) [to](#) [recover](#) [from](#). [Forests](#) [can](#) [be](#) [transformed](#) [from](#) [conifer](#) [to](#) [deciduous](#) [dominated](#) [forests](#) [after](#) [the](#) [black](#) [spruce](#) [has](#) [been](#) [destroyed](#). [For](#) [example](#), [when](#) [fires](#) [reduce](#) [the](#) [number](#) [of](#) [black](#) [spruce](#) [and](#) [other](#) [conifers](#) [and](#) [allow](#) [for](#) [more](#) [sun](#) [to](#) [reach](#) [the](#) [forest](#) [floor](#), [the](#) [landscape](#) [allowing](#) [deciduous](#) [trees](#) [to](#) [take](#) [their](#) [place](#). [Such](#) [changes](#) [can](#) [affect](#) [the](#) [habitat](#) [for](#) [species](#) [that](#) [depend](#) [on](#) [coniferous](#) [forests](#), [including](#) [caribou](#), [moose](#), [and](#) [lynx](#).



Another [threat](#) [to](#) [boreal](#) [forests](#) [is](#) [increasing](#) [tree](#) [cover](#) [loss](#) [due](#) [to](#) [fires](#) [in](#) [the](#) [tropics](#) [is](#) [causing](#) [higher](#) [carbon](#) [emissions](#). [Previous](#) [studies](#) [have](#) [found](#) [that](#) [forests](#) [have](#) [been](#) [accounted](#) [for](#) [more](#) [than](#) [half](#) [of](#) [all](#) [carbon](#) [emissions](#) [in](#) [the](#) [tropics](#) [in](#) [2021](#), [and](#) [that](#) [the](#) [tropics](#) [have](#) [been](#) [the](#) [source](#) [of](#) [almost](#) [a](#) [tripling](#) [of](#) [carbon](#) [dioxide](#) [emissions](#) [since](#) [the](#) [early](#) [2000s](#).

Smokescreen and Mirrors: Population Patterns Are Increasing Fire Risk in Temperate and Subtropical Forests

Historically, fires in temperate and subtropical forests have been [suppressed](#) by the [activities](#) [of](#) [humans](#). [Globally](#), [they](#) [accounted](#) [for](#) [19%](#) [of](#) [all](#) [fire-related](#) [tree](#) [cover](#) [loss](#) [between](#) [2001](#) [and](#) [2021](#). [Fires](#) [that](#) [are](#) [increasing](#) [in](#) [these](#) [regions](#) [as](#) [well](#), [in](#) [about](#) [16,500](#) [hectares](#) [(roughly](#) [3](#) [PR](#) [per](#) [year](#). [While](#) [temperate](#) [and](#) [subtropical](#) [forests](#) [are](#) [not](#) [typically](#) [fire-prone](#) [ecosystems](#) [of](#) [managed](#) [forests](#) — which [can](#) [have](#) [fatal](#) [fire](#) [regimes](#) [and](#) [are](#) [more](#) [vulnerable](#) [to](#) [fire](#) [damage](#) — [they](#) [can](#) [still](#) [pose](#) [significant](#) [risks](#) [for](#) [people](#) [and](#) [nature](#).

As with boreal forests, climate change is the primary driver behind increasing fire activity in temperate and subtropical forests. For example, heatwaves and monsoon droughts play a dominant role in determining [fire](#) [activity](#) [in](#) [Australia](#)'s [temperate](#) [forests](#). [In](#) [2019](#), [record](#) [breaking](#) [heat](#) [and](#) [drought](#) [conditions](#) [led](#) [to](#) [massive](#) [bushfires](#) [that](#) [burned](#) [the](#) [forest](#) [with](#) [fatal](#) [to](#) [human](#) [more](#) [than](#) [2](#) [million](#) [hectares](#) [in](#) [New](#) [South](#) [Wales](#) [and](#) [Victoria](#), [destroying](#) [nearly](#) [3,000](#) [homes](#) [and](#) [killing](#) [33](#) [people](#).



Fires in 2019 in Victoria, Australia, burned more than 1,000 homes and killed 33 people. Climate change is the primary driver behind increasing fire activity in temperate and subtropical forests. Photo: Getty Images

Land-use changes and shifting populations are also increasing the risk of fires in these forests. In Australia's [regions](#), [for](#) [Greece](#), [a](#) [combination](#) [of](#) [heatwaves](#), [drought](#), [and](#) [large](#) [plantations](#) [of](#) [highly](#) [flammable](#) [non-native](#) [species](#) [led](#) [to](#) [the](#) [2021](#) [fires](#) [that](#) [burned](#) [more](#) [than](#) [100,000](#) [hectares](#) [of](#) [forest](#) [and](#) [2023](#). [In](#) [Europe](#) [more](#) [broadly](#), [the](#) [abandonment](#) [of](#) [agricultural](#) [land](#) [in](#) [mountainous](#) [regions](#) [has](#) [led](#) [to](#) [increased](#) [fire](#) [risk](#).

In the United States, [land](#) [use](#) [and](#) [rapidly](#) [land-use](#) [expanded](#) [into](#) ["wildland-urban](#) [interfaces,"](#) [or](#) [physical](#) [areas](#) [where](#) [human](#) [development](#) [meets](#) [or](#) [is](#) [intermingled](#) [with](#) [trees](#) [and](#) [vegetation](#). [The](#) [increase](#) [in](#) [the](#) [risk](#) [of](#) [fire](#) [ignitions](#), [damage](#) [and](#) [loss](#) [of](#) [life](#). [In](#) [2021](#), [wildfires](#) [in](#) [the](#) [United](#) [States](#) [burned](#) [more](#) [than](#) [7](#) [million](#) [acres](#) [and](#) [caused](#) [nearly](#) [$3.5](#) [billion](#) [in](#) [damages](#). [One](#) [of](#) [the](#) [largest](#) [fires](#) [in](#) [California](#) [history](#) [destroyed](#) [hundreds](#) [of](#) [homes](#) [in](#) [and](#) [near](#) [Paradise](#) [in](#) [2018](#) [and](#) [was](#) [attributed](#) [to](#) [a](#) [utility](#) [power](#) [infrastructure](#), [destroying](#) [78](#) [structures](#) [in](#) [nearby](#) [communities](#).

Lightwood logged from 2.5, 2021 the Mosquito Fire occurred in and near areas classified as wildland-urban interface.



Both the [natural](#) [cost](#) [and](#) [number](#) [of](#) [deaths](#) from wildfires in the United States [have](#) [increased](#) [in](#) [recent](#) [years](#) [but](#) [decades](#). [As](#) [human](#) [activities](#) [continue](#) [to](#) [encroach](#) [the](#) [planet](#) [and](#) [climate](#) [change](#) [worsens](#), [the](#) [risk](#) [of](#) [fires](#) [will](#) [increase](#) [in](#) [forests](#) [around](#) [the](#) [world](#) [that](#) [are](#) [not](#) [typically](#) [fire-prone](#).

How Do We Reduce Forest Fires?

The causes of increasing forest fires are complex and vary by geography. Much has been written about how to [manage](#) [wildfires](#) [and](#) [extreme](#) [fire](#) [risk](#), but there is no silver bullet solution.

Climate change clearly plays an important role in driving more frequent and intense fires, particularly in boreal forests. As such, there is no solution for bringing the climate-driven increase in fires under control without first reducing greenhouse gas emissions and breaking the fire-climate feedback loop. Mitigating the worst impacts of climate change will require [a](#) [rapid](#) [and](#) [significant](#) [transformation](#) across all systems.

In addition to climate change, increasing fires in cool and [natural](#) [forests](#) [make](#) [them](#) [more](#) [susceptible](#) [to](#) [wildfires](#) [and](#) [more](#) [vulnerable](#) [to](#) [human-caused](#) [fires](#). [Reducing](#) [the](#) [risk](#) [of](#) [human-caused](#) [fires](#) [requires](#) [keeping](#) [forest](#) [resilient](#) [by](#) [ending](#) [deforestation](#) [and](#) [forest](#) [degradation](#). [Forests](#) [that](#) [are](#) [not](#) [degraded](#) [are](#) [more](#) [resilient](#) [to](#) [fires](#) [and](#) [can](#) [recover](#) [more](#) [quickly](#). [Protecting](#) [peatlands](#) [and](#) [mangroves](#) [from](#) [drainage](#) [and](#) [degradation](#) [can](#) [help](#) [prevent](#) [fires](#) [from](#) [burning](#) [deep](#) [with](#) [enough](#) [heat](#) [to](#) [release](#) [stored](#) [carbon](#). [Fire](#) [management](#) [can](#) [help](#) [reduce](#) [the](#) [risk](#) [of](#) [severe](#) [fires](#) [by](#) [reducing](#) [the](#) [amount](#) [of](#) [fuel](#) [available](#) [to](#) [burn](#).

While data alone cannot solve this issue, the recent data can help governments, companies and others to [develop](#) [more](#) [effective](#) [policies](#) [and](#) [actions](#) [to](#) [help](#) [to](#) [track](#) the activity to both the long-term and to near-real-time to identify trends and develop targeted responses.

This article was originally published in 2021. It was last updated in August 2024 to reflect the latest data on global fire trends.

Relevant Work

Explainer
Global Record-Breaking 2023 Wildfires Surpass Previous Records
Explainer
Global Tree Cover Loss Rose 10 Percent in 2016
Explainer
Intense Boreal Forest Fires a Climate Concern

How You Can Help
With data, tools and resources at their fingertips, the globe can respond to risk options. You can support the need by making right calls to explore to take action.
Donate | Read Our Plans

Stay Informed
Email *
SIGN UP
By submitting your email, you agree to our Terms of Use and Privacy Notice.

World Resources Institute
Our Work
Forests | Water | Cities | Food | Energy | Climate | Economics | Finance | Governance | Ocean | Equity | Countries | Regions
Research
Publications | Publications | Publications |

© 2025 World Resources Institute

SHARE

Wildfires and Climate Change

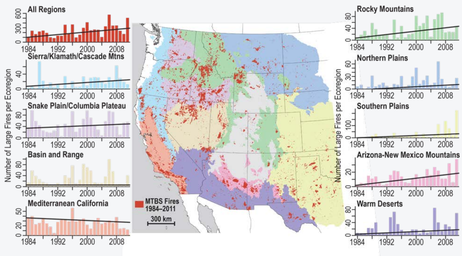
Climate change has been a key factor in increasing the risk and extent of wildfires in the Western United States. Wildfire risk depends on a number of factors, including temperature, soil moisture, and the presence of trees, shrubs, and other potential fuel. All these factors have strong direct or indirect ties to climate variability and climate change. Climate change enhances the drying of organic matter in forests (the material that burns and spreads wildfire), and has doubled the number of large fires between 1984 and 2015 in the western United States.

Research shows that changes in climate create warmer, drier conditions. Increased drought, and a longer fire season are boosting these increases in wildfire risk. For much of the U.S. West, projections show that an average annual 1 degree C temperature increase would increase the median burned area per year as much as 600 percent in some types of forests. In the Southeastern United States modeling suggests increased fire risk and a longer fire season, with at least a 30 percent increase from 2011 in the area burned by lightning-ignited wildfire by 2060.

Once a fire starts—more than 80 percent of U.S. wildfires are caused by people—warmer temperatures and drier conditions can help fires spread and make them harder to put out. Warmer, drier conditions also contribute to the spread of the mountain pine beetle and other insects that can weaken or kill trees, building up the fuels in a forest.

Land use and forest management also affect wildfire risk. Changes in climate add to these factors and are expected to continue to increase the area affected by wildfires in the United States.

Trends in the annual number of large fires in the western United States



NOTES

This graphic from the Fourth National Climate Assessment shows the growth in large wildfires throughout the West. The black lines are fitted trend lines. Statistically significant at a 10% level for all regions except the Snake Plain/Columbian Plateau, Basin and Range, and Mediterranean California regions.

SOURCE

Dennison et al

Since 2000, 15 forest fires in the United States have caused at least $1 billion in damages each, mainly from the loss of homes and infrastructure, along with firefighting costs. The 2017 wildfire season was well above average, with deadly fires in California and throughout the West, including Montana, Oregon, and Washington state. The 2018 wildfire season went on to also break records as the deadliest and most destructive season on record in California. NOAA estimates the total costs of wildfires in 2017 and 2018 to be more than $40 billion. In 2019, wildfires caused an estimated $4.5 billion in damages in California and Alaska. Alaska's record-breaking heat and dry conditions over the summer months set the conditions for the state's historic wildfire season. In 2020, five of the six largest fires on record burned in California and Oregon saw historic levels of wildfire spread and damage. Wildfires across the West led to weeks-long periods of unhealthy air quality levels for millions of people.

See a map of billion-dollar extreme weather disasters here.

- Wildfire can affect:
  - Federal and State Budgets: U.S. Forest Service fire suppression expenditures had increased from about 15 percent of the agency's appropriated budget to more than 50 percent in 2017. Nationwide suppression costs in 2017 and 2018 ballooned to $2.9 billion and $3.1 billion respectively, while state wildfire expenditures have also increased substantially.
  - Public Health: The growing number of people in wild lands is increasing the risk to life, property and public health. Smoke reduces air quality and can cause eye and respiratory illness, especially among children and the elderly. Wildfires that burn in residential areas can melt plastic water pipes and cause contamination of water systems with a known carcinogen.
  - Natural Environment: Wildfires are a natural part of many ecosystems. Although wildfires produce a number of greenhouse gases and aerosols including carbon dioxide, methane, and black carbon, the plants that re-colonize burned areas remove carbon from the atmosphere, generally leading to a net neutral effect on climate. However, when fires burn more frequently and consume larger areas, as they are doing with climate change, the released greenhouse gases may not be completely removed from the atmosphere if plants can't grow to maturity before burning, or if the plants that re-colonize are less efficient at carbon uptake.

How to Build Resilience

- Communities, builders, homeowners, and forest managers can reduce the likelihood and impacts of wildfires by:
  - Discouraging developments (especially residential) near fire-prone forests through smart zoning rules.
  - Increasing the space between structures and nearby trees and brush, and clearing space between neighboring houses.
  - Incorporating fire-resistant design features and materials in buildings.
  - Increasing resources allocated to firefighting and fire prevention.
  - Removing fuels, such as dead trees, from forests that are at risk.
  - Developing recovery plans before a fire hits, and implementing plans quickly after a fire to reduce erosion, limit flooding, and minimize habitat damage.
  - The Climate Mapping for Resilience and Adaptation portal helps communities understand and plan for their climate risks today and in the future, including a real-time map of wildfire, drought, flooding, and extreme heat across the United States.

For more details on wildfire resilience, read our report, *Resilience Strategies for Wildfire*.

Learn more about resilience by visiting our Climate Resilience Portal.

– Related Content

PUBLICATION
Resilience Strategies for Wildfire

PUBLICATION
Resilience Strategies for Extreme Heat

PUBLICATION
Resilience Strategies for Drought

Nature-Based Solutions for Resilient, Equitable Cities

PUBLICATION
Cities Advancing Climate Action: Federal Funds for Local Impact

The Climate Resilience-Economy Nexus: Local Strategies in Practice

+ Other Resources

+ News

WILDFIRE TODAY
Wildfire News & Opinion
June 2022

Wind-driven wildfire burns hundreds of homes near Boulder, Colorado

Bill Gabbert December 31st, 2021 Leave a Comment

At least 580 homes have burned in the Marshall Fire

Updated at 8:12 p.m. MDT Jan. 1st, 2022



Fire Perimeter from the Marshall Fire detected by satellites at 4:42 PM Jan. 1st, 2022

To see all articles on Wildfire Today about the Marshall Fire, including the more recent, click here.



Evacuation Maps for the Marshall Fire, accessed at 4:42 PM Jan. 1st, 2022. Boulder County. More details.

The Firestorm Hood to Superior, CO Sunset.



Updated at 6:12 p.m. MDT Dec. 31st, 2021

At 4 p.m. Sterling Boulder County Sheriff Joe Pelle said he was not aware of any fatalities that had been reported. He said the fire was moving rapidly in a northeasterly direction in the southern communities of Boulder, Colorado. Fire officers have blocked. (no more info)

"However," he said, "I would like to emphasize that due to the magnitude of this fire, the intensity of this fire, and its presence in such a densely populated area we would not be surprised if we were to find victims of our fatalities."

The Sheriff listed the numbers of structures that had burned at the time of the briefing. The numbers, totalling about 580, are estimates:

- 210 homes in the Sagamore subdivision just west of Superior,
- 100 homes in the Old Town Superior area,
- The Target shopping complex in Superior was on fire,
- The Element Hotel in Superior was fully engulfed.

Sheriff Pelle said the Middle Fork fire 2 miles north of Boulder near Highway 36 was reported at about 10:15 Thursday morning. The spread has been stopped.

The Marshall Fire, still vigorously spreading, started just after 11 a.m. Thursday.



Evacuation Centers

Three evacuation centers are available: North Boulder Recreation Center, Longmont Senior Center, and the YMCA in Lafayette. Cots are on their way and authorities are arranging for meals. Large animals should be taken to Jefferson County Fairgrounds, 15200 W. 6th Ave., Golden, CO 80401. The Boulder County Fairgrounds was reported to be full Thursday afternoon.

Weather Forecast

The forecast for the fire area Thursday night is for a wind shift to the north-northwest. The wind speeds will be decreasing through the night, with a south-southeast wind six to 14 mph becoming southwest 10 to 15 mph after midnight. Winds could gust as high as 31 mph.

On Friday winds are expected often to be from the northwest, shifting to be more, then fall to around 15 during the remainder of the day. The wind will be west- southwest at 15 to 25 mph becoming west-northwest in the morning. Winds could gust as high as 46 mph. The chance of precipitation is 30%. New snow accumulations of 1 to 2 inches are possible.

The National Weather Service posted this list of maximum wind gusts in Boulder County today.



Updated at 4:52 p.m. MDT Dec. 31st, 2021



We now have a better map of the Marshall Fire (above), based on heat detected by satellites at 4:42 p.m. MST December 30.



Fire Perimeter from satellite detection systems, Boulder County, 4:42 PM, Dec. 30, 2021



Marshall Fire, powered by wind, Dec. 30, 2021 by @kyleclark



Marshall Fire, powered by wind, Dec. 30, 2021

Updated at 3:45 p.m. MST Dec. 31st, 2021



Fire Perimeter from satellite detection systems, Boulder County, 4:42 PM, Dec. 30, 2021

There are reports that the fire southeast of Boulder, Colorado, now known as the Marshall Fire, has spread over along Highway 36, crossed Highway 36 near Superior, and is burning near Niwot Ridge, Rd Lodo Blvd, and St. Andrews Lane.

Unofficial reports put the size of the fire at 1,000 acres.

The Element Boulder Superior Hotel near Highway 36 and McCaslin Blvd has burned. Is firefighter told the fire is moving so fast and is so intense that it is, there was nothing they could do here, and the fire has another 2 miles to go before it reaches the city limits of Broomfield. It is currently unchecked, in a direction where there are many exposures for and that it "don't know where to stop."

We do not have a list of all areas under evacuation orders, but at 2:10 p.m. the Boulder Office of Emergency Management reported that an evacuation order is in effect for the city of Louisville which is between Highways 36 and 287.

1:51 p.m. MST December 30, 2021



Fire Perimeter from satellite detection systems, Boulder County, 4:42 PM, Dec. 30, 2021

Fire Perimeter from satellite detection systems, Boulder County, 4:42 PM, Dec. 30, 2021

Two wildfires broke out today in the Boulder, Colorado area, driven by very strong winds gusting well over 100 mph. The Marshall Fire, which is the more southern of the two, started around 11 a.m. MST and has burned 6 miles to about 1 miles north of Boulder near Highway 36 We have reports that multiple structures are burning and some evacuations have been ordered.

The fires started where winds were measured with the highest gusts, degrading visibility out ahead of the blaze. Firefighters have told me that if they are in a windy area to pull back until they can attack the fire safely.

The Marshall Fire is new and dangerous rapidly growing fire being spread quickly by strong winds. Anyone in the area should immediately evacuate should keep in mind that they may not receive evacuation orders quickly enough to leave.

Near the end of the video below, check out the extreme winds. It was posted at 11:13 p.m. Thursday by @tyler.hughes911.

While very strong winds were gusting well over 100 mph, the relative humidity at 1:30 p.m. near Superior was low, 14 percent, and the temperature was 54 degrees. This is the perfect cocktail for the wind speeds to sustain high Thursday afternoon as a cold front pushes through, but a decrease to 10 to 20 mph overnight. There is a possibility of some rain Friday.

This situation is evolving rapidly. We will update this article as more information becomes available.

Tweets sent a bit of the fear we are in left.

Topics: An incident (fire), and specific wind events. Please read the comment policy and follow our given comments.

Share this:

Related:

County Sheriff says no structures burned in Marshall Fire northeast of Boulder, Colorado
January 1, 2022

Ranging drones deployed for the first time in Colorado wildfire
December 30, 2020

Report released for the Marshall Fire investigating ignition in the southeast of Boulder, Colorado
December 28, 2022

Author: Bill Gabbert
Bill Gabbert is the author and webmaster for this site. He started it in October, 2006, and writes 95% of the articles on this site. View all posts by Bill Gabbert

81 thoughts on "Wind-driven wildfire burns hundreds of homes near Boulder, Colorado"

Greg Hill
January 1, 2022 at 4:44 pm

Well, it's better than your previous comments. But you don't know how long I have lived here, nor if you have ever been here. Nobody is evading. One of us was trying to point the conversation and it was not 1. You've been your way, and you have, so am I. It was you that wanted to say some topics were inappropriate. It was you that wanted to say that I was wrong to point out that the fire was not unprecedented. It was you that said inappropriate. Perhaps you are stupid. It may seem small to you, but that is not the motivation. It is also not a motivation to be rude. I am sorry you feel that way. I am not trying to call people names. It's a spade.

It's a spade.

Hinnie
December 5, 2020 at 4:09 pm

I am 52 and have lived here since I was born in Cheyenne. You said in the comment above my last one that you have been here 30+ years. I lived here for the first "turn in a century" Thompson Canyon Flood, we lost friends in that flood. I lived here for the second "turn in a century" Thompson Canyon Flood, we lost friends in that flood, too.

These guys have happened for as long as we have been remember. The only difference is now they are issuing building permits in holy companies who have no idea about our terrain. If they did Boulder would have never been allowed to be developed.

Sorry to sound all of this is new and pioneers who care about our environment but also recognize that the most affordable housing throughout the years could be seen in mobile/tiny anyway. I didn't suffer in the Marshall Fire, I'm not pretending I did either. We are all experiencing the effects of climate change

Greg Hill
December 5, 2020 at 4:14 pm

Your earliest point (if you can call it that) was that climate change is off the table for discussion and my response had to do with that climate change is absolutely on the table and that your injunction that it is off the table is not. Your second point was that I was wrong to say that "climate change is responsible" for all floods. As you put it, I was not actually living here for the Big Thompson Flood. What does it matter again? Some attempt to claim eternity? For what it's worth, people I knew who lived through the Big Thompson Flood, and who are still living here, have told me that this specific Canady Creek was new to the area before, and pretty darn not even anyone was home directly, but apparently you want to take credit for your terrible suffering anyway. I didn't suffer in the Marshall Fire, I'm not pretending I did either. We are all experiencing the effects of climate change

Sherry Davis
December 7, 2020 at 1:46 pm

Thanks. In the moment you said it here. Snarkiness is not appropriate. I love north of the devastating fire forest scrolled around 1:38. Depending on wind direction is only reason I still have a home this morning. Many of my friends lost theirs. Many more lost their insurance coverage. Many more will lose theirs. While not in the forest we have been ensuring some more than our suburban lot and thinking about how we can mitigate. Landscaping planned years ago seems inappropriate in light of what is happening now, and that is sad, because it is a beautiful neighborhood and area

Gilda Lashaw
December 7, 2020 at 8:17 pm

Wildfire "mitigation" explicitly means removing trees or controlling nature to perpetuate unsustainable human growth and preservation. It is a sick and outdated concept. When you and neighborhoods are willing to live with nature, fire becomes normal as are snowstorms...you've already identified 'snowstorm' as the problem.

Minnie
December 8, 2020 at 12:03 pm

Gosh all. We have lost homes and lives. We don't need your self righteousness. You will know a footprint wherever you go, will you kill yourself so you don't. I am sick of these stupid fights. Take the condescension

Sherry, forgot the fuel above me. We have lost so much that voice doesn't matter.

Greg Hill
December 8, 2020 at 4:09 pm

I saw no reason to label Chris' comment in this way. His viewpoint is a valid piece of the conversation, as are most of the others you seem to find the same way about. But the one that seems to be outraged. If it is true that you actually live here and especially if you yourself have been affected by the fires and floods, I am sorry to hear that. I live in Boulder, but I have a poor attempt to explain this discomfort with FOMO. Here is a post that is not "here-ish". By the way, I myself do live on the front range, in the path of one of the fires on 5/31. At the same day, that fortunately for us were just not quickly, and got an evacuation call in our Corridor that morning given the fast-comes down the same trajectory, and during the 10+ years I have been here, I have been evacuated from my home twice before. Once for the Four Mile Canyon wildfire and about 10 years ago, for what is now turning grass fire less than about a mile off. Fortunately for us, our number has not yet come up, but does have been several times it could have, and we are very grateful for the firefighters who protected our home. I am also very aware of the role that the consolidation of everything from population density, housing costs, politics, practical and open and impractical, and, absolutely, climate change are completely valid to discuss. I don't think that anyone is trying to shut down the discussion, but I do think that it is important to be careful what is said in a valid to discuss, as it's this need to express your almost comments as well as to anything else you may wish to add that is of a mature similar to what you have already said. I'm done with it.

Minnie
December 8, 2020 at 4:19 pm

I grew up here and am 52 years old. I have every right to speak my mind. My family are ranchers, we, yes, I understand nature and what fire can do.

I am not a climate denier.

Stop self righteous and hateful agenda. What won't be are all the basements left standing. I'm so sick of the environmental fervorism that happens when so many of us have been affected. Yes, I am angry. I am sad.

I will never be in a high rise and I am not a fan of the houses that are being built right now so I - it's NOT people some fires. They need affordable places to live. Granted hipster don't like that but I'm not a hipster. I'm a native who has been displaced.

Let's be kind to one another. Some of us have been evacuated more than they are allowing. Stop pointing to happy. For example is where Chris. They picked the absolutely worst weather area in Colorado. High winds over and over and terrible storms.

Superior was built in a similar area. They are now planning on building on the worst parts of the fire. Why? Because it's where the land is. Because it's where the people can afford to live who are get enough water from all of the fires. And this fuels and its toxic water flow to buried there and we have a fountain in the forest for allowing building there.

I'm not a climate denier. I'm not a fan of the houses that are being built. I have been my home a lot longer than yours and when I have family and friends losing their homes it's hard to read such stupid debates. This wasn't the time or place.

Monica
December 9, 2020 at 2:08 pm

My grandma lives in Soderland, I can't get in touch with her. If anyone knows how Soderland is doing, PLEASE let me know.

Minnie
December 9, 2020 at 2:20 pm

They have don't have towers. None of the fires went that direction that our town has reported. Many places lost electricity due to the high winds and now they're hard to shut down more, and unfortunately, it's a warning as the Hampton should be put out soon. I'm sorry you haven't heard from him yet but I'm sure he's fine. (((hugs))) I pray you host soon

Tracy DiFranco
December 9, 2020 at 10:49 am

A perspective from a 6yo.

"All these kids are probably sad because they lost all the presents Santa brought them, I want to give them some of my presents.

Terrell Lynn Hoops
December 10, 2020 at 7:06 am

I watched this unfold last night. And as we read more comments last night and this morning I would only add this. The people of colorado are strong and resilient, they are caring and giving. Im sure that those who have the misfortune of not having their homes, their belongings and the people of colorado as a whole will come together to help those who have lost so much. Please pray for those who are in need and have the strength to see you through this trying time. Be safe to everybody.

Minnie
December 10, 2020 at 8:43 am

The comments are sickening. All the bickering while we wait to see if our family will lose a home

I love my kids. For those of you who blame this on the need for population control or climate change please fight somewhere else.

Some of us need real information.

George
December 10, 2020 at 10:09 am

Tragic for those folks. But grass fires and structure loss are common throughout the southern plains — OK, KS, NE, TX, and CO. See the "Gash" of grass on management. Structures are ignitable. Period. Modern humans have come to expect that they have no responsibility to stay way from fire — just buy a house and build it where you want. Fire is a natural process in many ecosystems, and you little mind to natural processes, whether fire, flood, or wind. Ain't good and it's true.

Greg Hill
December 10, 2020 at 3:59 pm

Most of the above?

That is.

Loss of life, loss of homes and businesses: tragic.

Green: Destructive.

Gash: Scar on the surface of the foreseeable, in addition and/or purpose remember

Ain't: Not that bad?, provides bullshit, it's been here longer than we have.

Houses, hotels, stores: flammable.

Wind: Frequent here and also not infrequently indirectly ignites fires as well as spreads them.

Asphalt, concrete, and stores: not flammable also not suitable for life, apart from a few highly specialized organisms (not us).

Climate change: It's a planetary human caused phenomenon and it is affecting everything everywhere on the planet. Most absolutely connected to events like this one. Except for us, primarily drought and heat, more extreme.

Weather (which includes more windstorms), but also the 2013 flood.

Unfortunately the message from the planet is something like:

Dear Humanity,
Thank you so much for your stay on the planet. Checkout time is 11:59 a.
Payment in full at time of checkout. Please come visit us again sometime
soon!
Sincerely, Earth

Bill
December 10, 2020 at 10:44 am

Very guys, where y'all post a comment, remember people are losing their homes and some are losing friends and family. So, please be respectful. Thanks!

Sriram
December 10, 2020 at 10:46 am

Out of the 10 supramax above fuel loads and wind, the NREL's Flatirons Campus, home of the National Wind Technology Center is off of Highway 93 a few miles the South of Marshall Lake. It is there for a reason. Wind speeds are consistently high there. The Flatirons themselves are a natural wind break. Interestingly, just across 287 from the burning area. My father still lives there. he hasn't been told to evacuate, but he is ready. When we lived in Boulder, a neighbor's house lost their roof in wind. Wind and fire are a bad combination. Yes, we live in a fire prone area. Yes, humans do the potential for ongoing loss of life and homes and please stop bickering until the fires are out. Please.

Minnie
December 10, 2020 at 10:46 am

Thank you Brian. I have family there, own homes in 32 - on from Louisville. So we prayed for it wasn't required, yet, to a friends SF Boulder. Every family member knows of someone who's had to either evacuate or has to be or have to run in their yard. As you know, "it feels like nothing helpful to do anything to help." This is devastating. Many are feeling it tonight and will tomorrow when they're free to do much by having lost a home or business today.

John Ellison
December 10, 2020 at 10:47 am

I would to own a home up there across from El Dorado Rd, facing the road winds would batter the house so had to would outside and vibrate. Not a good place for a rich house, IMO.

Linda
December 10, 2020 at 10:50 am

We should be praying for the people that have been affected by this. "Acts of nature" instead of trying to blame it on climate change. Yes, I believe that climate change is happening but this is not the time. Maybe we can take all the energy used to blame someone and come up with a solution for what we can do to help one another in tragedies like this.

Kate Hallberg
December 10, 2020 at 10:51 am

Linda, there's nothing supernatural about a fire. It starts, it burns. There's been a massive change in our climate and if we don't spend time on solutions we're doomed and there's no ghost in heaven to stop it.

If you want to pray, have at it but it means you'll be doing little else. Christians who wear their Jeebuses on their sleeves and declare their prayers the loudest in the land. That's not me saying it, that's Jesus saying it in the Sermon on the Mount. At least hypocrisy is relatively unscathed by churches. And McDonald's. And weekend.

Cathy
December 10, 2020 at 10:52 am

Seems to me that fire didn't really care whether it hit a neglected open field or a well-maintained golf course.

Tim
December 10, 2020 at 10:52 am

It didn't. Open space grasses and golf course grass are dead and available to burn, along with houses and wooden fences.

Kate
December 10, 2020 at 10:53 am

Except when there's a desperate attempt to make golf courses look like those from their native Scotland. Unfortunately golf courses aren't planted with local grasses but it doesn't sound like they did anything to slow the fire.

Jason Smith
December 10, 2020 at 10:53 am

Cathy, 'neglected open fields' are commonly referred to as 'nature'. And in those 'neglected open fields' all lifeforms expect a sustainable natural order. But, I'm with you, Cathy...God forbid a wildfire scorch someones putting green, where no one respects the natural order.

Brad Rafin
December 10, 2020 at 10:53 am

Housing developments are very hot a fuel type as is grass, brush or timber.

Tim
December 10, 2020 at 10:54 am

Correct, and are not modeled in the world of the behavior calculations??? Massive fuel Beds??

Tobin Kuhlmann
December 10, 2020 at 10:54 am

Hosting for Natalie Fuller. Her common sense and fact based reply are a breath of fresh air in a bleak section of idiot responses. It's good to know that intelligence hasn't totally left Colorado. Sending positive wishes and hopes for the best to all of you facing a life changing catastrophe.

Jason Smith
December 10, 2020 at 10:55 am

Yep, burning for Natalie...let's keep procreating and building more communities...and, where we all die in our fire- storms of denial, may we all learn to hell for what we've done to this earth.

Dave
December 10, 2020 at 10:56 am

You're ridiculous.

Renee Sandy
December 10, 2020 at 10:56 am

Yep, and logic and reason make up the flimsy roof that the masses still cling to, in hopes of explaining the chaos... Mother Earth has a wicked fork, don't you think? And the best part of human suffering is how richly it is deserved.

Wade Fricke
December 10, 2020 at 10:56 am

Actually, come grass on those Marshall Mesa grasslands. That is part of Boulder's UNIVY land use plan, which is a conservation easy that is used for making hay - generally two crops, one in summer and one of corn and hay that is fed in the winter here. But it is not a mountain of wilderness or individual houses scattered about. It is a managed landscape, as mixed trees but, the mountains themselves. Lumberjills and logistics are basically one on the plains.

Wade Fricke

Dave
December 10, 2020 at 10:56 am

Dora Mesnick
December 10, 2020 at 10:56 am

The comments by Scott Gregs seem to disregard how intentionally managed this open space is. Ranchers pay for the right and a duty to cleanse the wildland fuels first, while neglecting to address the urban fuels actually surrounding homes.

https://bouldercolorado.gov/news/city-provide-updates-about-open-space-prairie-dog-management

Natalie McCormick Fuhlmer
December 10, 2020 at 10:57 am

Scott, I'm a former wildland firefighter, park ranger, and resident of Estes Park. The open spaces you're referring to in Boulder County aren't actually providing that much fuel for these fires. The culprits are two-fold. A whole - 40 consecutive years experience daily adiabatic winds. Those winds flare up the fires and push them into the communities. Secondly, the fuels in the forests are not the same as the PONDEROUS FUELS, and have been known to blow open houses under construction in Estes Park that are not yet enclosed. Boulder and Denver often experience damaging winds, although those winds are dramatic, they're not unprecedented. 2 consecutive - here's the important part - consecutive years of extreme drought are the necessary add-on for these fires. Drought, which impacts wildlife, the forestland, and the vegetation. Please don't blame the open space for the fires. Blame the drought and the wind. Blame our adjacent ecosystem in your state? Don't blame the mountain we are located? What fuels might exist around your house that could be abated - i.e. pine needles, downed limbs, etc. Many factors that go into the fire behavior and destruction of homes, but please don't blame the open space. Blaming development mistakes that the aforementioned state has suffered the ultimate consequences of.

Tim
December 10, 2020 at 10:58 am

Sorry, there are those a strong presence prophet ahead of every strong wind front. Different type of wind vs. what you are speaking of. Additionally, 2, 3 or high dead grass in open space has played a major role in the spread of the fire. If you were a Wildland Firefighter, then you should know the components of the fire behavior triangle. Fuels, Weather and Topography. The dismal wind front that you were trying to explain was not a player in this event.

Dora Mesnick
December 10, 2020 at 10:58 am

How much continuous "forest like high" grass is within that 100 acres? I have hiked those areas and there may be those high seedheads but not continuous forest like high grass. While those are some tall grass species present in between, this is not tall grass prairie. Those look high grass prairie species are not present in the burned area I hiked. There are also Prairie Dog towns in the area. Maybe we need more of those to fuel breaks?

The grass fueled aspect of the fire does not explain the scenes of property destruction and descriptions of fire that occurred across a major road that most people would describe as a sufficient fuel break to stem natural times.

Tim
December 10, 2020 at 10:58 am

Fuel breaks are not a consideration when a grass fire starts near neighborhoods in a typical Front Range wind event. Backyard fences, houses, fencing, are all part of the fuel bed in the example. Spotting across fuel breaks that you speak of was well beyond on the fuel loading in the grasses.

Renee Sandy
December 10, 2020 at 10:59 am

That's great Dora, let's grant Prairie Dogs habitat, only if it serves as fire breaks for human interests.

Nature is just another pawn to save us from ourselves? Is that your thesis, Dora?

Matt
December 10, 2020 at 10:59 am

I see they are reporting two homes, a organ, motel, and lots of vehicles destroyed

Scott L. Heape
December 10, 2021 at 10:14 am

Im not surprised by these lists. Boulder counties spare space policies where there's all that unused open space that's ever green has gotten to be nothing more than a wildfire waiting to happen. Im sure much of that land is owned by conservation groups. Maybe they should be the ones to take the damage these overgrown open space areas will do any responsibility? So good luck with that.

Christian H.
December 10, 2021 at 10:14 am

Big Data thinking right here. "If we just had no grasslands we couldn't have grassland fires!" The problem isn't that we haven't quite gazed over everything on the front range yet, it's that climate change is hurting increasingly unstable weather conditions that influence those things having to burn. 12" of precipitation in the last 3 months is...

"Do you think those who manage these overgrown open space areas will take any responsibility?" Jesus Christ, it's graceland, not a parking lot.

Scott Lynn Heape
December 10, 2021 at 10:14 am

That should be better taken care of? Dedicated mowed like hay. If it had been done over the years? Maybe it would be. But it's not. Its a natural area. Its not a park. Its not a golf course. Its a majority ocean of tan, tall weeds. Short grass burns less than long...overgrown. A lot about parting it, only about proper management...of which there obviously was none.

Amyl
December 10, 2021 at 10:14 am

Grass 4U

T G
December 10, 2021 at 10:14 am

They have been.

T G
December 10, 2021 at 10:14 am

It is managed, but there hasn't been any precipitation for a while now. There is also the strength wind things. I don't care how well you manage the forests/grasslands, dry and windy is going to burn.

https://www.bouldercounty.org/disasters/wildfire/mitigation/

Steve
December 10, 2021 at 10:14 am

Help me know... Sounds like someone not from Superior who is acting as though.

Jimmy
December 10, 2021 at 10:14 am

For the love of God guys, could it be that it's hotter than usual and there are fuels to burn and that's what is supposed to happen but the area is over populated with folks who feel their homes should be protected but what's permanent in world that's always changing. Is it emotional or reality based??

Tim
December 10, 2021 at 10:14 am

Climate Change? How do you equate climate change to a human caused fire in an area that is totally this time of year in a dead grass fuel bed. Without the human ignition component that has historically been present in this area there would be no fire. Climate change is not creating a dead of strong cold front. We now have a major human ignition problem in Colorado and the rest of California. Finally, the dryness and wind you speak of is not unusual during La Nina years out of the drinks.

Linda.
December 10, 2021 at 10:14 am

No precipitation, low humidity, high than normal temperatures.

Tim
December 10, 2021 at 10:14 am

You just described the typical pre- frontal environment along the Front Range of Colorado. And you forgot to speak to the abundant 1- hr dead fuel that could careless if precipitation is in the forecast or not. Human ignition + dead fuels + strong winds = explosive fire in a snow cover this time of year, even during average years. You forgot the human start.

Sean
December 10, 2021 at 10:14 am

Thank you. Fire managers try to create change in getting out of hand.

Heck of a lot of lessons to see burned. Scary.

Kate Stallberg
December 7, 2021 at 9:05 am

Whoa Jon! You don't think we should consider consider climate change when we keep having record breaking temps, fires, tornadoes at the wrong time of year? Maybe we should look at the fact that we've experienced the driest summer and the wettest winter where Missouri and Yahoo Space markers for our starting a tax disaster winners? When they have to bring in snow for a ceremonial start in Panhandle?

When did you notice how little snow was into the summer in the High Country? Or the patterns of summer thaw is nothing like it was for decades?

Central Illinois farmers figured out" they can use less fertilizer and dry fertilizer at least one, if not more passes of the plow. It's better for the soil and the water and may make a difference in the climate. If they complain it won't help.

* or, the Astronomy of Illinois department of Agriculture actually, and the landowners who graid extraction and convince their owners to do so

Dave
December 10, 2021 at 9:04 pm

oh...a warm, dry fall...

Phyllis
December 10, 2021 at 10:14 am

I live just off Cherry Creek Road in Louisville. At noon I left the house to quickly see where and why I smelled smoke able to a campfire, while it's right inside were blowing. So experience how with this stuff at all, now to the area, but growing up on a dairy farm in the middle of nowhere in Nebraska, I'm not afraid of fire, I've seen it, I've lived it, I've helped put it out, I've been burnt but I'm sure I wanted to see how to see and how much time we had (mind was blowing towards our house from where the smoke was starting, so seemingly had warmth). I made it to Safeway and visibility was bad to how down up to 4 hundos and looking back up at 3 never straight home and packed up the seriously kids and was gone by 1 p.m.

Seems I herded the news as anything, you just know when it looks and feels bad (I thought). Happy to have no reports of death. My only regret is not hanging up my neighbors dyson that I borrowed for the day. Hope they don't know I was out of it at noon in our small roundabout and that I was and holiday on.)

I grew up Davey Crock and Reelly Vista, it was bad. I'd compare not leaving or trying to pump, to sounding outside and videotaping a tornado within 2 miles of you while everyone else is in a basement bathtub.

Can't wait to help those in need there, houses gone or not. I want to know my neighbors better to hang on the door sooner rather than assume they know we or are out of town. Will never happen again for me, introduce yourselves more forwardly to those around you when you move / grow to my point. Covid help reminding during such a rare statistical occurrence such as this.

Skip
December 9, 2021 at 9:04 pm

A man who lives near the intersection where the Marshall fire is believed to have ignited, said Sunday he believes he witnessed the start of the wildfire on the property next door to him — a pack of houses and land occupied by members of the Twelve Tribes, a Christian religious sect. https://www.denverpost.com/2021/12/31/marshall-fire-origin-twelve-tribes/

Bill Gallmeir ★
December 9, 2021 at 9:04 pm

Just to be clear... the article does say that near the beginning, but quotes later in the article are much more vague. Here is an excerpt:

Zolkowski, who works with a company that builds fire-resistant homes, has lived next door to that property for about a month, in a home owned by his friend, Dave Phoppo.

When Zolkowski stepped out to investigate the fire Thursday morning, he approached a group of people who lived on the land. Some of those people headed toward the fire, trying to shelter from the brutal wind. Two younger guys crouched with an older man, Zolkowski said.

"The scary one, by far, was the shoeless," Zolkowski said of the older man. "And I was like, 'Oh man, what the hell's going on over here?' And they said, 'One of our dwellings caught on fire.' What was weird is they were like, 'It's OK ... it was a weird interaction."

Zolkowski helped the two younger men get the older man inside a house on the compound.

"Then I went over to their field and their field was on fire," he said. The strong winds pushed him over as he walked back to his house. At one point, he looked up to see a fire truck and children moving from one building on the compound to another, he said, holding hands.

He's sure now, thinking back, that the wildfire began on the Twelve Tribes' property.

"I don't want to speculate, it's still under investigation, but there is no possible way the fire started from any other place," he said.

Skip
December 9, 2021 at 9:04 pm

Did an undersigned read the quote the Marshall fire, investigators look into cool stoke near Marshall fire at possible source. https://www.thedenverchannel.com/news/local-news/marshall-wildfire-investigators-look-into-cold-stoke-near-marshall-fire-as-possible-origin-of-fire

Bill Gallmeir ★
December 9, 2021 at 9:04 pm

We just published this:
https://www.denverpost.com/2021/12/31/officials-are-investigating-smoldering-coal-stoke-as-cause-of-marshall-fire/

Jason Smith
December 9, 2021 at 9:04 pm

Yuck Scott...we should just wipe out all open space and get a federal grant to start building! Sign Award condos and parking lots all the way from the Flatirons to the Kansas border...Its an alternative revenue, wealth for you and 6 billion others to stop breathing and start wondering how much "HUMANITY" is contributing to these wildfires.

Scott Lynn Heape
December 9, 2021 at 9:04 pm

Im all for open space and parks now. But even you must admit short grass burns less or slower than long grass. Especially when its not managed properly. Overgrown and exploding like it has. Oh its so seasonal, guidelines, its a wildfire hazard that has now exploded.

Tamara Wojnicz
December 9, 2021 at 9:04 pm

Amen!! Never agreed wholeheartedly, different topic aside.

DeeDeeJunk
December 9, 2021 at 9:04 pm

Already assigning blame before all the facts are known? Who are you blaming for the grass fires to burn? Homeowners who live in the area? Those that are responsible for the open space? Maybe the wildfires were due to lack of snow, severe to exceptional long term drought that nothing in its path is, right?

Tamara Wojnicz
December 9, 2021 at 9:04 pm

Agree. Open space can no reduce infrastructure density. This is open plains, natural grasses, what, exactly, is the point of a wind break at all? The impact thousands of homes, businesses to fill your personal entertainment?

No, need, grasslands. This is an unprecedented wind event. It's December. Colorado is normally snow covered by now.

Tim
December 10, 2021 at 9:04 am

Wrong!!! Though it has been very dry, that area does not maintain a snow cover during the winter. It is low elevation east of the divide. It snows and melts.

Donald Mantzk
December 9, 2021 at 9:04 pm

Where it snows and melts it compresses the grass. Where it does not snow grass is like fluff. It burns even faster. Normally that grass type would have been exposed to more weather events that reduced its volatility.

You keep blaming the grass, without asking how 'pin' homes in a single subdivision burned, how homes within the old part of town burned, or how a Target shopping center burned, etc.

Sorry, there just isn't that much energy in a dozen to mid grass prairie to fuel three blocks of conflagrations.

Tim
December 10, 2021 at 9:04 am

I agree, there isn't much energy in the grass but fuel bed. I would also agree that there are pines that would add compact grasses. Compacted grass is burning at a rate which can still result in high rates of spread. Once the large fuels (houses, fencing) started burning, they are, energy increased. The larger fuels eventually played a big role. I'm not sure what your point is.

Claire
December 10, 2021 at 9:04 am

Compact snow types? You mean like natural?

Matt
December 10, 2021 at 9:04 am

Stop lol. Dawson, we don't need your help unless you want to come help with burning thousands of people.

Sherry Davis
December 10, 2021 at 9:04 am

At the time this fire was racing on the wind it was consuming homes that appear to be fairly close together. Superior/Louisville to Boulderites is extremely far, as in the entire Front range. The fire has also used dry drainage grasses as fuel. In our neighborhood mixed shade trees with thick trees though the trees are not as close together as in the mountains. Fire is a natural occurrence. Its incompliance. Remember it's the drought and the extreme wind that is the cause and density to feed the fire.

Kate Stallberg
December 7, 2021 at 9:05 am

I don't know what you mean by "aroused open space". I've lived within spitting distance of open space for 30 years. I've watched it change. I've seen the fires. I've seen the floods. I've seen the "Front" to "Back" that open space. I can't imagine living where my line of sight is limited by hundreds, if not tens of thousands of people. All of those impact us psychologically and the immediate surroundings. What do you think is happening because of the experimental climate we live in? I've seen more than anything that the Greys and Target that burned, personally? I guess that's I've never seen that parking lot even half full. The many other Front Range parking lots.

Do you really think the county should get out, mow and bale the rocks & sand, along with some grasses and weeds? Maybe we should just pave it all and call it a day? Maybe we should all live in Passenger Trains. Other plans would boost yachts, as they do now. After a point managing the animals might take priority to people wouldn't be allowed.

Rob
December 10, 2021 at 9:04 am

We live in Louisville and evacuated. Thank you for providing good detail on the direction of the fire. Something the local news has yet to mention. At the beginning it seemed like it was moving east north east.

JOHN TROWBRIDGE
December 10, 2021 at 9:04 am

Not being familiar with the area I followed calls on emergency scanner using maps. Is there a very large Target store in the area? Seemed like there were numerous calls and dispatches covering following up in Broomfield northeast. Several structures from ongoing occupancy.

Heraldo Martin
December 10, 2021 at 9:04 am

Are here many safe escape routes for the residents that need to evacuate rapidly & where are their locations?

Harris Edward Alexander
December 10, 2021 at 9:04 am

Causes?

Minnie
December 10, 2021 at 9:04 am

Read news link. Im can tph winds blew over power lines, burn transformers, started the grasslires. Wil is Im, no snow there yet. Some forecast up to 6" for Denver area tomorrow.

JOHN TROWBRIDGE
December 10, 2021 at 9:04 am

Winds dimming fire power lines

Snake
December 10, 2021 at 9:04 am

Sherry, I was in Missouri mid-fall. the last real flag in the nearby western states. Crazy winds similar to the ones used where Kansas alone took the brunt at 3 point acres! I couldn't imagine trying to fight them in it. Interesting times indeed

Tim
December 10, 2021 at 9:04 am

It sound like powerlines.

Leighanna
December 10, 2021 at 9:04 am

Fallen Power lines and high winds

Minnie
December 10, 2021 at 9:04 am

A link to the weather, from being reported in the Boulder County area of CO.

https://www.nytimes.com/article/weather-colorado-wrong-winds-trees-power-lines-dangers-in-touch.html?utm_source=google&utm_medium=cpc&utm_campaign=nyt-us-en&gclid=Cj0KCQiA1fiOBhCoARIsAJ1C-OMF-VaK7Dv8PE

0

0

Minnie

December 30, 2021 at 2:11 pm

My family lives in Boulder, and has been msging me this morning, sending pictures. One of the local stations has reported winds 80-100 mph.

0

0

Comments are closed.

PREVIOUS

New ICS map symbology

NEXT

It’s not common to have major wildfires in the northern and southern hemispheres at the same time

WILDFIRE TODAY
NORTH AMERICAN WILDLAND FIRE NEWS
April 2022
Weather News & Opinion

Tag: Marshall Fire

Marshall fire updated damage assessment: 1,084 residences destroyed

By Bill Gabbert April 27, 2022 Wildfire Colorado, Marshall Fire 0 Comments

Estimated value of those Boulder County, Colorado homes is $713 million



Map of the perimeter of destroyed homes for the Marshall fire with assessed values of each home. Click on the map to see it in more detail. Boulder County GIS.

On Wednesday damage assessment of the Marshall fire in Boulder, Colorado updated Jan. 3 has found 1,084 destroyed residences and 149 that were damaged. The total countywide estimated value of destroyed homes is $513 million. The estimated value of destroyed structures are in dollars of 2021 and unchanged. The total value of commercial damage is still being calculated. The commercial structures included a shopping center and the Sleep Inn hotel.

Residential Structures

- City of Louisville - 321 destroyed, 12 damaged, actual value of residential damage is approximately $209,000,000.
- City of Superior - 370 destroyed, 10 damaged, actual value of residential damage is approximately $124,000,000.
- Unincorporated Boulder County - 131 destroyed, 48 damaged, actual value of residential damage is approximately $79,000,000.

Commercial Structures

- City of Louisville - 4 destroyed, 14 damaged
- Town of Superior - 5 destroyed, 13 damaged
- Unincorporated Boulder County - 0 destroyed, 0 damaged

More information

- Countywide Damage Assessment map
- List of impacted Residential and Commercial properties (updated January 6, 2022)

To see all articles on Wildfire Today about the Marshall Fire, including the most recent, click here. https://wildfiretoday.com/tag/marshall-fire/

Please read a lot of the fair use is to these.

Share this:

Facebook Twitter Reddit WhatsApp Email Print

The first arriving firefighters had trouble finding the Marshall Fire

By Bill Gabbert March 1, 2022 Wildfire Colorado, Marshall Fire 0 Comments

Within hours it burned more than 6,000 acres and nearly 1,000 structures southeast of Boulder, Colorado



It seems hard to believe, but the first two firefighters on the Sheriff's deputy dispatch list in the Boulder/Fire-Rescue combined dispatch center, which was established in 2015, had trouble finding the Marshall Fire southeast of Boulder, Colorado which ran rapidly and destructively in the December 30 fire and forced tens of thousands of people to evacuate their homes. It was a windy day, and the fire was spotting and accelerating in a way unbelievable to us. Later they found that at least one of the fires started by [Colorado Public Radio](), but they did not see smoke or flames until 11 minutes after the first report of a fire.

To see all articles on Wildfire Today about the Marshall Fire, including the most recent, click here. https://wildfiretoday.com/tag/marshall-fire/

It is possible that the 10 -minute delay in finding the fire was due to the reported location being inaccurate. It's like the rear-ended cop light cast such as short green tree burning which did not produce a great deal of smoke and may have been hard to see from a distance. The wind was strong and it was from the west-northwest. Narrow fuel, and in spite of the wind produced a convective column topped by condensation.



During the hour before it started, firefighters were sent to two other vegetation fires which were south of Superior. Some with the fire were among those firefighters were able to stop both before they grew large.

These incidents may have reduced the number of fire resources that were available when the Marshall fire was first spreading rapidly northeast and then east. It is unclear if any of them ran out of water depending on the location.

Before the fires started a group that had been briefing staff for the wind, then it became a series of smoke and dust. Check out the dust forming in the video with the fire in the background.



The wind was not predicted early in its advance for the Boulder area and there was no Red Flag Warning in effect. Forecasters had predicted that the strongest winds would be in the foothills and mountains, with the foothills north to Fort Collins – 50 mile wind south from there the mountains into the areas northeast of Denver. An existing wind warning was issued.

From CPR.org:

> *"It wasn't a storm dark high wind event," said Jennifer Jacobs, meteorologist in charge at the Boulder office. "But conditions were setting together, and once we saw the latest model runs, we knew that there was a potential for a high wind event. We just didn't know how widespread it would get or within an hour."*
>
> *Before the day was over winds would gear up to 115 mph at one location.*
>
> *The warning, however, was not as technically a "red flag" warning, which is specific to fire weather. Instead, it was a high wind warning, which is more general in its scope, Jacobs said.*
>
> *The lack of a red flag warning was a surprise to Philip Shapiro, Professor of Fire Ecology at the University of Colorado Boulder. Shapiro said that under the right conditions, a red flag warning is dependent on criteria for red flag warnings, but it should be reviewed in an era of climate change.*
>
> *"One of the things that we're seeing broadly in the fire world is that the systems that we have in place are largely developed based on our past experiences," said Shapiro. "We're experiencing conditions that are outside of those experiences. And so, we're going to have to develop new systems that are more nimble and more responsive, as we don't fully changing rapidly."*
>
> *Still, the warning that was issued discussed the danger of a possible fire spreading rapidly, given months of drought in the region combined with the winds.*

In a news release after the event, law enforcement officials said that the three major factors that affect the spread of a fire are weather, fuels, and topography. Wildfires generally do not suddenly become rapidly spreading events. Strong winds are present, and they can make up to four times faster depending on topography.

The lengthy drought and recent tree-loss among precipitation on the Front Range of Colorado in October, November, and December had set the stage for the wind event. The Marshall Fire started in grass-covered terrain where much of the destruction occurred was low, 15 percent, and the temperature was 45 degrees. The relative humidity was 15 percent. The fuels were dry, and the fire was driven by strong winds that were gusting over 100 mph, which is a medium-topography and fuel-type scenario. The 150 structures that burned added a great deal to the fuel load. As buildings were consumed, radiant and convective heat generated from the structure fires were only six to 10 feet apart, which made burning embers blown by the wind 30 spots fire ahead or the [home ignition zones](), on structures, fuel-filled gutters, and roofs, as well as fuels between and outside beds which in some cases spread to and ignited the homes.

The Boulder Office of Emergency Management declined to release to CPR a recording of the initial phone call reporting the fire.

Unlike most states, in Colorado county sheriff's have statutory responsibility to coordinate wildland fire suppression. Boulder County Sheriff's Office Public Information Officer Turner Richardson said that the point of origin. In some ways wind events that have been worsened as a consequence that are where the investigators have been seen.

The investigation of the fire's cause is going to be huge. That, combined with some covering the point of origin, is why the investigators are taking their time, being careful and meticulous. Many of the nearly 1,000 structures destroyed are valued at $500,000 or more. Like in Superior, which is a $1 million dollar home.

Share this:

Facebook Twitter Reddit WhatsApp Email Print

Photos before and after the Marshall Fire in Boulder County, Colorado

By Bill Gabbert January 1, 2022 Wildfire Colorado, Marshall Fire 0 Comments

Evacuation orders lifted for Louisville and Superior



Superior, Colorado, fuels and cars for Marshall Fire. Sept. 12, 2021 (Photo: J. Lisec, Boulder)



Superior, Colorado, before and after the Marshall Fire. Sept. 12, 2021 (Photo: J. Lisec, Boulder)

Aerial photos of Superior, Colorado before and after the devastating December 30 Marshall Fire show the physical impact on the structures. Most of the homes within the 6,000 acre perimeter were completely destroyed. Some of the homes on the perimeter, on the boundary, at 80 to 100 mph while the interior families lost the most.



At 11 a.m. Wednesday the evacuations order for Louisville was lifted. Superior's closures were lifted at 8 a.m. Boulder County's map at 3:30 p.m. Wednesday showed "all clear" and no closures in effect in the fire area.

To see all articles on Wildfire Today about the Marshall Fire, including the most recent, click here. https://wildfiretoday.com/tag/marshall-fire/

Map, Marshall Fire, 12:00 AM, Jan 1, 2022, Boulder County

Investigators have been searching for the two persons still reported as missing at two locations. In the case there is a Marshall death is reported and Boulder County does have reported partial human remains of an adult. Investigators from both the Sheriff's office and Coroner's office continue to actively work at the scene.

The search in the Gun Barrel at E. 56th Street, Superior is ongoing.

There have been no other reports of fatalities tied to the fire.

The Boulder County Sheriff's office said there are no updates on the continuing investigations into the cause and origin of the Marshall Fire. The weather has been a factor in the speed at which the investigations are able to be conducted.

The Firestorm Assistance Center is available for those impacted by the fire. It is located at 1151 South Public Road, Lafayette, and is open from 9 a.m. to 7 p.m. every day.

Residents can file claims with the Boulder County Office to see the damage caused by the fire.

Below is information from Boulder County about how to help.

> *We know our community's heart is huge, and everyone wants to help. Official sites are unable to accept any material donations – please do not bring them to offices or other disaster support locations.*
>
> *Victims need money. While some families have gofundme accounts set up by friends, we cannot verify the authenticity of each of these, and we are concerned about fraud. The very best way to help is to donate funding, without any implications, is to donate to www.coloradogives.org.*
>
> *Victims also need volunteers. There will be many needs in the months ahead. Please be on call, deposit to disaster zone. Please register.*
>
> *at: https://coloradocaregivers.connectsuite.com/. This state clearinghouse will strive to match volunteers with community and individual needs.*



The drone video below is pretty impressive.

Before and after aerial imagery of the catastrophic #MarshallFire in Boulder County, Colorado on [date, yes]. The imagery of destroyed homes and structures blanketed by snow is visible evidence of the event per. The fire. @satyherd. pic.twitter.com/wVdAdUFIqd

— US Stormwatch (@US_Stormwatch) January 5, 2022

Share this:

Facebook Twitter Reddit WhatsApp Email Print

County Sheriff says 991 structures destroyed in Marshall Fire southeast of Boulder, Colorado

By Admin January 1, 2022 Wildfire Colorado, Marshall Fire 0 Comments

Updated 8:15 p.m. MST Jan. 1, 2022

County authorities have been ordered [a preliminary list]() of the number of destroyed homes and businesses in the fast-moving wildfire southeast of Boulder, Colorado. They described as grateful that no confirmed deaths at 5 p.m. January 1, 2022.

From the Denver Gazette, Saturday evening:

> *Three people are missing and dozens of homes are destroyed in the wake of the Marshall fire, the Boulder County Sheriff's Office announced, and nearly 30,000 residents remain under evacuation orders, marking the blaze by far the most destructive in Colorado history.*
>
> *Three of the three missing persons are in Superior, and the threat is in the Marshall area, Sheriff Joe Pelle said. Search and rescue teams, using recovery authorities are looking for the missing persons. Pelle said that the search and rescue teams are working to find them and through a Sunday. The Sheriff's Office is asking for anyone who has information to call the office.*

To see all articles on Wildfire Today about the Marshall Fire, including the most recent, click here. https://wildfiretoday.com/tag/marshall-fire/

Please read a lot of the fair use is to these.

SUBSCRIBE VIA EMAIL
Enter your email address to receive notifications of new posts by email.
Email Address
Subscribe
SEARCH
Search
FILTER
Events
All Events
News
All News
Go
Wildland Fire Leadership Foundation
Fire Shop Advantage
MAFFS
FEDS
Fire Shop
Fire Shop
COMMENTS
No new comments.
Add one to the site.
RECENT ARTICLES
Significant spring wildfire risk in southern U.S. and Great Basin through June
Wildland firefighter pay bonds approved by Congress and signed by President
Tracker: 2022 Calif. Dixie, Mosquito, Hermits Peak, Calf Canyon fires
Initial Assessment: Calif. Dixie Fire burned 963,309 acres, destroyed 1,329 structures
New Chicago area ICT3 wildland firefighter crew will be deployed to wildfires
Interview: Wildfires in Chile
INTERESTED IN WILDFIRE MAPPING?
CLICK FOR DETAILS
ARCHIVES
Select Month
Wildland Fire Lessons Learned Center
Wildland Fire Lessons Learned Center
Check out our companion site, the Lessons Learned Center, also available from Wildfire Today.

Map, Marshall Fire, Dec. 31, 2021

Unlike most states, in Colorado county sheriffs have statutory responsibility to coordinate wildland fire response within their county. Boulder County, the location of the Marshall Fire, has five year-round employees with fire responsibilities. They also have seasonal firefighters during the traditional wildland fire season.

Saturday afternoon Boulder County Sheriff Joe Pelle released damage assessment numbers for the 6,000-acre Marshall Fire southeast of Boulder.

Total numbers are 991 structures destroyed and 127 damaged.

Louisville:
Destroyed – 353
Damaged – 45

Superior:
Destroyed – 552
Damaged – 60

Unincorporated Boulder County
Destroyed: 108
Damaged: 22

The Sheriff did not specify how many of the structures were homes. Therefore, the numbers could include backyard sheds and other small uninhabited buildings.

What caused the Marshall fire?

Boulder County has clarified information that was previously released about the cause of the fire. In a press conference Friday morning, Sheriff Pelle told reporters that someone told fire authorities that there was a downed power line near where the fire started. That report and some investigation has not confirmed the scene, he said, and the specific cause had not been officially confirmed.

Saturday afternoon the Boulder Office of Emergency Management released a statement:

As of last night, no downed power lines had been found in the area [of the origin]. There were some downed telecommunication lines, but these are not likely to have started the blaze. The sheriff did confirm that one search warrant has been obtained, but he declined to release any additional information about the location or reason for the warrant.

Share this:

Tweet Share Telegram WhatsApp Email Reddit

Photos show devastation after the 6,000-acre Marshall Fire in Colorado

Bill Spencer January 1, 2022 Wildfire Colorado, fire codes, home ignition zone, Marshall Fire, NOAA, wildfire 0 Comments

The surviving homes in subdivisions that were destroyed had a common feature

Marshall Fire, Louisville, Colorado. Photo by McClatchy/Boulder Weekly, Dec. 31, 2021

Early Friday morning, about 20 hours after the Marshall Fire ignited, a drone operated by Twitter user McClatchy/Brandon Clement flew over subdivisions that were devastated by the December 30 fire. It found block after block of ash piles, some still smoldering. In many scenes there was scarcely a structure still standing. (Scroll down to see the video.)

To see all articles on Wildfire Today about the Marshall Fire, including the most recent, click here: https://wildfiretoday.com/tag/marshall-fire/

All of the reasons why some homes did not burn even though dozens around them were consumed could not be determined from the video, but there was one common feature – the structures were all separated from the neighboring homes. Many houses in the subdivisions were only 10 to 20 feet apart based on archived imagery in Google Earth.

The fire was driven by very strong winds gusting at 60 to 110 mph, extremely dry conditions after months of drought, and relative humidity in the mid-20s. These are the very worst fire conditions. The weather paired with the nearly back to back structures led to the fire spreading through a continuous human-caused fuel bed where one house burned the cornerstone and radiant heat easily ignited its neighbor, which ignited its neighbor, etc.

The fire in the vegetation and structures lofted burning materials far downwind, creating distant spot fires in the home ignition zone we have dry lawns, mulch beds around ornamental plants, and on structures. It is unknown at this point how many have been designed and built to fire resistive codes, such as the characteristics of the roof, eaves, siding, doors, windows, foundation, fences, eaves, and decks. A Wildland Urban Interface (WUI) code was adopted by Boulder County in 2015. Research has indicated the cost of building fire resistant homes is about the same as a standard home. Local building codes could regulate these features. But if the lot size is so small that residences are only 10 to 20 feet apart, if the home is densely wooded, the neighbors also burn, especially during windy conditions.

So far we have listed some factors that affect the vulnerability of structures during a wildland- urban interface fire: home spacing and lot size, the envelope of the structure itself, fire codes, and the home ignition zone. Others are:

- Evacuation capability and planning.
- Safety zones where residents can shelter in place.
- Road and driveway width, wide enough for large fire trucks;
- Water supply at the end of roads.
- Signage, and
- Emergency water supply.

The video below of the Marshall Fire devastation was shot by McClatchy/Brandon Clement at first light on December 31, 2021, the day after the fire started. Hat tip, amy, more August Sibling. The National Weather Service in nearby Boulder recorded an accumulation of eight inches.

Share this:
Tweet Share Telegram WhatsApp Email Reddit

Mapping shows Marshall Fire has burned thousands of acres

Bill Spencer December 31, 2021 Wildfire Colorado, Marshall Fire 0 Comments

The fire destroyed hundreds of homes southeast of Boulder, Colorado

Updated at 3:42 p.m. MST Dec. 31, 2021

Photo from a traffic camera in Boulder, CO at 3:44 p.m. Friday. Credit: city of Boulder.

Judging from the photo above taken in Boulder, Colorado at 3:44 p.m. the weather forecast was correct. Forecasters are predicting an additional six inches or so through noon Saturday in the area of the Marshall fire.

Updated 12:40 p.m. MST Dec. 31, 2021

Boulder County Sheriff Joe Pelle said in a briefing Friday morning that there have been no reports of fatalities on the 6,000- acre Marshall Fire southeast of Boulder, Colorado. That could change as crews search the area. The fire is 0% contained. Pelle said that the number of homes destroyed is increasing the rapid spread of the blaze which allowed some residents only minutes to escape. It is also a testament to the amazing job done by firefighters and law enforcement to make the necessary notifications, which no doubt saved lives.

To see all articles on Wildfire Today about the Marshall Fire, including the most recent, click here: https://wildfiretoday.com/tag/marshall-fire/

Friday morning there is very little remaining for activity, other than smoldering remains of destroyed structures. Firefighters do not expect the perimeter to grow, especially in light of the snow in the forecast.

The one person reported as missing has been found.

look at this!? one house survived when every other house around it is gone. ? I'd did not take this picture. just saw it elsewhere.#MarshallFire #Superior pic.twitter.com/TTNbQvnqYJ

— Miss Construed #ColoradoStrong (@theonejen) December 31, 2021

There are 1,578 homes within the perimeter of the fire, but not all of them were affected by the fire, which burned in a mosaic pattern. Some entire subdivisions were "totally gone," the Sheriff said, including the Sagamore subdivision in Superior. The Superior Town Hall and the Superior Library were two burned homes are now of importance to the Marshall Area, and on the south side of Louisville.

Governor Jared Polis and the Sheriff said Friday that there could be as many as 500 or 1,000 homes that were destroyed. That could be an increase from the estimated 580 figure released by the Sheriff Thursday evening. There were also a number of commercial properties damaged or destroyed.

As entire subdivisions were wiped out, many household plumbing systems were also damaged or destroyed, which led to water gushing from the remains of structures. This depleted the water available at fire hydrants which became a challenge for firefighters. Louisville residents were advised to either boil their water or use bottled water for drinking, making ice, and other uses because the city changed its water distribution to untreated water to its efforts to make water available to firefighters. Other communities providing mutual aid assistance to Boulder County include Lafayette, Longmont, Mountain View Fire, East Boulder County Water District, and the Colorado Air National Guard.

President Biden has approved a disaster declaration which will be finalized Friday. This will expedite approvals of assistance for home owners and small businesses that suffered losses.

Sheriff Pelle said the wind-blown power lines near the point of origin of the fire, but the specific cause has not been confirmed.

On Friday about 200 people were staying in emergency shelters.

The Incident Commander said the strategy during the first few hours was not to attempt to suppress the fire, but to evacuate people. That was a key factor in minimizing the number of the evacuation. With 20 to 30 mph winds, impressive smoke and heavy fuels, Louisville's evacuation was complete and the wind speeds had decreased, they were able to begin working on the flanks.

The Sheriff said "a federal reconstruction" is underway for IC that has been running for five days since Thursday morning. This means that an interagency incident management team (IMT) has been ordered. The National Situation Report dated 2 in Friday morning lists no fires in Colorado or the Southwest Area that are in an IMT. The Rocky Mountain Area has a Northern Fire Center, which is no doubt working with a skeleton staff during the holidays.

The map of the fire was updated late Friday morning, increasing the size by 30 acres, bringing the total up to 6,415. The tweaks were minor and involved a few changes in the perimeter south of Marshall Lake and on the east side near the intersection of Eldora Road and S. 99th Street.

look at this!? one house survived when every other house around it is gone. ? I'd did not take this picture. just saw it elsewhere.#MarshallFire #Superior pic.twitter.com/TTNbQvnqYJ

— Miss Construed #ColoradoStrong (@theonejen) December 31, 2021

7:05 a.m. MST Dec. 31, 2021

Map, Marshall Fire, Dec. 30, 2021

Overnight mapping Thursday night found that the Marshall Fire southeast of Boulder, Colorado had burned about 6,200 acres. The fire started at 10:30 Thursday morning and was pushed by wind that in some locations sped up to 110 mph while the entire burning area was in the 20s. Tens of thousands of residents have been under evacuation orders. At least 500 homes, a shopping center, and a hotel burned. That number will increase in the coming days as authorities are able to access the area.

Evacuation areas, Marshall Fire. Map accessed at 5 a.m. Dec. 31, 2021. Enlarge.

All persons were evacuated from the Arriva Adventist Hospital in Louisville. The Good Samaritan Medical Center in Lafayette transferred about 34 of their most critical patients to other facilities.

No deaths have been reported, but at 3 p.m. Thursday Boulder County Sheriff Joe Pelle said, "Due to the magnitude of this fire, the intensity of this fire, and its presence in such a heavily populated area we would not be surprised if there are fatalities."

Thursday afternoon the Target shopping complex and the Element Hotel in Superior were burning.

Closing Map, Marshall Fire, Dec. 31, 2021

Fire officials said the cause of the fire was likely downed power lines during the extreme winds.

The weather has changed for the better, at least from a firefighting viewpoint. The 30 to 100 mph winds with low humidities are being replaced Friday morning with temperatures around freezing and a 40 percent chance of snow. By 6 p.m. that chance will increase to 70 percent, then 90 percent by sunset. Snow accumulations are predicted to be 6 to 8 inch during the day on Friday, with another 2 inches overnight. Saturday there is a 30 percent chance of snow. Winds are predicted to be 10 to 20 mph, except at 7 to 9 mph gusting as the afternoon to 20 mph. We don't often include wind chill in our articles about ongoing wildfires, but that will be a factor today, 10° dropping to 0° by 5 p.m.

We will update this article as additional information becomes available.

Share this:
Tweet Share Telegram WhatsApp Email Reddit



Tag: Marshall Fire

Wind-driven wildfire burns hundreds of homes near Boulder, Colorado

Bill Gabbert December 30, 2021 Wildfire Colorado, Marshall Fire 81 Comments

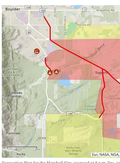
At least 580 homes have burned in the Marshall Fire

Updated at 8:23 p.m. MST Dec. 30, 2021



Map showing heat on the Marshall Fire detected by satellites at 2:05 p.m. MST Dec. 30, 2021.

To see all articles on Wildfire Today about the Marshall Fire, including the most recent, click here.



Evacuation Map for the Marshall Fire, accessed at 8 p.m. Dec. 30, 2021. Boulder County. More details.

The Element Hotel in Superior, CO burned:



Updated at 6:52 p.m. MST Dec. 30, 2021

At a 5 p.m. briefing Boulder County Sheriff Joe Pelle said he was not aware of any fatalities that had occurred at that point on the Marshall Fire, which has burned approximately 1,600 acres southeast of Boulder, Colorado. One officer has been injured. *Lee maps below!*

"However," he said, "I would like to emphasize that due to the magnitude of this fire, the intensity of this fire, and its presence in such a heavily populated area we would not be surprised if there are fatalities."

The Sheriff listed the numbers of structures that had burned at the time of the briefing. The numbers, totaling about 580, are approximate:

- 370 homes in the Sagamore subdivision just west of Superior,
- 210 homes in the Old Town Superior area,
- The Target shopping complex in Superior was on fire,
- The Element Hotel in Superior was "fully engulfed".

Sheriff Pelle said the Middle Fork Fire 5 miles north of Boulder near Highway 36 was reported at about 10:30 Thursday morning. The spread has been stopped.

The Marshall Fire, still vigorously spreading, started just after 11 a.m. Thursday.



Evacuation Centers

Three evacuation centers are available: North Boulder Recreation Center, Longmont Senior Center, and the YMCA in Lafayette. Cots are on their way and authorities are arranging for meals. Large animals should be taken to Jefferson County Fairgrounds, 15200 W. 6th Ave., Golden, CO 80401. The Boulder County Fairgrounds was reported to be full Thursday afternoon.

Weather Forecast

The forecast for the fire area Thursday night is for partly cloudy skies with a low around 27. The wind speeds will be decreasing through the night, with a south-southeast wind 9 to 24 mph becoming southwest 10 to 15 mph after midnight. Winds could gust as high as 37 mph.

On Friday snow is expected after 11 a.m. The temperature will rise to 34 by noon, then fall to around 27 during the remainder of the day. The wind will be west-southwest at 7 to 11 mph becoming east-northeast in the morning. Winds could gust as high as 18 mph. The chance of precipitation is 80%. New snow accumulations of 1 to 3 inches are possible.

The National Weather Service posted this list of maximum wind gusts in Boulder County today.

Highest wind gusts reported in Boulder County, Dec. 30, 2021. (Each line is a separate weather station.)

Updated at 4:42 p.m. MST Dec. 30, 2021

Map showing heat detected by satellites on the Marshall Fire, 2:05 p.m. MST Dec. 30, 2021.

We now have a better map of the Marshall Fire (above), based on heat detected by satellites at 2:05 p.m. MST December 30.

Marshall Fire evacuation information. Boulder County. 4 p.m. Dec. 30, 2021.

Marshall Fire, posted at 4:29 p.m. Dec. 30, 2021 by @KyleClark.

Marshall Fire, posted at 1 p.m. Dec. 30, 2021 by @brookdeeff.

Continue reading

Share this:
Share 2.7K LinkedIn Telegram WhatsApp Email Reddit

SUBSCRIBE VIA EMAIL

Enter your email address to receive notifications of new posts by email.

Email Address

SUBSCRIBE

SEARCH

Search ...

FILTER

Month | Year | State | Countries | Topics | GO

WILDLAND FIREFIGHTER FOUNDATION

MAFFS

RAPID RESPONSE ATTACK FIRE BOSS ADVANTAGE AMPHIBIOUS AIR

FEOS PROTECTION

PURE HOP

COMMENTS

We love comments. Click here for the rules.

RECENT ARTICLES

- "Significant" spring wildfire risk in southeast US, driven by hurricane damage and drought
- Wildland firefighter pay boost approved by Congress after years of anxiety
- Trump's EPA may change obscure rule in attempt to increase prescribed burns
- USDA hires back 26 of 1,000 fired workers from past month, including public land managers
- Mass firings create CO wildland firefighter
- How the Eaton Fire destroyed a delicate truce over Altadena's future

INTERESTED IN ADVERTISING ON WILDFIRE TODAY? CLICK FOR DETAILS

ARCHIVES

Select Month

International Association of WILDLAND FIRE

Check out our companion site, Fire Aviation. Our publisher, the International Association of Wildland Fire, also publishes the International Journal of Wildland Fire and Wildfire Magazine.



Marshall Fire Mitigation Assessment Team: Decreasing Risk of Structure-to-Structure Fire Spread in a Wildfire

June 2023

FEMA

DR-4634

This page intentionally left blank

Table of Contents

1. Introduction 1
2. Purpose 1
3. Key Issues 1
4. Vulnerable Building Components 2
   4.1. Roofing Systems 2
   4.2. Wall System Assemblies 3
   4.3. Vent Protection 5
   4.4. Glazing Systems 6
   4.5. Attachments 6
5. Building Configuration, Siting and Spacing 7
   5.1. Building Configuration 7
   5.2. Building Siting 8
   5.3. Building Spacing 9
6. Resources and Useful Links 10

1. Introduction

On December 30, 2021, a wind-driven wildfire affected over 2,000 residential structures and several commercial facilities in unincorporated Boulder County, the City of Louisville, and the Town of Superior, Colorado. Data gathered after the fire highlighted the importance of preventing or slowing down structure-to-structure fire spread. Such prevention begins with the selection of appropriate building systems and spacing between buildings. Foundations, roofing, siding, windows, and doors, and building configuration and siting all play into slowing or eliminating the ability of a fire to spread from an adjacent structure, shed, or fence.

Because of the unique nature of the incident, where extreme winds coupled with long term drought, high temperatures, and limited wildfire regulatory adoption, a fast-moving low-intensity grass fire became a highly destructive urban fire directly and indirectly impacting several communities and greater Boulder County area. The Federal Emergency Management Agency (FEMA) deployed its first-ever wildfire Mitigation Assessment Team (MAT) to evaluate building performance during the fire. The MAT was deployed to Louisville, Superior, and unincorporated areas in Boulder County, Colorado, to evaluate damaged homes and commercial structures. MAT members evaluated components and systems of primarily residential structures to determine the effectiveness of various building materials, design, and construction practices for wildfire resiliency. The MAT used the information gathered to evaluate how wildfire-urban interface (WUI) building codes and standards, as well as design, construction, and defensible space practices can be improved to increase community wildfire resilience. This is important as the landscape is continuously evolving due to climate change and putting more communities at risk.

2. Purpose

During a fully developed fire, temperatures can reach above 1,000° Celsius (about 1,800° Fahrenheit) which can lead to significant structural degradation of building structural systems. This degradation can lead to loss of capacity for structural elements and could potentially lead to life safety concerns in structures that remain standing. The purpose of this document is to provide recommendations to contractors and designers on new building construction that may prevent or slow the spread of a fire from structure-to-structure in densely-spaced neighborhoods.

3. Key Issues

Structure-to-structure fire spread is typically caused by one or both of the following:

- **Vulnerable building components**: Roof systems, composite siding, and single pane, or large glass panel windows can propagate fires due to radiant heat causing them to break and allow them to spread faster. Other combustible building components, such as attached structures (e.g., decks, balconies, fences), can ignite from embers or direct flame contact and spread fire to the building.

- **Building configuration, siting, and spacing**: Buildings with complex shapes can allow embers to collect on rooftops and cause fires to spread more rapidly to other buildings. Buildings sited

along ridgetops or placed closely together in densely-developed areas can ignite one another by direct flame contact or radiant heat.

Debris from various household and outdoor items surrounding a building can act as wicks to spread the fire hazard from one structure to another. Such items may include propane tanks, firewood, outbuildings, vehicles, and filled dumpsters too close to a structure. To address the issue of debris, refer to Marshall Fire MAT document *Homeowner's Guide to Reducing Wildfire Risk Through Defensible Space*.

In a widespread or intense wildfire there may be limited firefighting resources available to defend structures to prevent the spread of fire between them. Homeowners, designers, and contractors in high wildfire risk areas should consider using fire-resistant and noncombustible construction materials and techniques to increase the likelihood a home will withstand a wildfire if firefighting resources are limited.

4. Vulnerable Building Components

Vulnerable building components that contribute to structure-to-structure fire spread through combustion or other means typically include one or more of the following:

- Roofing systems
- Wall system assemblies
- Vent protection
- Glazing systems
- Attachments

In addition, landscaping and vegetation surrounding the building can contribute to structure-to-structure fire spread. (Refer to Marshall Fire MAT document *Homeowner's Guide to Reducing Wildfire Risk Through Defensible Space* for more information on this topic.)

The following sections describe the conditions observed and recommended migration strategies for each component listed above.

4.1. Roofing Systems

Although there were no direct observations of roofing systems resulting in structure-to-structure fire spread during the Marshall Fire, residential roofing systems are a key area of known wildfire vulnerability. Many homes during a fire hazard event burn from the top down when roofing materials or combustible roof decking are ignited by embers that generated from other structures, the flame front (the wave of the fire heading toward a structure) or when embers enter through roof vents or other openings in the roof.

Recommended mitigation strategies for roofing systems include:

- Select tested roofing systems that meet ASTM E108 or UL 790 Class A requirements should be used. Systems include, but are not limited to, asphalt shingles, concrete, brick, or masonry tiles (with bird stops), or metal panel/shingles. Note that Class A roof systems include the entire roofing assembly and not just the roof covering.
- Avoid materials such as wood and fiberglass when selecting new or replacement building roofing systems.
- Use metal valley flashing to avoid debris accumulation between and below tiles and add an underlying mineral surface cap sheet into assemblies that use metal valley flashing.
- Limit the number of joints and elevation changes in the roof design. Use proper flashing at the joints between walls and porch roofs/lower roofs and roof edges. Use noncombustible materials to construct roof expansion joints. Refer to the Marshall Fire MAT documents *Guide to Reducing Risk of Structure Ignition from Wildfire* and *Wildfire Resilient Detailing, Joint Systems, and Interfaces of Building Components* for additional information.
- Use metal gutters and downspouts. Install corrosion-resistant noncombustible drip edge flashing from the roof to the gutter, tightly fitting the flashing against the gutter. Use gutter covers made from noncombustible materials to prevent debris from accumulating in gutters.
- Use enclosed soffits or appropriate vent screens and batts in soffits.
- Provide bird-stops or mortar at open ends of tiles on profile-tiled roof edges. For other types of roof edges, provide underlayment that is continuous to the roof edge and metal flashing at the roof edge.
- Install spark arresters on chimneys.

4.2. Wall System Assemblies

Residential construction consisted of mainly wood-frame building systems with either brick or stone veneer and vinyl or fiber cement exterior siding. Siding and veneers appeared to be built over wood framing, with plywood or oriented-strand-board (OSB) sheathing and building paper (Figure 1).



Figure 1. Examples of damaged wall assemblies.

Recommended mitigation strategies for wall system assemblies include:

- Provide additional layers of exterior gypsum (5/8-inch thick type X) board sheathing to create a fire-resistant wall assembly that can slow fire propagation and structure-to-structure fire spread (Figure 2).

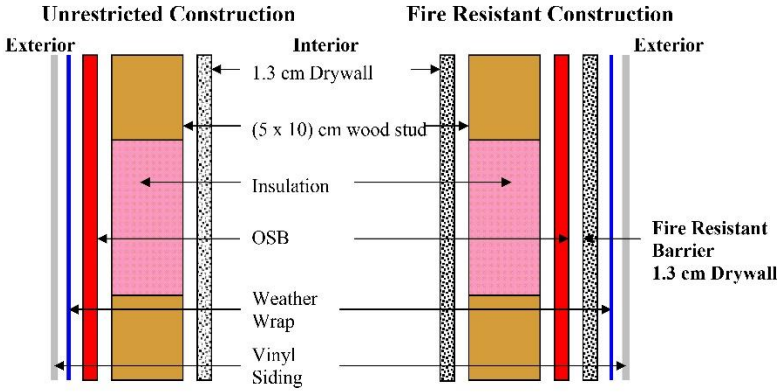


Figure 2. Fire-resistant wall assembly cross-section (NIST, 2008).

- Use non-combustible cement board cladding, masonry construction or veneer, stucco exterior or a combination of these three options, especially at head-of-wall locations.
- Designers should consider adding fire-resistant walls on sides of the building where fire hazards are within 25 to 50 feet to reduce or prevent fire spread (Figure 3).

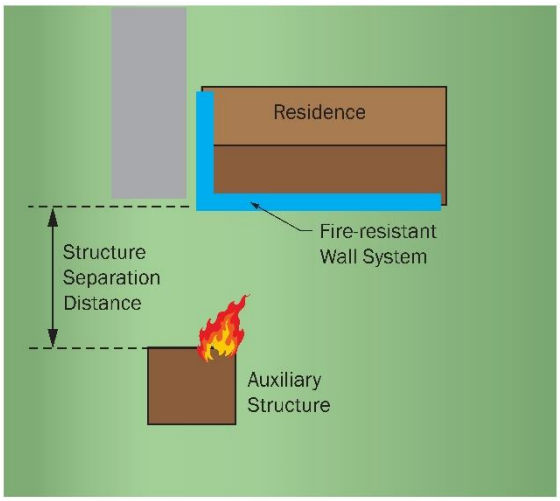


Figure 3. Fire-resistant wall system recommendations when desired structure separation distance (SSD) cannot be achieved (NIST, 2022).

- Use ignition-resistant fiberglass batt insulation inside wall cavities or ensure exterior walls are flashed/sealed with fire resistant caulk completely to prevent embers and hot gasses from entering the structure.
- Provide proper detailing at wall joints and interfaces along the base of the wall and the base of the roof to prevent gaps. Refer to the Marshall Fire MAT document *Homeowner's Guide to Reducing Risk of Structure Ignition from Wildfire* for additional details on addressing gaps at joints and interfaces.

4.3. Vent Protection

Plumbing and attic vents on existing construction did not appear to have proper screening to prevent ember intrusion into most of the observed structures. Soffit vents with opening sizes of more than 1/8-inch square mesh can allow embers to enter an attic that could cause a fire to propagate or continue. Crawlspace vents are typically covered with mesh screening that is 1/4-inch square to prevent rodents from getting in, but this can still allow embers to pass through and contribute to fire spread.

Recommended mitigation strategies for vent protection include:

- Cover all plumbing stacks, attic, crawlspace, soffit, and ridge vents with non-combustible mesh having opening sizes no larger than 1/8-inch square for new or retrofit construction (Figure 4).

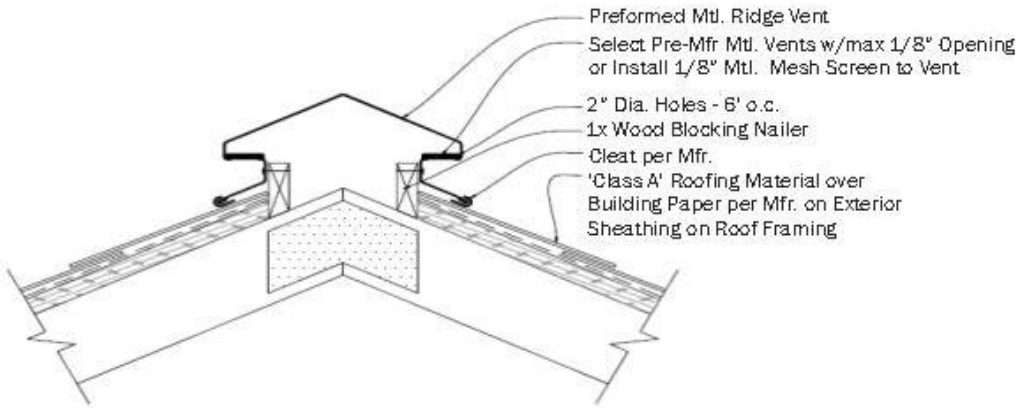


Figure 4. Example of ridge vent drawing with proper screening (Note: confirmation of proper attic ventilation by code still required) (City of Colorado Springs Fire Department, 2020).

Refer to the Marshall Fire MAT document *Homeowner's Guide to Reducing Risk of Structure Ignition from Wildfire* for additional details on protecting vents and other openings.

4.4. Glazing Systems

Glazing systems can break due to radiant heat or breakage from debris of single pane windows allow embers to enter and cause ignitions at the interior of a structure (Figure 5). Both single pane and multi-pane glazing systems were observed. In some cases where multi-pane glazing was present, the outer pane of glass was observed to be damaged.

Single-pane glazing will crack and fall out under intense heat and allow ember and flame spread into the structure and propagate the fire, especially if the window is located below or next to burning material or burning vegetation.



Figure 5. Example of glazing system failures.

Recommended mitigation strategies for glazing systems include:

- Use tempered-glass and double-pane glazing systems for windows and doors with glazing.
- Install aluminum coverings or use metal framing for window and door frames.
- Use fiberglass or metal screening on windows.

4.5. Attachments

In some cases, attachments such as decks, patios, porches, and balconies acted as "wicks" that, once ignited from embers or direct flame contact, provided a direct vehicle to igniting the home. Decks can provide a large surface area where embers can collect, which can lead to ignition of materials on the deck or of the deck itself. Many decks were observed to have materials stored on or underneath them that could - and in some cases did - provide fuel for ignition. See Marshall Fire MAT

document *Homeowner's Guide to Reducing Risk of Structure Ignition from Wildfire* for more guidance on mitigating fire risk posed by attachments.

Recommended mitigation strategies for attachments include:

- Use noncombustible materials for deck framing, walking surfaces, railings, and stairs. All metal components must be corrosion resistant.
- Space deck boards with 1/4-inch gap. As an alternative, consider installing a solid walking surface, such as lightweight concrete, or use aluminum decking without gaps.
- For decks four feet or less above the ground, enclose the space under the deck from the walking surface to the ground using corrosion-resistant metal mesh having openings 1/8-inch or less (IBHS, 2023). Alternatively, fully enclose the space using noncombustible materials. If the deck is over a 10% or greater slope, the enclosure should stop within 6 inches above the ground surface to allow for drainage.
- Install metal flashing between or on top of the deck surface and the adjacent exterior wall. Extend the flashing at least 18 inches up the wall and tuck it in behind the lap joint (Fire Safe Marin, 2023).
- See Marshall Fire MAT document *Homeowner's Guide to Reducing Risk of Structure Ignition from Wildfire* for additional details.

5. Building Configuration, Siting and Spacing

The following sections describe the building configuration, siting and spacing conditions observed and recommended mitigation strategies for each.

5.1. Building Configuration

Although there were no direct observations of building configuration leading to structure fires, complex building geometries can lead to debris collecting at roof valleys and re-entrant corners, allowing embers to spread fire between structures (Figure 6). Structural overhangs are also a possible location for debris and embers to collect and hot gases to enter the building.



Figure 6. Example of complex building geometry.

Recommended mitigation strategies related to building configuration include:

- Limit re-entrant corners on building designs to eliminate locations where debris could build up.
- At roof dormers, limit areas where debris could collect.

- Enclose the underside of structural projections from buildings with ignition resistant material to reduce the likelihood of fire spread in these areas.

5.2. Building Siting

Although there were no direct observations of siting issues (including set back) leading to structure fires, building siting plays an important role in preventing structure-to-structure fires. Orientation and location of buildings can help slow or prevent the spread. Understanding how topography can influence fire hazard behavior will allow designers to aid property owners in site selection to reduce the potential of fire hazard spread.

Recommended mitigation strategies related to building siting include:

- Avoid selecting a construction site in or adjacent to a topographic saddle or narrow mountain pass.
- Avoid constructing a home adjacent to or on a mild or steep slope. If a building is to be constructed at a ridgetop, the structure should be set back 50 feet from vegetation on the downslope side (Figure 7).

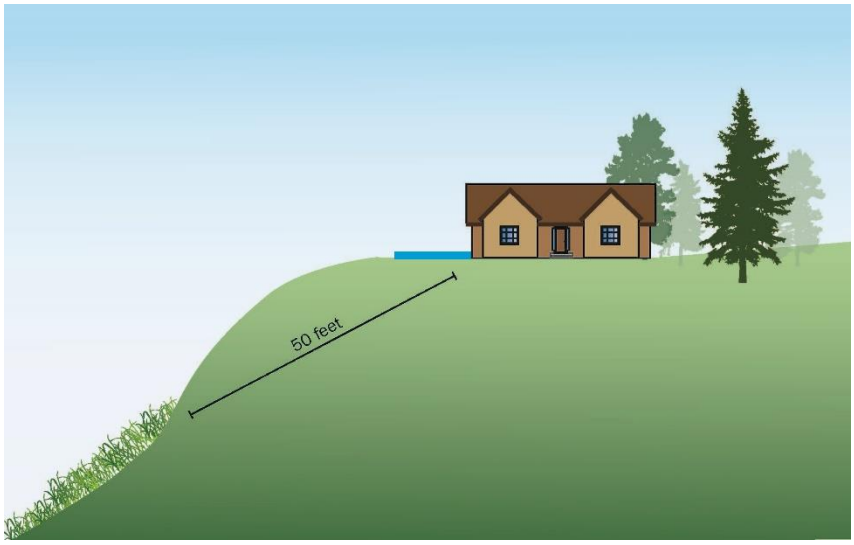
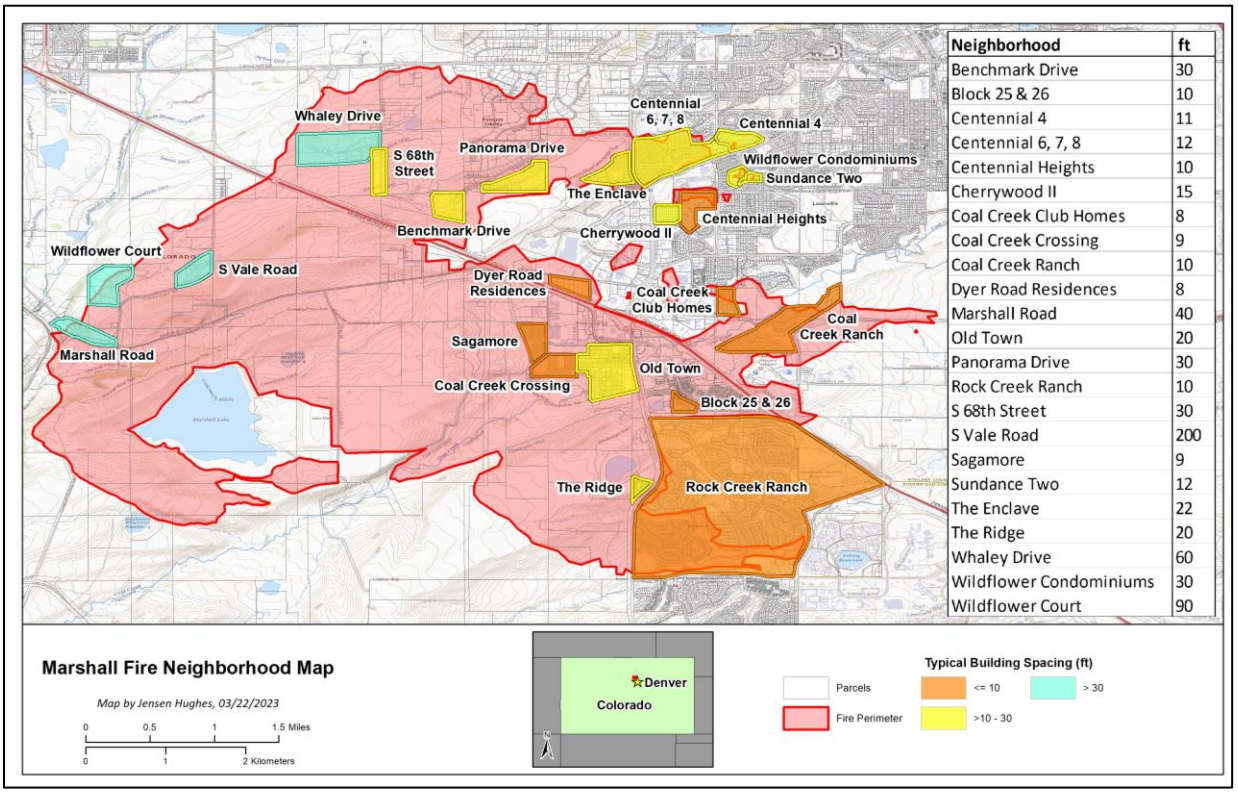


Figure 7. Example of recommended setback from a ridgetop (FEMA, 2008).

- Orient the narrowest wall of a structure toward the likely path of a fire hazard spread to minimize the risk of ignition. Orient the building based on prevailing wind and fuel sources nearby so that embers do not accumulate next to building walls.
- Pay close attention to building orientation with respect to inside corners and other offset walls.
- Refer to the Marshall Fire MAT document *Best Practices for Wildfire-Resilient Subdivision Planning* for additional details on building siting.

5.3. Building Spacing

Observations from the Marshall Fire indicated that the average spacing between buildings likely played a role in structure-to-structure fire spread (Figure 8). Although clustering homes together within a subdivision surrounded by community defensible space is generally considered beneficial for reducing wildfire risk, increasing the separation distance between individual buildings can help slow or prevent structure-to-structure fire spread. Note that increasing spacing between properties can drive up costs and impact affordability. This approach also may not be possible in more densely developed areas.



Neighborhood	ft
Benchmark Drive	30
Block 25 & 26	10
Centennial 4	11
Centennial 6, 7, 8	12
Centennial Heights	10
Cherrywood II	15
Coal Creek Club Homes	8
Coal Creek Crossing	9
Coal Creek Ranch	10
Dyer Road Residences	8
Marshall Road	40
Old Town	20
Panorama Drive	30
Rock Creek Ranch	10
S 68th Street	30
S Vale Road	200
Sagamore	9
Sundance Two	12
The Enclave	22
The Ridge	20
Whaley Drive	60
Wildflower Condominiums	30
Wildflower Court	90

Figure 8. Typical building spacing in Superior and Louisville, Colorado, neighborhoods impacted by the Marshall Fire.

Recommended mitigation strategies related to building spacing include:

- Provide a minimum spacing of 30 feet between structures when possible.
- Buildings in high-risk wildfire areas that are spaced within 30 feet of each other should be constructed with Class A roof systems and fire-resistant exterior wall assemblies. Placement of vegetation, fences, decks, vehicles, and outbuildings in areas where construction is close together can also contribute to structure-to-structure fire spread. Refer to the Marshall Fire MAT document *Homeowner's Guide to Reducing Risk of Structure Ignition from Wildfire* for more information on reducing risk of structure ignition from wildfires.
- Refer to the Marshall Fire MAT document *Best Practices for Wildfire-Resilient Subdivision Planning* for additional details on density of development.

6. Resources and Useful Links

City of Colorado Springs Fire Department. 2020. "Ignition Resistant Construction Design Manual"

Federal Emergency Management Agency. 2008. FEMA P-737: *Home Builder's Guide to Construction in Wildfire Zones.* Available at: https://basc.pnnl.gov/library/fema-p-737-home-builders-guide-construction-wildfire-zones-technical-fact-sheet-series

Fire Safe Marin. 2023. *Fire-Resistant Decks, Patios, & Porches*. Available at: https://firesafemarin.org/harden-your-home/fire-resistant-decks-patios-porches/

National Institute of Standards and Technology. 2022. WUI Structure/Parcel/Community Fire Hazard Mitigation Methodology. NIST Technical Note 2205. Available at: https://nvlpubs.nist.gov/nistpubs/TechnicalNotes/NIST.TN.2205.pdf

Institute for Building and Home Safety. 2023. *Wildfire Prepared Technical Standard.* Available at: https://wildfireprepared.org/wp-content/uploads/WFPH-Standard-2022-Final.pdf

International Wildland Urban Interface (IWUI) Code, 2021.

Maranghides, A. and Erik Lewis Johnsson. 2008. "Residential Structure Separation Fire Experiments." National Institute of Standards and Technology (NIST) Technical Note 1600. Available at: .https://www.govinfo.gov/content/pkg/GOVPUB-C13-61ebeb4a9065a1584c3a9b0561bbb525/pdf/GOVPUB-C13-61ebeb4a9065a1584c3a9b0561bbb525.pdf

National Fire Protection Association® (2022). NFPA 1140, 2022 Edition: Standard for Wildland Fire Protection

Quarles, Stephen and Standohar-Alfano, Christine. 2018. Wildfire Research Ignition Potential of Decks Subjected to Ember Exposure. *Institute for Building and Home Safety.* Available at: https://ibhs.org/wp-content/uploads/member_docs/Ignition-Potential-of-Decks-Subjected-to-an-Ember-Exposure_IBHS.pdf

Society of Fire Protection Engineers and SFPE Foundation. "WUI Virtual Handbook for Property Fire Risk Assessment & Mitigation." SFPE.org. 2023. Available at: https://www.sfpe.org/wuihandbook/home



Marshall Fire Mitigation Assessment Team: Best Practices for Wildfire-Resilient Subdivision Planning

June 2023

FEMA

DR-4634

This page intentionally left blank.

Table of Contents

1. Introduction 1

1.1. Purpose 1

1.2. Key Issues 2

1.3. Definitions 8

2. Subdivision Wildfire Planning 10

2.1. Wildfire Hazard Assessment 11

2.2. Siting of Development 13

2.3. Housing Density Considerations 17

2.3.1. "Clustered" or Higher Density Housing 19

2.3.2. "Traditional" or Lower Density Housing 20

2.4. Access, Egress and Evacuation Route Planning 21

2.5. Subdivision Landscaping and Vegetation Management 24

2.6. Protecting Critical Infrastructure 26

2.6.1. General Guidance 26

2.6.2. Electrical Utilities and Exterior Equipment 26

2.6.3. Access/Egress Routes 27

2.6.4. Fuel-Related Utilities 27

2.6.5. Fire-Protection Equipment 28

2.6.6. Communication Towers 29

3. Additional Resources and Useful Links 29

4. References 29

1. Introduction

On December 30, 2021, a wind-driven wildfire impacted residential and commercial structures in the City of Louisville, the Town of Superior, and unincorporated Boulder County, Colorado. Evidence gathered after the fire highlighted several vulnerabilities in subdivision planning and in the management of proximate or intermixed communal open spaces, greenbelts, and wildland spaces that likely played a significant role in the spread of fire. This document provides builders/contractors, planning professionals, homeowner associations (HOAs), and local land resource managers with information about subdivision/community planning and open space management to reduce the risk of loss or damage to residential and commercial structures in future wildfire incidents.

Because of the unique nature of the incident, where extreme winds coupled with long term drought, high temperatures, and limited wildfire regulatory adoption, a fast-moving low-intensity grass fire became a highly destructive urban conflagration directly and indirectly impacting several communities and the greater Boulder County area. The Federal Emergency Management Agency (FEMA) deployed its first-ever wildfire Mitigation Assessment Team (MAT) to evaluate building performance during the fire. The MAT was deployed to Louisville, Superior, and unincorporated areas in Boulder County, Colorado, to evaluate damaged homes and commercial structures. MAT members evaluated components and systems of primarily residential structures to determine the effectiveness of various building materials, design, and construction practices for wildfire resiliency. The MAT used the information gathered to evaluate how wildfire-urban interface (WUI) building codes and standards, as well as design, construction, and defensible space practices can be improved to increase community wildfire resilience, particularly as the risk to landscape due to climate change is continuously evolving and putting more communities at risk.

1.1. Purpose

This document provides builders/contractors, planning professionals, HOAs, and local land resource managers with information about wildfire resiliency planning and open-space management policies, best practices, and procedures at subdivision- and neighborhood-scales. The intent is to prevent or limit the risk of wildfire exposures and impacts through various regulatory and policy approaches during planning and entitlement phases (e.g., fire risk assessments, wildfire impact studies, zoning, wildfire-protection planning), such that wildfire hazards and risks are appropriately considered early in the planning-design-construction life cycle of future developments. Also included are approaches for holistic, ongoing management of communal open spaces, greenbelts, and proximate wildland spaces as integrated features of neighborhood-, subdivision- and community-scale wildfire resiliency of new and existing residential and commercial developments.

Note: This document should also be read in conjunction with the *Marshall Fire Mitigation Assessment Team: Mitigation Strategies to Address Multi-Hazard Events*.

1.2. Key Issues

In the U.S., the resistance of structures to wildfires in the built environment is typically addressed through the application of building and fire codes at the individual building or parcel level, and not usually at the neighborhood-or community-scale. The level, degree, and even presence of building-level wildfire safety requirements depends on the adoption and enforcement of these regulations at state and/or local levels. In some locations, wildfire safety requirements for buildings are based on where a structure or development is located relative to fire hazards, which can be defined in fire hazard maps (e.g., Fire Hazard Severity Zone (FHSZ) maps produced by the state in California[1], Colorado Springs Fire Department's Wildfire Risk Map)[2]. In locations where state and/or local building and fire code regulations are triggered by the fire-hazard classification, design features to improve wildfire/fire resiliency may be required and can include specific building materials, forms of construction, fire-rated or fire-resistive elements, components or assemblies (e.g., vents, exterior walls, windows, roofs, decks), defensible space requirements, minimum levels of access/egress, and water supplies. However, most states and local jurisdictions across the U.S. have limited or no wildfire-safety building codes, standards, guidance documents, programs, tools, and/or resources (FEMA, 2021)[3] to assist designers, engineers, planners, contractors/builders, and other professionals in wildfire resiliency. Even if a state or local jurisdiction has adopted a model WUI building code or local ordinances such as International Wildland-Urban Interface Code (IWUIC) and National Fire Protection Association (NFPA) 1140, these requirements are often limited to individual buildings and mostly residential occupancies, and there is often no information available for the neighborhood, community, city, or regional scales (FEMA, 2021) particularly during the planning phase of a development. Some best practice guidance is detailed throughout the rest of this document.

The following is a list of key issues for neighborhood- and community-scale wildfire resiliency planning and development (see also Figure 6 later in this document):

- **Wildfire Hazard and Risk Mapping –** A range of 'official' and 'unofficial' wildfire hazard and risk maps exist at local, state, and national levels (e.g., West Wide Wildfire Risk Assessment, CALFIRE's Fire Hazard Severity Zone maps, wildfirerisk.org) (FEMA, 2021). However, most available wildfire hazard and risk maps are not explicitly designed to inform land-use planning, zoning, building design codes and standards, or other wildfire resiliency construction practices at the local, neighborhood, or individual home scale, or during a development's life cycle (e.g., planning/entitlement phase to design/construction to long-term management and operations). California is one example where state-extent FHSZ maps are referenced in the California Building

[1] California Department of Forestry and Fire Protection (CAL FIRE). Forestry and Fire Protection's Fire and Resource Assessment Program (FRAP). https://frap.fire.ca.gov/mapping/pdf-maps/

[2] Colorado Springs Fire Department. Wildfire Risk Map. https://gis.coloradosprings.gov/Html5Viewer/?viewer=wildfiremitigation

[3] Rini, D et al. (2021). *Community Wildfire Resilience: Landscape Analysis* (Volume 1) White Paper. FEMA.

and Fire Codes (CBC, 2021)[4], and ultimately all buildings constructed in specific FHSZs (since 2008) are required to have wildfire-specific risk mitigation provisions. However, most states and local jurisdictions have limited or no available wildfire hazard and risk maps to trigger planning and building safety provisions. This means that numerous buildings and developments are potentially being planned, designed, and constructed in high fire risk areas without appropriate building fire safety provisions. Additionally, there are countless existing building stock and developments that may not currently be in a high wildfire prone area but could be at risk in the future due to ongoing changes in the wildfire risk landscape, climate change, and other factors. Understanding this potential change in the risk landscape is a major challenge that is not currently considered in land use planning.

- Siting of Structure or Development – The location of a development or subdivision on the general landscape is a major driver of its wildfire risk. Wildfire severity and rate-of-spread of fire increase at specific topographic features such as saddles, ridge lines, drainages, canyons, and steep slopes (Figure 1). This can present a significant threat to homes or developments in those locations, such as for a property located mid-slope, which cannot be more easily mitigated using standard defensible space, setback, and structural hardening provisions (described in other Marshall Fire MAT products). Some jurisdictions provide additional siting requirements (e.g., minimum setbacks, additional defensible space requirements, additional structural hardening measures, development of a fire protection plan) for buildings and developments located in higher hazard topographies. However, this is not consistently provided in most local jurisdictions. In addition, most jurisdictions do not have neighborhood-, community- or regional-level planning, or wildfire zoning requirements that introduce limitations on new developments in very high-risk landscapes.

[4] California Building Standards Code. (2022, July 1). Chapter 7A *California Building Code (CBC)*. https://www.osha.gov/coronavirus/safework

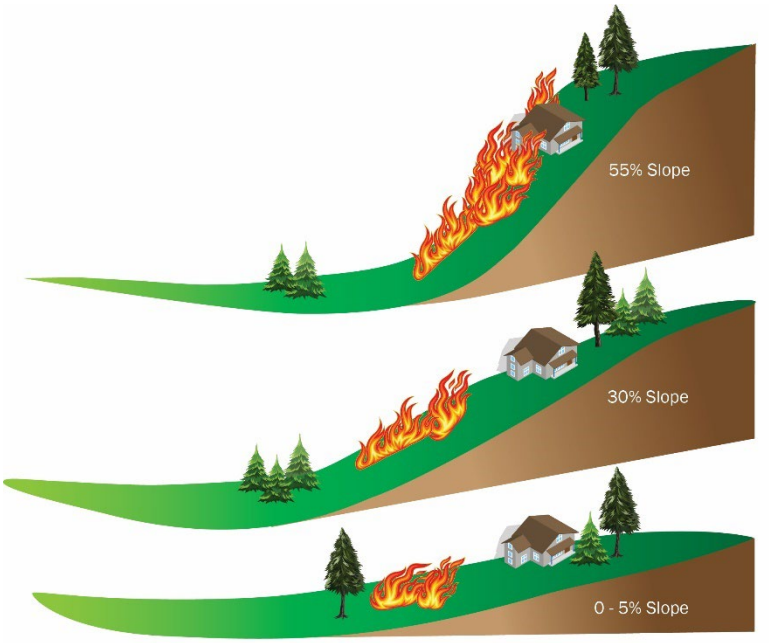


Figure 1. Wildfire intensity and rate-of-spread increases as slope increases.

- **Structure Density** – Current building fire safety regulations typically do not require structure-to-structure fire separations for single family residences (e.g., Type VB, R-3 buildings) unless the home is within 5 feet of the property line. In some cases, where automatic sprinkler protection is provided per NFPA 13D (NFPA 13D, 2016), fire-separation distances for residential homes can decrease to 3 feet or even 0 feet to the property line (IRC Table R302.1(2)). For most other occupancies and construction types, exterior fire-rated walls are typically required where buildings are within 10 feet of a property line in addition to limits on the presence of, or protection required for openings (e.g., windows). Existing fire separation requirements were designed to limit urban conflagration, originating from a single interior building fire (not wildfires or multiple structure fires occurring simultaneously). Under these assumed conditions, firefighters typically have sufficient resources to control and suppress a single-family home fire.

  However, under extreme wildfire conditions, where fires are simultaneously occurring in both the wildland and the built environment, firefighting resources are often overwhelmed and unable to limit structure-to-structure fire spread (particularly under severe fire weather). For typical parcel sizes and residential structure separations (e.g., 5–10 feet), the effects of radiation, direct flaming, and ember exposures from a home on fire are likely sufficient to ignite an adjacent structure, particularly under high-wind conditions (Figure 2). The parcel centric nature of existing codes, in which parcels are considered independently despite the impact they have on one another, leads to minimal structure separation distances (National Institute of Standards and Technology (NIST) Technical Note 2205). Additional wildfire zoning, planning, structural hardening, and other fire-safety features are likely needed to reduce structure-to-structure fire spread.



Figure 2. Typical residential building separations (10–20 feet) are vulnerable to structure-to-structure fire spread under extreme wildfire conditions, as most single-family residences have non-fire rated exterior walls.

- Access, Egress, and Evacuation Planning – Recent wildfires have highlighted the critical need for properly planning and designing safe paths of egress and access during a major wildfire incident. Many residents and first responders have been placed in dangerous situations, often at night and with limited time to either safely evacuate or respond to an approaching wildfire.

  Current building codes and standards are primarily focused on mitigating interior building fires for single parcels or buildings. However, access and egress requirements to safely manage people (e.g., number, separation of, and capacity of exits) are aimed at getting people out of buildings. There currently is not an equivalent fire safety code, standard, or consensus document that requires provisions for people management during wildfire events at neighborhood-, community- or regional-scales. This means that most existing and new developments may not have a sufficient number, arrangement, or capacity of egress routes to evacuate all residents to a relative place of safety during a major wildfire incident or allow for sufficient access for first responders (Figure 3).

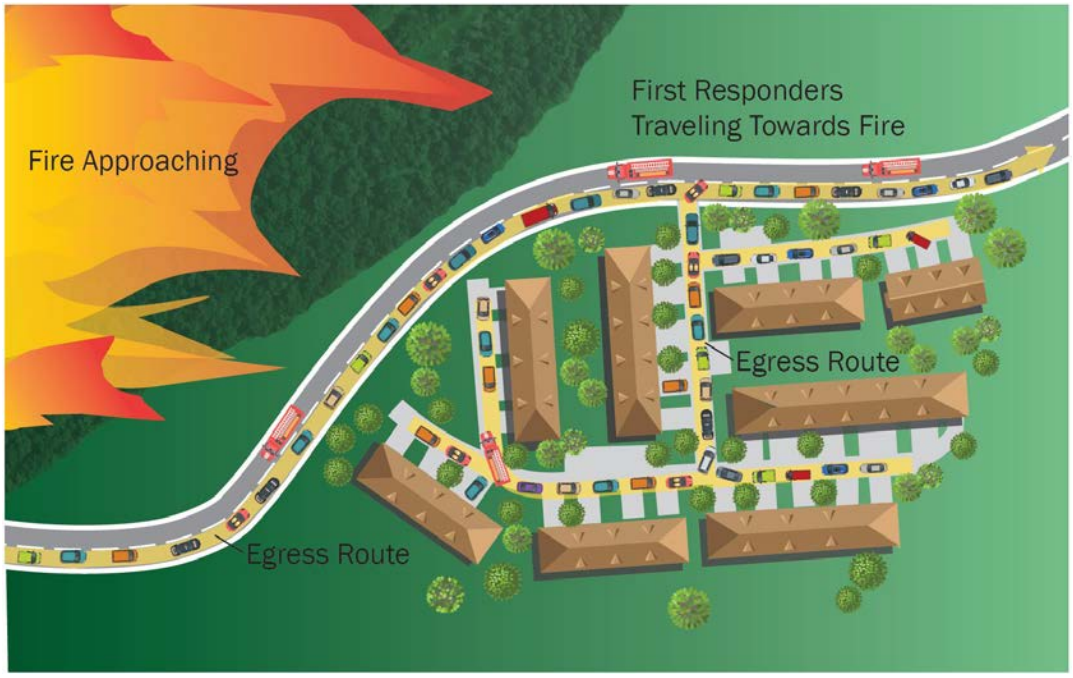


Figure 3. Wildfire evacuations place considerable stress on residents, first responders, resources, and transportation infrastructure. Few neighborhoods, communities- or cities- have properly planned for timely and safe egress from a fire.

Both infrastructure and evacuation planning are key components at the neighborhood- and community-scales in high wildfire-prone settings, such that people are able to safely and quickly evacuate before being endangered by fire, smoke, or hot gases, and first responders can safely and effectively conduct emergency operations.

- Subdivision Landscaping and Vegetation Management – The location and vegetative make-up of open spaces within and adjacent to a development can increase risk of wildfire intensity and spread at the WUI and provide pathways for wildfire to enter a community like a wick. Common spaces, greenbelts, and other types of open spaces can lead to high-risk vegetative conditions (e.g., non-fire adaptive plants, high fuel load due to presence of creek bed or other water features, no fuel management, more flammable vegetation types, proximity to structures) which, in combination with high fire hazard topographic features (e.g., slopes, drainages), can further exacerbate intermix/interface wildfire hazards and risks (Figure 4 and Figure 10).



Figure 4. Unmaintained open space adjacent to the Sagamore neighborhood in Superior CO pre- and post-Marshall Fire. This unmanaged open space likely played a role in the rapid spread and subsequent ignition of the proximate neighborhood.

- Protecting Critical Infrastructure - Though there are some regulations and guidance on mitigating wildfire risks for electrical infrastructure (e.g., vegetative management around poles and lines), other types of critical infrastructure (e.g., communication systems, road networks, power supplies, water supplies) at various scales have few codes, standards and/or guidance documents for wildfire resiliency, or post-wildfire hazards particularly at the subdivision planning scale. As most critical infrastructure is designed and managed at city and regional scales, most developers, contractors, engineers, and planners have little influence over the wildfire safety provisions for those large-scale systems. Recent and past wildfires have resulted in significant short- and long-term impacts to critical infrastructure (e.g., loss and/or damage of water tanks and associated pumps, post-fire debris flows and landslides washing out transit networks) that have resulted in greater financial losses, increased downtime, extended recovery and rebuilding periods, and general disruption to social capital in communities (Figure 5). Understanding what risks wildfire threats present to critical infrastructure (during and post-incident) in a subdivision, and what types of measures are necessary to protect these assets (pre-, during and post-incident) is critical, particularly where a developer, contractor or designer has control over the protection of those lifeline services (Figure 6).

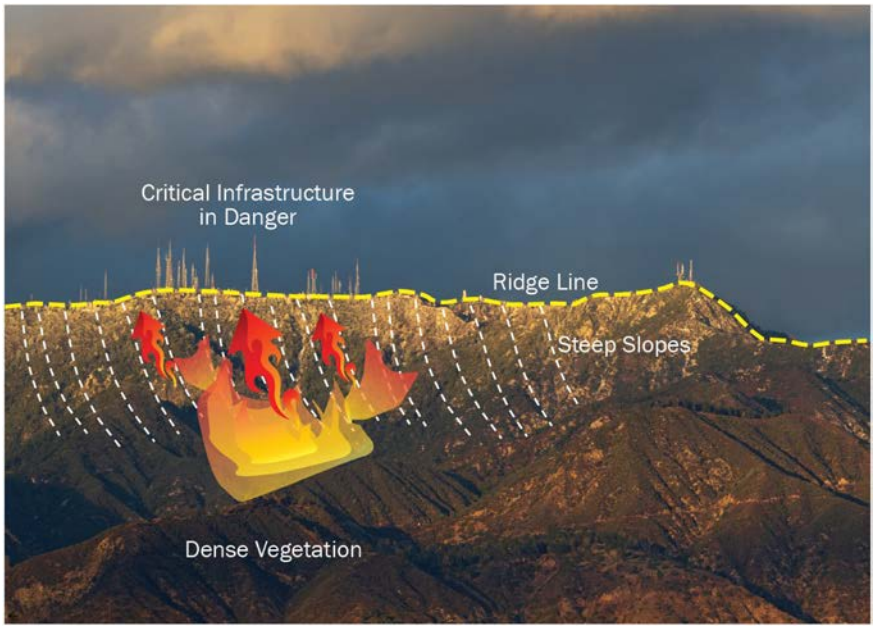


Figure 5. Critical infrastructure is often located in settings with severe wildfire risk (e.g., along ridge lines, on steep slopes, in remote settings with dense vegetation).

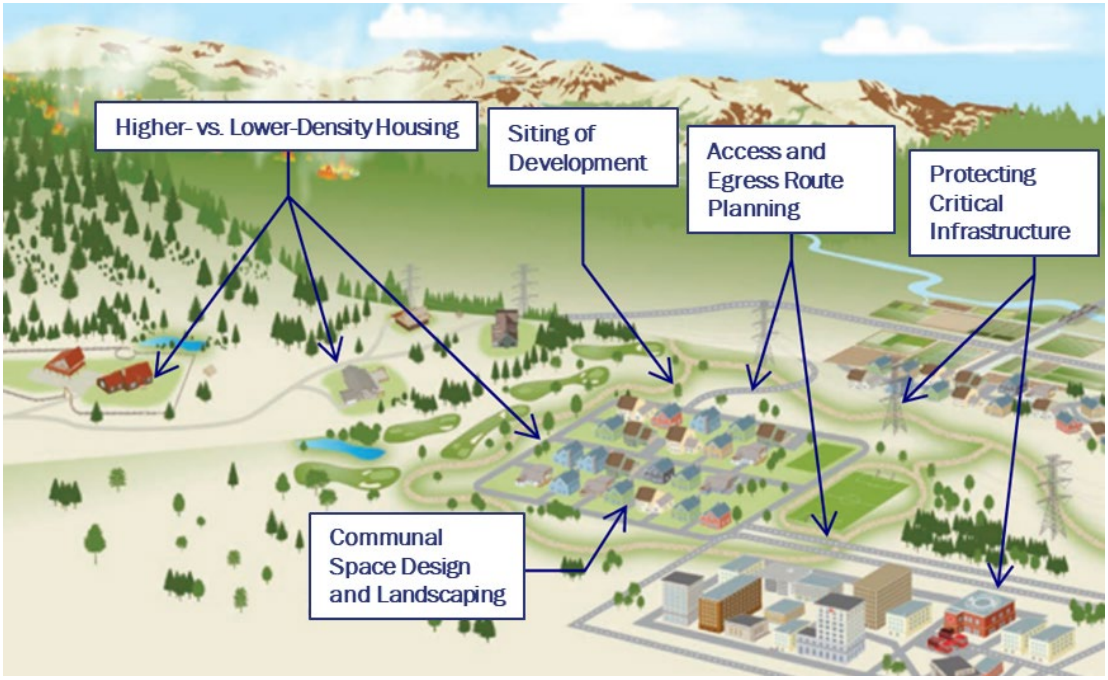


Figure 6. Multiple key issues at the subdivision, neighborhood, and community scales all influence the overall wildfire risk of structures (adapted from Wildfire Planning International, 2016).

1.3. Definitions

Approved or recommended plants – "Approved" or "recommended" plants are generally based on characteristics that allow for a more fire-resistant landscape. Common characteristics include

drought-resistance, high moisture content, low levels of volatile oils and other readily flammable chemicals, pest-resistance, noninvasive, slow, and low growing, low litter production and bark shedding, and sustainable without supplemental fertilization.

Communal defensible space – The area or space around a collection of properties where the minimum defensible space distances (30–100 feet) is achieved by the sharing of vegetation management and fuel treatments across neighbor property lines. This is in lieu of individual property owner's ability to achieve the requisite defensible distances for setbacks and defensible space within their own parcel. This is related to the concept of "overlapping ignition zones."

Communal or common space – Land or space that is intended for common ownership or use by the residents of surrounding dwelling units.

Community scale –A large area within a community or, in some cases, the whole community (i.e., an entire town or county) (adapted from NFPA, 2013).

Defensible space – The area or space around homes and buildings where vegetation and other features (e.g., trash, firewood piles) are managed to reduce the structure's risk of ignition due to radiation (heat), direct flame impingement, or exposure to firebrands from a wildfire (adapted from Bell et al. 2007). Defensible space also provides firefighters a place of relative safety to conduct firefighting operations (e.g., control or suppression fire, search-and-rescue) during a wildfire or urban conflagration.

Greenbelt – A belt of parkways, parks, or farmlands that encircles a community (Merriam-Webster, 2022).

Interface WUI – The area where developed/settled areas abut wildland vegetation (Radeloff et al., 2018).

Intermix WUI – The area where houses and wildland vegetation directly intermingle (APA, 2018a).

Neighborhood or subdivision – An area composed of a collection of residential structures (APA, 2018a) that are typically part of a defined subdivision or large Planned Unit Developments (PUDs), particularly when applications for major new developments are submitted for planning or permitting. These are smaller areal units of residential or commercial use that do not cover an entire community, city, or county (Adapted from APA, 2018a and NFPA, 2013).

Vegetation management – Tree thinning, spacing, limbing, and trimming; removal of any vegetation growing under tree canopies (typically referred to as "ladder fuels"), surface vegetation removal, and brush clearance; vegetation conversion, fuel modifications, and landscaping (NFPA, 2013).

Wildfire hazard assessment – Hazard assessment identifies areas based on natural factors such as fuel/vegetation, slope, and weather patterns that increase the likelihood of wildfire occurring (NFPA, 2013).

Wildfire risk assessment – Risk assessment identifies where wildfire is most likely to threaten something of community value, such as human life, property, natural/historic resources, or other features or resources of local value. Risk assessment often includes other risk factors, such as existing roof types, road access, water supply, location and density of structures, and likelihood of post-fire flood damage. A high hazard rating in an area with a low-risk rating (i.e., a wildfire in an undeveloped area) may therefore result in low risk (NFPA, 2013).

2. Subdivision Wildfire Planning

Neighborhood-level codes, standards, and guidelines for planning and design of subdivisions do not currently exist or are very limited. However, because subdivision regulations address a range of conditions on parcels, there are elements of subdivision planning that are critical for reducing wildfire risk (Figure 7). Planning at the subdivision scale can also be an effective tool for addressing several issues of concern for communities in the WUI. Important areas of consideration include:

- Wildfire hazard and risk assessment
- Siting of development
- Housing density considerations
- Access, egress, and evacuation planning
- Water sources for fire fighting
- Subdivision landscaping and vegetation management
- Protecting critical infrastructure & lifeline services

Note: Structural hardening and defensible space provisions at the building/parcel level are the subject of separate Marshall Fire Mitigation Assessment Team products including Marshall Fire MAT document *Homeowner's Guide to Reducing Risk of Structure Ignition from Wildfire* and Marshall Fire MAT document *Guide to Reducing Wildfire Risk Through Defensible Space*.

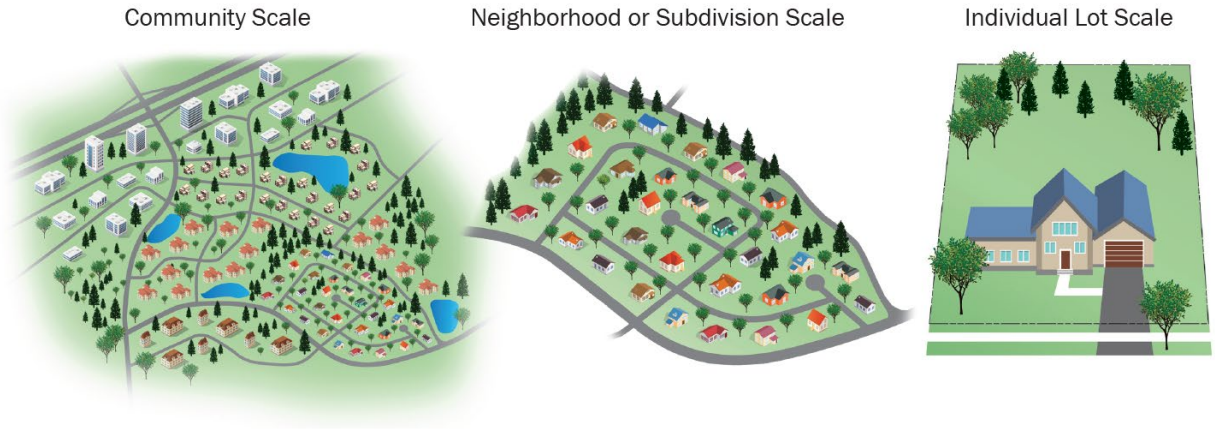


Figure 7. Schematic illustrating scale differences critical for holistic wildfire resiliency planning (adapted from UCANR 2020).

2.1. Wildfire Hazard Assessment

The effective use of wildfire hazard information (e.g., wildfire hazard and risk maps, local wildfire/fire safety ordinances, zoning restrictions, wildfire safety elements in general plans) in the early planning or entitlement phases of new developments including subdivisions is critical. Such information can help to avoid the placement of new developments in very high fire-hazard areas as well as understand site- and neighborhood-specific wildfire vulnerabilities and risks, allowing communities to more comprehensively plan for and design against potential loss of life, property, or other assets. It is fundamental that the evaluation of wildfire hazard conditions is not only conducted at the parcel-level, but also at the subdivision and community-scales. Contractors, developers, design professionals, and planners should undertake the following tasks to understand wildfire hazards during the planning process:

- Evaluate all relevant state and local wildfire hazard and risk maps. Wildfire hazard and risk maps at the state level are typically provided by the State Fire Marshall's office, State Forestry Department, or equivalent state fire agency (e.g., Colorado Forest Atlas, CALFIRE FRAP resources, Texas Wildfire Risk Explorer). At the local level, wildfire hazard and/or risk maps are typically provided by County or Local fire agencies, office of emergency services (OES), or other local government agencies. Local level fire maps (e.g., Colorado Springs wildfire risk maps, Boulder County Fire Zone maps, Local Responsibility Area maps in California) may supersede state level information. The availability and recency of wildfire hazard and/or risks maps will vary depending on the state and local jurisdiction.

- Most available wildfire hazard and "risk" maps only capture the potential severity of a wildfire due to local environmental settings (e.g., topography, vegetation, and weather). Although sometimes called "risk" maps, these maps often do not encompass the risk a wildfire may pose to community values or assets (e.g., life safety, property protection, environmental protection, social/economic impacts) or any existing or planned vulnerabilities in the neighborhood and community (Figure 8), such as:

    - Occupant characteristics (e.g., age, low-income, limited English proficiency, limited mobility)

    - High-risk land uses or occupancies (e.g., large assembly, hazardous facilities, schools, hospitals)

    - Availability of fire safety resources (e.g., access/egress, water supplies, power distribution, communications)

    - Construction practices (e.g., pre-WUI code building practices, combustible construction)

- As "risk" is a function of hazard, exposure, and vulnerability; a low-income housing development without WUI code construction and transit-dependent senior care facilities in a medium wildfire hazard zone may experience greater overall risk than a high-end construction, residential subdivision with golf courses and manicured greenbelts in a very high-fire-hazard zone. Given

this, the contractor, designer, and/or planning professional will need to evaluate not only site-specific hazards, but also potential risks to the proposed development (see next bullet point).

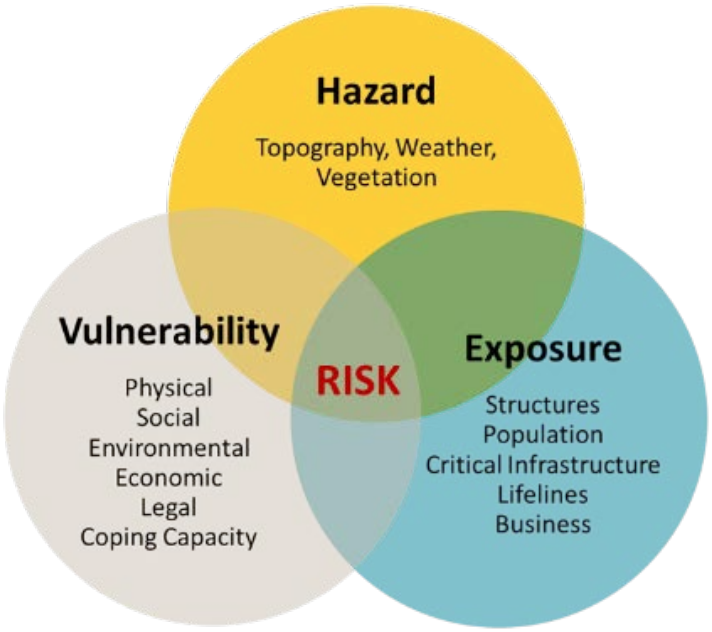


Figure 8. Wildfire risk identifies where wildfire is most likely to threaten a community value (e.g., human life, property) and is defined by the combination of hazard, exposure, and vulnerability.

- Determine if an environmental review (e.g., National Environmental Policy Act or California Environmental Quality Act) is required as part of the planning phase. The objectives of environmental reviews may conflict with the objectives of wildfire hazard and risk-reduction measures, so consultation with both a wildfire/fire safety specialist and an environmental protection specialist should be undertaken to appropriately address and balance public safety and environmental concerns.

- Evaluate all relevant local level community planning documents, plans, and maps. This may include, but is not limited to the following:

  - Community Comprehensive Plans at county, city, and local levels
  - General plans, master plans, form-based plans, zoning requirements, and land-use planning
  - Community Wildfire Protection Plans (CWPPs)
  - Hazard Mitigation Plans (HMPs) (e.g., All-Hazard Mitigation Plans, Multi-Jurisdictional HMPs). Reference *Marshall Fire Mitigation Assessment Team: Mitigation Strategies to Address Multi-Hazard Events* for additional guidance
  - Emergency operational plans and procedures
  - Unit Strategic plans or other fire department planning documents

The existence of and detail in these documents varies widely between jurisdictions. In best-case scenarios, these plans should provide hazard mapping for the area, indicate overlap between natural hazards and vulnerable community assets, detail structural vulnerabilities, and list concerns about post-wildfire impacts (APA, 2018).

- Consult state and locally adopted wildfire safety building and fire codes, ordinances, and other relevant regulatory documents. Where the state or local jurisdiction have not adopted any wildfire-specific safety regulations, refer to the 2021 International WUI Code (Table 502.1 and/or Appendix C: Fire Hazard Severity Form) for general guidance around analyzing the fire hazard of a specific site.

- Consult with the local fire department to understand any local requirements, additional guidance documents, wildfire planning processes and reviews, and existence of any mutual aid agreements and/or alternative mitigation initiatives appropriate to the area.

2.2. Siting of Development

The location of a development or subdivision on the landscape is a major driver of its wildfire risk. Local site conditions (e.g., topography, vegetative characteristics, vegetative maintenance, proximity of fuels and other developments, weather, and orientation of a site) can markedly influence site-specific wildfire hazards and exposures not typically captured by the federal, state, and local level wildfire hazard and risk maps discussed in the previous section. The following paragraphs include recommended best practices to consider during planning for siting a development in the WUI:

Consult existing state and local wildfire hazard and risks maps, as well as other wildfire related planning documents described in the previous section for a general understanding of “landscape” level fire hazards. Where state or local hazard maps are nonexistent, out-of-date, or of low spatial resolution, consider contracting a specialist to complete a project-specific wildfire hazard and risk assessment. A project-specific assessment will provide a higher level of granularity of anticipated wildfire behavior, will highlight any vulnerabilities due to the presence of local topographic conditions (e.g., hilltops, ridges, steep slopes), and will show potential fire flow paths from neighborhood- or community-level features such as greenbelts, open spaces, or drainages. In recent fires, such as the Marshall fire in Colorado, drainages and other communal open spaces provided an avenue for wildfire to spread into the more developed urban/suburban environments. This type of detailed analysis may be particularly prudent if your development will be in an interface or intermix WUI or in an occlusion zone (Figure 10).

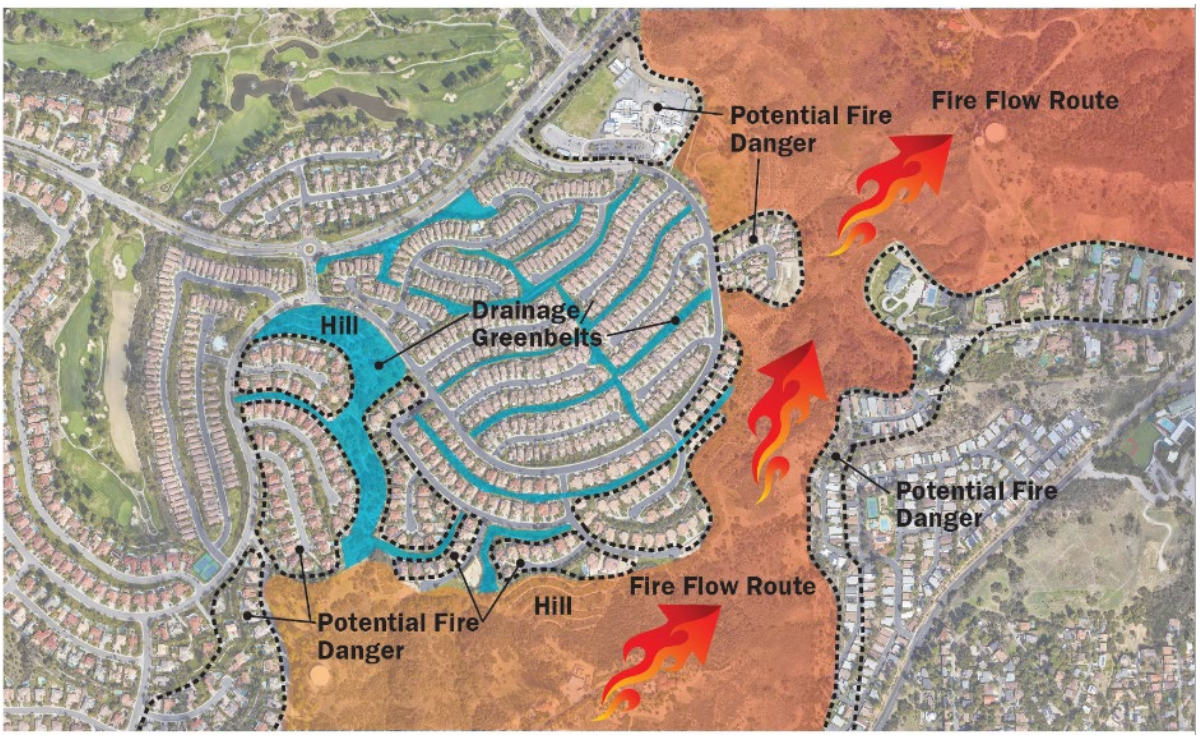


Figure 9. Drainages and greenbelts in or adjacent to communities can provide access for fire to flow into the urban/built environment.

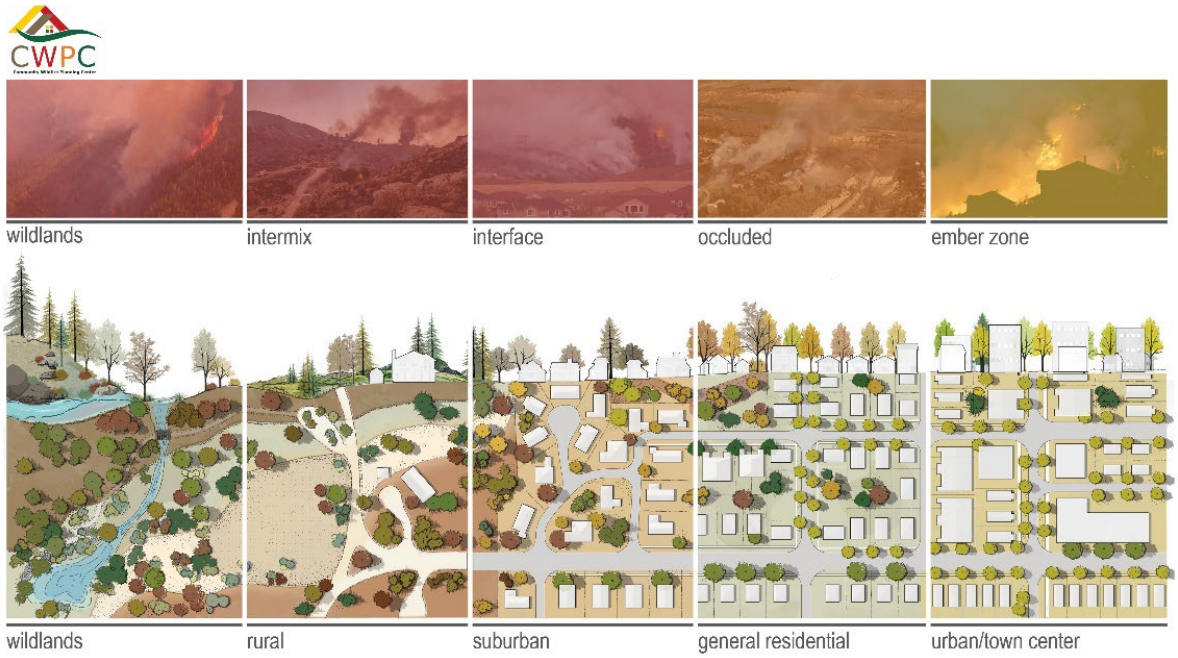


Figure 10. The spatial relationship between vegetation and development changes along a continuum from wildland to urban. Intermix, interface, and occluded/urban forest WUI often have the highest wildfire hazard (Image courtesy of Community Wildfire Planning Center).

If a detailed wildfire hazard assessment is not available or feasible, the following general guidance for siting a subdivision or development can help reduce wildfire risk:

- Avoid selecting a construction site along a gully or in a narrow canyon
- Avoid selecting a construction site in or adjacent to a saddle or narrow mountain pass
- Avoid constructing a new development adjacent to or on a steep slope. If a ridgetop site is selected, consider the following:
    - Choose an area that allows for a minimum 30–100-foot setback from wildland vegetation on the downslope side (see Figure 11). Increase the setback at sites with heavier fuels such as in a forested environment. Implement the measures in Marshall Fire MAT document *Homeowner's Guide to Reducing Risk of Structure Ignition from Wildfire* and Marshall Fire MAT document *Homeowner's Guide to Reducing Wildfire Risk Through Defensible Space*.

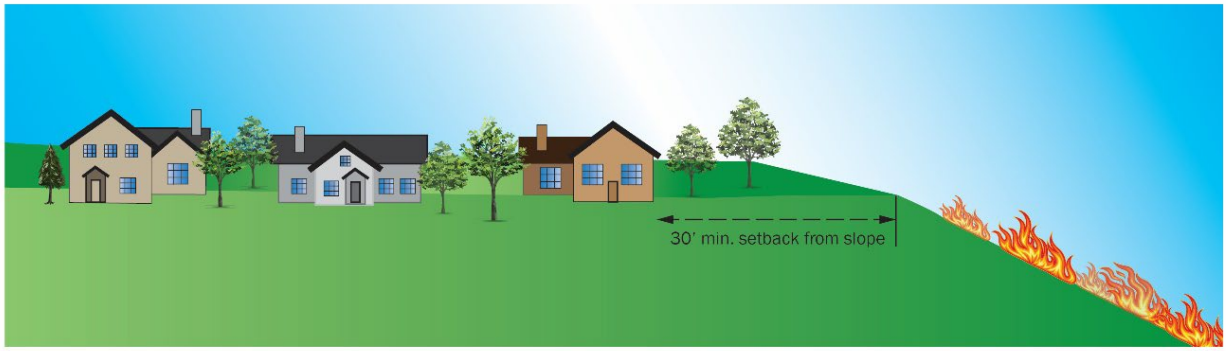


Figure 11. Topographic features, such as slopes, may increase wildfire risk. Appropriate mitigation actions, such as slope setbacks, should be undertaken.

    - Develop a fuel modification and long-term vegetation management plan for the steep slopes proximate to the development site (if within your control) (Figure 12). Given the specific topographic and vegetative conditions more than 100 feet of defensible space will likely be needed. Consult with the local fire department or other authority having jurisdiction for site-specific guidance and/or local ordinance requirements. In some jurisdictions, this can be as much as 200+ feet (e.g., Los Angeles County, Orange County in California). See vegetation management section below. Refer to the *Marshall Fire Mitigation Assessment Team: Homeowner's Guide to Reducing Wildfire Risk Through Defensible Space* as well as additional guidance documents in the references section.

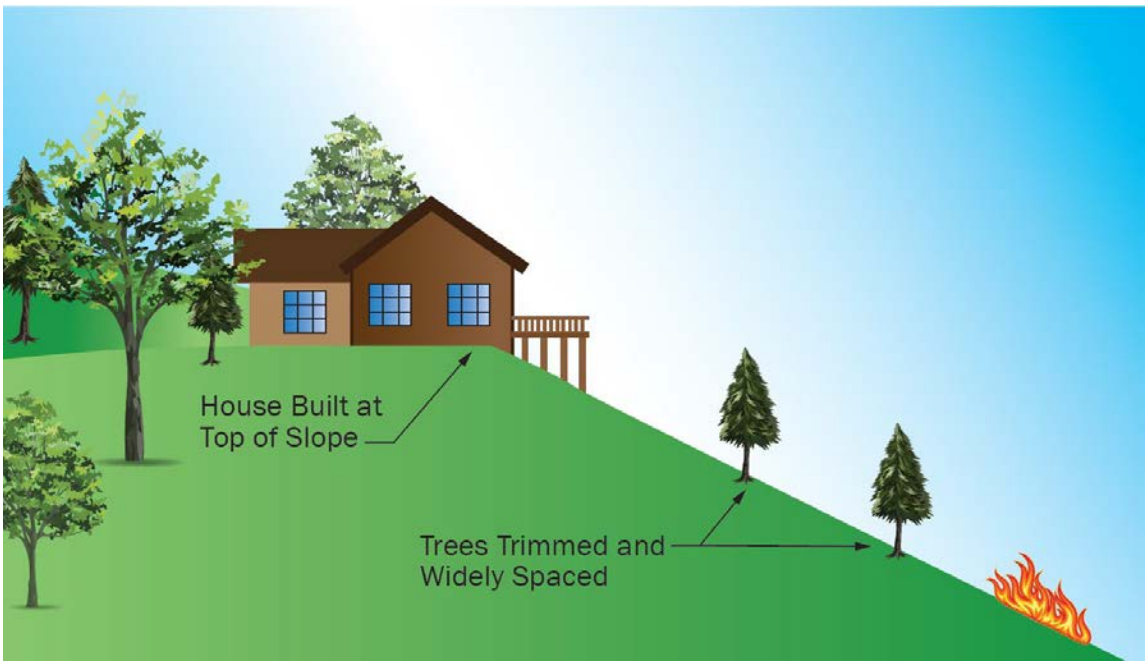


Figure 12. Topography and vegetation influence wildfire risk. Where 50-foot setback to steep slopes is not feasible, provide a minimum of 100–200 feet of fuel modifications along the proximate slope.

- Avoid constructing a new development adjacent to an unmanaged open or wildland space where 50 to 100 feet of defensible space cannot be provided on the proposed site. If a site is selected that is proximate to an unmanaged open or wildland space, consider the following design features:
  - Integrate inherent fuel breaks such as fruit orchards, irrigated landscaping/greenbelts, golf course or other similar low-wildfire hazard features (Figure 13).
  - In addition, or where achieving perimeter defensible space is infeasible, consider providing increased structural hardening measures for structures proximate to the open or wildland space such as 6-foot non-combustible perimeter walls or 1-hour fire-resistant exterior walls and protected openings (Figure 13).
  - Refer to Marshall Fire MAT document *Decreasing Risk of Structure-to-Structure Fire Spread in a Wildfire* and Marshall Fire MAT document *Homeowner's Guide to Reducing Wildfire Risk Through Defensible Space*.
  - Refer to Marshall Fire MAT document *Decreasing Risk of Structure-to-Structure Fire Spread in a Wildfire* for additional siting recommendations at the building-scale (e.g., building orientation relative to fire flow paths, debris and ember accumulation, window number, and orientation.



Figure 13. Example of golf course placement around a development to limit wildfire exposure (left) and fire-resistant construction techniques (right).

In recent catastrophic wildfire incidents (e.g., 2017 Camp Fire, 2021 Marshall Fire), fire spread rapidly not only via wildlands and other open spaces, but also from structure to structure (via direct flame contact, hot gases, radiation, and embers). Given the devastating influence nearby subdivisions can have during a wind-driven fire incident, developers and planners should consider the extent and proximity of surrounding developments and their influence on fire behavior. The following provides general guidance for siting a subdivision or development relative to other existing or future developments:

- Avoid construction sites proximate to an existing or future development in a high or very high fire hazard severity zone, where a minimum 30-foot setback to the property line cannot be provided. Where this cannot be avoided, consider integrating design features, such as fuel breaks and increased structural hardening measures, like those described for sites proximate to unmanaged open or wildland space (see section above).

- If there will be any hazardous land uses on the site that could potentially exacerbate risk (e.g., storage of combustible materials, fuel storage facilities) and which cannot be restricted, consider providing additional mitigation measures (APA, 2019), such as larger setbacks and defensible space areas, secondary emergency water supplies and associated emergency power, increasing exterior wall fire resistance rating (e.g., 1-hour to 2-hour). Consult with a fire-safety engineer, design professional, or local fire department for guidance, as needed.

2.3. Housing Density Considerations

When planning a new housing development, there are various options and considerations in selecting the density of houses and structures, both across multiple lots and on a single lot. These decisions are generally guided by local regulations and zoning, economic and financial needs of the developer, and preferences of homeowners/buyers. In WUI areas, an additional consideration must

be reducing wildfire risk. There may be conflict between guidance and best practices for wildfire risk mitigation with residential development needs and preferences.

Currently, there is limited formal guidance to assist developers, design professionals and planners in providing appropriate wildfire safety provisions given the range of housing density and layout considerations in practice (see NIST Technical Note 2205 and UCANR 8680 for additional detail). Development planning provides a unique opportunity to mitigate wildfire risk at a neighborhood scale, rather than at the individual lot scale, which forms the basis of current building and fire code requirements. This document provides general guidance given two different housing density designs: (A) "Clustered" or High-Density and (B) "Traditional" or Low-Density, as shown in Figure 14.

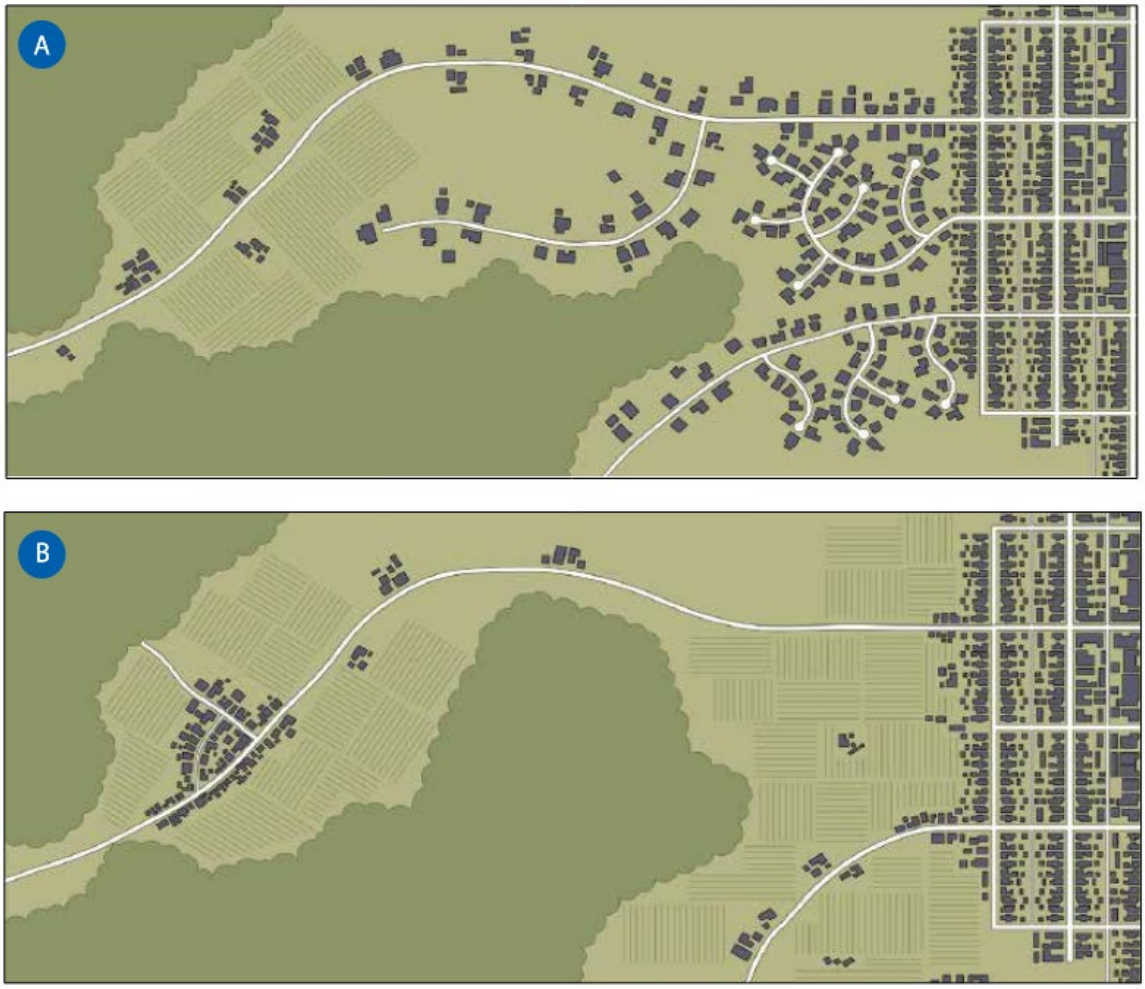


Figure 14. Conventional, or traditional, development with low-density houses (A) versus clustered development with several high-density clusters of structures (B) (UCANR, 2020).

The following sections provide potential fire safety design considerations given "clustered" or high-density designs vs. "traditional" or low-density design options.

2.3.1. "CLUSTERED" OR HIGHER DENSITY HOUSING

Clustering homes together within a subdivision can reduce the expansion of development in high-wildfire hazard areas while also minimizing the overall number of houses on a site. This design strategy can also help limit impacts to environmental services, ecological needs, and recreational goals for open spaces, while also reducing the distribution of firefighting resources during a major wildfire incident (APA Multihazard Planning Framework for Communities in the WUI, 2018; UCANR, 2020).

However, higher-density designs may increase structure-to-structure ignitions due to the closer arrangement of buildings, and therefore require additional fire safety mitigations to offset reduced fire separations (e.g., fire-rated exterior walls, non-combustible construction materials, ember resistant vent protection). These include:

- Provide vent covers with 1/16-inch wire mesh or an approved ember and flame-resistant vent. Some jurisdictions have "pre-approved" products such as CALFIRE's Building Materials Listing Program[5] . Local building and/or fire officials have discretion to approve products.
- Provide combustible siding with non-combustible or ignition resistant materials (e.g., fiber cement, stucco).
- Provide combustible decking with non-combustible decking.
- Provide noncombustible materials for non-vegetative features (e.g., ornamental grass, sheds, pergolas, gazebos) or design any combustible elements in surrounding landscape (e.g., trash bins, wood piles, vehicles) to be more than 30 feet away from homes or structures or to be enclosed in non-combustible construction.
- Provide double-paned or tempered-laminated glazing. Recommend reducing the number of openings (i.e., windows, glazed doors, vents) on the aspect where exterior walls are in close proximity to other buildings.
- Use noncombustible materials (e.g., concrete, masonry, metal), particularly for fences that attach to adjacent homes or structures.
- Provide structural hardening measures for the entire home (e.g., upgrading to a Class A roof). Refer to Marshall Fire FS-2 "*Homeowner's Guide to Reducing Risk of Structure Ignition from Wildfire*".

Given the increased structural hardening measures and other fire safety features, higher-density designs, can be viewed as one large "building" or development, where prescriptive requirements for

[5] https://osfm.fire.ca.gov/divisions/fire-engineering-and-investigations/building-materials-listing/bml-search-building-materials-listing/

achieving 100 feet of defensible space is provided around the perimeter of the entire development site, while also considering the following integrated design features:

- Provide a minimum 100-foot inherent fuel breaks around the entire development such as fruit orchards, irrigated landscaping/greenbelts, golf courses, roads, or other similar low-wildfire hazard features. See vegetation management section below for further discussion of this topic.
- Concentrate housing on inner side of roadways and away from vegetation (UCANR, 2020).

Although high-density development can efficiently create vegetative buffers (e.g., green belts, golf courses, orchards) and allow for fire department response, additional risks are involved when structures are closely spaced. See Marshall Fire MAT document *Decreasing Risk of Structure-to-Structure Fire Spread in a Wildfire* for information on mitigating risk for high-density neighborhoods and subdivisions. Additionally, reference Marshall Fire MAT document *Homeowner's Guide to Reducing Wildfire Risk Through Defensible Space*. Marshall Fire MAT document *Homeowner's Guide to Reducing Risk of Structure Ignition from Wildfire* for information on protecting structures within high-density developments. and "Traditional" or lower-density housing.

2.3.2. "TRADITIONAL" OR LOWER DENSITY HOUSING

Traditional housing developments, with lower density designs, allow each individual home/structure to directly integrate wildfire safety provisions (e.g., structural hardening measures and defensible space) prescribed in wildfire codes and standards for each individual building or home. However, as shown in Figure 15, lower-density housing, collectively, requires a higher amount of land area dedicated to defensible space compared to higher-density designs, which can have negative impacts to environmental services and other ecological goals of the community. Lower density developments can also result in the need to disperse firefighting resources and suppression activities in the event of a major wildfire incident, given the larger spread of development. (UCANR, 2020).

Be aware that unplanned subdivisions or structures on adjacent lots may not have been designed to meet an equivalent level of safety as described in this document, therefore, the fire risk they can present to surrounding properties is uncertain. Thus, the guidance in this document is intended to mitigate this uncertainty by recommending fire safety measures at the neighborhood level during planning and development specific to subdivisions, such as communal defensible space or high-density vs low-density design options.

In the event that the low-density housing development still is unable to meet 100 feet of defensible space on all sides of an individual structure, contractors should ensure that communal defensible space considerations and structural hardening measures on all affected properties are implemented as described in the *Marshall Fire Mitigation Assessment Team: Homeowner's Guide to Reducing Wildfire Risk Through Defensible Space*. Refer also to this fact sheet, where 30 feet of setback from property lines is not feasible.

2.4. Access, Egress and Evacuation Route Planning

Both road infrastructure and evacuation planning are key components at the neighborhood- and community-scales in high wildfire prone settings, such that people are able to evacuate during a major wildfire safely and quickly along primary and secondary routes, and first responders can effectively gain access to conduct emergency operations. This includes providing sufficient number, arrangement, and capacity of road networks, as well as meeting specific roadway standards, and understanding the impact of new development on the regional road network. The following guidance provides recommendations for planning appropriate wildfire access/egress for new subdivisions:



Figure 15. Access roads should have sufficient separation.

- **Separation of Access/Egress Routes** (Remoteness of exits) – Emergency access/egress to or from a neighborhood is necessary to protect life safety in the case of evacuation and fire responder activities. Access/egress routes should be spaced sufficiently so that both routes are not blocked during a wildfire emergency event. Where two access/egress roads are required (e.g., developments of one- or two-family dwellings where the number of dwelling units exceeds 30), they should be separated by a distance not less than one-half the length of the maximum overall diagonal dimension of the area to be served (IFC Appendix D) (Figure 15). The ease of separating access will depend on site setting and surrounding terrain and may require consultation with the local fire authority. (Planning for Wildfires; APA Zoning Practice 9, 2018).

- **Subdivision or Neighborhood Wildfire Access/Egress Capacity and Dead-End Conditions**

    - All roads should provide a minimum of two 10-foot traffic lanes, not including shoulder and striping. These traffic lanes should provide for two-way traffic flow to support emergency

vehicle and civilian egress unless other standards or additional requirements are mandated by Local Jurisdictions or local subdivision requirements.

- Where one-way roads are provided, they should provide a minimum of one 12-foot traffic lane, plus shoulders. One-way roads should connect to a road with two traffic lanes providing for travel in different directions and provide access to an area currently zoned for no more than 10 Residential Units. Avoid providing one-way roads in excess of 2,640 feet in length. Where one-way roads are provided, turnouts should be placed and constructed at approximately the midpoint of each one-way road.

- All lengths should be measured from the edge of the road surface at the intersection that begins the road to the end of the road surface at its farthest point. Where a dead-end road crosses areas of differing zoned parcel sizes requiring different length limits, the shortest allowable length should apply.

- Fire Apparatus Access – Fire codes, local ordinances, and standards for roads, driveways, and bridges to ensure access by fire department apparatus and emergency services equipment should be followed and may be more restrictive than the following suggestions. These include minimum road width, maximum grade, number of turnarounds/turnouts, and load limits. Note: The following guidance provides minimum suggestions. Consult with local fire and other authorities having jurisdiction where requirements may be more restrictive.

  - Fire apparatus access roads should have a minimum width of 20 feet, and a minimum clear height of 13 feet 6 inches. Dead-end roads more than 150 feet in length should have turnarounds. A driveway which does not meet the requirements of a fire access road should not serve more than five residences (IWUIC 2021). Consult the local fire department for jurisdiction-specific requirements.

  - Grades for all roadways and driveways should not exceed 16% or as limited by the local fire department. Consult the local fire department for confirmation.

  - Driveways in excess of 150 feet in length should be provided with turnarounds. These turnarounds should have an inside turning radius of not less than 30 feet and an outside turning radius of not less than 45 feet (IWUIC 2021). Road intersections should accommodate similar turn requirements.

  - Driveways in excess of 200 feet in length and less than 20 feet in width should be provided with both turnarounds and turnouts. Turnouts should be an all-weather road surface and not less than 10 feet wide and 30 feet long (IWUIC 2021).

  - Roads should be designed and maintained to support the imposed load of fire apparatus weighing 75,000 pounds and provide an aggregate base. Consult the local fire department for jurisdiction-specific requirements.

- Road signs should be uniform and meet visibility requirements. Any locked gates should have a Knox box installed for emergency responder access (APA Zoning Practice 9, 2018; PAS 594).

- **Protection of Primary and Secondary routes** – Planning for fire-adapted landscaping and/or fuel treatments such that a minimum of 10 feet on either side of all major access/egress routes within the subdivision should be considered (Figure 16). Consult with a wildfire specialist, landscape architect or other design professional for detailed guidance and best management practices.

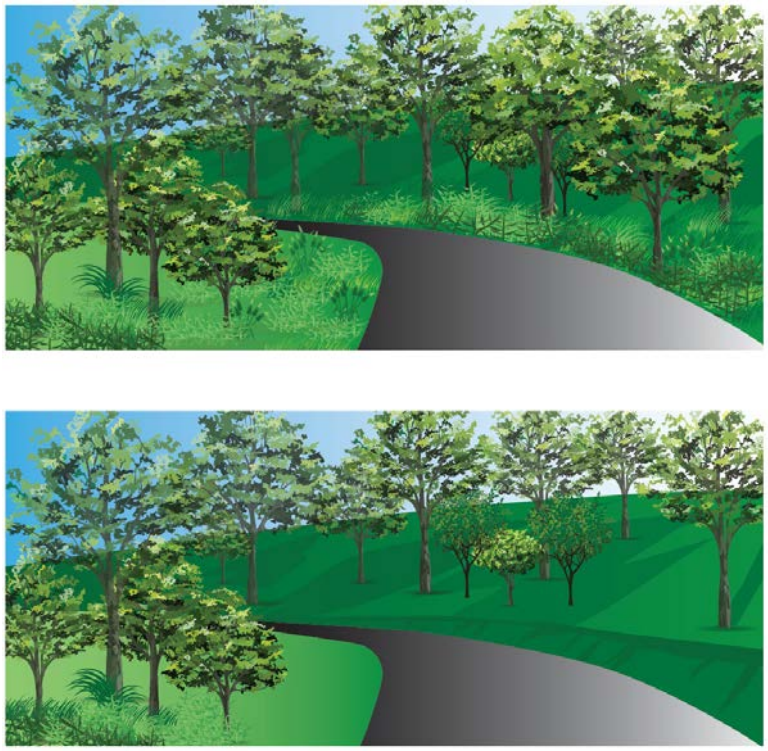


Figure 16. A minimum of 10-feet of fuel modification should be maintained around primary and secondary egress routes. This distance may increase where an access road is in high hazard topography (e.g., steep slopes, ridgelines, drainages, canyons).

- **Community Scale Wildfire Evacuation Capacity** – The planning process for new developments (particularly large developments) in very high fire hazard areas should consider undertaking a wildfire evacuation analysis to consider various likely wildfire scenarios, assess how a new development will impact the broader community road network during an evacuation, and undertake equitable and inclusive evacuation modeling and planning (e.g., considering limited access to personal vehicles, language barriers, access and functional needs populations, and accessibility challenges). Standard roadway designs do not explicitly consider large scale emergency evacuations. A wildfire evacuation often results in larger egress flows which exceed typical roadway design flow assumptions, whether employing phased or total evacuation strategies. Wildfire-specific analysis and consideration is crucial to prepare for sufficient

evacuation capacity or alternative people management strategies. Consult with the local planning and fire department for local guidance and requirements.

2.5. Subdivision Landscaping and Vegetation Management

Most subdivisions will include various common open spaces (e.g., parks, play areas, undeveloped lots, road medians, trails). Careful consideration needs to be given to planning these areas with fire-adaptive landscape design features. In addition to initial design and planning, long-term maintenance plans must be developed and implemented. The placement of open spaces within a development, specific types of plants to use and avoid, and ongoing maintenance are all important planning elements. Specific topics to consider and recommendations include:

- Place open spaces within the development site with consideration to underlying wildfire hazard and risk. This may include designating areas of high wildfire hazard as permanently conserved open spaces (with ongoing fuel reduction treatments), thereby reducing the introduction of people and property in higher-hazard areas. An added benefit of this technique may be conserving useful habitat for native plants and animals (UCANR, 2020; APA, 2018a).

- Consider the different types of open space which may exist or be built within the development. Small, landscaped, and manicured open spaces have a lower risk profile than large spaces with non-native, and possibly more flammable, vegetation. Surround larger spaces with defensible space and plan for them to burn periodically (UCANR, 2020). The outside perimeter of a development is a good place to locate walkways and trails, to reduce fuel loading adjacent to structures.

- Design vegetated open spaces so that relatively high-water content is maintained in leaves, which makes plants less likely to ignite. This requires consideration of both plant selection, irrigation systems, and a regular maintenance schedule (UCANR, 2020).

- Consider placement of vegetation within each open space. Recommended separation distances will vary by community and vegetation type (Figure 17). Reference recommendations and requirements for tree spacing based on the slope and location of the property.

    - Select specific plant types based on fire-resistance. There may be an approved or recommended plant list for your location. Also be aware of plants to avoid specific to your local area. Be aware that native plants may not be fire resistant and some may be extremely flammable.

    - In addition to initial vegetation and landscape planning, ongoing vegetation management and maintenance is crucial (Figure 18). This includes all areas with vegetation in the development—both heavily landscaped open spaces and those dominated by native vegetation. Regular fire mitigation over the long-term should be required or performed (APA, 2019).

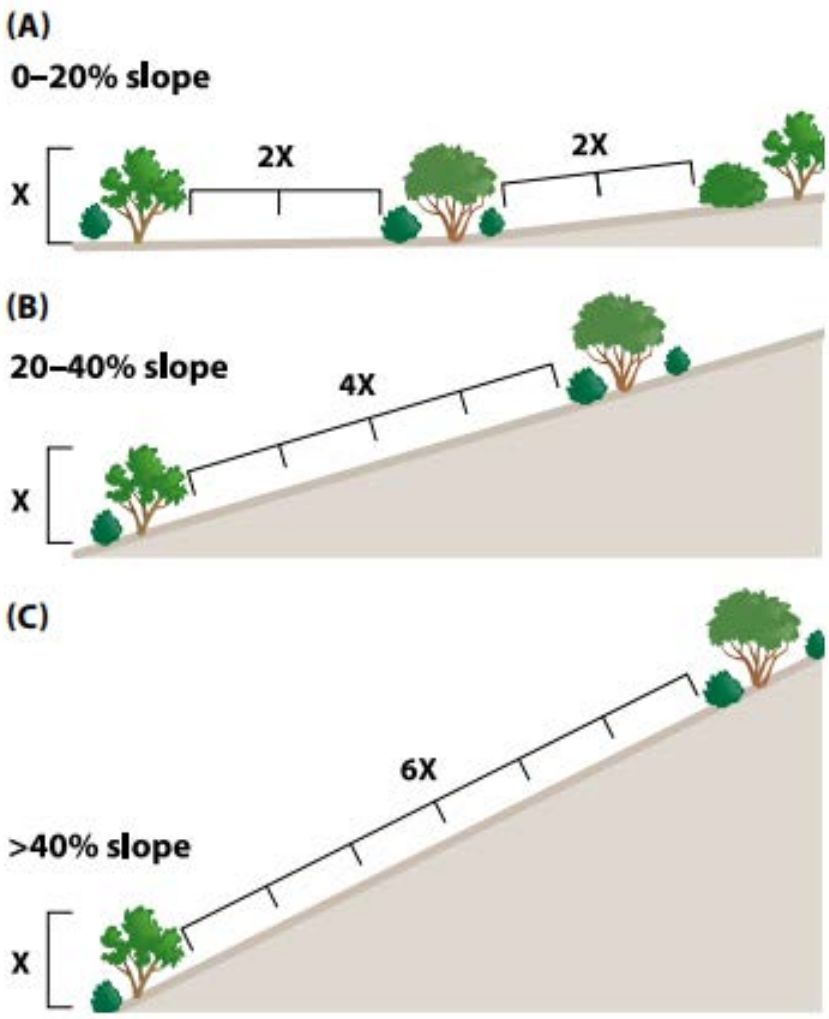


Figure 17. As slope increases, recommended distance between vegetation also increases. Steeper slopes should have widely spaced vegetation (UCANR 8695).



Figure 18. Before (left) and after (right) fuel reduction thinning treatment (California Climate Investments, 2022).

2.6. Protecting Critical Infrastructure

The protection of critical infrastructure (e.g., access/egress routes, communication systems, water supplies/infrastructure, electrical power infrastructure) from wildfire hazards, as well as limiting the potential source of wildfire ignitions due to some of these features, is an important planning consideration where relevant to a new development or subdivision. Currently, there are limited codes, standards, and guidance documents for protecting certain types of critical infrastructure from wildfire, but also ensuring that certain types are not sources of wildfire ignitions themselves at the subdivision or development scale.

The following guidance and best practices should be considered where a new development requires the design and installation of critical infrastructure. Refer also to FEMA's *Home Builder's Guide to Construction in Wildfire Zones Technical Fact Sheet No. 16* for additional details.

2.6.1. GENERAL GUIDANCE

- Critical infrastructure may span across multiple jurisdictions and may have multiple responsible entities (e.g., public utilities, city, county). Coordinate with all responsible parties. Infrastructure should be inventoried and assessed to determine vulnerability. Mitigation strategies, such as the removal of hazardous vegetation, may be part of an existing CWPP or HMP. If a critical infrastructure plan exists separately, planners should seek connections between these plans (APA, 2019).

- Consider hiring a fire protection engineer or wildfire safety specialist to evaluate and recommend wildfire safety provisions, protection measures, etc.

2.6.2. ELECTRICAL UTILITIES AND EXTERIOR EQUIPMENT

- Where possible, place all electrical distribution equipment in conduit underground.

- Where underground distribution equipment is infeasible, consult any relevant state and local fire safety ordinances for adequately designing overhead electrical distribution lines and associated equipment (e.g., transformers) to reduce the likelihood of this equipment providing a source for wildfire ignitions. Consideration should be given not only to the hardening of the equipment, but also in providing adequate vegetation clearance, appropriate plant selection such that fall-in, grown-in and lean-in of vegetation is minimized, and long-term management.

- Where state or local guidance is not available, Chapter 17 of NFPA 1 provides some limited and general guidance on clearance of brush and vegetation growth around electrical lines. This includes a combustible free zone around poles and towers of not less than 10 feet in each direction (Figure 19). For distribution lines, vegetation clearances are defined as a function of line voltage and time of trimming (e.g., a 4160V line requires a minimum of 4 feet clearance, so trimming requirements are triggered when vegetation is 4 feet from the line and must be trimmed to 6 feet clearance, to allow for growth in between trimming cycles).



Figure 19. A minimum of 10 feet of clearance should be maintained around utility equipment.

- Regular vegetation maintenance should be planned to maintain appropriate clearances, and should take into consideration species' growth rates, trim cycle, and line sway (NFPA 1, Chapter 17).

2.6.3. ACCESS/EGRESS ROUTES

Refer to the "Access, Egress and Evacuation Planning" section above for details.

2.6.4. FUEL-RELATED UTILITIES

- Fuel tanks (e.g., propane) can present a significant hazard to both structures and first responders if they start off-gassing or explode during a wildfire. Exposed, fuel lines can also be vulnerable to wildfire damage (see NFPA 58).
- Bury or shield fuel lines to protect them from the effects of radiation, direct flaming, and ember exposure.
- Bury pressurized fuel-storage vessels underground, where possible.
- Where fuel storage tanks are stored or installed above ground, the following guidance should be considered:
    - Install tanks a minimum of 30 feet from habitable structures
    - For cylindrical tanks, use vertical tanks (e.g., Figure 21) or orient horizontal tanks so that the circular ends are pointed away from residences or structures since the ends are weaker than the tank body
    - Install tanks on and surrounded by noncombustible surfaces
    - Provide a non-combustible masonry wall enclosure, where possible

- Avoid installing tanks near high-risk topographic features (e.g., steep slopes, drainages)
- Maintain at least 10 feet of clearance from other combustibles
- Avoid installing tanks in proximity to primary or secondary egress routes (APA, 2019)
- Ensure pressurized storage tanks have a pressure-relief valve and that the valve/vent is directed away from residences and structures

- Provide signage or other form of notification of type and location of fuel-related utilities, where concealed or inconspicuous.

2.6.5. FIRE-PROTECTION EQUIPMENT

- Critical fire-protection equipment (e.g., water tanks, water supply pumps, pump houses) may necessitate fire-hazard reduction measures to protect this infrastructure from being damaged or lost during a wildfire incident.

- As a minimum, 30 feet of brush clearance should be maintained around critical fire protection equipment (Figure 20). This distance may vary pending review and discussion with local fire authorities. Refer to NFPA 1 and local ordinances for detail.

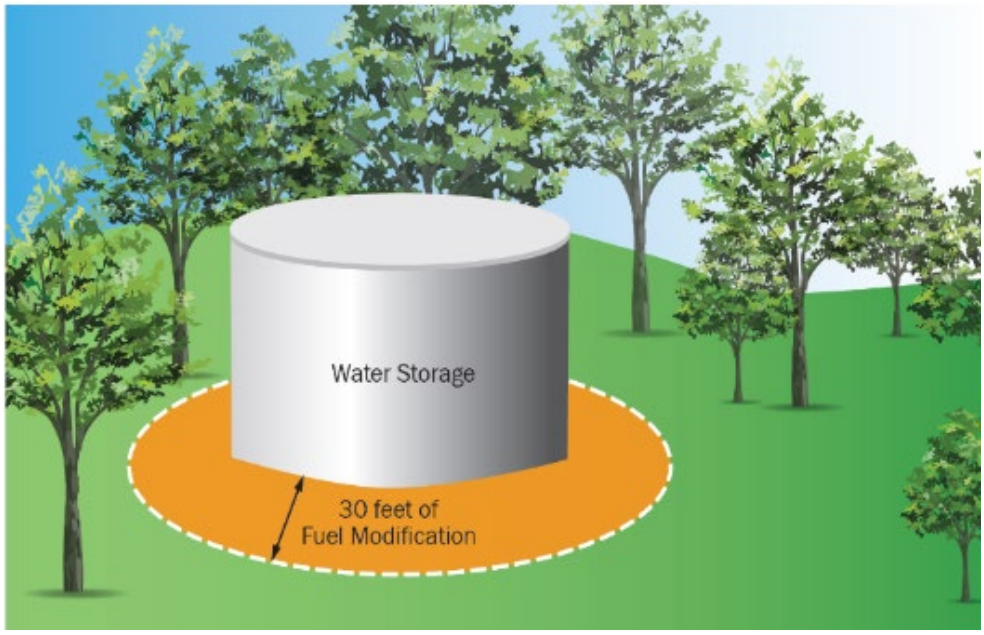


Figure 20. A minimum of 30 feet of fuel modification should be maintained around water storage tanks.

- Water supply and water storage, including on-site storage, are components of critical infrastructure within a development. Minimum water storage requirements should be applied to provide protection for dwellings and other structures where adequate public/private water supply is not available.

- Developers should coordinate with local fire departments to determine water supply requirements and hydrant placement (APA, 2018a). Many fire authorities provide specific requirements for their jurisdiction on water storage requirements and equipment (e.g., hose adapter).

2.6.6. COMMUNICATION TOWERS

- Consider providing 30 feet of hardscaping or brush clearance around communication towers and associated equipment. Consult with local fire authorities for any local requirements, guidance, and best practices. Where no local guidance is provided, consult NFPA 1, NFPA 1140 or IWUIC.

3. Additional Resources and Useful Links

Design Guidance for New Construction

While the recommendations in this Recovery Advisory focus on existing residential structures, several resources are available with design guidance for new homes.

- International Wildland Urban Interface (IWUI) Code, Section 603
- NFPA 1140, 2022 Edition: Standard for Wildland Fire Protection
- SFPE & SFPE Foundation WUI Virtual Handbook for Property Fire Risk Assessment & Mitigation

Guidance for Wildfire Vulnerability Assessments

- NFPA 1140, 2022 Edition: Standard for Wildland Fire Protection
- NFPA “Assessing Structure Ignition Potential from Wildfire" training. https://www.nfpa.org/Training-and-Events/By-topic/Home-Ignition-Zone?gclsrc=aw.ds&?order_src=G076&gclid=Cj0KCQjw1vSZBhDuARIsAKZlijT7pqdYOPLrprSJ0_ZdMy3IYD3yT6Z521MfTaXnFcW8gYI4etDRGPcaAogJEALw_wcB&gclsrc=aw.ds
- Fire Adapted Communities Learning Network. https://fireadaptednetwork.org/

4. References

American Planning Association. (2018). Multihazard Planning Framework for Communities in the Wildland-Urban Interface. Chicago, IL.

American Planning Association. (2018a). Zoning Practice. Chicago, IL.

American Planning Association. (2019). Planning the Wildland-Urban Interface. Chicago, IL.

Boulder County. (2022). Prescribed Burn Projects. https://bouldercounty.gov/open-space/management/prescribed-burns/

Boulder County. (2017). Your Defensible Space Slideshow. https://assets.bouldercounty.gov/wp-content/uploads/2017/02/defensible-space-slideshow.pdf

Boulder County. (2011). Community Wildfire Protection Plan. https://assets.bouldercounty.gov/wp-content/uploads/2017/02/community-widfire-protection-plan-book-low-resolution.pdf

CALFIRE. (2022). Prepare for Wildfire: Defensible Space. https://www.fire.ca.gov/programs/communications/defensible-space-prc-4291/

CALFIRE. (2019). Defensible Space. https://www.readyforwildfire.org/prepare-for-wildfire/get-ready/defensible-space/

California Climate Investments. (2022). A Forested Area at Camp Butano Creek Before (Left) and After (Right) Fuels Reduction Treatment. https://www.caclimateinvestments.ca.gov/2022-profiles-1/2022/forest-health

Colorado State Forest Service. (2022). Home Ignition Zone Checklists. https://csfs.colostate.edu/wildfire-mitigation/home-ignition-zone-checklists/

Colorado State Forest Service. (2021) The Home Ignition Zone: A guide to preparing your home for wildfire and creating defensible space. https://csfs.colostate.edu/wp-content/uploads/2021/04/2021_CSFS_HIZGuide_Web.pdf

Colorado State Forest Service. (2012). Protecting Your Home from Wildfire: Creating wildfire-defensible zones. https://static.colostate.edu/client-files/csfs/pdfs/FIRE2012_1_DspaceQuickGuide.pdf

East Bay Municipal Utility District. (2022). Dangerous materials and conditions for sloped sites. https://www.ebmud.com/water/conservation-and-rebates/watersmart-gardener/firescaping

FEMA: Protect Your Property from Wildfires: https://www.fema.gov/sites/default/files/2020-11/fema_protect-your-property_wildfire.pdf

FEMA: Technical Fact Sheet – Home Builder's Guide to Construction in Wildfire Zones https://wildfiretoday.com/documents/FEMA_home_builders_guide_wildfire_zones.pdf

Fire Adapted Communities (FAC). (2014). Guide to Fire Adapted Communities. https://ucanr.edu/sites/SoCo/files/272862.pdf

Fire Adapted Communities (FAC). (2021). Fire Adapted Communities Graphic and Facilitator's Guide. https://fireadaptednetwork.org/resource/fire-adapted-communities-graphic-and-facilitators-guide/

Humboldt County (2022). Fire Adapted Landscapes and Safe Homes. https://humboldtgov.org/690/Fire-Adapted-Landscapes-Safe-Homes-Progr

IBHS: Home Preparedness Guide https://disastersafety.org/wp-content/uploads/2021/08/WFR-Home-Preparedness-Guide.pdf

International Code Council. (2021). International Fire Code. Country Club Hills, Illinois.

International Wildland Urban Interface (IWUI) Code. (2015): Section 202 (definitions)

Merriam-Webster. (2022). Greenbelt. https://www.merriam-webster.com/dictionary/greenbelt

National Fire Protection Association (2022). How to prepare your home for wildfires. https://www.nfpa.org/Public-Education/Fire-causes-and-risks/Wildfire/Preparing-homes-for-wildfire#:~:text=Space%20trees%20to%20have%20a,the%20edge%20of%20the%20structure

National Fire Protection Association. (2022a). NFPA 1140, 2022 Edition: Standard for Wildland Fire Protection

National Fire Protection Association. (2022b). NFPA – Firewise Factsheets: https://www.nfpa.org/Public-Education/Fire-causes-and-risks/Wildfire/Firewise-USA/Firewise-USA-Resources/Research-Fact-Sheet-Series

National Fire Protection Association. (2022c). NFPA “Assessing Structure Ignition Potential from Wildfire" training.

National Fire Protection Association. (2020). NFPA “WUI-NITY: a platform for the simulation of wildland-urban interface fire evacuation”. https://www.nfpa.org//-/media/Files/News-and-Research/Fire-statistics-and-reports/WUI/RFWUINITY.pdf

National Fire Protection Association. (2013). NFPA “Community Wildfire Safety Through Regulation: A Best Practices Guide for Planners and Regulators”. https://www.nfpa.org/-/media/Files/Public-Education/By-topic/Wildland/WildfireBestPracticesGuide.ashx?la=en

National Institute of Standards and Technology. (2022). NIST Study Finds Wildfire Hazards in Residential Fences and Mulch Beds. https://www.nist.gov/news-events/news/2022/08/nist-study-finds-wildfire-hazards-residential-fences-and-mulch-beds#:~:text=Across%20nearly%20200%20fire%20experiments%2C%20researchers%20at%20the,generally%20disproportionately%20higher%20when%20combustible%20objects%20burned%20together.

National Institute of Standards and Technology. (2022a). NIST WUI Structure/Parcel/Community Fire Hazard Mitigation Methodology. https://nvlpubs.nist.gov/nistpubs/TechnicalNotes/NIST.TN.2205.pdf

University of California Agriculture and Natural Resources (UCANR). (2022a). Landscape Restoration. https://ucanr.edu/sites/fire/Recovery/Revegetation/

University of California Agriculture and Natural Resources (UCANR). (2022b). Wildland Fire Safety Starts in the Home. https://ucanr.edu/sites/SAFELandscapes/

University of California Agriculture and Natural Resources (UCANR). (2020). Building to Coexist with Fire: Community Risk Reduction Measures for New Development in California. Mountain View, CA.

USDA Forest Service (2022). Urban and Community Forestry Program: Tree Pruning Guide. https://www.arborday.org/trees/tips/

Wildfire Planning International. (2016). A fire adapted community is prepared for the next wildfire.

Valachovic, Y., Quarles, S. L., and Swain, S. V. (2021). Reducing the Vulnerability of Buildings to Wildfire: Vegetation and Landscaping Guidance. University of California Agriculture and Natural Resources. Irvine, CA.



Marshall Fire Mitigation Assessment Team: Homeowner's Guide to Reducing Wildfire Risk Through Defensible Space

June 2023

FEMA

DR-4634

This page intentionally left blank

Table of Contents

1. **Introduction** **1**
   - 1.1. Purpose 1
   - 1.2. Key Issues 3
   - 1.3. Definitions 5
2. **What is Defensible Space?** **7**
3. **Fire-Resistant Landscapes** **8**
   - 3.1. "Recommended" or "Approved" Plant Lists 9
   - 3.2. Hazardous or "Prohibited" Plant Lists 11
   - 3.3. Landscape Design and Layout – Make Wildfire Resiliency Attractive 12
   - 3.4. Best Management Practices – Any Plant Can Burn! 13
4. **How to Increase Home Survivability Without Firefighters** **14**
5. **What if Your Property Has No Space?** **14**
   - 5.1. Where 100 Feet of Defensible Space is Limited 15
   - 5.2. Where 30 Feet of Property Line Setback is Limited 16
6. **Monitor and Evaluate Your HIZ** **17**
7. **References** **18**

1. Introduction

On December 30, 2021, a wind-driven wildfire affected over 2,000 residential structures and several commercial facilities in unincorporated Boulder County, the City of Louisville, and the Town of Superior, Colorado. Data gathered after the fire highlighted several vulnerabilities in the Home Ignition Zone (HIZ), particularly with respect to defensible space principles, that likely played a significant role in spreading fire from the wildland and open spaces to the built environment.

Because of the unique nature of the incident, where extreme winds coupled with long term drought, high temperatures, and limited wildfire regulatory adoption, a fast-moving low-intensity grass fire became a highly destructive urban fire directly and indirectly impacting several communities and greater Boulder County area. The Federal Emergency Management Agency (FEMA) deployed its first-ever wildfire Mitigation Assessment Team (MAT) to evaluate building performance during the fire. The MAT was deployed to Louisville, Superior, and unincorporated areas in Boulder County, Colorado, to evaluate damaged homes and commercial structures. MAT members evaluated components and systems of primarily residential structures to determine the effectiveness of various building materials, design, and construction practices for wildfire resiliency. The MAT used the information gathered to evaluate how wildfire-urban interface (WUI) building codes and standards, as well as design, construction, and defensible space practices can be improved to increase community wildfire resilience. This is important as the landscape is continuously evolving due to climate change and putting more communities at risk.

1.1. Purpose

This document provides homeowners with steps they can take now to protect their homes from loss or damage from wildfires due to vulnerabilities introduced by surrounding landscaping and other exterior features (e.g., outbuildings, sheds, furniture, and trash bins) within the homeowner's property. The goal is to increase homeowner's awareness of the key mechanisms and characteristics of WUI fires that can result in home ignition, and to provide homeowners with guidance and various options to assist in the following:

1. Limit the ability of a fire to spread uninterrupted from adjacent wildlands and open spaces directly to the home (via direct contact from flames, exposure to hot gases or heat from radiation)
2. Limit the likelihood of embers igniting receptive fuel beds and other combustible items within the homeowner's property leading to home ignition (via heat from radiation, direct contact from flames, exposure to hot gases or additional embers created by vegetative and non-vegetative features (fuel)

These mechanisms, summarized in Figure 1, not only spread fire from wildlands, open spaces, greenbelts, and communal spaces to structures, but can also lead to the spread of fire from structure-to-structure and other items in the built environment. This is known as an urban conflagration.

This document provides homeowners with practical information, resources, and methods to better reduce or mitigate key vulnerabilities within their property from the home outward. This includes:

1. Creating and maintaining fire-adapted landscaping in terms of selection, location, and management of vegetation on the property
2. Increasing the home's chance to survive a fire whether firefighting resources are available or not available
3. Implementing additional wildfire-resiliency measures when property-line setbacks or defensible space are insufficient or unavailable which includes suggestions for how a homeowner can routinely check and evaluate the vulnerability of their home

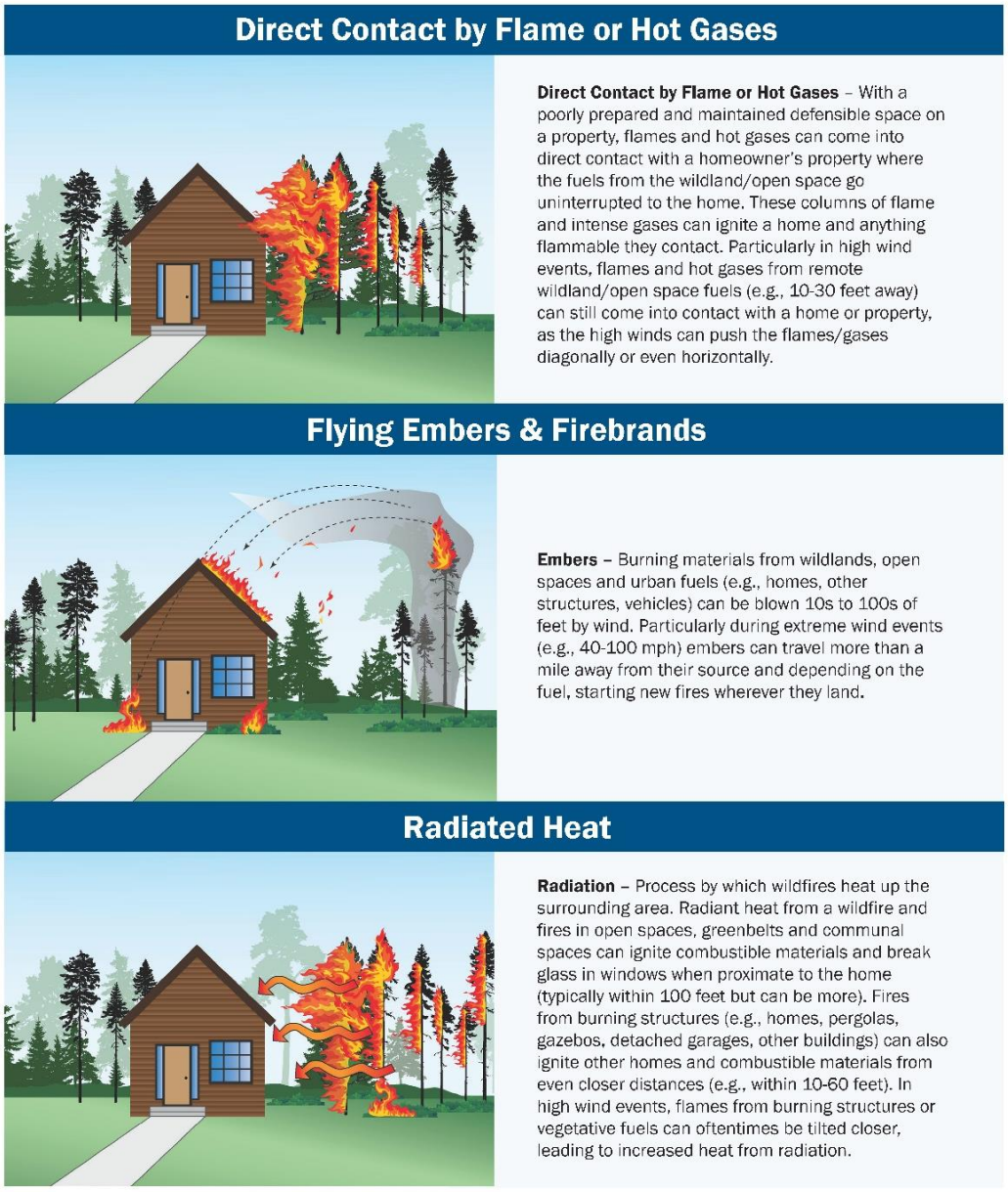


Figure 1. Key Mechanisms for Wildfires Leading to Property Damage and Loss.

Note: This document focuses on increasing wildfire resiliency in the defensible space around a home. Marshall Fire MAT document *Homeowner's Guide to Reducing Risk of Structure Ignition from Wildfire* provides actionable items for increasing wildfire resiliency for the home itself such as the building materials, components, assemblies, and attachments throughout the exterior envelope (i.e., structural hardening) from the top of the roof down to the foundation.

1.2. Key Issues

Defensible space is intended to provide a buffer between the building and the wildland or open spaces that surround it. It should be developed and maintained so that if vegetative or non-vegetative components ignite, they will not threaten the home from generated embers, radiant heat, or direct flames. During a major wildfire event, first responders will likely be unable to actively defend individual homes, so it is essential for homeowners to take proactive measures, so their homes and yards survive with or without defensive actions by first responders (i.e., "survivability "). That said, properly developed and maintained defensible space will also create a place of relative safety that may increase the likelihood of first responders to defend a property. Ultimately, the responsibility of developing and maintaining defensible space, fire-resilient landscapes, and monitoring parcel-level wildfire vulnerabilities lies with homeowners, Information in this report highlights key opportunities for homeowners to reduce their wildfire risk.

Fires rapidly spread via various flow paths that can lead to ignition of structures throughout communities. Structure ignitions can be caused by one or multiple mechanisms, building materials and features, site conditions, or adjacent environmental settings (Figure 2), including:

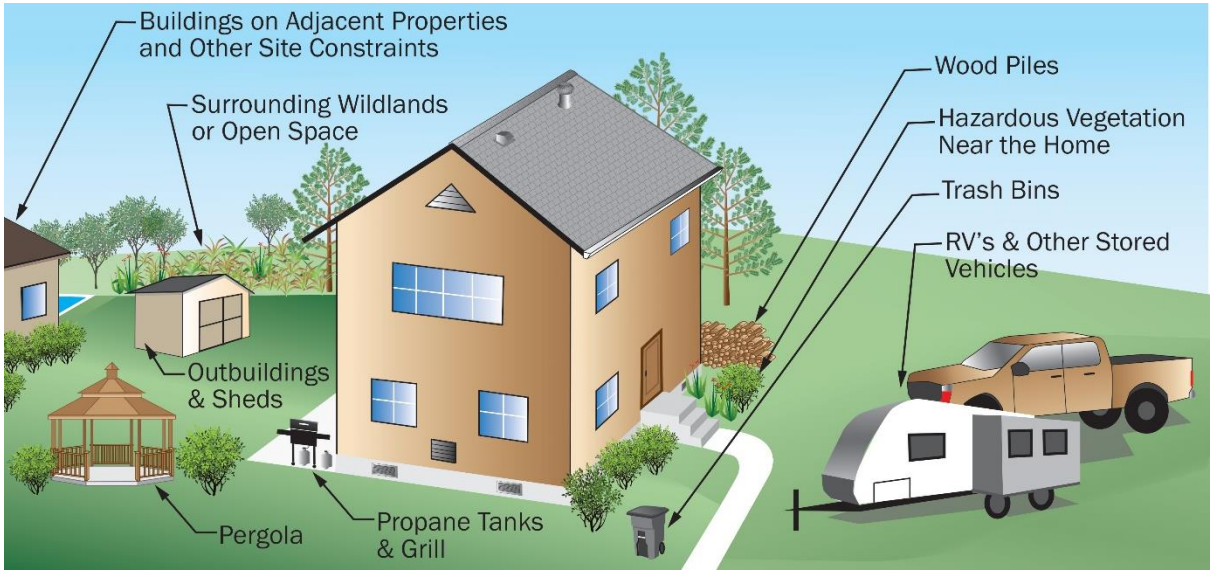


Figure 2. Key Wildfire Vulnerabilities Near a Home.

- **Wildland and Open Space Vegetation (e.g., grasses, shrubs, and trees)** – Fires in these spaces, whether intermixed or next to a community or home, can present a significant risk due to the intensity and rate-of-spread they are often characterized by (particularly in severe fire weather conditions). Large and uninterrupted open spaces or wildlands that border or mix with communities and neighborhoods, if not managed or considered in city or community land-use planning, can easily ignite homes and community assets through elevated radiative exposures, convective heat, and embers.

- **Landscape Vegetation –** Landscaping can consist of a wide range of managed vegetation types (e.g., trees, shrubs, flowers, grasses), plant characteristics and arrangements (e.g., height, growth type and extent, native vs. non-native, tendency for dead material accumulation), landscape purposes (e.g., food, shade, recreation), fire ecology attributes, and quality of ongoing maintenance. These 'man-made' landscape environments can be just as combustible as wildland vegetation and can provide a pathway for fire to spread from wildlands, open spaces, and greenbelts to the home both horizontally through surface fuels or vertically as ladder fuels from grasses and other low-lying vegetation and accumulated debris.

> While some plants are marketed and described as "firesafe" or "fire resistant", all plants will burn under the right conditions. The environment plants grow in and how they are maintained will generally have more influence on the flammability of the plant than its inherent characteristics. (CAL FIRE, 2022)

- **"Approved" and "Prohibited" Plants** – Many areas have compiled lists of both "approved" and "prohibited" plants to guide homeowners in landscaping design. The ability or inability to resist ignition is based on the physical characteristics of the plant. While these lists are beneficial to homeowners, they can be incomplete or misleading and can provide a false sense of security. These lists are highly dependent on a variety of local factors that may not be relevant to other locations. Numerous factors (e.g., plant species, plant structure, plant products such as resins, setting, surface mass, branching patterns, foliage size, density, litter production and retention, maintenance practices, placement, weather, weather history, etc.) influence whether a plant should be considered "hazardous" or "approved". Of these factors, maintenance is crucial, and any plant can become a hazard if not maintained properly. Homeowners are encouraged to consult with local fire departments or plant ecologists to evaluate plant "safety" due to the variety and nuances of plant flammability. Even "approved" plants will burn.

- **Embers** – Embers are responsible for the majority of wildfire structure ignitions (estimated to be at least 2/3 of ignitions, Maranghides 2009). Embers can be produced from burning vegetative fuels; other combustible materials such as buildings and contents; and other fuels such as vehicles, and waste bins in the area surrounding the built environment. Embers can be carried by high winds in front of the wildfire at varying distances (e.g., 1/2–2 miles). This creates a wind-driven fire hazard that is unique to wildfire incidents. See Figure 3.



Figure 3. Embers are the primary driver for rapid spread of wildfires into communities. (Valachovic, et al. 2021).

- Site Constraints and Limited Setbacks –Site constraints and limited setbacks to adjacent properties restrict a homeowner's ability to achieve 30–100 feet of defensible space. These constraints can oftentimes mean that homeowners must contend with additional hazards e.g., adjacent unmanaged vegetation, vacant lots, structure-to-structure fire spread, that are mostly outside of their control. Alternative methods, such as common defensible space with neighbors and other structural hardening measures, are needed to address these increased risks.

- Other Fuels in the Built Environment – There are a wide range of other types of combustible fuels that homeowners may have stored adjacent to the primary structure, which may ignite due to a wildfire and present an additional fire hazard to homes. This can include firewood piles, sheds, outdoor grills, propane tanks, outdoor furnishings, lawnmowers, trash bins, vehicles, and decorative landscaping (e.g., artificial grass/turf). The type, quantity, and characteristics of these other fuels range dramatically and can present additional challenges in predicting fire behavior (e.g., fire severity, rate of spread, burning characteristics) and damage loss potential in the WUI (Society of Fire Protection Engineers WUI Handbook, 2023).

1.3. Definitions

- Approved or Recommended plants – "Recommended" or "approved" plants are generally based on characteristics that allow for a more fire-resistant landscape. Common characteristics include drought-resistance, high moisture content, low levels of volatile oils and other readily flammable chemicals, noninvasive, slow, and low growing, low litter production and bark shedding, and sustainable without supplemental fertilization.

- **Defensible space** – The area around a home where the location, selection, and maintenance of vegetation and other combustible materials are managed such that a fire or wind-blown embers are less likely to ignite the structure. This managed area provides a "defense" against the fire to reduce the structure's exposure to radiation (heat), direct flame contact and ignition from embers, which are considered the three principal factors of ignition in a wildfire. (Bell et al. 2007).

- **Defensibility –** The level and degree of wildfire mitigation measures that are provided for a structure such that it can be safely defended by firefighting resources in a wildfire but may not survive if firefighting is unavailable.

- **Embers (a.k.a. firebrands) –** Smoldering or flaming particles of vegetation from tree branches, leaves, shrubs, grass, chaparral, or other urban combustibles (such as building components, fences, sheds) that ignite and burn during a wildfire and are carried by winds in front of the wildfire at varying distances. Embers are sometimes also referred to as firebrands.

- **Fire-Adapted Plants –** Plants that have adapted to survive and live in environments with fire. Plant species can typically be classified into five different categories based on their adaptations, although some fit into more than one category. These categories include resisters (i.e., survive moderate to low-intensity fires), sprouters (i.e., endure fire and resprout from their roots), seeders (i.e., evade fire by shedding lots of seeds that sprout after a fire such as serotinous cones of lodge pole pine), invaders (i.e., take over recently burned areas) and avoiders (i.e., grow in areas where fire does not normally occur) (BLM, 2010).

- **Fire-Resistant Landscapes** – This type of landscape uses fire-resistant plants that are strategically planted and maintained to resist the spread of fire to your home. (CAL FIRE, 2019)

- **Hazardous or "Prohibited" Plants –** "Hazardous" or "prohibited" plants are generally based on characteristics that increase ignitability and introduce fire hazards in the landscape. Common characteristics include blade-leaf or needle-leaf evergreens; stiff, woody, small or fine, lacey leaves; leaves and wood containing volatile waxes, fats, terpenes, or oils. Other traits include gummy or resinous sap; plentiful fine, twiggy, dry, or dead materials, loose or papery bark, or produce a large amount of vegetative debris or duff. These types of "hazardous" plants typically flame when preheated and ignited (Fire Safe Marin, 2022).

- **Home Ignition Zone (HIZ)** – The HIZ consists of three zones around a structure including the immediate or ember-resistant zone, the intermediate zone, and the extended or reduced fuel zone (Figure 4). Different names and numbering may be given to these zones by different agencies and organizations.

- **Survivability –** The level to which a structure has the potential to withstand wildfire without being defended.

2. What is Defensible Space?

Defensible space, coupled with home hardening, is essential to increasing your home's likelihood of surviving a wildfire. It is the space that provides a buffer between your home and potential fires in adjacent open spaces or wildland areas comprised of grasses, shrubs, and trees. This buffer is needed to slow or stop the progression of wildfire, and it helps protect your home from damage or loss. Maintaining defensible space includes specific actions for vegetative and non-vegetative objects (e.g., trash cans, fencing and sheds) around a home generally up to 100 feet from the structure (IWUIC, 2021). Defensible space is generally subdivided into three zones, whereby the highest priorities and most restrictive measures are required for the area closest to the structure. The National Fire Protection Association® (NFPA) defines the three zones as follows (see Figure 4):

- **Zone 0**, "Immediate Zone", "Ember-Resistance Zone", or "Noncombustible Zone" (0–5 feet). Zone 0 is considered the most important and includes areas immediately surrounding a structure, as well as areas under any attached decks or overhangs.

- **Zone 1**, "Intermediate Zone", or "Lean, Clean and Green" (5–30 feet). Zone 1 adds a defensible zone that extends from Zone 0 to Zone 2. The goal of this area is to reduce the connectivity between garden beds, shrubs, and trees; removing lower branches of trees and shrubs; and creating areas of irrigated and mowed grass or hardscape between lush vegetation islands so that wildfire does not burn to the house or into the crown of trees. Plants should be properly irrigated and maintained to remove dead/dry material (Valachovic, et al., 2021). This designation also applies to the area within 10 feet of driveways, access roads, or public roads adjacent to the property.

- **Zone 2**, "Extended Zone" or "Reduce Fuel Zone" (30–100 feet+). The goal of Zone 2 is to create a fuel break that interrupts the continuous vegetative fuel path of a wildfire, minimize flame length, and keep fires on the ground by reducing ladder fuels and crown clustering.

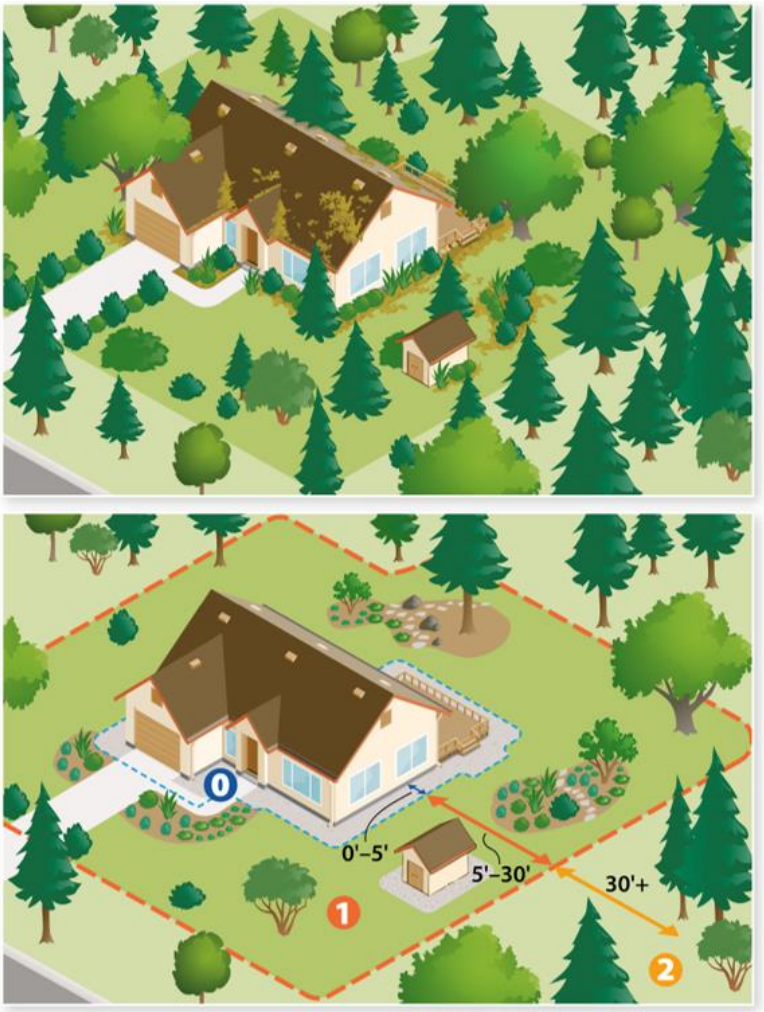


Figure 4. Before (upper) and after (lower) implementation of the three-zone defensible space strategy. While this figure shows a forested setting, the same concepts apply to other vegetation types (e.g., grass- and shrub-lands) and residential settings (Valachovic, et al. 2021).

Many federal, state, and local resources provide a range of information, guidance, and recommendations specific to each zone. See the Reference section for details. Note: Homeowners are encouraged to refer to their local fire department, other local government agencies (e.g., planning department), and other community groups (e.g., HOAs, Firewise communities, fire safe councils, and non-profits) for additional requirements and/or guidance specific to their area. Local ordinances and guidance documents can often provide more tailored and nuanced information for the region or area, and in some cases more stringent requirements.

3. Fire-Resistant Landscapes

Reducing or eliminating hazardous fuels (vegetative or non-vegetative) and maintaining the landscape within the HIZ of a structure can greatly increase its survivability. This helps not only reduce potential sources of embers, but also reduces the likelihood of wildland fuels, landscaping

and other materials directly surrounding the structure or below the structure to serve as ember receptors.

3.1. "Recommended" or "Approved" Plant Lists

Jurisdictions often provide "approved" or "recommended" plant lists with recommendations on vegetation that has more fire-resistant characteristics given the specific climate, topography, and ecological systems in the local area. Some general characteristics of plants included on "approved" lists are (Kuhns, 2019):

- Drought-resistant
- Contain more moisture
- Contain low amounts of volatile oils and other readily flammable chemicals
- Noninvasive
- Slow growing
- Produce less litter and dead material
- Low growing
- Sustainable without supplemental fertilization

While these "approved" or "recommended" plant lists provide a starting point for creating a fire-resistant landscape, it is critical that homeowners know how to properly locate, care, and maintain their landscape. All plants, even recommended plants, shrubs, and trees, will burn given the right conditions and have the potential to become fuel during a wildfire. Also, some plants are difficult to maintain because of the amount of maintenance they require. Homeowners should understand the amount of care and maintenance required for their landscape and verify that this aligns with their available resources. Refer to best management practices below for more details.

Colorado State University Cooperative Extension Service has developed a comprehensive list of fire-resistant plant, shrub, and tree species list. These plants are available at many nurseries which, when combined with defensible space landscaping management practices, can reduce fire risk. The list includes many species attractive in suburban settings like iris, penstemon, beebalm, maples, plum, river birch, mountain ash, and lilac. (Colorado Extension Service, 1999).

Additionally, the Colorado State University Cooperative Extension Service and the Colorado Forest Service have developed plant, shrub, and tree recommendations for Colorado's wildfire environments through the Firewise program which are appropriate to Boulder County's wildfire risk and Wildland Urban Interface (WUI) conditions (Colorado State University Extension. Fire-Resistant Landscaping Fact Sheet 6.303 06303.pdf (colostate.edu)).

See a sample list of references provided in the box below.

Federal, State, And County Best Management Practices of Defensible Space

National Non-Government

- International Wildland-Urban Interface Code (IWUIC). (2021).
- National Fire Protection Association (2022). Firewise USA®. https://www.nfpa.org/Public-Education/Fire-causes-and-risks/Wildfire/Firewise-USA
- NFPA 1140, 2022 Edition: Standard for Wildland Fire Protection
- NIST. (2022). WUI Structure/Parcel/Community Fire Hazard Mitigation Methodology. https://nvlpubs.nist.gov/nistpubs/TechnicalNotes/NIST.TN.2205.pdf

Federal

- USDA Forest Service. (2022). Urban and Community Forestry Program: Tree Pruning Guide. https://www.arborday.org/trees/tips /

State

- Colorado State University (CSU). (2010): Front Range Tree Recommendation List. https://extension.colostate.edu/docs/pubs/garden/treereclist.pdf
- Colorado State Forest Service. (2021). The Home Ignition Zone: A guide to preparing your home for wildfire and creating defensible space. https://coloradoforestatlas.org/customers/colorado/information/2021_CSFS_HIZGuide_Web.pdf
- Colorado State Forest Service. (2012). Protecting Your Home from Wildfire: Creating wildfire-defensible zones. https://static.colostate.edu/client-files/csfs/pdfs/FIRE2012_1_DspaceQuickGuide.pdf
- CALFIRE. (2022). Prepare for Wildfire: Defensible Space. https://www.fire.ca.gov/programs/communications/defensible-space-prc-4291/

County

- Boulder County. (2011). Boulder County Community Wildfire Protection Plan: Defensible Space. https://assets.bouldercounty.gov/wp-content/uploads/2017/02/community-widfire-protection-plan-book-low-resolution.pdf
- Boulder County. (2017). Your Defensible Space Slideshow. https://assets.bouldercounty.gov/wp-content/uploads/2017/02/defensible-space-slideshow.pdf

3.2. Hazardous or "Prohibited" Plant Lists

Many communities within high wildfire-prone areas have a list of common plants that are considered "hazardous" or "prohibited" for use. Specific guidance has not been developed for Boulder County, Colorado. However, observed highly-flammable tree types common to eastern Boulder County include species in arborvitae (cedars), Juniperus (junipers), Pinus (pines), Douglas fir, spruce, cypress, and yew. Flammable shrubs include Tamarisk, Russian Olive, sagebrush, rosemary, bitterbush and scotch broom. Ground covers such as pampas grass are also extremely flammable in dry conditions. Plants like junipers, Italian cypress, feather and fountain grasses, and ice plant are often considered hazardous due to the amount of maintenance required to manage dead thatch inside or under a green surface layer (Figure 5). Other plants like eucalyptus, palms and some manzanitas are also typically not recommended in medium- to high-wildfire risk areas due to the shedding of dry bark, leaves, fronds, and other duff that can readily ignite and spread fire (UCANR, 2022).

Common characteristics of wildfire vulnerable vegetation include:

- Low moisture content
- Volatile resins and oils, generally aromatic when crushed
- Narrow leaves or long, thin needles
- Waxy or fuzzy leaves
- Accumulates dead leaves and twigs on and/or under the plant
- Loose or papery bark
- Invasive species



Figure 5. Junipers (left) are among the least fire-resistant plants commonly used in landscaping. Their leaf structure and the volatile oils they contain make them highly flammable. Cheatgrass (right), a non-native species, is a flashy fuel meaning that it is highly flammable and can burn rapidly to spread fire and ignite other fuels.

The following publications provide general guidance and considerations for identifying hazardous or "prohibited" plants. For more site and neighborhood-specific guidance, homeowners are encouraged to reach out to their local fire department, their county forester, landscape architects, nurseries, cooperative extension agents, or other fire ecology/fire safety professionals to evaluate their landscaping design.

References for Restricted Invasive Plants (Boulder County, Colorado)

- Boulder County. (2021). Boulder County Invasive Plants 2021 Yearly Report.
- Boulder County, Colorado. https://assets.bouldercounty.gov/wp-content/uploads/2020/05/weeds-annual-report.pdf
- Typical invasive trees within Boulder County include: Trees of Heaven, Russian Olive, and Tamarix.
- Other plants that are on Boulder County's List A Watch list include: Mediterranean Sage, Rush Skeletonweed, Myrtle Spurge, Purple Loosestrife, Hairy Willow-herb, Orange Hawkweed, Spotted Snapweed, Yellow Flag Iris, Garden Loosestrife, Yellow Toadflax, Leafy Spurge, and Japanese Knotweed (Boulder County, 2021).

3.3. Landscape Design and Layout – Make Wildfire Resiliency Attractive

A homeowner's landscape can be tailored to reduce the likelihood of ember ignition, fire intensity, and spread of fire to a home. Methods such as mosaic planting and fuel breaks can greatly reduce radiative exposures, high-severity fires proximate to the home, and ultimately increase the probability that a structure will survive a wildfire. When done well, landscaping around a home can be both fire-resistant and achieve a variety of other goals (e.g., aesthetics, soil retention, healthy and native ecosystems, temperature control, flood control). See Figure 6.



Figure 6. Examples of Fire-Resistant Landscapes, including Mosaic Design Features. (Left Photo Credit: CALFIRE, 2022b)

From a fire-prevention perspective, reducing connectivity or continuity of vegetation by creating islands of vegetation or mosaic patterns by increasing spacing between trees and shrubs can limit the spread of fire (Valachovic et al. 2021). Clustered trees and shrubs that are continuous over large areas provide an uninterrupted path, which enables wildfire to gain intensity and spread rapidly. In a WUI setting, this can potentially increase wildfire exposure to homes in intermix zones, and into the developed parts of a community. Landscape designs can also incorporate fuel breaks using pavers and other noncombustible materials. In addition to general spacing, homeowners should reduce the amount of ladder fuels in their landscaping. Ladder fuels are low-growing vegetation such as tall grasses, shrubs, and tree branches, both living and dead that can more readily ignite in a wildfire and lead to ignition of taller vegetation.

Figure 7 illustrates some of the concepts used in successful defensible space development. See the References section for more information. Additional site-specific landscape design guidance is available from the local fire department, county forester, landscape architects, cooperative extension agents or other fire ecology/fire safety professionals.

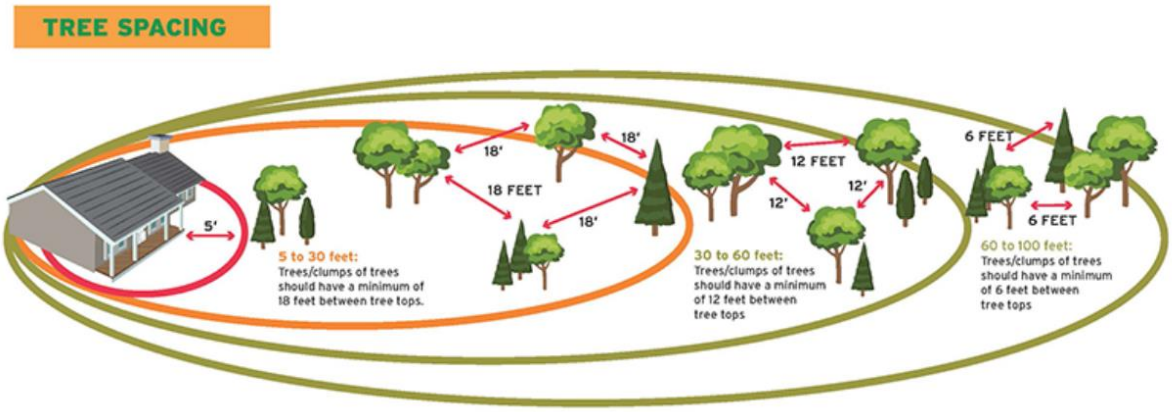


Figure 7. Prescriptive Tree Spacing Guidance (Reproduced from NFPA's website, ©NFPA 2022).

3.4. Best Management Practices – Any Plant Can Burn!

Choosing appropriate plants for landscaping will still require maintenance throughout the HIZ. Plants require water, trimming, and sometimes removal to reduce the hazard that vegetative fuels pose during a wildfire. Best management practices, even for the same species of plant, can vary depending on site topography and local weather and climate conditions (Figure 8). Strategies used by residents and landscapers to alter influences on flammability (e.g., pruning and plant establishment methods), impacts to plant vigor versus flammability, and other landscaping objectives still need development and industry standardization.

Due to the large variety and detailed nuances of plant flammability, homeowners are encouraged to reach out to local experts (e.g., fire departments, local universities, landscape architects and local fire ecologists) to evaluate their vegetative landscape and how best to manage the vegetation surrounding their home.

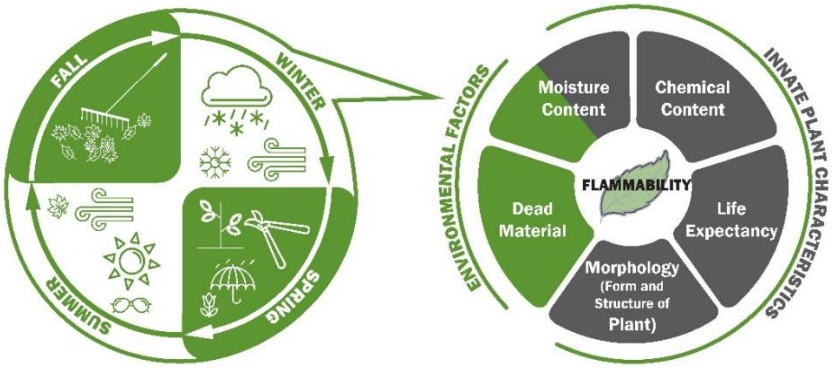


Figure 8. Factors to consider throughout seasons in the year for maintaining defensible space (Sustainable Defensible Space, 2022).

4. How to Increase Home Survivability Without Firefighters

During a major wildfire incident, firefighters and other first responders will likely be unable to "defend" most residential properties. As seen during and after the Marshall Fire (and most major wildfires in the U.S.), the severity and scale of the incident limited the opportunity and safety of first responders to contain or suppress the wildfire let alone defend threatened structures and neighborhoods. Therefore, homeowners are encouraged to develop and maintain appropriate defensible space and structural hardening provisions to ensure that their home and property have a greater chance of survival without relying on the presence of firefighting interventions.

Remember to implement the following methods to protect your home from wildfire:

- Develop and maintain defensible space or alternative risk mitigations where site restrictions exist
- Work with adjacent property owners to develop and maintain "communal defensible space"
- Select, locate, and maintain recommended fire-resistant plants, shrubs, and trees throughout your property
- Develop and maintain a fire-resistant landscape (e.g., tree/shrub spacing, mosaic design), and where necessary, consult a local wildfire specialist, fire department personnel, fire ecologist or fire landscape architect
- Monitor and evaluate your home ignition zone annually and prior to core fire season(s)
- Ask your local fire department, fire safe council or other local wildfire resiliency organization such as Wildfire Partners (https://wildfirepartners.org/) to inspect your home and property
- Develop and maintain structural hardening provisions (see Marshall Fire MAT document *Homeowner's Guide to Reducing Risk of Structure Ignition from Wildfire*)

5. What if Your Property Has No Space?

As was observed in the Marshall Fire and numerous WUI fires in recent years, significant damage and loss of property can result from fire spreading from structure–to–structure and not necessarily from the wildlands or open space to the structure. Structure-to-structure fire spread (or urban conflagration) increases in likelihood when homes are closely spaced (e.g., within 60 feet of another structure). This is already recognized in building codes and standards in fire separation requirements. However, most existing codes provide exceptions that allow residential homes to be within 5 feet from a property line (or roughly 10 feet to another home). In some high wildfire jurisdictions, local wildland/WUI fire ordinances have been adopted that require 20 or 30 feet of separation from the primary home to the property line to limit structure–to–structure fire spread, in

addition to the typical defensible space requirements described earlier. While this may be possible for new construction, for most existing properties achieving 30 feet of separation let alone the 100 feet of defensible space is not possible, leaving homeowners unable to achieve prescriptive defensible space measures or optimum wildfire resiliency. The following provides homeowners with guidance on approaches to take to where building setbacks, property line constraints or other practical challenges limit the ability to achieve 100 feet of defensible space or 20–30-foot setbacks to the property line.

5.1. Where 100 Feet of Defensible Space is Limited

Where 100 feet of defensible space next to wildlands, open space, or adjacent properties is not available, homeowners are encouraged to consider the following strategies:

1. Work with neighbors and other adjacent property owners to ensure that common defensible space considerations are implemented between and adjacent to structures on both properties within Zones 0–2 within their own property lines (Figure 9).

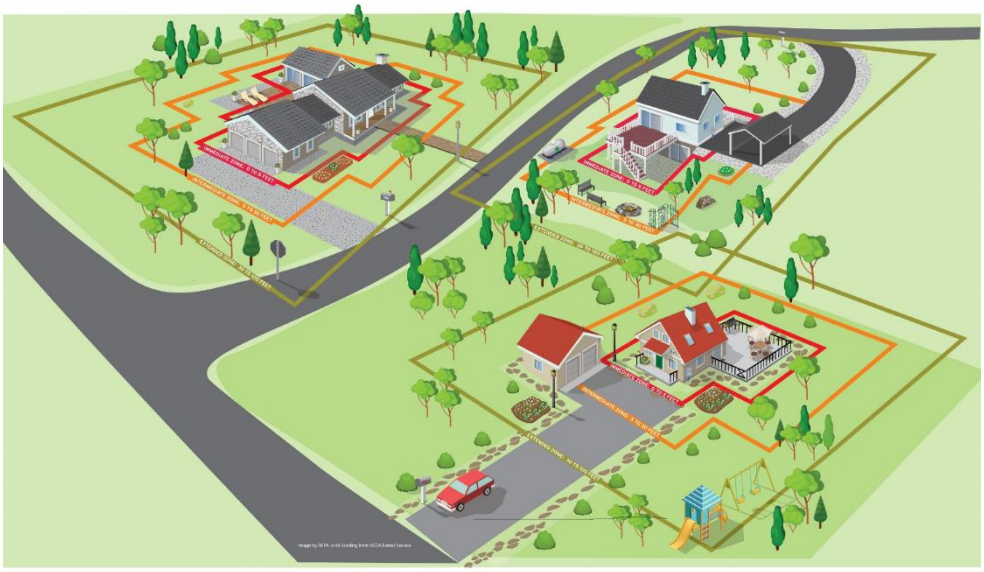


Figure 9. Communal defensible space boundaries.
(Reproduced from NFPA's website, ©NFPA 2022)

2. Prioritize localized structural hardening measures on the sides of the home with insufficient separation to adjacent properties, such as:

- Replace existing vent covers with 1/16-inch wire mesh or an approved ember and flame-resistant vent. Some jurisdictions have "pre-approved" products such as CALFIRE's Building Materials Listing Program (https://osfm.fire.ca.gov/divisions/fire-engineering-and-investigations/building-materials-listing/bml-search-building-materials-listing/). Local building and/or fire officials have discretion to approve products.

- Replace combustible siding with non-combustible or ignition resistant materials (e.g., fiber cement, stucco).

- Replace combustible decking with non-combustible decking.
- Remove all combustible non-vegetative features (e.g., ornamental grass, trash bins, sheds, pergolas, gazebos, wood piles, vehicles).
- Replace single-pane window with double-paned or tempered-laminated glazing.
- Replace combustible fences with non-combustible materials (e.g., concrete, masonry, metal), particularly for fences that attach to a neighbor's combustible fence.

3. Provide structural hardening measures for the entire home (e.g., upgrading to a Class A roof). Refer to Marshall Fire MAT document *Homeowner's Guide to Reducing Risk of Structure Ignition from Wildfire*.
4. Prioritize the reduction of receptive fuel beds around the entire home from ember attack. Refer to Fire Resistant Landscapes section above.

Hardening structures and parcels to reduce risk of ember exposure and mitigating the major fire pathways that lead wildfire toward residences can be the most important way to protect high-density communities (Maranghides et all, 2022). See *Marshall Fire Mitigation Assessment Team: Mitigation Strategies to Address Multi-Hazard Events*. Refer also to other federal, state, and local references for more details.

5.2. Where 30 Feet of Property Line Setback is Limited

Where 30 feet of setback to the property line is not possible for practical reasons (e.g., parcel dimension or size, topographic limitations, or other easements), homeowners are encouraged to provide additional fire-safety enhancements to their home to reduce the likelihood of structure-to-structure fire spread. The following are potential options (Figure 10):

- Install a six-foot, solid, noncombustible property line wall or fence (e.g., brick, masonry, or concrete masonry unit walls) to minimize ember transmission, radiation, and other forms of heat transfer from adjacent properties. Note: This is more effective for grass and shrubland landscapes.
- Install five to ten feet of noncombustible material (e.g., pavers, gravel) horizontally around the home. Where there is significant hardscaping around the home, additional measures may be needed to limit potential drainage or flooding issues.
- Prioritize localized structural-hardening measures on the side of the structure with less than 30 feet of setback (e.g., replace combustible siding with non-combustible siding). Refer to bullet point 2 in the above section.
- Provide additional structure hardening such as installing or upgrading exterior walls, windows, vents, and under-eaves areas of the home to be fire-resistance rated (e.g., 1-hour rated).

Homeowners may need to contact a licensed contractor or design professional for assistance. Refer to Marshall Fire MAT document *Decreasing Risk of Structure-to-Structure Fire Spread in a Wildfire* for details.

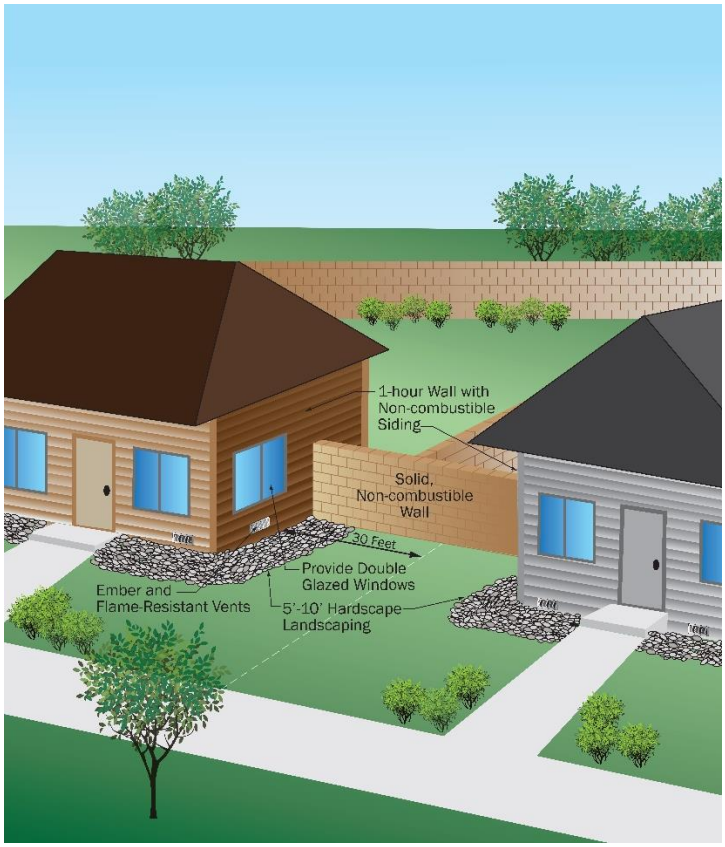


Figure 10. Examples of additional structural hardening and defensible space features where 30 feet of setback to the property line is not feasible.

6. Monitor and Evaluate Your HIZ

In addition to the measures described above, it is critical that homeowners periodically monitor and evaluate the defensible space and structural hardening provisions in their property's HIZ. A thorough HIZ assessment identifies potential wildfire vulnerabilities that could result in damage or total loss of a structure. These assessments should be performed by the property owner in consultation with wildfire/fire safety professionals (e.g., fire engineers, fire department prevention officers) or other trained individuals (e.g., Firewise USA®), members of the local fire safe council, Wildfire Partners (https://wildfirepartners.org/) or those who have taken a recognized HIZ assessment course, such as NFPA®: Assessing Structure Ignition Potential from Fire). The reference section highlights resources which outline best practices for conducting HIZ assessments for defensible space, including the Colorado State Forest Service's Home Ignition Zone Checklist.

There are numerous best management practices (BMPs) for parcel and community-level vegetation management available at the Federal, State, and County levels. For example, the Colorado State

Forest Service has published recommendations for homeowners to prepare the HIZ of their property for wildfire.

Best Practices for Conducting HIZ Assessments for Defensible Space

- NIST WUI Structure/Parcel/Community Fire Hazard Mitigation Methodology. https://nvlpubs.nist.gov/nistpubs/TechnicalNotes/NIST.TN.2205.pdf
- NFPA 1140, 2022 Edition: Standard for Wildland Fire Protection
- NFPA® "Assessing Structure Ignition Potential from Wildfire" training.
- Fire Adapted Communities Learning Network. https://fireadaptednetwork.org/
- Colorado State Forest Service Home Ignition Zone Checklists. https://csfs.colostate.edu/wildfire-mitigation/home-ignition-zone-checklists/
- IBHS, How to Maintain Your Home's Defensible Space. https://wildfireprepared.org/article/how-to-maintain-your-homes-defensible-space/
- Society of Fire Protection Engineers: Virtual WUI Handbook. https://www.sfpe.org/wuihandbook/home#about-handbook

FEMA Fact Sheets for Defensible Space in The Home Ignition Zone

FEMA Technical Fact Sheet Series FEMA P-737: *Home Builder's Guide to Construction in Wildfire Zones*. https://defensiblespace.org/wp-content/uploads/2021/01/FEMA_2008_P-737-Home-Builders-Guide-to-Construction-in-Wildfire-Zones.pdf

7. References

American Planning Association. (2019). Planning the Wildland-Urban Interface. Chicago, IL.

Bell, C.E., J.G. Gonzales, V.J. Mellano, M. Nakamura, S.L. Quarles, T.P. Salmon, and D.A. Shaw. (2007), Wildfire Preparedness and Recovery in San Diego County: A Review and Analysis White Paper of Data and Research Studies Relevant to Wildfire. Farm and Home Advisor's Office, University of California Cooperative Extension, County of San Diego. San Diego, CA. 65p.

Boulder County. (2021). Boulder County Invasive Plants 2021 Yearly Report. Boulder County, CO.

Boulder County. (2011). Community Wildfire Protection Plan. https://assets.bouldercounty.gov/wp-content/uploads/2017/02/community-widfire-protection-plan-book-low-resolution.pdf

Boulder County. (2017). Your Defensible Space Slideshow. https://assets.bouldercounty.gov/wp-content/uploads/2017/02/defensible-space-slideshow.pdf

Bureau of Land Management. (2010). Fire Ecology. https://www.blm.gov/or/resources/recreation/tablerock/files/fire_ecol_intro.pdf

CALFIRE. (2022). Prepare for Wildfire: Defensible Space. https://www.fire.ca.gov/programs/communications/defensible-space-prc-4291/

CALFIRE. (2022a). Defensible Space. https://www.fire.ca.gov/dspace/

CALFIRE. (2022b). Maintaining Defensible Space During a Drought. https://www.readyforwildfire.org/prepare-for-wildfire/get-ready/defensible-space-drought/

Colorado State University (CSU). (2021). Home Ignition Zone Checklist. https://csfs.colostate.edu/wp-content/uploads/2021/04/2021_CSFS_HIZGuide_Web.pdf

Colorado State University (CSU). (2010): Front Range Tree Recommendation List. https://extension.colostate.edu/docs/pubs/garden/treereclist.pdf

Colorado State Forest Service. (2021) The Home Ignition Zone: A guide to preparing your home for wildfire and creating defensible space. https://csfs.colostate.edu/wp-content/uploads/2021/04/2021_CSFS_HIZGuide_Web.pdf

Colorado State Forest Service. (2012). Protecting Your Home from Wildfire: Creating wildfire-defensible zones. https://static.colostate.edu/client-files/csfs/pdfs/FIRE2012_1_DspaceQuickGuide.pdf

Fire Adapted Communities (FAC). (2014). Guide to Fire Adapted Communities. https://ucanr.edu/sites/SoCo/files/272862.pdf

Fire Adapted Communities (FAC). (2021). Fire Adapted Communities Graphic and Facilitator's Guide. https://fireadaptednetwork.org/resource/fire-adapted-communities-graphic-and-facilitators-guide/

Fire Safe Marin. (2022). Choosing Plants. https://firesafemarin.org/create-a-fire-smart-yard/plants/.

International Wildland Urban Interface (IWUI) Code. (2021): Section 202, (definitions), Section 603, (defensible space).

Maranghides, A., Link, E. D., Hawks, S., McDougald, J., Quarles, S. L., Gorham, D. J., and Nazare, S. (2022). WUI Structure/Parcel/Community Fire Hazard Mitigation Methodology. https://nvlpubs.nist.gov/nistpubs/TechnicalNotes/NIST.TN.2205.pdf

Maranghides, A. and Mell, W. (2009), A Case Study of a Community Affected by the Witch and Guejito Fires (NIST TN 1635), Technical Note (NIST TN), National Institute of Standards and Technology, Gaithersburg, MD. https://doi.org/10.6028/NIST.TN.1635

National Fire Protection Association (2022). How to prepare your home for wildfires. https://www.nfpa.org/Public-Education/Fire-causes-and-risks/Wildfire/Preparing-homes-for-wildfire

National Fire Protection Association (2022a). Firewise USA®. https://www.nfpa.org/Public-Education/Fire-causes-and-risks/Wildfire/Firewise-USA

National Fire Protection Association (2022). NFPA 1140, 2022 Edition: Standard for Wildland Fire Protection.

National Institute of Standards and Technology. (2022). NIST Study Finds Wildfire Hazards in Residential Fences and Mulch Beds..

Sustainable Defensible Space. (2022). Sustainable Defensible Space. https://defensiblespace.org/plants/

USDA Forest Service (2022). Urban and Community Forestry Program: Tree Pruning Guide. https://www.arborday.org/trees/tips/

Valachovic, Y., Quarles, S. L., and Swain, S. V. (2021). Reducing the Vulnerability of Buildings to Wildfire: Vegetation and Landscaping Guidance. https://anrcatalog.ucanr.edu/pdf/8695.pdf



Mitigation Assessment Team Report

Marshall Fire

Building Performance, Observations, Recommendations, and Technical Guidance

FEMA P-2320 / June 2023

FEMA

Any opinions, findings, conclusions, or recommendations expressed in this publication do not necessarily reflect the views of FEMA. Additionally, neither FEMA nor any of its employees makes any warranty, expressed or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, product, or process included in this publication. Users or information from this publication assume all liability arising from such use.

All photographs and figures used in this report were taken by the Mitigation Assessment Team or developed for this report unless stated otherwise.

All documents were prepared with accessibility and compliance with Section 508 of the Rehabilitation Act of 1973 in mind. For further information or clarification regarding items such as technical drawings or maps, please contact the FEMA Building Science Helpline at FEMA-BuildingScienceHelp@fema.dhs.gov or 866-927-2104.

Authors and Members of the Mitigation Assessment Team

FEMA Building Science Disaster Support Manager and MAT Lead:

Daniel Bass, RA, CFM
FEMA HQ

Task Order Manager:

Stacy Franklin Wright, AICP, PMP, CFM
Atkins

FEMA Building Science Marshall Fire MAT Points of Contact:

Christina Aronson, PE, SE
FEMA HQ

Sean McGowan, PE
FEMA Region 8

MAT Members

Stuart Adams, Stantec
Faith Berry, USFA
Julia Cuendet, Jensen Hughes
Erica Fischer, PhD, PE, Oregon State University
Brad Gillespie, Jensen Hughes
Meagan Joy, Jensen Hughes
Nicole LaRosa, USFA
Abbie Liel, PhD, PE, University of Colorado, Boulder
Laurel McGinley, PE, PMP, Dewberry
Tony Mendes, FEMA
Deborah Mills, CFM, Dewberry
Amelia Pludow, Jensen Hughes
Cameron Ramey, Stantec
Michael Riemer, PE, Atkins
Darlene Rini, PE, Jensen Hughes
John Squerciati, PE, CFM, Dewberry
Brad Wham, PhD, University of Colorado, Boulder

Internal Support

Technical Editor:
Corina Coulas, Stantec

Graphic Artist:
Susanne Dunleavy, Stantec

This page intentionally left blank

Table of Contents

Acronyms and Abbreviations ii

Executive Summary vi

1. Chapter 1: Introduction 1

1.1. Organization of the Report 2

1.2. Wildfire Basics 4

1.2.1. Evolution Of Risk 5

1.2.2. The Evolving Definition of the Wildland-Urban Interface 6

1.2.3. Multi-Hazard Wildfire Interactions 8

1.3. Overview of Boulder County, Colorado 9

1.3.1. Boulder County Demographics 10

1.3.2. Boulder County Wildfire History 11

1.3.3. Boulder County Wildfire Environmental Settings 13

2. Chapter 2: The Marshall Fire Event and Impact 19

2.1. Marshall Fire Weather Conditions 19

2.2. The Marshall Fire as a Multi-Hazard Wildfire 21

2.3. Impacts and Extent 21

2.3.1. Built Environment Impacts 24

2.3.2. Impacts to Firefighting Operations 26

2.4. Marshall Fire Pre-MAT 27

2.5. Marshall Fire MAT 28

3. Chapter 3: Regulatory Setting, Analysis, and Other Considerations 31

3.1. Overview of Colorado Wildfire Regulations 31

3.1.1. Code of Colorado Regulations Before the Marshall Fire 32

3.1.2. New or Amended State Level Building Codes and Standards 33

3.1.3. Colorado Strategic Documents, Programs and Technical Resources 34

3.2. Existing Community Level Wildfire Regulatory Mechanisms 37

3.2.1. Unincorporated Boulder County 38

3.2.2. Louisville, Colorado 43

3.2.3. Superior, Colorado 47

3.3. Additional Regulation Considerations - Energy Storage Systems 50

3.4. Regulatory Gap Analysis 52
3.4.1. Gaps in Model WUI Codes 52
3.4.2. Gaps in Wildfire Testing Standards 55
3.4.3. Structural Hardening Gaps in Codes 61
3.4.4. Other Relevant Gaps in Wildfire Codes and Standards 61
4. Chapter 4: Marshall Fire Observations –Community and Neighborhood/Subdivision Level 63
4.1. Management of Parks and Other Common Spaces 67
4.2. Local Wildland Interface and Multi-Hazard Conditions 69
5. Chapter 5: Marshall Fire Observations – Parcel and Building Level 71
5.1. Parcel-Level Wildfire Vulnerabilities 71
5.1.1. Common Parcel-Level Landscaping Issues 71
5.1.2. Communal Defensible Space 75
5.1.3. Parcel-Scale Structure Fire Separations 75
5.2. Building-Level Wildfire Vulnerabilities 77
5.2.1. Roof Components 79
5.2.2. Roof Joint Systems 83
5.2.3. Roof-to-Exterior Wall Components 86
5.2.4. Exterior Wall Components 88
5.2.5. Wall System Joints 94
5.2.6. Bottom of Exterior Wall Detailing 96
5.2.7. Foundations 98
5.2.8. Attachments 98
5.2.9. Smoke and Ash Infiltration 103
5.2.10. Energy Storage Systems 104
6. Chapter 6: Conclusions and Recommendations 105
6.1. Standardized Wildfire Terminology and Public Education Recommendations 106
6.2. Wildfire Hazard and Risk Recommendations 107
6.3. Community and Neighborhood/Subdivision Level Recommendations 108
6.4. Parcel/Building Level Recommendations 112
6.5. Summary of Conclusions and Recommendations 122
Appendix A: Acknowledgements 132
Appendix B: References 133

Appendix C: Glossary....139

Appendix D: Homeowner's Guide to Risk Reduction and Remediation of Residential Smoke Damage....143

Appendix E: Homeowner's Guide to Reducing Risk of Structure Ignition from Wildfire....145

Appendix F: Homeowner's Guide to Reducing Wildfire Risk Through Defensible Space....147

Appendix G: Decreasing Risk of Structure-to-Structure Fire Spread in a Wildfire....149

Appendix H: Mitigation Strategies to Address Multi-Hazard Events....151

Appendix I: Best Practices for Wildfire-Resilient Subdivision Planning....153

Appendix J: Wildfire-Resilient Detailing, Joint Systems, and Interfaces of Building Components....155

This page intentionally left blank

Acronyms and Abbreviations

AAR	After Action Report
AHJ	Authority Having Jurisdiction
ASCE	American Society for Civil Engineers
ASTM	American Society for Testing and Materials
BCAT	Building Code Adoption Tracking
BCEGS	Building Code Effectiveness Grading Schedule
BMP	Best Management Practice
BRIC	Building Resilient Infrastructure and Communities
BSDS	Building Science Disaster Support
CBC	California Building Code
CDC	Centers for Disease Control
CMU	concrete masonry unit
CPAW	Community Planning Assistance for Wildfire
CSFS	Colorado State Forest Service
CWPP	Community Wildfire Protection Plan
CWPC	Community Wildfire Planning Center
ESS	energy storage systems
FAC Net	Fire-Adapted Communities Network
FEMA	Federal Emergency Management Agency
FLASH	Federal Alliance for Safe Homes
FPRF	Fire Protection Research Foundation
FRWRM	Forest Restoration and Wildfire Risk Mitigation Grant Program

GEER	Geotechnical Extreme Events Reconnaissance Association
HB	House Bill
HERS	Home Energy Rating System
HOA	Homeowners Association
HIZ	Home Ignition Zone
HVAC	Heating, Ventilation and Air Conditioning
I-Codes	International Codes
IBHS	Institute for Building and Home Safety
IBC	International Building Code
ICC	International Code Council
IEBC	International Existing Building Code
IECC	International Energy Conservation Code
IFC	International Fire Code
IgCC	International Green Construction Code
IRC	International Residential Code
IWUIC	International Wildland-Urban Interface Code
kWh	kilowatt hour
Li-ion	lithium-ion
LTRG	Long Term Recovery Group
MAT	Mitigation Assessment Team
mph	miles per hour
MST	Mountain Standard Time
NEC	National Electrical Code
NFPA	National Fire Protection Association

NIBS	National Institute of Building Sciences
NIST	National Institute for Standards and Technology
NOAA	National Oceanic and Atmospheric Administration
NSF	National Science Foundation
NWCG	National Wildfire Coordinating Group
NWS	National Weather Service
OSB	Oriented Strand Board
OSHA	Occupational Safety and Health Administration
PBS	Public Broadcasting System
PIRG	Property Insurance Research Group
Pre-MAT	Preliminary Mitigation Assessment Team
PV	Photovoltaic
RESNET	Residential Energy Services Network
SFPE	Society of Fire Protection Engineers
SB	Senate Bill
SLTT	state, local, tribal and territorial
SVI	social vulnerability index
SWIFT	State Wildland Inmate Fire Teams
UBC	Uniform Building Code
UCADB	Uniform Code for the Abatement of Dangerous Buildings
UCANR	University of California Agriculture and Natural Resources
UL	Underwriters Laboratories
USDA	U.S. Department of Agriculture
USFA	U.S. Fire Administration

USFS	U.S. Forest Service
USGS	U.S. Geological Survey
WFLC	Western Forestry Leadership Coalition
WUI	Wildland-Urban Interface
WWA	West Wide Wildfire Risk Assessment

Executive Summary

The Marshall Fire was the most destructive fire in Colorado history with respect to buildings burned[1].

The Marshall Fire was a wind-driven wildfire that started on December 30, 2021, shortly before 10:30 a.m. MST in Boulder County, Colorado. The fire quickly spread to the Town of Superior and later to unincorporated Boulder County and the City of Louisville due to high winds with recorded gusts of up to 115 mph. By 5 p.m. MST the fire was estimated to be 1,600 acres, increasing to 6,200 acres by 10:00 a.m. MST on December 31, 2021. By the next day, the winds died down and heavy snow extinguished the fire and covered over 1,000 destroyed single- and multi-family houses and commercial structures in Louisville, Superior, and unincorporated Boulder County (Boulder County, 2022). This fire was unique in that it originated in grasslands/flatlands near a heavily populated area and traditional suburban developments.

MITIGATION ASSESSMENT TEAM DEPLOYMENT AND OBSERVATIONS

Several factors have been attributed to the devastation caused by the Marshall Fire: extreme winds, long term drought, unseasonably high temperatures, and limitations in existing wildfire safety and planning regulations. Because of the unique nature of the incident, a fast-moving grass fire became a highly destructive urban conflagration that directly and indirectly impacted several communities and the greater Boulder County area. As a result, the Federal Emergency Management Agency (FEMA) Building Science Disaster Support (BSDS) Program deployed its first-ever wildfire Mitigation Assessment Team (MAT) to evaluate building performance during the fire. The MAT was deployed to Louisville, Superior, and unincorporated areas of Boulder County, Colorado, to evaluate damaged houses and commercial structures. MAT members evaluated components and systems of primarily residential structures to determine the effectiveness of various building materials, design, and construction practices for wildfire resiliency. The MAT used the information gathered to evaluate how the wildfire-urban interface (WUI) and more general building codes and standards, as well as design,

This was the first opportunity for FEMA's BSDS Program to deploy the MAT to assess building performance following a wildfire. FEMA believed it was important to study this fire because the nature of the origin, weather conditions, and impacts on the built environment in the nontraditional WUI represent risks that need to be better understood by planners, developers, government officials, and the public-at-large.

[1] *Boulder County 2022-2027 Hazard Mitigation Plan*

construction, land-use planning, and defensible space practices can be improved to increase community wildfire resilience, particularly as the risk to landscape due to climate change is continuously evolving and putting more communities at risk (e.g., beyond perceived WUI).

SUMMARY OF DAMAGE OBSERVED

The structures affected by the Marshall Fire vary greatly across the damaged areas. In general, the observations of the MAT found that many of the impacted residential structures were built in the early 1980s and early 1990s although even newer structures sustained some damage or were declared a total loss. The majority of the damaged or destroyed residential buildings in the affected areas included the following consistent construction materials, detailing, and other architectural features:

- One- or two-story light-timber framed structures.
- Exterior wall systems typically consisted of Oriented Strand Board (OSB) sheathing clad with either a brick veneer or fiber cement siding material.
- Roofing systems observed typically consisted of asphalt-composite shingles or metal shingle systems.
- Glazing systems included both single- and multi-pane windows.
- Most structures did not have flame- or ember-resistant vent protection coverings.
- Many structures also had combustible non-structural attachments such as fences and decks.

The MAT observed structural hardening vulnerabilities (from the top of structure down) that are susceptible to wildfire damage. While many of these vulnerabilities to fire are already well-established and well-known points of weakness in the building or home's exterior envelope, codes and standards in effect in the impacted Boulder area prior to the fire did not require houses to be hardened against wildfire. Some key vulnerable features are:

- Roof components (e.g., roof covering, underlayment, chimneys)
- Roof to wall interfaces
- Exterior wall components
- Exterior wall to foundation interfaces
- Opening protection (e.g., vents, windows, doors)
- Joint systems (e.g., head-of-wall, bottom-of-wall, wall-to-wall interfaces)
- Non-structural attachments (e.g., fences, decks)
- Appurtenant structures (e.g., sheds)

Generally, houses with combustible siding, fences, and decks were more likely to be damaged or destroyed than those with fire-resistant or noncombustible components. Combustible fences along the interface of grasslands/open spaces and neighborhoods acted as wicks that enabled fire spread to structures. Single-pane windows were also observed to be more easily damaged or destroyed than multi-pane windows. Most houses were vulnerable to ember intrusion via unprotected inlet and outlet vent openings. Many landscaping features were observed to be inconsistent with current Home Ignition Zone (HIZ) standards. Lists of fire-resistant native plants did not appear to be readily available to homeowners for landscaping purposes. Neighborhoods with closely spaced houses (e.g., less than 30 feet of separation) were more likely to have structure-to-structure fire spread and disproportionate levels of damage. Before the Marshall Fire, local wildfire mitigation efforts appeared to focus on houses in the mountains and foothills with less emphasis on the plains/grasslands.

Neighborhoods with closely spaced houses (e.g., less than 30 feet between structures) were more likely to have structure-to-structure fire spread and disproportionate levels of damage.

The MAT also observed a relationship that was not widely recognized prior to the Marshall Fire between some community-level planning features and wildfire behavior. In particular, the MAT observed the presence of drainage ditches used for flood control and other greenbelts used for recreation that served as wildfire “superhighways” due to the presence of unmanaged biomass and hazardous vegetation. These land-use features ultimately provided receptive fuel loads and facilitated increased spread and severity of wildfire conditions from the wildlands/open spaces into suburban and urban neighborhoods.

While the winds during the Marshall Fire were very strong with recorded gusts up to 115 miles per hour (mph), widespread significant wind damage was not observed. Most of the wind damage that may have occurred was likely consumed by the fire. The MAT did observe several occurrences of roof tiles/shingles being uplifted or removed and some cases of siding being blown off exteriors of houses. In addition, anecdotal information suggests that windborne debris may have played a role in breaching some building envelopes, particularly through glazed openings, which may have allowed embers and flames to reach the interiors of some buildings. Though significant wind damage was not observed, wind played a major role in the fire spread and hampered firefighting efforts in the event.

MAT RECOMMENDATIONS

The MAT uses observations to draw conclusions and make actionable recommendations. The conclusions and recommendations presented in this report are based on the MAT’s field observations; evaluation of relevant codes, standards and regulation; as well as information gathered from interviews with first responders and subject matter experts. They are intended to guide homeowners and building owners, community planners, design professionals, contractors, state, local, tribal and territorial (SLTT) officials, building code professionals, and standards organizations. Some additional recommendations are directed to FEMA and other industry partners. Chapter 6 provides detailed information on the conclusions and recommendations, including a

summary table. The recommendations have been summarized and grouped into overarching concepts here:

- **Holistic Wildfire Resiliency** – Recent events have highlighted that a more holistic approach to wildfire resiliency is needed. Actions can and should be taken at the **Community** level, **the Neighborhood/Subdivision** level, and at the individual **Parcel/Building** level. Actions must be taken at all levels for disaster preparedness, planning, response, mitigation, and recovery especially for the wildfire hazard.

    - **Community -** Community planners, officials, developers, and residents also need to understand the relationship of their community to the surrounding area in the context of wildfire. Large scale landscape management and fire suppression needs should be considered including establishing and maintaining fuel breaks, managing community open spaces in-house or through contracted landscapers, and ensuring sufficient evacuation routes are available and well-marked. Local hazard mitigation plans should address wildfire risk and actions for the community as well as those required at the **Neighborhood/ Subdivision** and **Parcel/Building** levels. As evidenced with the Marshall Fire, dry grasslands in combination with high winds and inconsistent implementation of WUI practices at various scales in the built and natural environment can pose a significant threat.

    - **Neighborhood/Subdivision** - Building owners, developers and design professionals need to incorporate natural hazard mitigation, especially for the wildfire hazard, when designing neighborhoods and subdivisions in striving for the perfect balance between economics and risk. There are many well-known practices and resources available. In many cases, the MAT observed spacing of 10–15 feet between houses. With this type of spacing between homes, it is important for entire neighborhoods to undertake mitigation actions. Similarly, community planners, designers, and engineers need to consider natural topography effects on wildfire and potential unintentional effects mitigation for one hazard can have on another.

    - **Parcel/Building** - Much research has been completed and communicated focusing on building and parcel level mitigation and this remains an important area of focus. The MAT observed several instances of houses that had been hardened and established defensible space that survived, while houses around them burned to the ground.

All levels of action should include evaluation, customization, and adoption of model codes for wildfire by the appropriate Authority Having Jurisdiction (AHJ). See Building Codes and Standards recommendation below.

- **Standardized Wildfire Terminology and Public Education** - The Marshall Fire highlighted how the public perception of wildfire and wildfire risk differs from the accepted definitions understood by experts. The WUI is perceived as the forested mountain and canyon areas. Current terminology needs to be updated, expanded, and socialized into a suite of definitions used to define wildfire risk. This can be used universally and be better understood by the public, so awareness of risk is increased especially as the wildfire risk expands into urban areas due to climate change. Federal

agencies may want to agree upon some additional terms to help distinguish between different areas subject to wildfire risk. Public education materials should be enhanced with visual aids to clearly communicate wildfire, wildland, and WUI concepts.

- **Wildfire Hazard and Risk Considerations** – Creating nationwide consensus-based wildfire risk maps that link to building codes, zoning and mitigation actions at building, neighborhood and community-scales will help agencies, planners, builders, design professionals, and property owners not only to understand wildfire hazards and risks, but also what actions, policies and programs should be taken to help mitigate that risk. This would align with how other natural hazard like wind, seismic and flood risk addressed.

- **Building Codes and Standards** – While there are multiple recommendations related to building codes, they generally can be summarized in a few categories.

    - **Property Protection and Survivability** – Recognizing that building codes are written to address life-safety concerns, this event highlighted that firefighting resources can be stretched very thin such that they cannot defend all properties that are threatened. However, most people have an expectation or a desire that their home or building should be able to survive a wildfire especially in suburban and urban areas. A second performance objective for building codes should be developed to address the ability of a building to survive a fire without defensive actions. There are many validated and widely accepted passive mitigation actions that can be taken. Communities could adopt a version of the International Wildland-Urban Interface Code (IWUIC) that most closely meets their needs and expectations. Additionally, some simple code revisions in the International Code Council (ICC) parent codes, the International Building Code (IBC), the International Residential Code (IRC) and the International Existing Building Code (IEBC) should be considered for the non-designated WUI areas as the wildfire risk expands into urban areas due to climate change.

    - **Wildfire Resiliency at Scale** – The IWUIC currently addresses mitigation mostly at the building and parcel levels. As discussed in the Holistic Wildfire Resiliency recommendation above, multiple levels of action must be leveraged. The IWUIC should be expanded to include mitigation at multiple scales to provide a more holistic approach to wildfire risk mitigation, which is particularly important in suburban areas like the Boulder/Louisville/Superior area.

    - **IWUIC: Close Known Gaps and Integrate of Latest Research** – The IWUIC currently includes requirements that are not consistent with the latest wildfire research (e.g., such as for vent screens and decks). The IWUIC, other state WUI codes and testing standards have numerous gaps in wildfire-specific requirements on various building components, systems, and details. The IWUIC should be updated to align with these research findings.

    - **Incorporate IWUIC into ICC Parent Codes by Reference** – Incorporating the IWUIC into the IRC and the IBC by reference would promote stronger wildfire code compliance in high-risk areas.

- **Statewide Building Code Adoption Including IWUIC**– The MAT recommends adopting a statewide building code to provide a standard basis for all jurisdictions in the state. This helps with providing mutual aid in addition to providing a uniform level of safety and hazard resistance across jurisdictions. This approach also would allow the State to meet FEMA's State Mitigation Planning Policy guidance to address building codes in all standard hazard mitigation plans and for enhanced plans to develop a strategy for statewide building code adoption and implementation.

Chapter 1: Introduction

The *Marshall Fire was the most destructive wildfire incident in Colorado history—approximately 6,000 acres were burned, over 1,000 buildings destroyed, and over $510 million in damages*.[2]

The Marshall Fire was a wind-driven wildfire that started on December 30, 2021, shortly before 10:30 a.m. MST in Boulder County, Colorado. While the official cause of the fire is still unknown, the fire is believed to have started from multiple ignition points leading to a grass fire in a neighborhood off State Highway 93 and Marshall Road. The fire then rapidly spread to the Town of Superior and later toward the cities of Louisville, Broomfield, and unincorporated Boulder County due to high winds with recorded gusts of up to 115 mph. By 5:00 p.m. MST the fire had spread to an estimated 1,600 acres, increasing to 6,200 acres by 10:00 a.m. MST on December 31, 2021.

Noteworthy Marshall Fire Metrics

- Unusually humid spring with above average growth of grass, followed by unusually warm and dry summer/fall and then lack of snow prior to incident.
- Recorded wind gusts of up to 115 mph (NWS, 2022).
- Most destructive wildfire in Colorado history, with an estimated $500 million in damages (Phillips, 2022).

In response to a request for technical support from FEMA's Region 8 Office in Denver, Colorado, FEMA's BSDS Program deployed a Pre-Mitigation Assessment Team (Pre-MAT) to Colorado in January of 2022 to collect perishable data and undertake a preliminary evaluation of the performance of residential and commercial buildings during the Marshall Fire. As a result of the Pre-MAT observations and the unique nature of the event, FEMA deployed a full MAT to the area in August 2022 to conduct interviews and collect additional data.

The objective of this MAT report is to provide actionable recommendations to improve residential building performance under wildfire conflagration conditions. It describes the MAT's observations during the field deployments, draws conclusions based on those observations, and provides recommendations for actions that property owners can take to help increase the resiliency of their homes and neighborhoods to future wildfires. It also provides recommendations that local government officials, planners, builders, design professionals, and homeowners' associations can implement to reduce the potential impacts of wildfires on communities and improve their resilience.

This MAT report also considers the multi-hazard nature of events, such as the Marshall Fire, which had a strong interaction between wildfire and wind. Field observations also noted a relationship between wildfire and natural- and man-made flood control systems, primarily drainage ditches, which served to rapidly propagate and intensify wildfire behavior from the wildland/open spaces into and

[2] *Boulder County 2022-2027 Hazard Mitigation Plan*

within suburban communities. Mitigation strategies for this (and other future) events require a multi-perspective approach that considers the interplay between various hazards and addresses them collectively.

Some of the topics evaluated by the MAT include building and fire codes and standards; vulnerabilities of structural elements and systems to wildfire, structure spacing, smoke and ash infiltration; defensible space; and management of parks and common spaces. Wind played an important role in the spread of the fire, accelerating the movement of flames, hot gases, and embers across open space and then quickly into suburban neighborhoods. Though wind-related damages to buildings were observed only sporadically, it is likely that wind-borne debris caused impact damage to the exterior envelop of buildings, particularly through glazed openings, increasing the vulnerability of those structures to embers, hot gases, and flames entering the structures directly. Also noted was the role of combustible non-structural attachments such as wood fences and decks, which provided fire pathways leading to the structure.

This was the first opportunity for FEMA's BSDS program to deploy the MAT to assess building performance following a wildfire. It draws collaboratively from other efforts to study the Marshall Fire, including those of the Geotechnical Extreme Events Reconnaissance Association (GEER), Insurance Institute for Business and Home Safety (IBHS), the ICC, National Institute for Standards and Technology (NIST), and state and local level efforts such as those led by the Colorado Division of Fire Prevention and Control on behalf of the Mountain View Fire Department, Louisville Fire Department, and Boulder County.

This was the first opportunity for FEMA's BSDS program to deploy the MAT to assess building performance following a wildfire. FEMA believed it was important to study this fire because the nature of the origin, weather conditions, and impacts on the built environment in the nontraditional WUI represent risks that need to be better understood by planners, developers, government officials, and the public-at-large.

This fire was unique in that it originated in grasslands/flatlands near a heavily populated area and traditional suburban developments. High winds quickly spread the fire closer to the Town of Superior and City of Louisville as well as parts of Unincorporated Boulder County. FEMA believed it was important to study this fire because the nature of the origin, weather conditions, and impacts on the built environment in the nontraditional WUI represent risks that need to be better understood by planners, developers, government officials, and the public-at-large. Most people believe that wildfire risk is generally limited to heavily forested areas. It is important to convey that wildfires can occur in any vegetated area and spread by ground, wind, or both to populated areas.

1.1. Organization of the Report

This MAT report is divided into six chapters and four appendices.

- Chapter 1 (this chapter) provides an introduction to this report including objectives, the organization of the report and fire basics such as terminology and history. It also discusses an overview of Boulder County and a history of recent wildfires in the area.
- Chapter 2 discusses the Marshall Fire event including its impacts and extent as well as the MAT background and process.
- Chapter 3 presents the wildfire regulatory mechanisms including building codes, standards and regulations that were in effect at the state and local levels at the time of the fire, and updates made to state and local codes and standards since the fire occurred. It also provides an analysis of conflicts between and omissions from some of the primary codes and standards that are used to protect buildings against wildfire.
- Chapter 4 describes the MAT observations at the community and neighborhood scale related to land use planning and neighborhood design, management of parks, and other common spaces. It also provides best management practices and recommended plants.
- Chapter 5 describes the MAT observations at the parcel and building scale related to the performance of primarily residential but also some non-residential buildings and appurtenant structures exposed to the fire, smoke and ash infiltration, vulnerabilities associated with defensible space, and structure fire separation distances.
- Chapter 6 presents the MAT's conclusions and recommendations and is intended to help guide recovery efforts for communities impacted by wildfire as well as planning and preparedness efforts for communities susceptible to wildfire. It provides strategic recommendations to improve codes and standards, community planning and design, and construction guidance.

In addition to the report chapters, this report includes the following appendices:

- Appendix A: Acknowledgements
- Appendix B: Bibliography
- Appendix C: Glossary
- Appendix D: Homeowner's Guide to Risk Reduction and Remediation of Residential Smoke Damage
- Appendix E: Homeowner's Guide to Reducing Risk of Structure Ignition from Wildfire
- Appendix F: Homeowner's Guide to Reducing Wildfire Risk Through Defensible Space
- Appendix G: Decreasing Risk of Structure-to-Structure Fire Spread in a Wildfire
- Appendix H: Mitigation Strategies to Address Multi-Hazard Events
- Appendix I: Best Practices for Wildfire-Resilient Subdivision Planning
- Appendix J: Wildfire-Resilient Detailing, Joint Systems, and Interfaces of Building Components

1.2. Wildfire Basics

Wildfires are a natural part of many of Earth's wildland ecosystems and play a number of important roles in maintaining healthy forests, including clearing out understory biomass, providing soil nutrition, controlling invasive species, and supporting ecological cycles (Bowman, 2009). Humans have not only used fire to shape the landscape and support numerous survival needs, but also sought to suppress fires that threatened their homes and towns. The federal government's approach has evolved from suppressing all fires on forested lands to recognizing fire as an ecological process, using prescribed fire, as well as more preparation, collaboration, and oversight.

Fundamentally, three ingredients are necessary for fires to occur (aka "the ignition triangle"): oxygen, which starts and sustains combustion; heat, which raises the fuel temperature or simply heats fuel to its ignition point; and fuel, which sustains and carries flames. Eliminating or reducing one or more of these components is the basis of fire mitigation and suppression techniques.

Wildfires, however, are more complex and challenging than the ignition triangle. The nature of the wildfire problem is a product of natural and/or man-made ignition sources, vegetative fuels, topography, weather, and characteristics of the built environment (e.g., building typologies, urban fuel loads, density). Understanding how these factors interact, along with fire history, fire ecology, climatology, and human interactions with these various facets, is central to developing appropriate and effective mitigation strategies.

Each year only a small fraction of wildfires become large enough to result in significant negative impacts. These low percentages can be attributed to a combination of favorable environmental conditions, limitations in adoption and/or implementation of WUI codes and standards, limited knowledge of wildfire hazards/risks, limited resources for retrofits, increasing construction in high wildfire areas, availability of firefighting resources to effectively respond to fire incidents especially during the incipient stages of fire development, and the evolution of the risk. Refer to Sections 1.3.2 and 1.3.3 for additional details and specifics about the wildfire environment in Boulder County.

- **Weather** – is the most variable element of the wildland fire environment. Important components of fire weather that influence wildfire behavior are temperature, relative humidity, precipitation, wind, and atmospheric stability. All these elements have the potential to enhance or retard wildfire spread and intensity.

- **Vegetation** – is the primary fuel source for wildfires and, along with weather, is a key factor in determining the risk of wildfire hazards. In the WUI, both wildland vegetation and urban fuels present a hazard. Urban sources of fuel such as combustible structures (e.g., houses, businesses, industrial facilities, outbuildings), combustible non-structural features (e.g., decks, fences, ornamental landscaping), vehicles, fuel tanks, etc., can contribute to the fire environment and significantly influence the fire behavior and overall hazards. Locally, the abundance of non-native trees and shrubs used as landscaping vegetation and screening has a negative effect on the overall wildland fire environment. Thus, linking the potential risk of a large-scale, destructive wildland fire to the adjacent vegetation and associated characteristics.

- **Topography** – is the configuration of the earth's surface and is the most stable of the elements in the fire environment. Topography significantly impacts wildfire behavior as it influences local winds by sheltering areas from prevailing winds or channeling winds through prominent canyons and drainages. Factors of topography that affect fire behavior include slope, aspect, terrain features, and elevation with the steepness of slope being the most influential.

There are many terms that carry specific meaning in the context of wildfire. This section provides a few key definitions and explanations of some of these terms as they are used in this MAT report. A more comprehensive glossary is in Appendix C for reference. The majority of these definitions come from the National Wildfire Coordinating Group's (NWCG's) online glossary[3], other nationally recognized fire organizations and from existing FEMA terminology.

- **Conflagration** – A large destructive fire that causes substantial destruction (National Fire Protection Association (NFPA) 101®, Life Safety Code Handbook).
- **Wildfire** – A wildfire is an unplanned, unwanted fire burning in a natural area.
- **Wildland** – A natural environment that has not been significantly modified by human activity.
- **Wildland-Urban Interface** (WUI)– The line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetation fuels.

1.2.1. EVOLUTION OF RISK

Over the last 35 years, the number of reported wildfires has stayed the same but more have become catastrophic events measured in more than just acreage. Lives lost, property damage, and post-fire impacts such as landslides, flash floods, and mudslides are elements of wildfire impacts to individuals and communities.

Changes in climate, development patterns and the slow development and adoption of wildfire safety codes, standards and practices are exacerbating the impacts of wildfire threats in the U.S. Many parts of the western U.S. are experiencing reduced precipitation, warmer spring and summer temperatures, and longer, drier fire seasons (Westerling and Bryant, 2008). While other parts of the U.S. that have not historically suffered from major wildfire threats (e.g., Eastern U.S.) are likely to increase in susceptibility as the impacts of climate change are resulting in environmental conditions (e.g., increases in drier, warmer weather, longer droughts, insect infestation) that increase the likelihood of wildfire ignitions (U.S. Global Change Research Program, 2018).

The boundary or interface between urban and wildland development is a very dynamic element that shifts every year. As more people move into wildland areas, the relative wildfire risk dramatically increases due to the higher consequence of having more people and property exposed to the wildfire hazard. The population living in the WUI has grown significantly; from 1990 to 2010, the WUI had the

[3] https://www.nwcg.gov/publications/pms205

largest rate of growth compared to any other land use type. During this time, there was a 41% increase in houses and a 33% increase in the land area considered to be within the WUI. These trends underline that there are not just more severe wildfires, but more development and more people living in wildfire-prone regions and areas that could be prone to wildfires in the future.

1.2.2. THE EVOLVING DEFINITION OF THE WILDLAND-URBAN INTERFACE

The WUI is often defined as a transition area where unoccupied land and human development meet. Historically, the WUI has been primarily associated with the intersection of uninhabited wildland (primarily perceived as forested areas) with human development. This perception has led many people who live in suburban and urban areas "near the WUI" to believe they are not at risk from wildfire because they are not specifically at the interface of wildlands, or they live adjacent to large open spaces of primarily grass and shrublands (instead of forestlands).

The National Wildfire Coordinating Group (NWCG) (2009) defines the WUI as the "line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetation fuels."

A common misperception of the WUI is that it occurs only near forested areas. Grasslands and shrublands can also be in the WUI.

As environmental conditions continue to change the landscape and as human development continues to expand into vegetated areas near what has traditionally been deemed the WUI, it has been identified that the definition of "interface" may need to change or terms such as "intermix" and "occluded"[4] may need to be better socialized to convey wildfire risk to communities.

Interface – The interface community exists where structures directly abut wildland fuels.

Intermix – The intermix community exists where structures are scattered throughout a wildland area.

Occluded – The occluded community generally exists in a situation, often within a city, where structures abut an island of wildland fuels (e.g., park or open space).

A more comprehensive glossary is in Appendix C for reference.

Figure 1 illustrates the range of WUI conditions and associated terminology where wildlands and the built environment intermingle. As this continuum moves from the natural environment to urban, town centers, the associated wildfire hazards and risks posed to structures and people inherently shift and thus necessitate different strategies to reduce these risks.

[4] as defined by the U.S. Forest Service, Bureau of Indian Affairs, Bureau of Land Management, Fish and Wildfire Service and National Park Service in the Federal Register on January 4, 2001, or from CAL FIRE

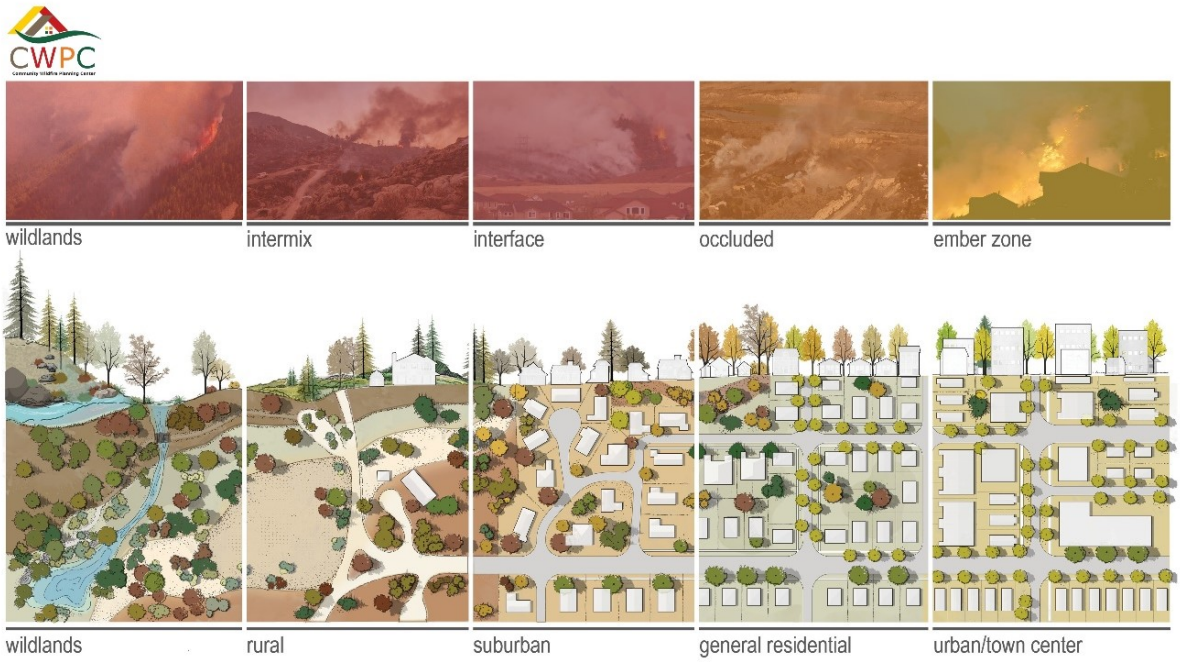


Figure 1. Communicating a continuum of environmental conditions will allow planners, engineers, community officials, and residents to better understand their wildfire risk (Image courtesy of Community Wildfire Planning Center).

Numerous agencies and organizations, including the U.S. Forest Service (USFS), the State of California, the State of Washington, the State of Oregon, and NIST, have already established more comprehensive and substantive definitions for the WUI to encompass the broad range of environmental settings (e.g., topography, vegetation, weather) and built environment conditions (e.g., rural, semi-rural, urban, building typologies) where wildfires pose a major threat. Wildfire/fire safety professionals and the industry need to continue to provide ongoing educational tools, resources, and public awareness campaigns to reinforce and contextualize existing definitions that are relevant to specific regions, communities, and neighborhoods. This includes mainstreaming the definitions of the wildland-urban interface and intermix with broader vegetative categories such as grasslands and shrublands, such that the general public as well as planning and design professionals (e.g., planners, architects, and engineers), contractors, and government officials have a clearer understanding of the potential risk of their community to wildfire. Based on this understanding, they can then take the necessary steps to mitigate these risks.

Currently the evolution is occurring around the need for consensus-based wildfire hazard and risk maps. Various forms of wildfire hazard and risk mapping layers have been developed by some state and federal agencies to address a variety of applications (e.g., land use management); however, a national consensus-based wildfire risk map for community planning and wildfire building safety does not currently exist. Current practices in assessing wildfire risks to the built environment are not based on risk-informed approaches analogous to other hazards (e.g., seismic, wind), where recurrence intervals and damage potentials are quantified at the national level.

In 2021, Congress passed the Wildland Fire Mitigation and Management Commission Act including the formation of the Wildland Fire Mitigation and Management Commission[5]. The commission is tasked with forming federal policy recommendations and strategies on ways to better prevent, manage, suppress, and recover from wildfires. This commission and its' workgroups are currently exploring needs and opportunities that could drive actions regarding how we assess and communicate wildfire risk.

1.2.3. MULTI-HAZARD WILDFIRE INTERACTIONS

Wildfire behavior is largely influenced by fuel, weather, and topography but other natural hazards can also influence wildfire behavior and severity. For example, lightning is a common ignition source for wildfire, especially in conditions of low relative humidity and abundant dry fuels. Extreme heat can work in tandem with drought to increase the volume of dry fuel available for ignition. High winds can increase the speed with which wildfires travel, help spread embers to ignite new fuel sources, and hinder fire suppression efforts.

In turn, wildfires can influence the severity and behavior of other natural hazards. In post-fire conditions, the significant loss of vegetative cover and erosion control can increase the risk of secondary natural hazards, such as floods, landslides, and debris-flows in and downslope of burned areas. These post-wildfire hazards often have cascading effects on the local natural and built environment, including incursions of invasive species, loss of watershed function, as well as impacts to critical infrastructure, buildings, and people.

For the purposes of this report, wildfires that occur in combination with other natural hazards are considered "multi-hazard wildfire events." The natural hazards that make up a multi-hazard wildfire event along with wildfire are lightning, drought, extreme heat, high wind, flood, and landslide (see Figure 2).

[5] https://www.usda.gov/topics/disaster-resource-center/wildland-fire/commission

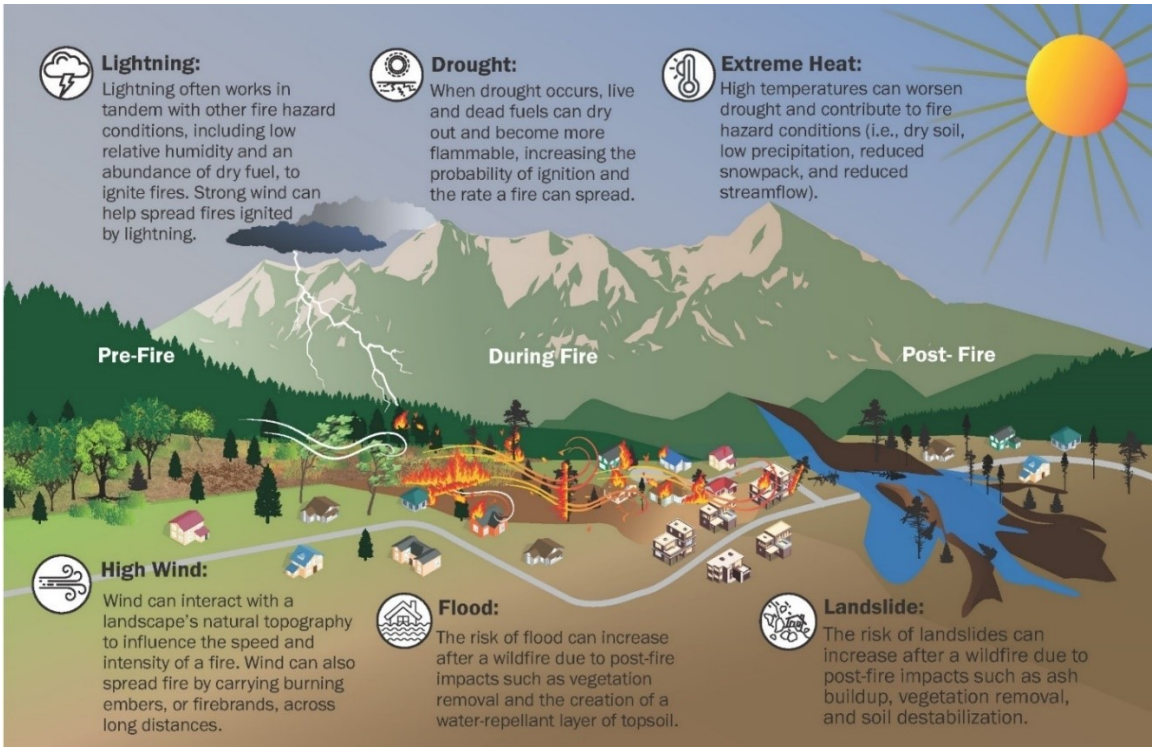


Figure 2. Multiple hazards can contribute to or result from wildfires.

Wildfire mitigation strategies are evolving to keep pace with a changing climate and an expanding definition of wildfire risk. For example, the federal interagency NWCG is incorporating new science on the impact of drought and wind into fire personnel training (Schmidt, 2023). Consideration of wildfire as a "multi-hazard event" is not currently standard practice in wildfire mitigation and is an area of developing research.

1.3. Overview of Boulder County, Colorado

Boulder County covers approximately 740 square miles northwest of Denver (Figure 3). The western two-thirds of the county are generally mountainous and forested, while the eastern one-third is dominated by gently rolling hills and grasslands. Boulder County is home to over 300,000 people, most of whom live in the eastern one-third of the county. Incorporated towns and cities include Boulder, Erie, Jamestown, Lafayette, Longmont, Louisville, Lyons, Nederland, Superior, and Ward. The Boulder County 2022-2027 Hazard Mitigation Plan notes: "Most of the County is susceptible to wildland fires, with highest risk areas located in the Front Range Foothills in the central portions of Boulder County" (Boulder County, 2022).

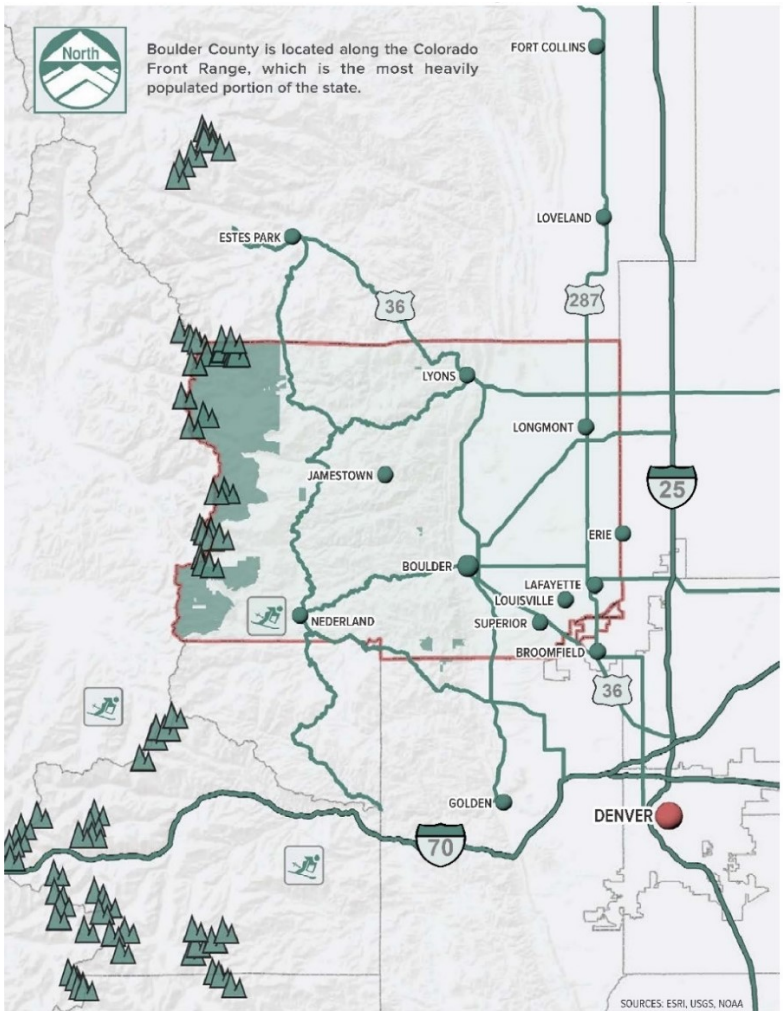


Figure 3. Boulder County Location Map (Boulder County Comprehensive Plan, 2020).

Locations in the Colorado Front Range region, including portions of Boulder County, are categorized in American Society for Civil Engineers (ASCE) 7-16 *Minimum Design Loads and Associated Criteria for Buildings and Other Structures* (ASCE, 2017) Section 26.5.2 as "special wind regions" meaning that those topographic areas have the potential to be hazardous due to wind. Wind contour maps for the special wind regions are available to determine design wind speeds that are specially produced and adopted by local jurisdictions in Colorado. Adopting the latest wind-related building codes and standards are important to ensure that new or retrofitted buildings will resist higher wind loads and wind debris to prevent additional damage that could propagate or spread wildfire. Boulder County currently has adopted the 2018 IBC and IRC. Both reference ASCE 7-16 for determining wind loads.

1.3.1. BOULDER COUNTY DEMOGRAPHICS

Table 1 presents U.S. Census data for Boulder County based upon 2019 American Community Survey estimates as well as social vulnerability index (SVI) values. Social vulnerability is quantified by aggregating 16 factors into four themes that summarize how socially vulnerable a region is to a disaster. Social vulnerability refers to a region's ability to prepare for and respond to a disaster

caused by a natural hazard, such as a wildfire, or to human-caused threats. The Centers for Disease Control (CDC) calculates the social vulnerability by census tracts with scores ranging from zero (0) to one (1). Boulder County's SVI score indicates low vulnerability, and the City of Louisville and the Town of Superior SVI scores are categorized as low to moderate vulnerability.

Table 1. Demographic information for the Marshall Fire Area.

Demographic Measure	City of Louisville	Town of Superior	Boulder County	State of Colorado	National Average
Population, 2020	21,226	13,094	330,758	5,773,714	N/A
Population Increase 2010 to 2020	15.5%	15.5%	12.3%	14.8%	7.4%
Median Household Income	$103,017	$127,292	$88,535	$80,184	$71,400
Poverty Rate	5.9%	4.2%	11.7%	9.7%	11.4%
Homeownership Rate	70.6%,	58.2%	61.6%	65.2%	64.6%
Housing Units Constructed after 1990	42.9%	91.9%	40.7%	N/A	N/A
Median Home Value	$677,000	$576,800	$575,500	$397,500	$244,900
*SVI Calculated Value (CDC)**	*0.1384 - 0.3905*	*0.129 - 0.374*	*0.2062*	*N/A*	*N/A*

Sources: 2019 American Community Survey and CDC
**SVI scores from 0 to 0.333 are considered to have low vulnerability; scores from 0.334 to 0.666 are considered to be moderately vulnerable; and scores from 0.667 to 1 are highly vulnerable.*

1.3.2. BOULDER COUNTY WILDFIRE HISTORY

Historically, most wildfires in Boulder County have occurred during peak fire seasons in the summer but major fires have recently occurred in December, January, and February with approximately 64 fires occurring during March of 2011 (Boulder County, 2022), and the Marshall Fire in December. The most notable wildfires in Boulder County are the 1989 Black Tiger Fire, the 1990 and 2009 Olde Stage Fires, the 2003 Overland Fire, the 2010 Fourmile Canyon Fire, the 2016 Cold Springs Fire, and the 2020 Cal-Wood & Lefthand Canyon Fires (Boulder County, 2022, and Boulder County website). Table 2 summarizes major wildfires that have recently occurred in the area prior to the Marshall Fire.

Table 2. Recent Major Wildfires in Boulder County Prior to the Marshall Fire (Colorado State Forest Service).

Event Date	Event Name	Cause	Weather Conditions	Foothills or Flatlands	Number of Acres Burned	Impacts
October 2020	Cal-Wood Fire	Unknown	Red flag warning*	Foothills	600	Damaged 27 properties and destroyed 20 homes
October 2020	Lefthand Canyon Fire	Unknown	Cold and snowy	Foothills	460	Burned brush and timber 1 mile west of the Town of Ward
July 2016	Cold Springs Fire	Campfire	Heavy fuel loads, windy	Foothills	606	1,900 people evacuated; 1,000 homes threatened; 8 homes destroyed
March 2011	Lefthand Canyon Fire	Human (likely vehicle)	Red flag warning*	Foothills	622	223 homes evacuated
September 2010	Fourmile Canyon Fire	Out-of-control burn pile	Dry, windy (up to 40 mph) conditions	Foothills	6,200	168 homes (35% of homes in area) destroyed
January 2009	Olde Stage Fire	Energized power lines snapped	High winds (60+ mph)	Flatlands	3,008	2 homes and 3 barns destroyed
February 2006	Elk Mountain Fire	Discarded fireplace ashes	Dry, windy (wind speed up to 32 mph with gusts up to 44 mph)	Foothills/ Flatlands	600	Grasslands, apple orchard, two farm trucks destroyed
October 2003	Overland Fire	Tree fell on power line	High winds	Foothills	3,500	12 homes destroyed; post-fire debris flow in the Spring
September 2000	Walker Ranch Fire/ Eldorado Fire	Human (likely discarded cigarette)	Drought, high winds	Foothills	1,100	No homes destroyed and no loss of life
November 1990	Olde Stage Fire	Arson	High winds (80+ mph)	Flatlands	3,000	10 homes and 5 outbuildings destroyed

Event Date	Event Name	Cause	Weather Conditions	Foothills or Flatlands	Number of Acres Burned	Impacts
July 1989	Black Tiger Fire	Human (likely discarded cigarette)	Dry/drought, windy	Foothills	2,100	44 homes destroyed

Sources: Colorado Forest Atlas and Boulder County Hazard Mitigation Plan
**Red Flag Warnings: For Boulder County, a Red Flag Warning requires a combination of weather and fuels conditions (as determined by fire management) for any 3 hours or more in a 12-hour period.*

Figure 4 illustrates some of the most recent, large wildfires in Boulder County near the impacted areas of the Marshall Fire as documented in the Boulder County Hazard Mitigation Plan.

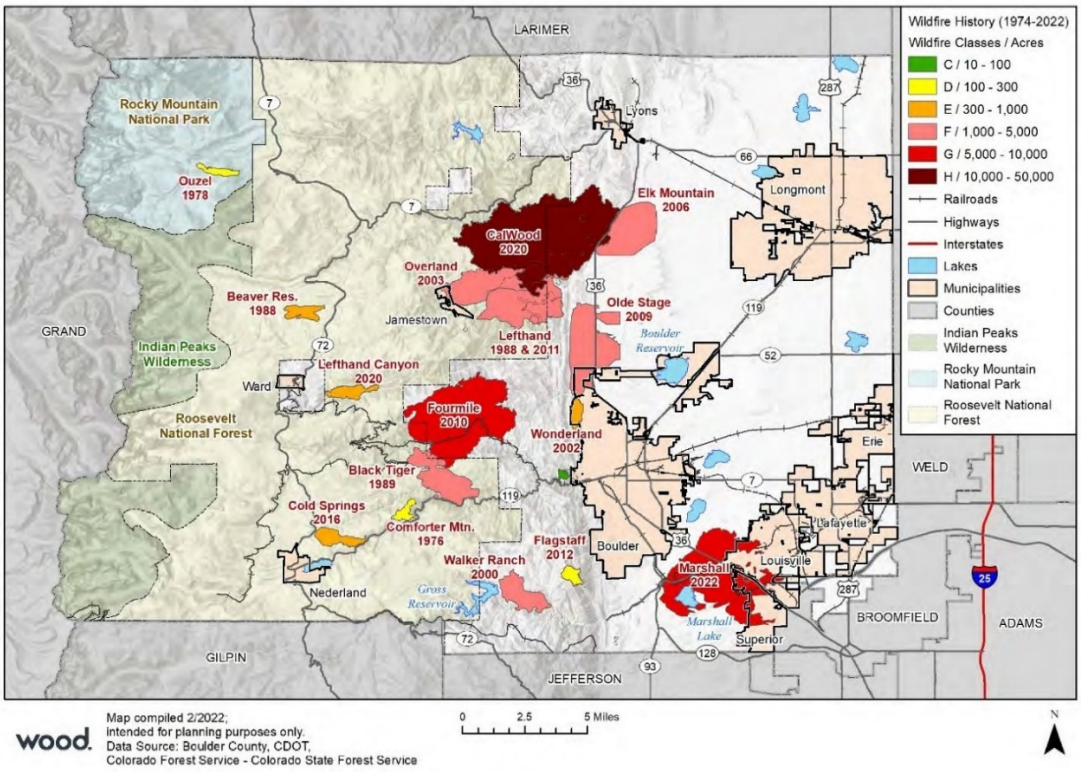


Figure 4. Historical Wildfires in Boulder County (Boulder County Hazard Mitigation Plan, 2022).

1.3.3. BOULDER COUNTY WILDFIRE ENVIRONMENTAL SETTINGS

Wildfires are historically part of Boulder County's landscape (e.g., weather and climate, vegetative coverage, topography) even prior to human development. Due to various land management practices (including fire exclusion and suppression policies), expanding development and human presence, invasive species and climate change, wildfire is increasingly impacting communities within the local WUI.

Boulder County features a range of landscapes and ecosystems. From the plains to the Continental Divide, Boulder County is defined by three distinct forest types or life zones (lower montane, upper

montane, and subalpine), with the mountainous life zones experiencing the majority of historic wildfires (Figure 5). Environmental factors such as aspect (i.e., compass direction that a terrain surface faces), slope, soil type, and fire history all influence where the transitions ("ecotones") between life zones occur in the county. The area of the Marshall Fire occurred in the lower montane ecotone.

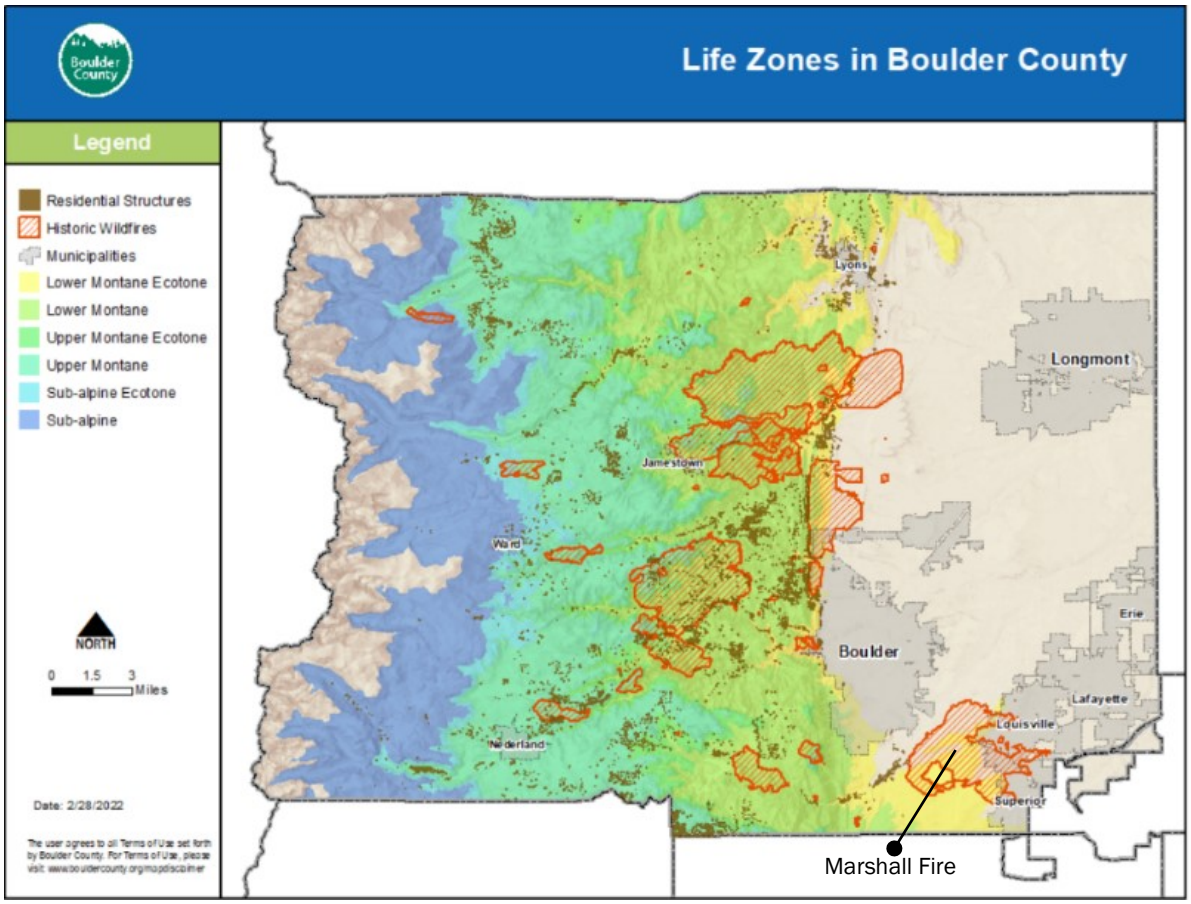


Figure 5. Life zones across Boulder County with past fire history overlay (Boulder County).

Many of Boulder County's residents live in the lower foothills, dominated by ponderosa pine and Douglas fir forests. These forests occupy the lower montane life zone (5,900–8,000 feet in elevation) with a historic fire frequency of 8–30 years. At higher elevations (7,500–9,200 feet), the upper montane life zone has an historic fire frequency of 50–300 years. The highest elevation life zone (at 9,000–11,500 feet), the subalpine life zone, has a historic fire frequency of 300 to more than 500 years (Figure 6) (Boulder County, U.S. Department of Agriculture (USDA) Forest Service).

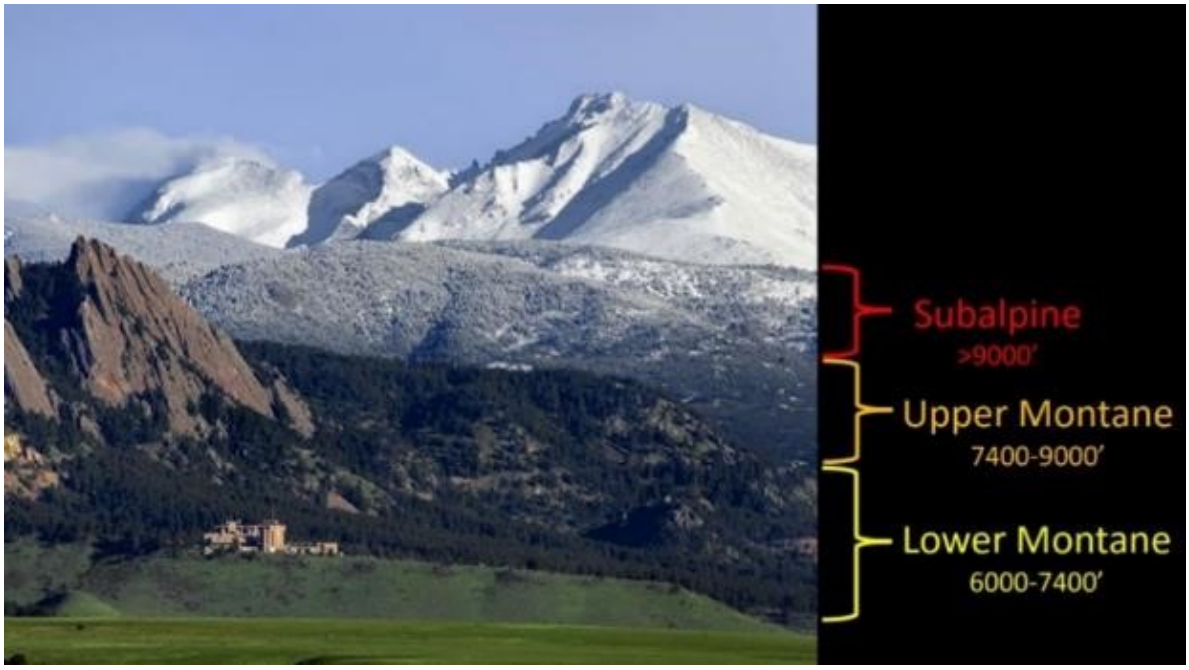


Figure 6. Three main life zones in Boulder County (USDA, Forest Service).

Both the intensity and frequency of historic wildfires can be linked to life zones. In the dry, low-elevation, lower montane life zone, frequent fires have occurred with low to moderate intensity. In contrast, in the moister, cooler, higher-elevation life zones, the less frequent fires were mostly high-severity fires.

According to the Colorado Forest Atlas, the area where the Marshall Fire started and surrounding open/wildland space are considered high wildfire prone areas, ranging from moderate-high, high to high-very high hazard based on burn probabilities (Figure 7). Burn probability is the annual probability of any location burning due to wildfire, assuming high and extreme weather conditions. In Boulder County, some areas are considered "non-burnable" due to the associated fuel type (e.g., water, roads, towns, agricultural areas) and the limitations of current wildfire behavior models[6].

[6] Colorado Forest Atlas, Wildfire Risk Public Viewer, https://co-pub.coloradoforestatlas.org/#/, assessed August 5, 2022.

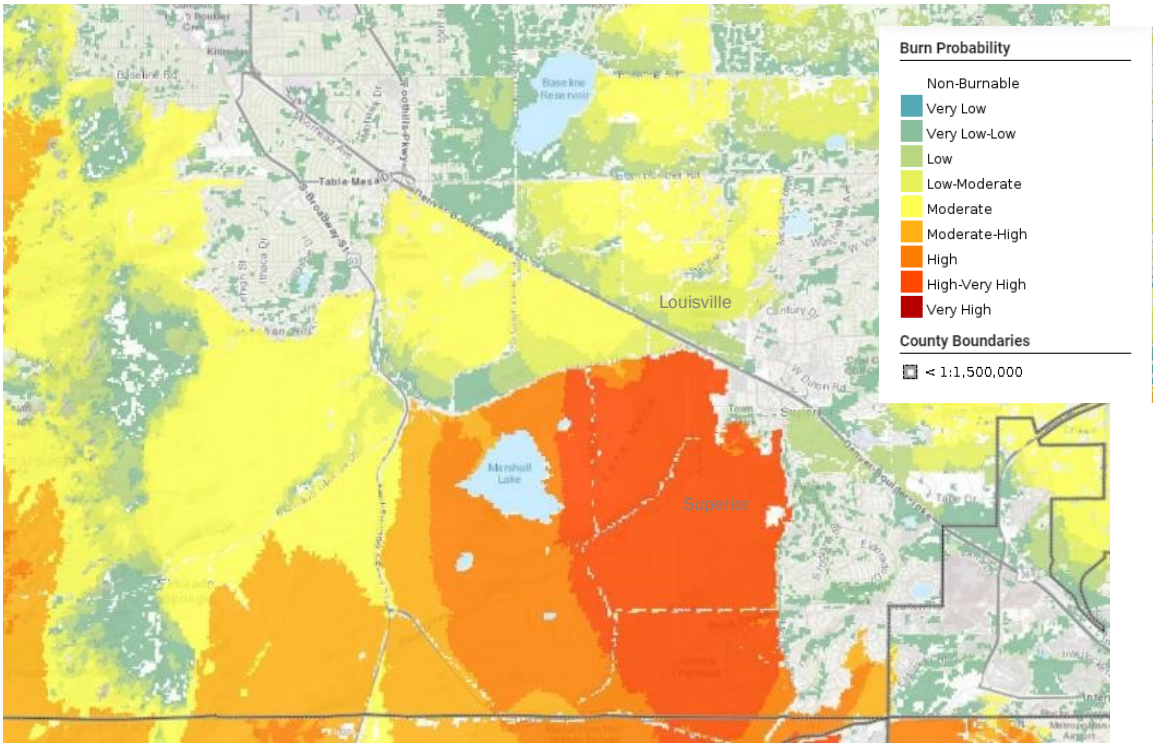


Figure 7. Relative burn probability across Boulder County (Colorado Forest Atlas).

Boulder County Weather and Climate

The climate in the immediate vicinity of the Marshall Fire perimeter is classified as "Humid Subtropical"—temperate, with hot summers and no dry season according to the Koppen-Geiger Climate Classification System. Weather is the most variable element of the wildland fire environment. Important components of weather that influence fire behavior are temperature, relative humidity, precipitation, wind, and atmospheric stability. Each element has the potential to enhance or hinder wildfire spread and intensity. Refer to Section 2.1 for weather conditions during and leading up to the Marshall Fire.

A typical fire season in the region usually does not begin until the herbaceous fuels are cured in late summer and fall. Depending on the amount and timing of springtime rains, this may occur as early as mid-August some years but can lag into September. On average, May is typically the wettest month of the year (3.21 inches) in this area per the Colorado Climate Center[7]. Summers are warm, drying out the living vegetation while also raising surface fuel temperatures. These conditions increase ignition potential and enhance the spread of wildfire. July is the warmest month of the year

[7] https://climate.colostate.edu/normals_stn_select.html

locally, with an average dry bulb temperature of 72°Farenheit. However, temperatures in excess of 85°Farenheit can occur from June through September.[8]

While temperature and precipitation play a key role, wind is the most critical element of the fire environment that influences large fire development and the ability of firefighters to successfully suppress a fire during initial suppression phases. Prevailing winds for summer fire season months in this area are from the west, though high wind events (i.e., gusts of 100-plus mph) in the foothills and along the adjacent plains are not uncommon for Colorado during winter months.

Boulder County Vegetation

Positioned in the foothills-plains of Boulder County, the impacted communities of the Marshall Fire (Superior, Louisville, and portions of unincorporated Boulder County) are primarily developed with the Rocky Flats National Wildlife Refuge to the south, and Boulder County open space to the west. In addition, parks, and open space (e.g., owned natural space, natural space under conservation easements and developed open space) comprise a large percentage of the land area (31% for Superior and 26% for Louisville) creating a mixture of WUI interface and WUI intermix.

The undeveloped lands are largely comprised of agriculture, shrublands and grasslands, as shown in Figure 8. Grassland and shrubland fires are low intensity, fast-burning fires. A main factor determining wildfire behavior is fuel load quantity and quality. Large quantities of fuel elevate wildfire burning potential, and long dry periods enhance flammability and increase wildfire probability in grassland and shrubland wildland ecosystems. Compared to forests, the availability of fuel in grasslands and shrublands is low; however, this fuel is very dry. Therefore, fires are easy to start and spread fast, which is also why they're called "flashy fuels."

[8] https://www.weather.gov/wrh/climate?wfo=bou

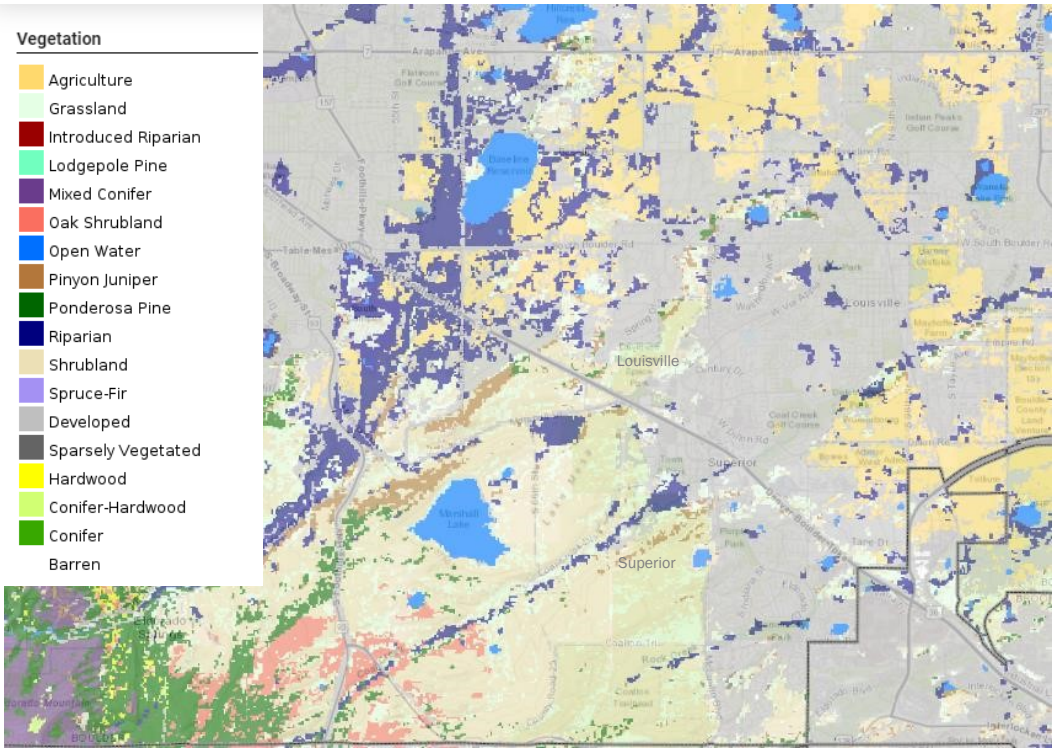


Figure 8. Vegetation map in and around the impacted communities of the Marshall Fire (Colorado Forest Atlas).

Boulder County Topography

As the communities impacted by the Marshall Fire are situated in the foothills-plains of Boulder County, the topography is generally characterized by plains and rolling hills. It provides a distinct transition from the foothills and canyons to much flatter terrain. It is a recognized wind corridor as exhibited by the windmills and National Renewable Energy Labs located here.

Chapter 2: The Marshall Fire Event and Impact

The Marshall Fire occurred on December 30, 2021, in Boulder County, Colorado. It was the state's most destructive fire to date and was declared by the National Ocean and Atmospheric Administration (NOAA) as a billion-dollar disaster (NOAA NCEI, 2022). Several factors have been attributed to its devastation: extreme winds, long term drought, unseasonably high temperatures, and limitations in existing wildfire safety and planning regulations.

The fire started near Marshall Road and Colorado Highway 93 during the morning of December 30, 2022 and moved quickly east due to strong mountain wave gusts and dry grassland fuels (National Weather Service (NWS), 2022). Though the exact cause of the fire remains under investigation, time-stamped dispatch reports, radar images, and personal accounts provide a timeline of events (See Figure 9). Sources pinpointed the origin to an area west of Marshall Lake, but once lit, winds carried embers and flames across open land and into densely populated areas (Scott, 2022).

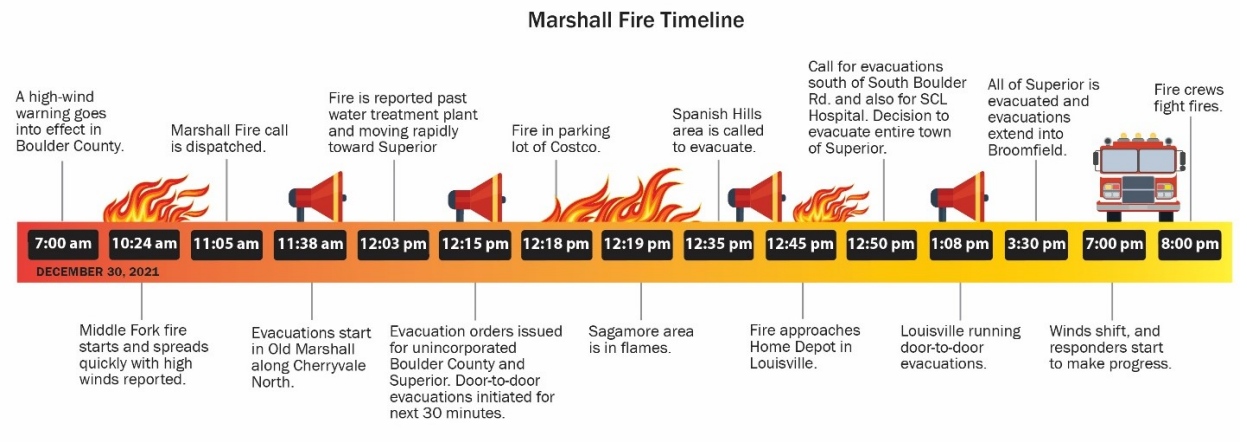


Figure 9. Marshall Fire Timeline Overview.

2.1. Marshall Fire Weather Conditions

Two environmental conditions have been tied to the start and spread of the Marshall Fire: drought and high winds. The combination of an unusually wet spring followed by significant drought during the second half of the year provided "perfect" environmental conditions that increased the likelihood of ignition and rapid spread of the fire. The first half of 2021 had higher than normal rainfall, spurring vegetation growth, particularly annual and perennial grasses, and other low-lying vegetation, which are easily ignitable and fast-burning fuels. A persistently dry pattern lasted through the fall and into winter of 2021 (GEER, 2022). Specifically, "in Denver, Colorado there were 1.92 inches of precipitation recorded between June 1 and December 30, which is the lowest precipitation level since 1939" (GEER, 2022; NWS, 2022). It is reported in the area impacted by the Marshall Fire that higher-than-normal temperatures combined with low precipitation levels caused drought conditions

beginning in October 2021, and by December 2021, extreme drought conditions prevailed (GEER, 2022; NWS, 2022). Between July 1 and December 29, a day before the fire, the area temperatures averaged 60.3° Fahrenheit, the second warmest temperatures ever recorded in that time period (NWS, 2022).

On December 30, there was a windstorm within the area and a High Wind Warning was officially issued. Atmospheric pressures on the east side of the Rockies plummeted, leading to strong downslope winds (GEER, 2022). Sustained winds persisted throughout the day at 50 to 60 mph, with gusts up to 100 mph recorded along Highway 93 and a gust of 115 mph recorded just east of the intersection of Highway 93 and Highway 72. These gusts extended eastward up to and around Superior and Louisville. These strong, sustained winds helped move the fire front at a rapid rate (GEER, 2022). From the National Weather Service's analysis of the event, "high winds developed in the mid-morning hours on Thursday, December 30, 2021, the result of a mountain wave that developed as very strong westerly winds raced over the Front Range Mountains and Foothills and crashed down onto the plains" (NWS, 2022).

On December 30, winds were hitting the continental divide from the west, known as cross barrier flow. Further, there was a stable layer of air near the mountaintops, which forced a wave. When the wind hit the Rockies, it was forced up, but because of the stable layer of air near the top, the air was blocked and forced back down, creating a wave effect (Stein, 2021). Also, on that day, there was minimal wind shear, meaning there was very little change in wind speed as one moved up in the atmosphere (Stein, 2021). The stable layer and lack of wind shear that were in place that day played a key role in strengthening the mountain wave (Stein, 2021). These three factors—cross barrier flow, a layer of stable air near the mountaintops, and minimal wind shear—were major reasons the Marshall Fire behaved and moved the way it did.

Figure 10 depicts how the strong westerly winds moved down the mountain to the base of the foothills. From there, the winds pushed east into Superior and Louisville before weakening to the east (the jump region) (NWS, 2022). Easterly winds were also observed immediately to the east of the jump area, creating a rotor (NWS, 2022). An abrupt wind shift occurred late that day, sometime between 11:00 p.m., December 30 and 1:00 a.m., December 31. This shift was reported by responding fire personnel and was recorded by nearby weather stations (Colorado Division of Fire Prevention and Control, 2022). The wind shift resulted in cooler, wetter air entering the fire area, slowing the winds which aided fire suppression efforts.

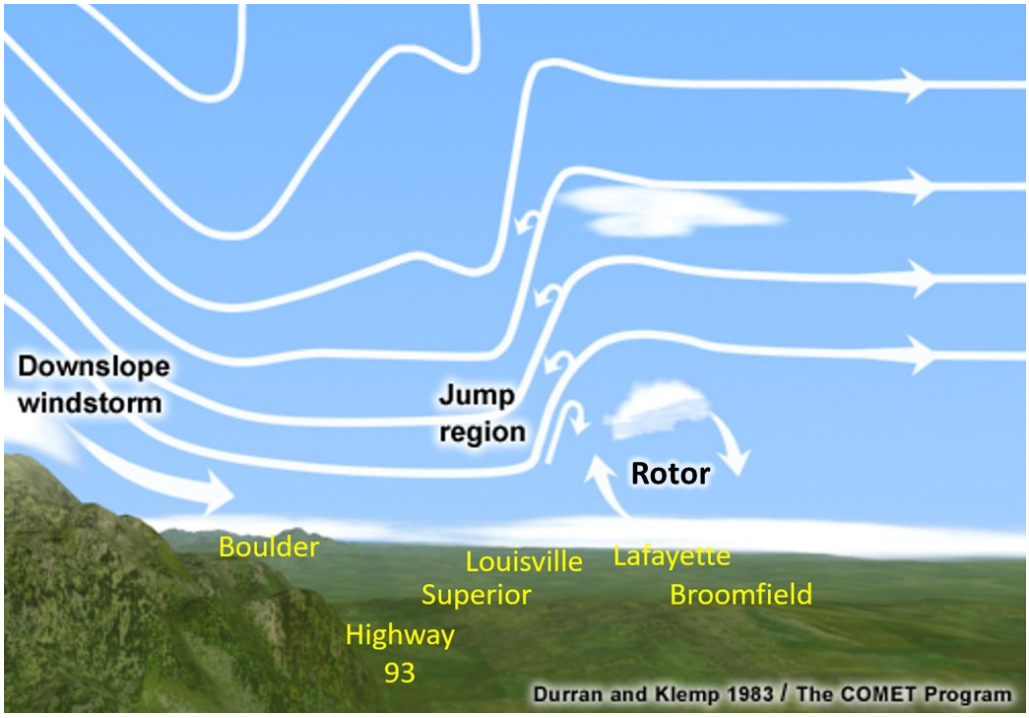


Figure 10. Conceptual model of a mountain wave (NWS, 2022).

2.2. The Marshall Fire as a Multi-Hazard Wildfire

The severity and behavior of the Marshall Fire was influenced by several natural hazards, including high wind and drought. These hazards worked in tandem with unusual weather and vegetative growth, the natural topography of the area, and characteristics of the built environment, including suburban housing density and abundant interwoven green spaces, to propel the fire through Superior, Louisville, and Boulder County communities.

Specifically, high winds combined with the natural topography of the area helped propel the fire (i.e., flames, hot gases, and embers) into communities. It was also observed that many of the impacted houses were adjacent to greenbelts, open spaces, and drainage ditches with an abundance of dry vegetative fuel. Drought conditions combined with unusual weather contributed to the amount of dry vegetative fuel, while the proximity of water collection and diversion features and greenbelts overgrown with vegetation created fuel "superhighways" for the fire to travel. High wind speeds also made the multi-hazard nature of the fire challenging for fire suppression efforts.

2.3. Impacts and Extent

Given the environmental conditions—high winds, unseasonably high temperatures and overgrowth in vegetation—and the inherent characteristics of the built environment, the Marshall Fire had catastrophic impacts on the Town of Superior, City of Louisville, and areas within unincorporated Boulder County. Homes burned at temperatures ranging from 300°Celsius to 900°Celsius (GEER, 2022). Figure 11 shows the extent of the Marshall Fire in Boulder County.

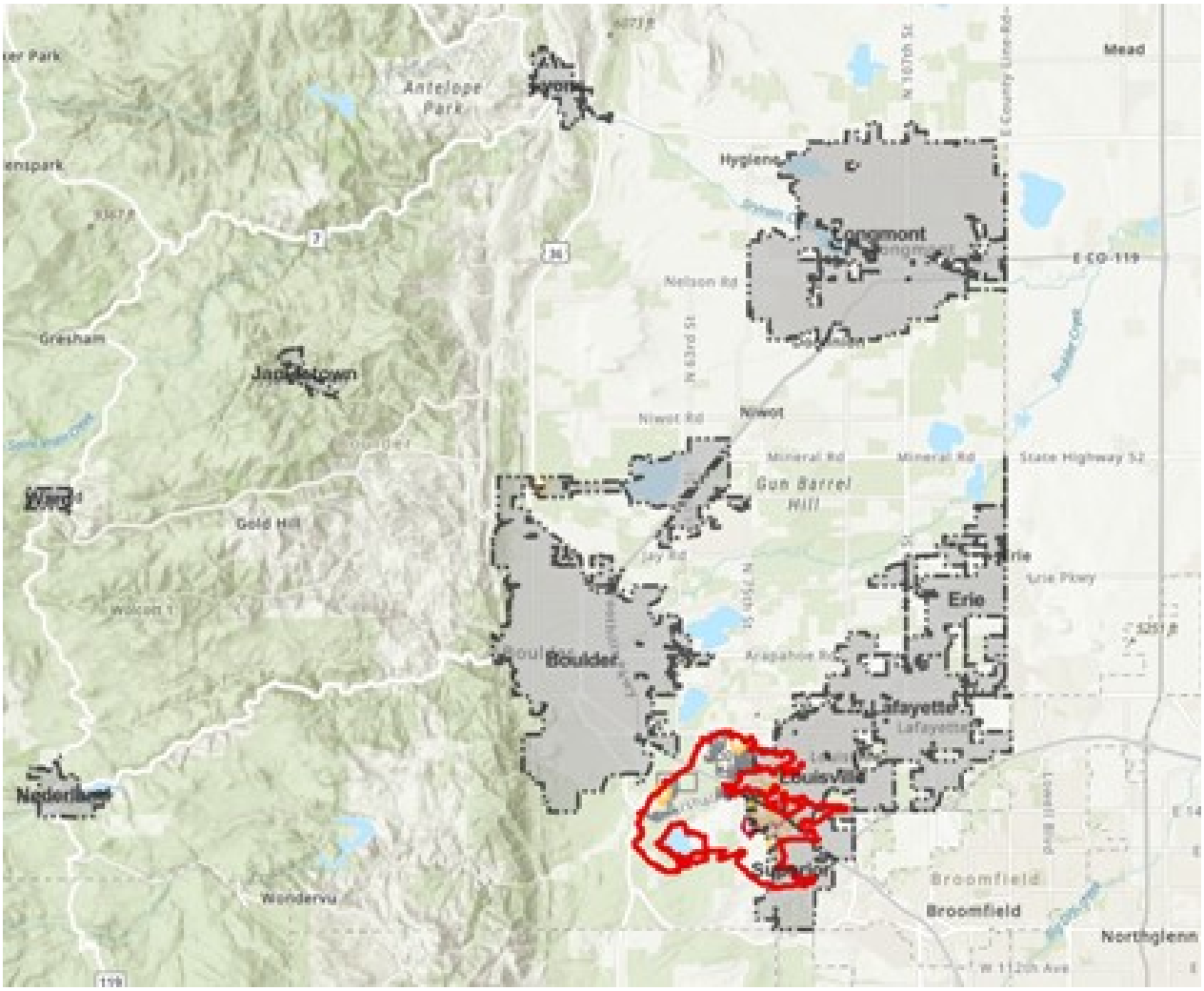


Figure 11. Marshall Fire Extent in Boulder County (Boulder County, 2023).

By the end of the day, over 6,000 acres had burned destroying over 1,000 structures and damaging over 170 additional structures across unincorporated Boulder County, Louisville, and Superior. Of those structures destroyed and damaged, 97% were residential structures. Across the three jurisdictions, the total residential damage exceeded an estimated $500 million (GEER, 2022). As of January 6, 2022, the Boulder County Office of Disaster Management completed a damage assessment of the impacted residential and commercial properties (Figure 12.).

The 2021 Marshall Fire was incredibly intense and consumed over 1,000 houses in Boulder County in less than 4 hours. By contrast, Boulder County lost 200 houses in 18 hours in the Fourmile Fire (2010) and 50 houses in 8 hours in the Cal-Wood Fire (2020).

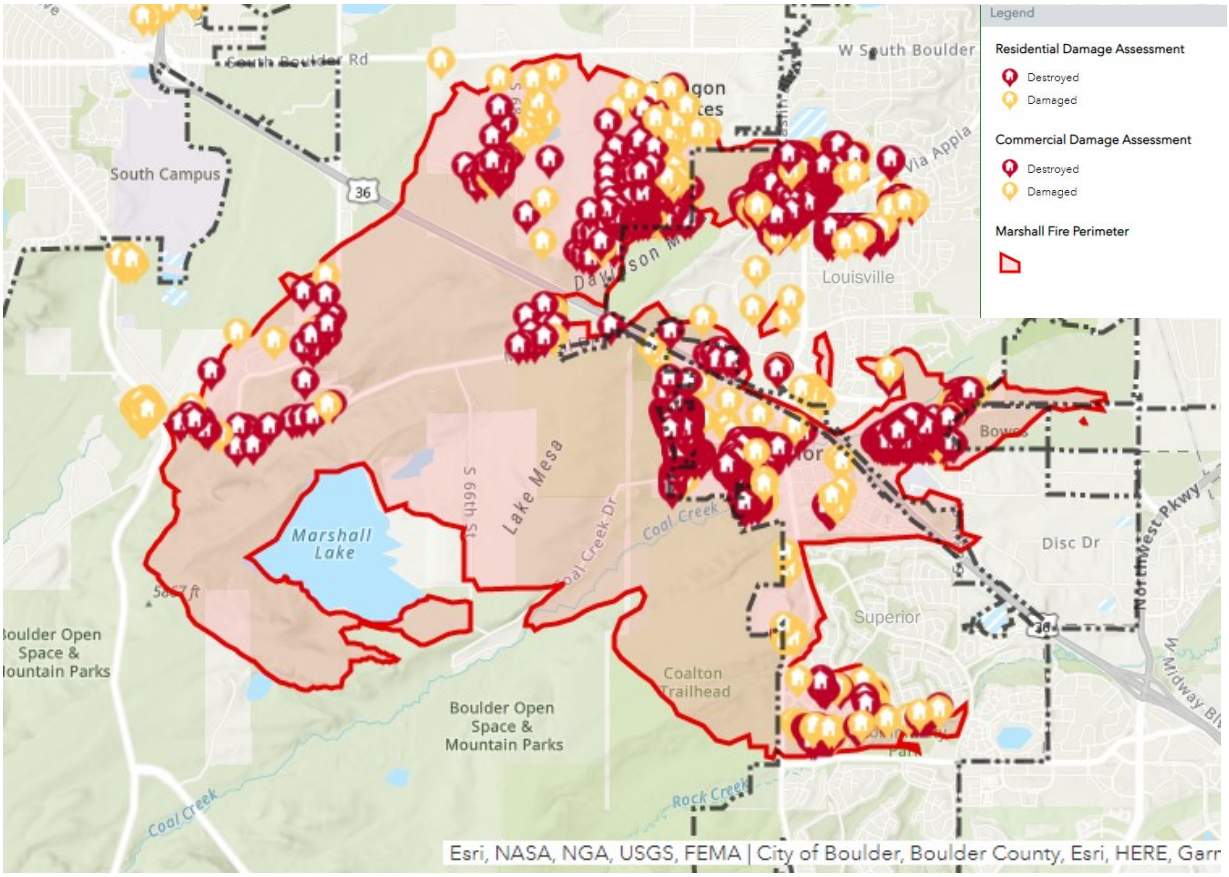


Figure 12. Destroyed (red) and damaged (yellow) structure locations in the Marshall Fire Perimeter (Boulder County, 2022).

Several manufactured home communities in Boulder County sustained substantial damage or were destroyed by high winds that accompanied the Marshall Fire ("Marshall Fire Recovery Milestones", n.d.). Rocky Mountain Public Broadcasting System (PBS) also noted that residents of manufactured homes were vulnerable to cold temperatures when utility companies turned off electricity and natural gas to prevent ignition by power lines (Moore, 2022). Boulder County has developed an Equity Map to identify residents in need of additional recovery aid due to racial or socioeconomic disparity.

In addition to property losses, more than 1,000 households were displaced by the fire. Survivors were eligible for some FEMA assistance, but many reported being underinsured. Many homeowners did not have insurance covering "guaranteed replacement cost" so rebuilding to current code with increased construction costs and supply chain issues presented challenges. The Marshall ROC (Restoring Our Community) was created to support survivors in housing recovery. It is a nationally recognized Long Term Recovery Group (LTRG). They are providing case management support to survivor households, are engaged in long-term community recovery planning, and have partnered

with the Colorado Department of Local Affairs to seek reconstruction funding[9]. As of Spring 2023, hundreds of families are still recovering.

2.3.1. BUILT ENVIRONMENT IMPACTS

The structures affected by the Marshall Fire varied greatly across the damaged areas. The majority of the built environment damaged in the event was residential construction; however, commercial structures were not immune. An estimated 1,084 residential structures were destroyed (550 in Louisville, 378 in Superior, and 156 in unincorporated Boulder County), with an additional 149 damaged. Seven commercial structures were destroyed (four in Louisville and three in Superior), and an additional 30 were damaged (Phillips, 2022).

Residential Construction

In general, the observations of the Pre-MAT and MAT found that many residential structures were built in the early 1980s and early 1990s though some houses appeared to date back to the 1950s and earlier while others appeared to have been constructed within the past 10 years. While many houses constructed before the 2000s appeared to have been adversely impacted by the Marshall Fire, some newer structures also sustained damage or even total loss.

The majority of the damaged or destroyed residential construction observed was one- or two-story light-timber framed structures, as these were the most prevalent structure types in the affected area. These structures' wall systems consisted of OSB sheathing clad with either a brick or stone veneer, fiber-cement board, and vinyl siding material. Roofing systems observed consisted of asphalt-composite shingles, tile, or metal shingle systems. The MAT observed glazing systems in most of the damaged structures typically to be single-pane windows. Most structures observed, both damaged and remaining, did not have fire-resistant vent coverings or home fire sprinklers. Residential structures also had flammable attachments such as fences and decks. Section 5.2 provides information regarding MAT observations related to residential construction.

Commercial Construction

The Marshall Fire MAT focused on residential structures since they comprised the vast majority of damaged structures. Commercial buildings were not the focus of the analysis and therefore the information gathered about their performance was very limited; however, the MAT did note some impacts to commercial structures and obtained additional information during interviews with first responders. Commercial buildings featured stucco, brick, or stone facing exteriors and flat roofs with parapets, although some low slope shingle roofs were also observed. Where the framing was visible, it consisted of cold-formed steel studs, rafters, and joists.

Most commercial buildings appeared to fare reasonably well. Some wind damage was observed to roofs, where shingles and underlayment were torn off, exposing the sheathing. Wind damage was

[9] https://marshallroc.org/dcm-committee/

also apparent in some soffits where soffit coverings were partially dislodged. Several buildings that were not destroyed by fire appeared to have damage to the roofs and parapets. Some windows and glass doors were observed to be boarded up, though many appeared to have remained intact. A brand-new hotel that burnt down and an electric vehicle dealership building across the street both appeared to sustain damage from wind-blown embers, some of which were very large pieces of burning debris due to the wind. The MAT also observed some burned landscaping, such as trees and grass, adjacent to the buildings, and smoke damage was apparent on the exterior cladding at these locations.

Major retailers Target and Costco in Superior were damaged by the fire. Target experienced significant damage as water from the sprinkler system flooded the store, destroying merchandise. The roof also was significantly damaged.

Interviews with first responders provided additional information about how commercial buildings fared and what may have caused some of the damage. Specifically, first responders indicated:

- Large chunks of flaming debris carried by the wind shattered windows and entered some buildings.
- Roof ballast carried by the wind also may have contributed to broken windows that allow embers and flaming debris to enter the structure.
- Some sprinkler systems may not have worked properly because of the drop in water pressure in the community water distribution system.
- Diminished air quality resulting from smoke and ash infiltration required some air handling units to be shut down and resulted in evacuations of critical facilities such as hospitals.
- First responders had specific concerns about exterior tanks (oxygen, fuel) catching fire and exploding. They also were concerned about potential environmental impacts of lithium-ion (Li-ion) batteries catching fire.
- High winds damaged the Superior Town Hall roof as well as downing fencing and trees in multiple locations.

Critical and Lifeline Infrastructure

Avista Adventist Hospital which serves Louisville, Superior, and Broomfield as well as portions of unincorporated Boulder County fully evacuated the facility, including approximately 51 patients and 150 staff, at about 4:15 p.m. on December 30, 2021, due to loss of power and natural gas. Patients were transferred to sister facilities within the Centura Health network including Longmont United Hospital and St. Anthony North. After cleaning and smoke damage mitigation, the facility re-opened on January 18, 2022.

Community lifeline infrastructure is not typically addressed by a MAT; however, lifeline infrastructure plays an important role in a community's response to and recovery and resilience from a wildfire. Adequate water supply and pressure is necessary to fight fires. Roads can serve as both evacuation routes and fire breaks. Power and natural gas supplies must be managed to keep first responders safe. The GEER Association, some of whose members also contributed to the MAT efforts, conducted an in-depth evaluation of lifelines including water utilities, electricity, and natural gas, telecommunications, and transportation infrastructure and published their findings[10].

2.3.2. IMPACTS TO FIREFIGHTING OPERATIONS

The first evacuation order was issued at 11:47 a.m. to people living in the area between Highway 93, Marshall Road, and Cherryvale Road and with winds still increasing, an evacuation order was issued for both sides of Marshall Road between 76th Street and McCaslin Boulevard, by 12:15 p.m. (Miller, 2022). The fire then moved eastward as the winds shifted into Superior and Louisville, and between 12 noon and 2 p.m., mandatory evacuations had been issued for all of Superior, and areas south of Louisville that were heavily impacted (Miller, 2022).

Public safety agencies managed evacuation of the impacted communities. A unified command structure was established to coordinate fire suppression and public safety but was hampered by the uniqueness of this specific fire emergency event and the lack of interoperable communication equipment. Anecdotal information from residents in Louisville and unincorporated Boulder County suggests they had not received evacuation notices. Additionally, there were issues with registration requirements for cellular phone text or voice notifications.

The fast-moving nature of the fire amplified by high winds hampered firefighting efforts, as documented in interviews and other sections of this report. Water for suppression was limited by availability; lack of dry hydrants to access water from ponds, lakes, and stormwater facilities; and low water pressure (in the limited number of community hydrants) due to power interruption and failure affecting water supply from one of the pump stations. The Colorado Forest Service and National Forest Service have some fire suppression capability through aviation support, but their air suppression resources were not deployable due to high winds.

In the early hours of the fire, high wind conditions severely limited early suppression operations[11]. Under these conditions, both traditional and more advanced firefighting operations, using water, construction of fire lines, backfiring and aerial suppression tactics respectively, are usually ineffective. In addition, it is also unsafe for firefighters to be conducting suppression, structure defense and aerial operations in these conditions. These well-known issues were reported to the MAT and confirmed by local firefighters during field interviews. Firefighters reported that the winds either blew the water from the hoses right back at them or dispersed into a fine mist, making water suppression ineffective. In addition, fire hoses burned and sprung leaks during initial firefighting

[10] https://geerassociation.org/index.php/component/geer_reports/?view=geerreports&layout=build&id=103
[11] https://www.weather.gov/bou/MarshallFire20211230

efforts. Firefighters also confirmed unsafe conditions as fire apparatus and equipment were damaged due to the high winds and intense fire conditions.

Due to the unsafe and extreme nature of the wind conditions that challenged suppression, firefighters focused on life safety objectives by supporting local law enforcement in public communication and evacuation. High wind conditions rendered water-based suppression techniques ineffective, so non-water-based firefighting tactics such as removing combustibles (e.g., fences, outdoor furniture) were employed to help prevent fire spread. Wind-borne burning debris was a significant concern. Firefighters tried to saturate grasses, mulch, and wooden debris though vegetation dried out immediately due to wind and heat and reignited. Houses reignited after the flames were extinguished.

During the fire, many firefighting decisions had to be made "on-the-fly" as conditions changed rapidly. Due to the scale and severity of fire, intense wind conditions, and constrained firefighter resources, structure triaging was considered necessary for the safety of firefighter personnel and to increase the likelihood of structure defense where efforts would be considered the most effective. In communities with a single-entry point and exit, firefighters had to make decisions about when to "cut and run" for safety reasons. This was particularly relevant in the Sagamore neighborhood.

Firefighters strategically defended the hospital and an electric vehicle dealership. The hospital was defended to allow patient and staff evacuation, with adjacent townhouses (to the west) also defended to protect the hospital. The electric vehicle dealership was defended due to environmental and combustibility concerns for on-site stored lithium ion (Li-ion) batteries.

Impacts to utilities affected firefighting decisions as well. Natural gas was not shut off immediately in some neighborhoods. Firefighters had to let the gas flow and burn. Gas was eventually shut off to the entire Town of Superior when Target caught fire. Also, low water pressure due to power loss impacted the limited number of community hydrants and firefighting operations.

2.4. Marshall Fire Pre-MAT

Within one week of the Marshall Fire in Boulder County, Colorado, FEMA's BSDS Program deployed a Pre-MAT assessment to collect perishable data including photographs and determine if a full MAT should be deployed. FEMA identified two teams to deploy to the Boulder area to evaluate conditions in Louisville and Superior, the two communities most acutely impacted by the event. The teams identified neighborhoods and structures to visit, including destroyed and damaged structures, as well as some undamaged structures adjacent to damaged or destroyed structures. Structures identified for evaluation were primarily residential, but also included several commercial buildings and critical facilities. Team members spent three days in the field collecting data, interviewing eyewitnesses and local agencies, and evaluating structures. The teams surveyed over 100 structures in various states including undamaged, partially damaged, and fully destroyed. Several interviews were also conducted with stakeholders, including residents in the impacted areas and various government agencies.

While in the field, the teams identified multiple potential vulnerabilities of structures to wildfires including combustible attachments, lack of opening protection from embers, limited fire separation distances between buildings, limited parcel-level vegetation management, and limited vegetation management in common and public open spaces. Based on their observations and data collected, the team recommended proceeding with a full mitigation assessment.

2.5. Marshall Fire MAT

FEMA deployed the full Marshall Fire MAT the week of August 15–19, 2022 consisting of two teams tasked to collect additional information. The Interview Team was primarily responsible for conducting interviews with local officials and department representatives. They met with representatives of Boulder County Parks, Boulder Planning Department, City of Louisville, Mountain View Fire and Rescue, Louisville Fire Protection District, and the Town of Superior. The Field Team was primarily responsible for collecting additional information from sites in unincorporated Boulder County, Louisville, and Superior. They visited sites that were not able to be observed during the Pre-MAT. They also evaluated open space and areas along the burn perimeter to determine inter-relationships with the built environment.

The seven interviews conducted by the MAT Interview Team revealed several key findings related to fire response, codes and standards, and building successes and vulnerabilities. Table 3 below summarizes key findings from the various interviews.

Table 3. Summary of MAT Interviews and Key Findings.

Interview Date	Interviewee	Key Findings
8/16/2022	Boulder County Parks	▪ The broad range of open space property ownership in Boulder County is a big issue that affects landscape mitigation projects moving forward. ▪ Even a large (100 foot) buffer zone would have been unlikely to have stopped the Marshall Fire driven by 100+ mph winds. ▪ The overall vegetation management strategy for Boulder County Parks of allowing agricultural tenants to manage the land with livestock grazing was relatively successful. ▪ FEMA funded replacement of 15 miles of damaged perimeter fencing with noncombustible steel posts (repurposed from recycled pipe casings) and barbed wire instead of wood.
8/16/2022	Boulder County Planning Department	▪ Even building materials like fiber-cement siding failed due to inadequate construction installation detailing, especially at the attic venting, gutters, and the base of the structure. Additionally, some houses had severe smoke damage that made them uninhabitable even though not directly impacted by the fire. ▪ If the building codes used in the mountains were used in the plains, there would have been fewer houses lost. Code features like defensible space and ember-resistant venting can go a long way to reduce the number of houses burned.

Interview Date	Interviewee	Key Findings
		▪ City of Boulder had eliminated cedar shakes for new construction; hailstorms destroyed existing cedar shake shingles, so they are no longer in use. ▪ Boulder County had required Class A roofs in the mountains and Class B roofs in the grasslands. Now Class A roofs are required for new and replacement roofs everywhere in unincorporated Boulder County.
8/17/2022	City of Louisville	▪ Concerns about irrigation ditches. Vegetation in the ditches not always well maintained since the ditch company's primary concern is with moving water along, not maintenance. ▪ Main concern about grassland planting as a fuel is juniper, which may have been planted by residents and is a non-native, high hazard species. As a result of the Marshall Fire, the city will be looking at a wildfire mitigation plan with measures including mowing/buffer strips to knock down some of the fuel, getting rid of juniper trees and shrubs, and considering using livestock grazing to control grass. ▪ City is considering an ordinance to allow noncombustible fencing next to houses, even if combustible materials are required by local Homeowners Association (HOA). (Ordinance proposed and debated, but current status is unknown.) ▪ City also considering new WUI codes, but there are affordability concerns because many residents were massively under-insured. Other folks already started rebuilding, so it is hard to get the word out.
8/17/2022	Mountain View Fire and Rescue	▪ One firefighter stated "The Marshall was unlike anything he has experience in his 40 years as a firefighter. Fire spread rapidly due to 100 mph winds, with 2-foot flame heights having flame lengths that extended up to 200 feet; so, there was little that could be done to stop it." ▪ Decision was made to protect the electric vehicle dealership due to the potentially disastrous impacts of Li-ion batteries catching fire on site. ▪ Firefighting operations hampered due to high winds that damaged ground equipment and grounded air resources, communications issues between fire crews due to equipment inoperability, and lack of pressurized water to hydrants from loss of power to compressor station. ▪ Dispatch records cannot be shared due to an on-going investigation and are under a gag order, and information was redacted from the After Action Report (AAR). ▪ Working on water system improvements and adopting strong WUI fire codes, but there's a lack of consistency among municipalities.
8/17/2022	Boulder Office of Emergency Management	▪ The 2021 Marshall Fire was incredibly intense and consumed 1,100 homes in Boulder County in less than 4 hours. By contrast, Boulder County lost nearly 200 homes in 18 hours in the

Interview Date	Interviewee	Key Findings
		Fourmile Fire (2010) and had 50 affected homes in 8 hours in the Cal-Wood Fire (2020). ▪ Wood fences were "wicks" creating a combustible pathway for fire to flow directly to the structure. ▪ Proximity to open space and re-ignition of smoldering materials contributed to the fire and caused home ignition. ▪ Ignition-resistant fence materials should extend 3 to 5 feet from all walls and overhanging eaves so the house can survive without suppression resources.
8/17/2022	Louisville Fire Protection District	▪ The Marshall Fire started as a small grass fire, but moved incredibly fast, traveling eight miles in 30–40 minutes due to high winds and smoke. ▪ Old cedar fencing acted like wicks and was a major source of fire spread to buildings. ▪ In the Sagamore neighborhood in Superior, houses that burned were over 20 years old, closely packed together and constructed of weathered, dried materials and burned by radiant heat. Few had fire sprinklers. ▪ Structure-to-structure distance between houses made a difference in the amount of destruction (densely clustered houses were more likely to burn). ▪ Some houses had tile roofs and stucco walls and it looked like some of this material helped. One house still standing in the St. Andrews neighborhood had turned on sprinklers and evacuated.
8/18/2022	Town of Superior	▪ Evacuation plans need to be improved after pre-planned evacuation routes led to hours of traffic delays. ▪ Large amounts of fencing and trees came down due to high winds, as well as the Superior Town Hall roof. ▪ Superior has adopted WUI standards for some parts of the Town (Sagamore), but sensitivities to high residential rebuilding costs have led to opt-out provisions and delayed implementation of the adoption of some building codes. ▪ Looking at improving open space management (more hardscaping and grazing vs planting) and water supply.

Chapter 3: Regulatory Setting, Analysis, and Other Considerations

This section presents an overview of wildfire safety regulations, codes, standards and other guidance or policy documents at the state and local levels in the Town of Superior, City of Louisville, and unincorporated Boulder County prior to and post-Marshall Fire. Part of this analysis was informed by a FEMA white paper on Community Wildfire Resilience that evaluated wildfire safety regulations and current practices, primarily in the Western U.S. (FEMA, 2021). The intent of this information is to help identify and assist in advancing and prioritizing wildfire safety code development and adoption practices by state/local governments. It is understood that wildfire codes and standards at the state level and locally in the impacted communities are rapidly evolving, so the information in this chapter is a "snapshot" of the adopted wildfire regulatory frameworks/practices including the identification of gaps at the time of writing this report.

3.1. Overview of Colorado Wildfire Regulations

Based on the FEMA Community Wildfire Resilience white paper, Colorado, prior to the Marshall fire, had limited wildfire regulations at the state level, as most wildfire regulatory powers and duties reside with local jurisdictions. An evaluation of the State's wildfire regulatory environment compared with that of other states suggests that Colorado's regulatory maturity for wildfire is relatively low. Colorado is experiencing a rapidly growing population and expansion of the WUI, yet there are few state land use requirements for the WUI. As a result, many WUI risk reduction efforts are implemented locally.

Below is a high-level "snapshot" of the current state of WUI codes and standards, guidance documents and programs at the state level in Colorado:

- A Wildfire Resiliency Code Board was established in May 2023 to adopt state-wide model codes and standards that support structural hardening and reduce fire risk in the defensible space surrounding structures in the wildland-urban interface. Governing bodies in the wildland-urban interface are required to adopt and enforce a code that meets or exceeds the minimum standards of the code adopted by the Board within three months of the Board's code adoption date. The Wildfire Resiliency Board is housed within the Colorado Department of Public Safety Division of Fire Prevention and Control.
- **No WUI code** at state level. At the time of this publication, the Wildfire Resiliency Board has not yet adopted model codes for the WUI areas. However, several cities and/or counties (e.g., Colorado Springs, Pueblo County, Boulder County, Eagle County, Summit County) have either adopted their own WUI code or part of the IWUIC (See Table 9 later in this section). Codes are mostly limited to new construction, improvements, and repairs at building-scale.

- No specialized wildfire codes for critical infrastructure such as roads, bridges, healthcare facilities, schools, police/fire stations or utilities.
- No engineering and construction design criteria and/or standards for various wildfire-specific protection systems (e.g., suppression, water supplies, emergency power, detection, and notification).
- No regulatory guidance on "how" to enforce wildfire codes and standards, particularly for local fire agencies.
- State provides wildfire hazard and risk maps through the Colorado Wildfire Risk Assessment Portal[12].
- Counties and municipalities are required to adopt a master plan, but only municipalities must address hazards. Colorado's 1041 Regulations give local governments authority for planning decisions related to areas or activities of statewide concern, including hazards.
- Some local programs and planning efforts exist: Community Wildfire Protection Plans (CWPPs), Community Planning Assistance for Wildfire (CPAW), Firewise communities.

The following sections provide further details on the level of WUI-specific regulatory guidance in Colorado prior to the Marshall Fire.

3.1.1. CODE OF COLORADO REGULATIONS BEFORE THE MARSHALL FIRE

At the time of the Marshall Fire, Colorado did not have an adopted WUI code and/or associated standards. The state did have some wildfire safety policies that help support wildfire risk mitigation efforts, including Senate Bill (SB) 21-258 enacted in 2021.

SB 21-258 – Wildfire Risk Mitigation

This policy concerns the administration of state assistance programs to mitigate the risk of wildfire. It relates to the creation of the wildfire-mitigation capacity development fund and the hazard mitigation fund. This act allows for the following:

- Gives the Colorado State Forest Service (CSFS) permission to issue forest restoration and wildfire mitigation grants for projects on federal lands.
- Increases the amount that the CSFS may use for the direct and indirect costs in administering the Forest Restoration and Wildfire Risk Mitigation Grant Program (FRWRM) from 3% to 7% of any amounts appropriated in any fiscal year.

[12] https://coloradoforestatlas.org/

- Allows the technical advisory panel that evaluates the proposals for forest restoration and wildfire risk mitigation grants to scale up and down in size.
- Expands the allowable uses of the FRWRM by allowing the grant program to fund capacity-building efforts to provide local governments, community groups, and collaborative forestry groups with the resources and staffing necessary to plan and implement forest restoration and wildfire risk mitigation projects.
- Allows the CSFS to hire non-temporary additional field capacity to support wildfire risk mitigation efforts.
- Creates the wildfire mitigation capacity development fund and the hazard mitigation fund.

3.1.2. NEW OR AMENDED STATE LEVEL BUILDING CODES AND STANDARDS

Since the Marshall Fire, the State of Colorado has yet to adopt a statewide wildfire code. In 2023, the State legislature created a board tasked with developing statewide building standards for the WUI. While efforts to establish statewide building standards for the WUI are ongoing, the Colorado State Legislature has passed several bills that aid wildfire risk mitigation following the Marshall Fire. This includes, but is not limited to, bills that:

- Support an increase in wildfire mitigation outreach efforts (SB22-007)
- Create incentives for local governments to participate in wildfire mitigation efforts (House Bill (HB)22-1011)
- Further regulate wildfire mitigation services including controlled burns (HB22-1132)
- Increase the resources available for fire protection services available for volunteer firefighters (SB22-002)
- Establish new insurance coverage requirements for loss declared fire disaster (HB22-1111)
- Create additional disaster preparedness and recovery resources (SB22-206)
- Provide funding for wildfire mitigation and recovery in forests (HB22-1012)
- Create provisions for fire suppression pond designations (SB22-114)

Please note that the Colorado State Legislature is very active in introducing and passing bills related to wildfire risk mitigation. In the span of time that this report was written, several additional bills have been introduced related to many facets of wildfire mitigation, such as wildfire detection, fire investigations, and grants to aid homeowners in retrofitting their homes for wildfire resiliency.

3.1.3. COLORADO STRATEGIC DOCUMENTS, PROGRAMS AND TECHNICAL RESOURCES

The following is a summary of some key strategic wildfire programs/plans in Colorado that were created prior to the Marshall Fire.

Colorado Strategic Wildfire Action Program

The Colorado Strategic Wildfire Action Program was created in 2021 in response to the devastating 2020 fire season. The program is designed to move state stimulus dollars to start on-the-ground work and fuel reduction projects as well as increase Colorado's capacity to conduct critical forest restoration and wildfire mitigation work. Fuel reduction efforts are supported by the Colorado Strategic Wildfire Action Program in two ways: (1) Fund wildfire mitigation work done by conservation corps and the Department of Corrections State Wildland Inmate Fire Teams (SWIFT) and wildfire mitigation workforce development training. (2) Strategically award funds for landscape-scale strategic wildfire mitigation projects.[13]

Colorado Forest Action Plan 2020

The Colorado Forest Action Plan was created by the CSFS and its partners and serves as an in-depth analysis of forest trends and offers solutions and guidance for improving forest health. One of the main themes of this Plan is "Living with Wildfire" which promotes risk-reduction practices as populations increase in the WUI.[14]

West Wide Wildfire Risk Assessment

Colorado is part of the Council of Western State Foresters and the Western Forestry Leadership Coalition (WFLC), which undertook a wildfire risk assessment of all lands for the 17 western states and select Pacific islands in 2011. This assessment, known as the "West Wide Wildfire Risk Assessment" (WWA) supports the use of science-based data to quantify the magnitude of the current wildland fire problem in the west, providing a baseline for quantifying mitigation activities and monitor change over time. It also provides a more standardized approach to comparison of wildfire risk across regional geographic areas. Colorado is using the WWA for state-level strategic wildfire resiliency planning and policy discussions.[15]

Colorado Forest Atlas Information Portal

Colorado has extensive, online, interactive wildfire hazard and risk-mapping tools (i.e., Forest Atlas Information Portal) that is available for public use (Figure 13). This online resource provides a range

[13] https://dnr.colorado.gov/divisions/forestry/co-strategic-wildfire-action-program

[14] https://climate.colorado.gov/2020-colorado-forest-action-plan#:~:text=The%202020%20Colorado%20Forest%20Action%20Plan%20provides%20a,forests%20face%20across%20political%2C%20jurisdictional%20and%20ecological%20boundaries.

[15] https://www.adaptationclearinghouse.org/resources/west-wide-wildfire-risk-assessment.html

of data layers and information on Colorado's forests, wildfire hazards, State Forest service activities, and more. Notable applications include a wildfire risk reduction planner and a wildfire risk viewer .[16]

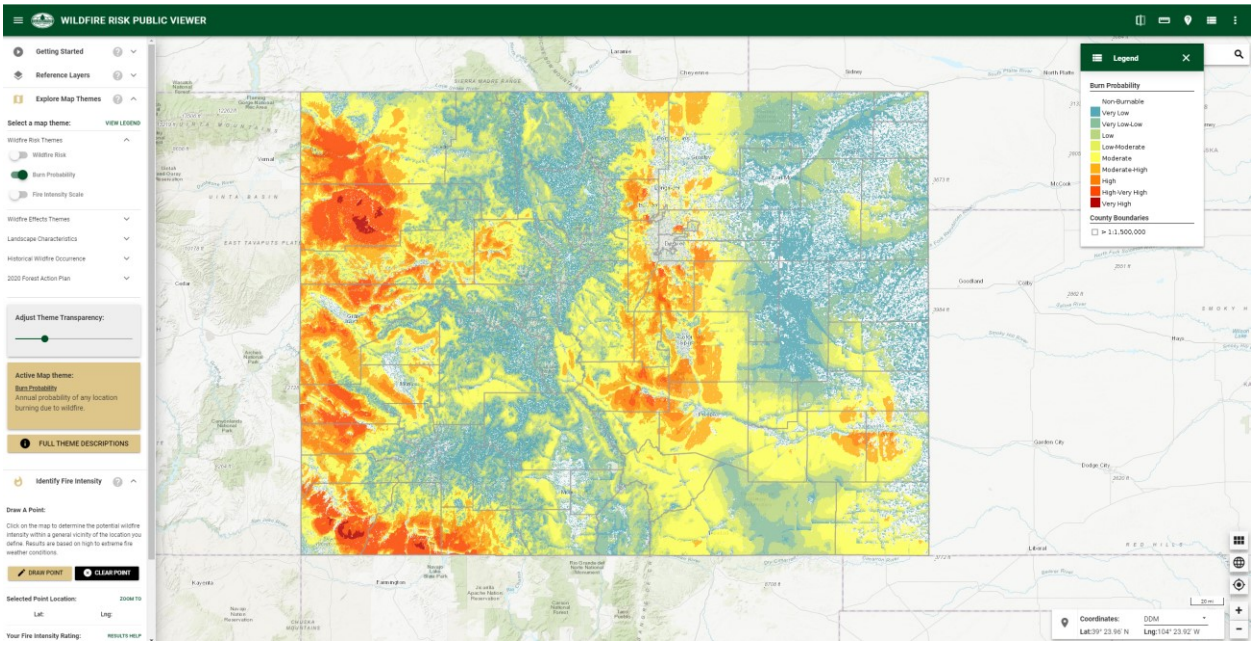


Figure 13. Colorado Forest Atlas Wildfire Risk Public Viewer (Colorado State Forest Service, 2022).

Wildfire Partners, Boulder County Colorado

Some counties have local community wildfire resiliency programs, such as The Wildfire Partners Program in Boulder County[17], which support homeowners in preparing for future wildfires. This program, and those similar to it, offers property-level wildfire risk assessments with detailed mitigation action recommendations as well as funding opportunities to implement projects and expert advice. Those that participate in the Wildfire Partners program and effectively pass final inspections receive a Wildfire Partners Certificate, which is accepted by local insurance companies to maintain or receive insurance coverage.

RealFire Program, Eagle County Colorado

Another local community wildfire resiliency program is the RealFire Program in Eagle County[18], which enables residents of Eagle County to receive property assessments from locally qualified assessors free-of-charge. This program operates very similarly to the Wildfire Partners Program in Boulder

[16] https://coloradoforestatlas.org/
[17] https://wildfirepartners.org/
[18] https://realfire.net/

County. After the initial property assessment, homeowners receive a list of recommended property-specific mitigation actions that they must implement to receive a RealFire certificate, which recognizes completion of the required mitigation actions and provides documentation for potential insurance benefits.

West Region Wildfire Council Site Visit Program

The West Region Wildfire Council[19] serves Delta, Gunnison, Hinsdale, Montrose, Ouray, and San Miguel counties of Colorado and runs a site visit program for residents that live in the WUI[20]. Residents may apply for a site visit, where a West Region Wildfire Council Mitigation Specialist and/or forester will meet with the landowner or community resident at their property to discuss site-specific wildfire risk and wildfire mitigation strategies.

Community Wildfire Planning Center (CWPC)

The Community Wildfire Planning Center (CWPC) is a Colorado-based non-profit organization that provides wildfire education and action plans for individuals and communities[21]. It provides community-based property assessment programs, education trainings and outreach, wildfire project advisory support, and other community-based activities. The CWPC provides several online wildfire/WUI planning and resource tools: (1) WUI Planning Hub that contains tools useful for both homeowners and local jurisdictions; (2) an interactive map of other state and national-level wildfire resiliency planning tools and resources; and (3) a land use planning evaluation tool that can support local jurisdictions in planning and regulating WUI/wildfire risk mitigation planning efforts.

Fire-Adapted Communities

Colorado currently has three communities within the Fire-Adapted Communities Network (FAC Net): the Coalition for the Upper South Platte, Firewise of Southwest Colorado, and Summit County. FAC Net is the result of a partnership between the Watershed Research and Training Center, The Nature Conservancy, the USDA Forest Service, and the Department of the Interior. This is a national network of wildfire-resilience practitioners focused on building wildfire resilience capacity in fire-prone communities by supporting and connecting individuals and communities working on wildfire resilience. FAC Net provides resources, tools, and connections to increase resilience in "Fire-Adapted Communities."[22] In 2014, the FAC Learning Network included 10 hub communities across the United States, three of which were in Colorado.[23]

---

[19] West Region Wildfire Council | Working together to reduce wildfire risk (cowildfire.org)

[20] https://cowildfire.org/

[21] https://www.communitywildfire.org/

[22] Fire Adapted Communities Learning Network. 2022. https://fireadaptednetwork.org/.

[23] Colorado State Fire Service. *Colorado Fire Adapted Communities*. 2022. https://csfs.colostate.edu/wildfire-mitigation/colorado-fire-adapted-communities/.

Firewise®

The NFPA, with funding received from the U.S. Forest Service, developed and manages the Firewise USA® Program. The program helps educate homeowners on appropriate steps to better protect their home from wildfire through home hardening and vegetation management. Homeowners can form a Firewise USA® community (typically at a neighborhood level) by establishing a site boundary of focus, collaborating with local fire departments and emergency managers to create a framework of action for reducing the risk of wildfire.



Firewise USA® communities gain significant education in wildfire risk reduction and may be eligible for homeowners insurance discounts. This program relies on homeowners at a grass-roots level, motivating and empowering homeowners to take action to protect their lives, the lives of their families and property in their neighborhood from wildfire. The program also provides resources to help homeowners learn how to adapt to living with wildfire and encourages neighbors to proactively work together to prevent losses.

Firewise USA® recognizes communities that meet its standards. This program was initiated in 2002 and now has nearly 1,000 active member communities in 40 states, as well as a participation retention rate of 80% over the past decade.[24] Colorado is ranked third for the number of recognized Firewise USA® sites[25] with more than 180 sites that have earned Firewise USA® recognition. Five of these sites are located in Boulder County, but none were impacted by the Marshall Fire.

3.2. Existing Community Level Wildfire Regulatory Mechanisms

In Colorado, building codes and standards are adopted at the community level according to “home rule” (Bernard, 2020) but the state can set a minimum standard for local building code adoption. For example, House Bill 19-1260, passed in 2019, requires local jurisdictions in Colorado to adopt and enforce one of the three most recent versions of the International Energy Conservation Code (IECC) upon adopting or updating any other building code (Colorado Energy Office, n.d.). Amendments to the IECC are permitted as long as they do not weaken the effectiveness or energy efficiency of the code. State agencies can also adopt and enforce building codes for state-led building projects.

[24] National Fire Protection Association. Firewise USA®. 2022. https://www.nfpa.org/Public-Education/Fire-causes-and-risks/Wildfire/Firewise-USA .

[25] Colorado State Forest Service. *Colorado Firewise USA® Sites*. 2022. https://csfs.colostate.edu/wildfire-mitigation/colorado-firewise-communities/ .

Jurisdictions have a menu of options for establishing minimum standards for wildfire hazard resistance, including WUI Codes, such as the IWUIC, and the ICC's package of building codes, commonly known as the I-Codes. The ICC codes are updated every three years and include three primary model codes, the IBC, the IEBC, and the IRC. To become legally enforceable in Colorado, building codes must be explicitly selected and adopted through ordinance by an AHJ, such as the City of Louisville or Boulder County. Responsibility for building code adoption and enforcement is often shared by multiple departments and offices of the local jurisdiction.

Local subdivision regulations do not currently include provisions that fully address wildfire risk.

3.2.1. UNINCORPORATED BOULDER COUNTY

In the unincorporated areas of Boulder County, the Board of County Commissioners is responsible for adopting local ordinances including building codes and their amendments. The Community Planning and Permitting Department, within the Office of the County Administrator, enforces those building codes, as well as zoning and land use codes. The Land Use Board of Adjustment adjudicates appeals regarding certain sections of the land use code and requests for variances. The Board of Review adjudicates technical appeals regarding the county's building code amendments and reviews proposed amendments to make recommendations to the Board of County Commissioners prior to adoption. As with similar offices listed for Superior and Louisville above, these offices have a role in managing defensible space, vegetative fuels, and other WUI-related issues.

WUI Building and Fire Codes and Standards

Boulder County has used building codes to mitigate the risk of wildfire since the 1980s ("Land Use Tool: Building Code", n.d.). For example, Class A fire-resistant-rated roofs have been required for all new houses in high-risk wildfire zones since 1989 (CWPP, 2011). These codes have been expanded upon by local amendment to include defensible space as well as noncombustible and ignition-resistant material. Boulder County's Building and Land Use Codes also require homeowners who are constructing new homes, or remodeling some existing houses, in wildfire prone areas to submit a wildfire mitigation plan before a building permit can be issued ("Wildfire Mitigation FAQ", n.d.). The plans must include, but are not limited to, the use of ignition resistant building materials, defensible space, and fuel reduction measures. For regulatory purposes, unincorporated Boulder County is divided into two Wildfire Zones (Figure 14). Wildfire Zone 1 includes the mountains and forested portion of the County, and Wildfire Zone 2 includes the plains and grasslands in the County (Boulder County, 2022).

At the time of the Marshall Fire, most of the residential wildfire mitigation standards were required in Wildfire Zone 1 only. The areas directly affected by the Marshall Fire predominantly fall within Zone 2.

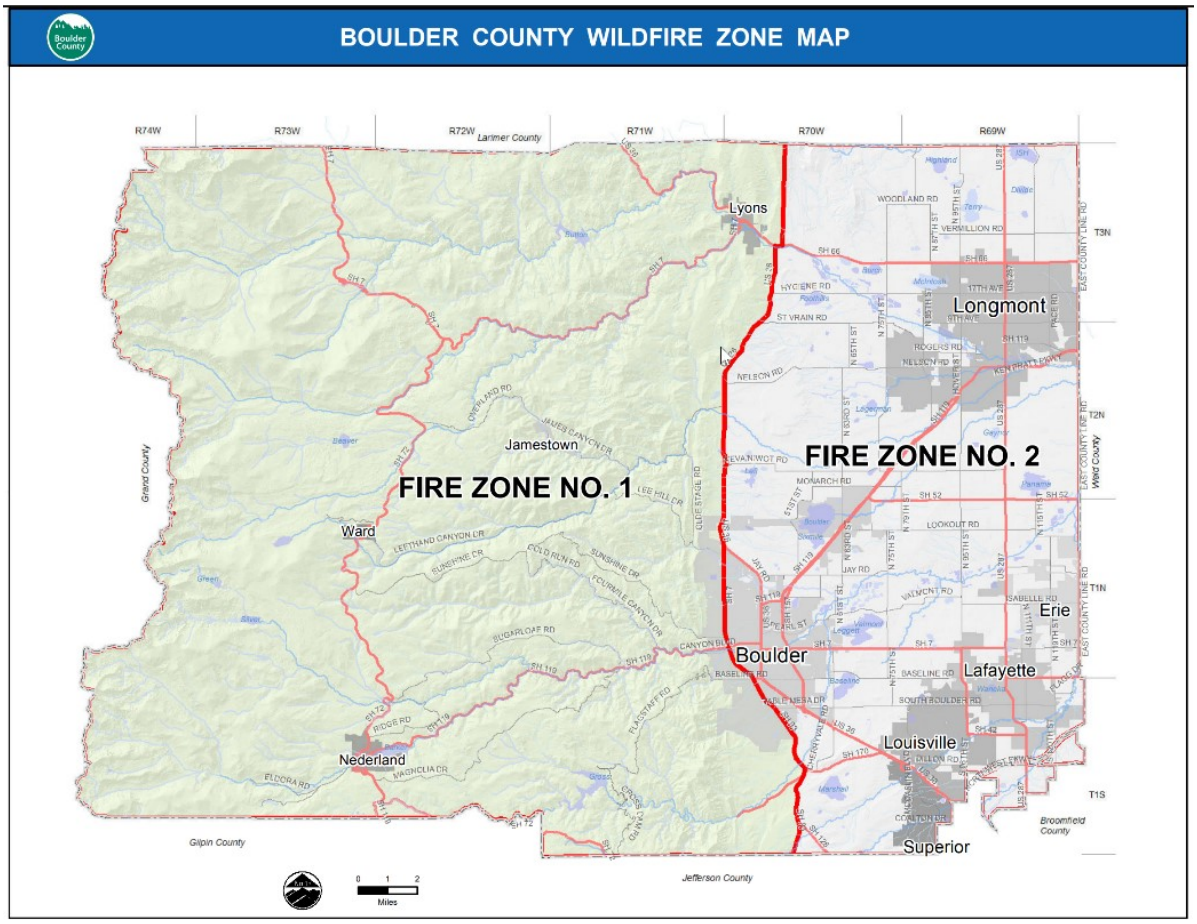


Figure 14. Boulder County is divided into two Wildfire Zones (Boulder County).

At the time of the Marshall Fire, the 2015 IRC was in effect in Boulder County with the following amendments:

- Boulder County considers fire sprinklers as a means of preventing fire spread from structure-to-structure or structure-to-vegetation and reducing structural damage, especially in cases where larger houses in more remote areas may require longer firefighter response times ("Fire Sprinkler System Plan", n.d.). These Section R313 amendments strengthen automatic fire sprinkler requirements above the 2015 IRC, which does not require an automatic residential fire sprinkler system, where one is not already installed, for existing townhouses where additions or alterations have been made, or for additions and alterations of existing one- and two-family dwellings.
    - Amended Section R313, Automatic Fire Sprinkler Systems.
    - Amended Section R313.2: Automatic residential fire sprinklers are not required for federally certified manufactured dwellings or state-certified factory-built dwellings that are certified to pre-2012 IRC editions.

- Amended Section R313.2.1 to require an automatic residential fire sprinkler system, designed and installed in accordance with IRC Section P2904 of NFPA 13D, in existing one- and two-family dwellings with additions when the sum of the total floor area is increased to 4,800 square feet or greater; and in existing one- and two-family dwellings with a floor area of 4,800 square feet or greater where permitted renovations or remodeling takes place in more than 50% of the structure.

  Exceptions include one-time additions less than 200 square feet in floor area and carport additions that do not qualify as "Residential Floor Area" as defined by the Boulder County Land Use Code.

- Added Section R324.7: Access and Pathways for Rooftop Solar Energy Systems, which provides additional standards for roof access, pathways, and spacing requirements for rooftop solar energy systems. These standards are modelled after the City of Boulder Fire Department's 2012 IFC adoption and strengthen the wildfire hazard mitigation provisions of the 2015 IRC. These additional requirements are significant for the county's wildfire resilience given the potential increase in residential solar systems resulting from the adoption of Boulder County's Solar Pre-Wire Option.

- Added Section R327: Establishing standards for defensible space, ignition-resistant construction material, Class A roof assemblies and roof coverings, and use of noncombustible material for buildings in Wildfire Zone 1 and 2. The addition of Section R327 strengthens the provisions for wildfire hazard mitigation above the 2015 IRC. However, at the time of the Marshall Fire, Wildfire Zone 2 had fewer wildfire hazard mitigation standards in place than in Wildfire Zone 1.

  - Subsection R327.4 lists detailed requirements for buildings in Wildfire Zone 1, including but not limited to: roof coverings, gutters, spark arrestors, fences, eaves, exterior walls, unenclosed under floor protection, decks, exterior windows and glazing, exterior doors, vents, detached accessory structures, and defensible space.

  - Subsection R327.5 lists requirements for buildings in Wildfire Zone 2. This subsection includes standards for roof coverings but omits the remaining standards required in Wildfire Zone 1.

- Added Section R328: Solar Pre-Wire Option, requiring new single-family detached residences to include a residential photovoltaic solar generation system or solar thermal system, or the foundational equipment that would facilitate future installation (e.g., upgraded wiring or conduit).

- Added Section R329: Electric Vehicle Charging Pre-Wire Option, which requires every one-- or two--family dwelling garage or carport to include a Level 2 (240-volt) electric vehicle charging receptacle outlet, or the foundational equipment that would facilitate future installation (e.g., upgraded wiring or electrical conduit).

Boulder County made the following change to the 2015 IBC:

- Added Section 723: Applying the ignition-resistant construction and defensible space requirements of the Boulder County IRC amendment to all new buildings, additions, and repairs, unless more restrictive requirements, such as those provided by the Boulder County Land Use Code, apply. This amendment strengthens the wildfire hazard mitigation provisions of the 2015 IBC.

Other Relevant Codes and Standards

At the time of the Marshall Fire, the 2017 National Electrical Code (NEC), the 2015 IBC, the 2015 IRC, the 2015 IECC, the 2015 IEBC, and the 2012 IFC, and the 2015 International Green Construction Code (IgCC) were in effect for Boulder County, with amendments.

The Boulder County Comprehensive Plan directly addresses the threat of wildfire and acknowledges the role of codes and standards, in addition to public education and land use management, in mitigating wildfire risk (2020). According to the CWPP, Boulder County aims to improve the wildfire resiliency of the existing housing stock, which is not subject to ignition-resistant standards for new construction. The CWPP identifies a goal to replace all wood roofs with Class A fire rated roofs using a combination of voluntary incentives, such as low-interest loans (2011). This goal is not currently operationalized into local ordinance. The CWPP emphasizes a voluntary incentive approach to wildfire mitigation for Boulder County's existing housing stock, as opposed to the regulatory approach (i.e., building and land use code) used for new construction (2011).

Additionally, all new residential construction and additions are also subject to the BuildSmart program, the county's residential green building code. The BuildSmart program first took effect in May 2008. The most recent edition of the code (effective January 1, 2016) is adapted from the 2015 IRC Chapter 11 standards for energy efficiency (Boulder County Land Use Department, 2017). BuildSmart standards aim to reduce greenhouse gas emissions from residential buildings, reduce landfill waste, conserve natural resources during construction, and improve indoor air quality. The expansion of homeowner-led wildfire mitigation strategies, such as completion of the Wildfire Partners Certificate, is also incorporated into the goals of the 2018 Boulder County Environmental Sustainability Plan (2018).

Code History

Historically, Boulder County has adopted new code editions at semi-regular intervals. Prior to adopting the codes in effect during the Marshall Fire, Boulder County adopted the following I-Code editions summarized in Table 4.

Table 4. Summary of Boulder County's International Code adoptions prior to the codes in place at the time of the Marshall Fire.

Effective Date	I-Code Adoptions	NEC Adoptions
July 1, 2003	2003 IBC and IRC	
Jan. 1, 2008	2006 IBC, IRC, IECC	2005
Jan. 1, 2011–Dec. 31, 2013	2009 IBC, IRC, IECC 2010 IgCC – select portions only	2008
Jan 1, 2013–Dec. 31, 2015	2012 IBC, IRC, IECC 2012 IgCC	2011
Jan 1, 2016–Dec. 31, 2016	2015 IEBC	2014

Code history was selected for relevance to wildfire hazard mitigation and is not inclusive of all known building code adoptions. Available records for build code adoption history vary by jurisdiction. Building code adoption history prior to 2003 was not publicly available.

Current WUI Code

After the Marshall Fire, Boulder County strengthened the wildfire hazard mitigation provisions of its building code by expanding the existing WUI standards in Wildfire Zone 2. Specifically, it amended its 2015 IRC Section R327 to require that residential buildings in Wildfire Zone 2 meet additional standards for ignition-resistant construction material, Class A roof assemblies and roof coverings, and use of noncombustible material. Many of these standards were already in effect for Wildfire Zone 1. These amendments took effect on June 6, 2022.

The adoption of these WUI standards for Wildfire Zone 2 coincides with the Wildfire Partners Eastern County Expansion Program, as outlined in the Boulder County Hazard Mitigation Plan. If implemented, the Expansion Program would extend the operation of the Wildfire Partners program to the eastern portion of the county, encompassing grasslands and plains to support the enforcement of wildfire mitigation standards required by the Boulder County building code.

Finally, Boulder County is currently updating its Boulder County Community Wildfire Protection Plan. Updates will include, but are not limited to, an expanded understanding of wildfire risk in the grassland WUI, ember risk mapping, and identification of wildfire-risk reduction strategies (Halford, 2023).

Recovery And Repair

In response to the fire, Boulder County amended its Land Use Code to streamline the planning and building permit review processes and maintain standards for wildfire resilient construction (Community Planning & Permitting Department, 2022). Per the Land Use Code, redevelopment of a damaged property must mitigate the risk of wildfire to that property and its neighboring properties (2022). Appendix A of the Land Use Code specifies fire hazard mitigation construction standards

effective beginning March 29, 2022, until June 6, 2022, when the Boulder County Building Code wildfire standards (i.e., the 2015 IRC Section R327 amendments) took effect.

New construction must also meet the requirements of the BuildSmart program, the county's residential green building code. Homeowners also have access to free EnergySmart advisors that can recommend modifications for improved energy efficiency, as well as the EnergySmart Rebuilding Better toolkit, which consolidates guidance on energy efficient and resilient construction, rebates, and incentives for post-Marshall Fire rebuilding ("Rebuilding Better", n.d.).

Finally, to offset the cost of rebuilding, Boulder County has reduced building permit fees by $4,400 for single-family homes and by 25% for accessory structures for permits filed by December 31, 2024 ("Marshall Fire Finances and Rebates", n.d.). Homeowners who lost their homes in the Marshall Fire and file a building permit by December 31, 2024, are also eligible for a $4,200 use tax rebate ("Marshall Fire Finances and Rebates", n.d.).

3.2.2. LOUISVILLE, COLORADO

In the City of Louisville, the City Council is responsible for adopting local ordinances, including building codes and their amendments. The Department of Building Safety is responsible for enforcing these building codes. The Building Code Board of Appeals adjudicates appeals from property owners contesting a building code official's interpretation and application of the city's building code to their property, and the Board of Adjustment adjudicates zoning variances. The Open Space Advisory Board advises the City Council on management of the city's open space properties, and the Planning Commission evaluates land use proposals and makes recommendations to the City Council; both offices have a role in managing defensible space, vegetative fuels, and other WUI-related issues.

WUI Building and Fire Codes and Standards

At the time of the Marshall Fire, the City of Louisville had not adopted any version of WUI code.

Other Relevant Codes and Standards

At the time of the Marshall Fire, the 2018 IBC, 2018 IRC, 2018 IEBC and 2018 International Fire Code (IFC) were in effect, with amendments. The 2021 IECC took effect on November 23, 2021, replacing the previously adopted 2018 IECC a month prior to the Marshall Fire. Louisville's 2021 IECC adoption included Appendix RC, Zero Energy Residential Building Provisions, Appendix CB, Solar Ready Zone (Commercial), and Appendix RB, Solar Ready Provisions (Detached One and Two-Family Dwellings and Townhouses). The 2020 National Electrical Code (NEC), published by the National Fire Protection Association, was also in effect.

The Louisville Fire Protection District 2021-2026 Strategic Plan does not explicitly address wildfire mitigation strategies or codes and standards. Louisville does not have a Community Wildfire Protection Plan, but it is co-coordinating the update to the 2011 Boulder County Community Wildfire

Protection Plan in partnership with the Boulder County government. Louisville does not have specific wildfire resiliency codes, wildfire safety elements (in a comprehensive plan) or wildfire hazard/risk assessment processes for new construction during planning.

Code History

Historically, Louisville has adopted new code editions at semi-regular intervals. Prior to the adoption of the I-Codes, buildings in Louisville were constructed to the standards of the Uniform Building Code (UBC), a building code commonly adopted by western states until it was replaced by the ICC's IBC in 2000. Louisville also adopted relevant secondary UBC codes such as the Uniform Code for the Abatement of Dangerous Buildings (UCADB). Louisville's pre- I-Code adoptions are summarized in Table 5 and I-Code adoptions are summarized in Table 6.

Table 5. Summary of Louisville's building code adoptions before creation of the International Codes.

Adoption Year	UBC Edition	UCADB Edition	NEC Edition	Fire Code
1962	1961 UBC		1959 NEC	1960 Fire Prevention Code
1971	1970 UBC		1968 NEC	
1975	1973 UBC			
1977	1976 UBC			
1979	1979 UBC			
1983	1982 UBC			
1986	1985 UBC			
1988	1988 UBC			
1994	1991 UBC		1993 NEC	1991 Uniform Fire Code (UFC)
1995	1994 UBC	1994 UCADB		
1997	1997 UBC	1997 UCADB		1997 Uniform Fire Code

Table 6. Summary of Louisville's International Code adoptions prior to the codes in place at the time of the Marshall Fire.

Adoption Year	I-Code Adoptions	NEC Adoptions
2005	2003 IBC and IRC	
2010	2009 IBC, IRC*, IFC, IECC *Louisville amended 2009 IRC to remove automatic fire sprinkler requirements, limiting the wildfire hazard provisions of the 2009 IRC	2011
2014	2012 IBC, IRC, IFC, IECC	

Code history was selected for relevance to wildfire hazard mitigation and is not inclusive of all known building code adoptions. Available records for build code adoption history vary by jurisdiction.

Current WUI Code

To date, the City of Louisville has not adopted any WUI code, but the city has adopted the following changes to its building codes and standards to provide additional wildfire protections.

Acknowledging the role that wood fences played in facilitating the spread of the Marshall Fire, Louisville amended Title 17 of its municipal code; homeowners required by Planned Unit Development rules to install fences made from wood or other combustible material may use noncombustible material for the portion of the fence that connects the home to the side property line, ("Ordinance NO. 1838", 2022).

The City of Louisville and the Louisville Fire Department have also published an Ignition Resistant Construction Guide, detailing voluntary actions that homeowners can take to protect their homes against wildfire ("Ignition Resistant Construction Guide", n.d.). The guide, focused primarily on home hardening and fuels management, is intended to be implemented as a package rather than pick-and-choose strategies. The guide references sources such as the 2021 IWUIC, the California Office of the State Fire Marshal, the NFPA, and Colorado State University Extension.

In addition, the City of Louisville has updated several of its strategic and long-term plans to address wildfire mitigation, recovery, and repair post-Marshall Fire:

- The Louisville Annex of the Boulder County Hazard Mitigation Plan affirms the City of Louisville's commitment to enforcing disaster-resistant building codes; however, the City notes that code enforcement needs during the recovery stage outpace the capacity of their available staff and city budget. The plan identifies FEMA Hazard Mitigation Assistance grants and state grants as potential funding sources for post-disaster code enforcement projects (2022).
- The Louisville Strategic Plan briefly describes city goals to repair infrastructure and property damaged by the fire, reduce future risk, identify opportunities for disaster mitigation and preparedness, and increase community resilience ("Strategic Planning Framework 2023-2024", n.d.).
- The Louisville Marshall Fire Recovery Plan details a long-term milestone to adjust or add permits, ordinances, and internal policies to prepare for the broader recovery process and build back better ("Recovery Plan for Marshall Fire", 2022).
- The Department of Parks and Open Space plans to release a request for proposals for the completion of a Wildfire Mitigation Plan for city public lands, date to be determined ("What's New with Parks and Open Space", 2022).
- The City has begun development of a Wildfire Risk Assessment, to identify hazards, risks, and mitigation opportunities in Louisville's public lands.

Recovery And Repair

To facilitate more efficient and flexible rebuilding and repairs after the Marshall Fire, Louisville amended its building codes, allowable variances, and permitting process. Louisville notes that enforcement of local building codes during post-Marshall Fire reconstruction poses a challenge due to high need and limited staff capacity (Boulder County Hazard Mitigation Plan, 2022). Local building code amendments, inspection, and enforcement standards should be compared against best practices for disaster-resistant construction to ensure that reconstruction supports wildfire resilience.

Louisville made the following changes to the 2018 IRC:

- Louisville deleted Section P2904 from the 2018 IRC intending to remove the requirement for automatic fire sprinkler systems for single-family homes. Because IRC Section R313 "Automatic Fire Sprinkler Systems" is still in effect, the change is insufficient to remove the automatic fire sprinkler systems requirement for single-family homes. This change, if it were to take effect as intended, would limit the wildfire hazard mitigation provisions of the 2018 IRC.

- The 2021 IECC was made optional for homeowners facing financial hardship who are rebuilding or repairing their homes after the Marshall Fire. These homeowners have multiple options for meeting IECC standards:

    - Option A – rebuild according to the 2018 IECC prescriptive path, which specifies residential insulation, glazing, windows, mechanical, electrical, and air change requirements.

    - Option B – rebuild according to the 2021 IECC with a Home Energy Rating System ("HERS") rating of 50, or the prescriptive path. The HERS index is a scoring system established by the Residential Energy Services Network (RESNET) for measuring a home's energy consumption compared against a reference home (based on the 2006 IECC) as a baseline, which has a HERS value of 100. Values less than 100 mean the home is more energy efficient than the reference home, while values greater than 100 mean the home is less energy efficient than the reference home.

    - Option C – rebuild according to the 2021 IECC Appendix RC (Zero Energy). Appendix RC provides requirements for residential buildings intended to result in net-zero energy consumption over the course of a year. Homes built in compliance with Appendix RC should produce at least as much energy as they consume in a given year.

- While 2021 IECC compliance is optional for affected homeowners, Louisville has adopted incentives for voluntary adoption. On October 3, 2022, the City Council approved a Use Tax Credit program for residents who lost their homes in the Marshall Fire ("Marshall Fire Use Tax Credit Program", n.d.). Homeowners with building permits that comply with the 2021 IECC (with or without Appendix RC) will receive a 100% credit for the use tax paid on construction materials. Permits complying with the 2018 IECC will also receive credit for a percentage of the use tax paid.

- Additionally, residents whose property was damaged or destroyed by the Marshall Fire can apply for minor impact variances, which allow deviations of up to 10% from a published standard (for example, up to 1-foot deviation in a 10-foot rear setback, or up to 33% maximum lot coverage where 30% is permitted) ("Ordinance No. 1824", 2022). Reductions in setback distances or separation distances between houses could increase the risk of structure-to-structure fire spreading.

- Finally, homeowners that need to replace insulation, such as in an attic, due to the Marshall Fire can also apply for an expedited permit through a special online portal on the city website ("Insulation Replacement", n.d). This insulation must meet the energy efficiency requirements of Louisville's 2021 IECC adoption, which includes a simplified table of insulation requirements that meets, or in some cases, exceeds the requirements of the model code version.

3.2.3. SUPERIOR, COLORADO

In the Town of Superior, the Board of Trustees is responsible for adopting local ordinances, including building codes and their amendments. The Building Department, under the direction of the Town Manager, is responsible for enforcing these building codes. Like Louisville, Superior has additional offices that have a role in managing defensible space, vegetative fuels, and other WUI-related issues, namely the Planning Department and the Parks, Recreation, and Open Space Department.

WUI Building and Fire codes and Standards

At the time of the Marshall Fire, the Town of Superior had not adopted any version of WUI code.

Other Relevant Codes and Standards

At the time of the Marshall Fire, the 2020 NEC, and the 2018 IBC, 2018 IRC, 2018 IFC, 2018 IEBC, and 2018 IECC were in effect, with amendments. These codes were adopted in August 2020.

Wildfire risk is not explicitly addressed in Superior's Land Use Code, the 2021 Parks, Recreation, Open Space and Trails Master Plan (updated post-Marshall Fire), or the 2012 Comprehensive Plan. Superior falls under the jurisdiction of the Rocky Mountain Fire Protection District. The Rocky Mountain Fire CWPP acknowledges the role of ignition-resistant construction in wildfire mitigation but does not reference specific construction standards (2010).

New residential construction, restorations of residential structures, and additions or renovations to residential structures of 500 square feet or greater are also subject to Superior's Green Building Program, which sets standards for energy efficiency, waste management, and water conservation. Compliance with the adopted IECC is a requirement of the Green Building Program ("Green Building Program", n.d.).

Code History

Prior to the adoption of the I-Codes, buildings in Superior were constructed to the standards of the UBC and its secondary codes. Superior's pre- I-Code adoptions are summarized in Table 7. I-Code adoptions prior to the codes in effect at the time of the Marshall Fire are listed in Table 8.

Table 7. Summary of Superior's building code adoptions before creation of the International Codes.

Adoption Year	UBC Edition	UCADB Edition	NEC Edition	Fire Code
1989	1988		1987	1988 UFC
1996	1994		1996	1994 UFC

Table 8. Summary of Superior's International Code adoptions prior to the codes in place at the time of the Marshall Fire.

Adoption Year	I-Code Adoptions	NEC Adoptions
2001	2000 IBC, IRC, IFC, IECC	1999 NEC
2002		2002 NEC
2004	2003 IBC, IRC, IFC, IECC, and IEBC	
2007	2006 IBC, IRC, IFC, IECC, and IEBC	2005 NEC
2008		2008 NEC
2012	2012 IBC, IRC, IFC, IECC, and IEBC	2011 NEC
2015		2014 NEC
2017	2015 IECC	2017 NEC

Code history was selected for relevance to wildfire hazard mitigation and is not inclusive of all known building code adoptions. Available records for build code adoption history vary by jurisdiction.

Current WUI Code

Following the Marshall Fire, the Superior Town Board consulted WUI experts to consider applicable amendments to its residential building code. In May 2022, the Town Board directed the Town Attorney to prepare an ordinance detailing a residential WUI code. The WUI regulations considered include ignition-resistant and noncombustible building materials, roof and eave installation standards that minimize the exposure of wood sheathing, noncombustible or ignition-resistant decks, tempered or multi-layered glass windows, vents that have a mesh covering to prevent flame and ember penetration, a 5-foot zone of defensible space, and noncombustible fencing. However,

the Town Board ultimately declined to adopt a town-wide WUI code ("Information for Meeting of the Superior Board of Trustees", 2022).

In July 2022, the Sagamore neighborhood in Superior adopted WUI regulations guiding the use of ignition-resistant materials, noncombustible building materials, Class A fire resistance-rated roof assembly and defensible space to reduce wildfire risk. These regulations were adapted from the proposed town-wide WUI code; however, homeowners affected by the Marshall Fire have the option to "opt out" of these new WUI building code standards ("Town of Superior Ordinance No. O-13, 2022). By allowing homeowners affected by the Marshall Fire to "opt-out" of newer model codes, these measures could reduce protections for residents in the event of a future fire.

According to the Boulder County Hazard Mitigation Plan (2022), the Town of Superior plans to install fire and wind-resistant materials at the Water Treatment Plant, Wastewater Treatment Plant, the Community Center, Park Field Office, all Parks structures, and the Town Hall. Examples of these materials and retrofits include cement board, brick, metal roofs, concrete retaining structures, pour-in-place playground safety surfacing, attic venting, and leaf gutter covers. The Plan identifies the FEMA Building Resilient Infrastructure and Communities (BRIC) grant program as a potential funding source to cover the estimated $5 million cost.

Recovery And Repair

Superior has also made several regulatory changes aimed at facilitating expeditious and flexible rebuilding and recovery after the Marshall Fire. Some of these changes potentially reduce protections for residents in the event of a future fire.

Effective starting March 28, 2022, the 2021 IECC was adopted with appendices RB, CB, RD, and CD, encouraging the installation of renewable energy and electric-vehicle infrastructure for commercial and residential properties. Superior allows homeowners who owned the property at the time of the fire to "opt out" of the 2021 IECC and instead build to 2018 IECC standards (Town of Superior Ordinance No. O-2, 2022). Impacted homeowners who move to a different impacted property are still eligible to "opt out" of the 2021 IECC and instead apply the 2018 IECC standards to the new property (Town of Superior Ordinance No. O-7, 2022). As of February 2023, 70% of the residential building permits for homes damaged or destroyed by the Marshall Fire are designed to meet either the 2021 IECC, or a more energy efficient standard ("Majority of Permitted Rebuilds in Superior Choose Energy Efficiency", 2023).

Additionally, in April 2022, the Town of Superior reduced its side yard setback requirements for accessory and principal structures abutting a street or alley in low- and medium-density residential districts (Town of Superior Ordinance No. O-3, 2022). In April 2022, the Sagamore neighborhood also amended its height, setback, and elevation requirements to allow for more expeditious and flexible rebuilding after the Marshall Fire. Changes include increasing maximum building height and reducing minimum building setbacks for the front sides of the building (Town of Superior Ordinance No. O-5, 2022). Reducing the required setback distances could reduce protections for residents in the event of a future fire.

In May 2022, Superior also amended the 2018 IRC Section R313.2 to allow owners of single-family townhomes affected by the fire to "opt out" of the required automatic residential fire sprinkler system installation (Town of Superior Ordinance No. O-8, 2022). This change limits the wildfire hazard mitigation provisions of the 2018 IRC.

Superior also streamlined insulation permit applications for impacted homeowners by removing the permit fee and the requirements for submission of plans. Listed insulation requirements meet, and in some cases, exceed the energy efficiency requirements of the 2021 IECC. Xcel Energy offered rebates on home insulation replacement through June 30, 2022 ("Permits for Insulation Replacement", n.d.).

Finally, to offset the cost of rebuilding, Superior offers rebates equal to 47% of plan check and building permit fees and the Town's portion of use tax to residents rebuilding their homes after the Marshall Fire ("Permit Fees and Tax Rates", n.d.).

3.3. Additional Regulation Considerations - Energy Storage Systems

Both commercial and residential codes and standards provide fire safety protections for energy storage systems (ESS) but do not explicitly address the risk of wildfire. Within the fire safety standards for ESS, protections for Li-ion battery ESS are more limited.

Commercial Energy Storage Systems Regulations

The ICC publishes prescriptive requirements for ESS including specific requirements for fire-resistive construction, automatic fire sprinkler system protection, and detection and alarm system requirements. Within the I-Codes, the installation of ESS is controlled by the International Fire Code. Though these provisions govern the general fire safety, construction, and electrical installation requirements, they do not yet provide specific fire protection requirements for large-scale electrical storage systems using Li-ion batteries.

FM Global, in conjunction with NFPA's Fire Protection Research Foundation (FPRF) and the Property Insurance Research Group (PIRG), have undertaken several studies aimed at understanding the performance of Li-ion battery ESS in fires. Results have formed the basis of FM Global Data Sheet 5-33 and NFPA 855. Data Sheet 5-33 is used by FM Global to address risk at FM-insured properties, whereas NFPA 855 refers to UL 9540A, a test method designed to enable a standard approach to determine the fire and explosion risks of Li-Ion battery energy storage systems. The 2023 edition of NFPA 855 also includes Annex G, an informational Guide for Suppression and Safety of Li-Ion Battery Energy Storage Systems. These documents provide guidance on separation distances or barriers between multiple units in an energy-storage system consisting of multiple batteries, as well as the distances between racks and walls in storage areas or enclosures where these units are stored. They also provide the basis for the recommended sprinkler designs for the storage areas and enclosures. Note that these standards are intended to protect ESS from fire spread within the building or adjacent to ESS assets and may be insufficient to provide protection against a wildfire.

Residential Energy Storage Systems Regulations

ESS protection provisions are relatively new additions to the model building codes. Provisions for residential construction first appeared in Section R327 of the 2018 IRC. The provisions were significantly expanded in the 2021 IRC. Additional standards related to vehicle impact protection can be found in the California modifications to the 2021 IRC (i.e., Section R328 of the 2022 California Residential Code). NFPA 855 also provides fire safety protections for residential ESS in parallel with the 2021 IRC, including unit spacing, unit capacity limitations, fire detection, and location.

The most recent provisions of the 2021 IRC (R328 Energy Storage Systems) provide requirements for the following (summarized):

- **Listing and labeling**: ESS must be listed and labeled in accordance with UL 9540 standards and marked "for use in residential dwelling units".
- **Installation**: Installation to be in accordance with NFPA 70, inverters listed and labeled in accordance with UL 1741 or provided as part of the UL 9540 listing. If connected to the grid, inverters are to be compatible with the local utility's system.
- **Spacing**: Minimum spacing between units to be 3-feet (R328.3.1). Smaller separation distances allowed based on documented compliance with fire testing described in Section 1207.1.5 of the International Fire Code.
- **Permissible Locations**:
    - Detached garages and accessory structures.
    - Attached garages provided the garage is separated from the dwelling unit living space with a common wall that has a minimum of:
        - 1/2-inch gypsum wallboard applied to the interior side of the garage wall
        - 1/2-inch gypsum wallboard applied to interior side of garage walls, if the garage is separated by a distance of less than 3 feet
        - 5/8-inch gypsum board applied to ceilings where there is a habitable space above the garage
    - Outdoors on exterior side of exterior walls located at least 3 feet from any door or window directly entering the dwelling unit.
    - Enclosed utility closets, basements, storage, or utility spaces within dwelling units provided they meet certain fire resistance requirements and do not open directly into sleeping rooms.
    - No installations allowed in sleeping rooms.

- **Energy Ratings**: Maximum unit size is 20 kWh. The maximum system aggregated size is 80 kWh and differs based on location. Larger systems to be installed per Section 1207 of the International Fire Code.
- **Fire Detection:** Smoke alarms are required unless they are in areas where smoke alarms cannot be used because of their rating or listing. In this case, a heat detector interconnected to the smoke alarms is required.
- **Impact protection requirements**: Protection using approved barriers for installations potentially subject to vehicle impacts or damage.
- **Ventilation**: If the system produces hydrogen or other flammable gases during charging mechanical ventilation is required to keep gas levels below acceptable levels (See 2021 IRC Section M1307.4).
- **Electrical Vehicle Use to Power Dwelling Unit:** Attachment of a vehicle to power dwelling unit must comply with the vehicle manufacturer's instructions and NFPA 70.

3.4. Regulatory Gap Analysis

3.4.1. GAPS IN MODEL WUI CODES

While Colorado has or is in the process of developing and/or adopting wildfire safety codes and standards, many model WUI codes and standards are still missing key fire safety requirements and associated fire testing, design, construction, inspections and maintenance standards. This section provides a high-level gap analysis of wildfire safety codes and standards at state and local levels in Colorado, as well as at the national level. The analysis is based on industry understanding and knowledge of fundamental fire safety engineering first principles, well-established or codified fire/wildfire risk control measures, and other national/international best practices for mitigating wildfire risks. Risk control categories have been identified as essential components for achieving more comprehensive wildfire-risk mitigation designs based on traditional fire safety concepts and industry best practices in wildfire-risk mitigation. Table 9 lists the risk control categories and summarizes gaps in current wildfire safety codes and standards at the local levels in the impacted zones, and at the national level.

Table 9. Gaps in Wildfire Safety Regulations in Current Local and National Codes and Standards

Wildfire-Specific Risk Control Measures	Local Level Regulations: Louisville, CO (2018 ICC Codes & Amendments)	Local Level Regulations: Superior, CO (2018 ICC Codes & Amendments)	Local Level Regulations: Unincorporated Boulder County (2015 ICC Codes & Amendments)	IWUIC 2021 Edition	NFPA 1[1] 2021 Edition	NFPA 1140[2] 2022 Edition
1. Ignition Sources	-	-	-	✓	✓	✓
2. Structural Hardening	-	-	✓	✓	See NFPA 1144	✓
3. Defensible Space (Parcel-Level)	-	-	✓	✓	✓	✓
4. Fire Department Access	-	-	✓	✓	✓	✓
5. Means of Egress	-	-	-	-	-	-
6. Suppression Systems	-	-		✓	-	✓
7. Firefighting Water Supplies	-	-	✓	✓	✓	✓
8. Detection Systems	-	-	-	-	-	-
9. Emergency and Public Communication Systems	-	-	-	-	See NFPA 1144	✓
10. Emergency Power	-	-	-	-	-	-

Wildfire-Specific Risk Control Measures	Local Level Regulations: Louisville, CO (2018 ICC Codes & Amendments)	Local Level Regulations: Superior, CO (2018 ICC Codes & Amendments)	Local Level Regulations: Unincorporated Boulder County (2015 ICC Codes & Amendments)	IWUIC 2021 Edition	NFPA 1[1] 2021 Edition	NFPA 1140[2] 2022 Edition
11. Smoke Protection	-	-	-	-	-	-
12. Vegetation Management (landscape-level)	-	-	-	✓	✓	✓
13. Planning	-	-	-	-	✓	✓
14. Existing Building Hardening	-	-	-	-	See NFPA 1144	✓

[1] The planning, construction, maintenance, education, and management elements for the protection of life and property from wildfire shall meet the requirements of NFPA 1 Chapter 17 and NFPA 1144. Within this table, 'See NFPA 1144' refers to regulations that are not covered in Chapter 17 of NFPA 1 but are covered in NFPA 1144.

[2] As part of the Emergency Response and Responder Safety Document Consolidation Plan, as approved by NFPA Standards Council, NFPA 1140 is a combination of Standards NFPA 1051, NFPA 1141, 1143, and NFPA 1144.

Though unincorporated Boulder County does have some amendments for structural hardening, defensible space, etc., there are many wildfire-specific risk-control measures that are unaccounted for. Additionally, Louisville and Superior have not adopted WUI codes that include regulations requiring the above-mentioned wildfire-specific risk control measures. Should these jurisdictions adopt the IWUIC, which is currently the most likely WUI code to be adopted, wildfire specific risk control measures would be increased. As demonstrated in the table above, even should these jurisdictions adopt the IWUIC there are still gaps within the IWUIC.

There are also opportunities within "green" building codes to enhance energy efficiency while simultaneously reducing vulnerability to natural hazards. For example, multi-pane windows using tempered glass as the exterior pane can improve both a building's energy efficiency and fire resistance. The 2021 IWUIC Chapter 5 and NFPA 1144 Standard for Reducing Structure Ignition Hazards from Wildland Fire describes standards for fire-resistant exterior windows. Another potential dual benefit could arise from the construction of a tighter building enclosure (i.e., less air leakage through the building enclosure via walls, ceiling, widows, and doors). Less air leakage is ideal for energy efficiency and can help prevent wildfire smoke intrusion. Several houses in the area affected by the Marshall Fire experienced damage to interior finishes and contents by smoke entry into the building.

Some design options intended to add "green" value to the building can inadvertently make them more vulnerable to wildfire risk. For example, modest increases in wall insulation requirements and the desire to create homes that suffer less air leakage have resulted in the increased use of rigid foam insulation. Rigid sheet foam products are typically more flammable than fiberglass batt insulation and are often added to the exterior of a building. Despite its benefits for energy efficiency, additional research and testing may be required to determine this insulation's flammability compared to other insulation types, such as fiberglass batt insulation, and its impact on the spread of fire to and through buildings. Future editions of ICC and local green building incentives could provide an opportunity to maximize dual benefits and reduce conflicts with WUI codes and other wildfire safety design standards.

3.4.2. GAPS IN WILDFIRE TESTING STANDARDS

Few wildfire-specific test standards currently exist. Those that do exist are currently more focused on exterior fire exposure. According to the American Society for Testing and Materials (ASTM) International website, there are several wildfire-specific test standards in development, including those focused on under-deck flame impingement exposure and performance of gutter cover devices. Even with these standards that are in development, there are still significant gaps, including wildfire exposure to exterior roof and wall surfaces (Table 10).

Table 10. Gaps in Wildfire Fire Test Standards at National Level

Building Component	Fire Test Standard	Main Purpose of Test(s)	Exposure Condition: Interior Fire	Exposure Condition: Hydrocarbon Fire	Exposure Condition: Exterior Fire	Known Wildfire Gaps
Roof covering	ASTM E108: Standard Test Methods for Fire Tests of Roof Coverings	Measure fire spread			✓	▪ Fire test not explicitly designed for wildfire exposures ▪ Fire test does not account for weathering of materials prior to fire exposure
Roof covering	UL 790: Standard Test Methods for Fire Tests of Roof Coverings	Evaluate resistance of fire penetration from exterior			✓	Fire test does not account for weathering of materials prior to fire exposure
Roof construction, Wall construction, Floor construction, Columns, & Beams	ASTM E119: Standard Test Methods for Fire Tests of Building Construction and Materials	Evaluate duration for which building elements contain a fire and/or retain structural integrity (Fire resistance)	✓		✓	▪ Fire test not explicitly designed for wildfire exposures ▪ Fire test does not account for weathering of materials prior to fire exposure
Roof construction, Wall construction, Floor construction, Columns, & Beams	UL 263: Fire Tests of Building Construction and Materials		✓		✓	▪ Fire test not explicitly designed for wildfire exposures ▪ Fire test does not account for weathering of materials prior to fire exposure

Building Component	Fire Test Standard	Main Purpose of Test(s)	Exposure Condition: Interior Fire	Exposure Condition: Hydrocarbon Fire	Exposure Condition: Exterior Fire	Known Wildfire Gaps
Joint Systems	ASTM E1966: Standard Test Method for Fire-Resistive Joint Systems	▪ Evaluate ability of a fire-resistive joint system to undergo movement without reducing the fire rating of the adjacent fire separating elements ▪ Evaluate duration for which building elements contain a fire and/or retain structural integrity (Fire resistance)	✓	✓		▪ Fire test not explicitly designed for wildfire exposures ▪ Fire test does not account for weathering of materials prior to fire exposure
Vents (Roof, Roof Eave, Wall Vent)	ASTM E2886: Standard Test Method for Evaluating the Ability of Exterior Vents to Resist the Entry of Embers and Direct Flame Impingement	Evaluate the ability of exterior vents to resist the entry of embers and flame penetration through the vent			✓	▪ Fire test not explicitly designed for wildfire exposures ▪ Fire test does not account for weathering of materials prior to fire exposure ▪ Fire test does not evaluate ability of vents to limit entry of embers and flame penetration ▪ Fire test does not include evaluation of roof-ridge and off-ridge vents
Vents (Roof, Roof Eave, Wall Vent)	ASTM E2957: Standard Test Method for Resistance to Wildfire Penetration of Eaves, Soffits and Other Projections	Monitor the fire characteristics and the ability of eave overhangs and other projections to resist exterior fire penetration from underneath under the specified fire exposure conditions			✓	▪ Fire test does not account for weathering of materials prior to fire exposure ▪ Fire test does not account for impact of typical wildfire conditions (i.e., high wind & flying debris)

Building Component	Fire Test Standard	Main Purpose of Test(s)	Exposure Condition: Interior Fire	Exposure Condition: Hydrocarbon Fire	Exposure Condition: Exterior Fire	Known Wildfire Gaps
Interior Finishes	ASTM E84: Standard Test Method for Surface Burning Characteristics of Building Materials	Measure burn characteristics (i.e., smoke development and flame spread)	✓			▪ Fire test not explicitly designed for wildfire exposures ▪ Fire test does not account for weathering of materials prior to fire exposure
Interior Finishes	UL 723: Standard for Test for Surface Burning Characteristics of Building Materials	Measure burn characteristics (i.e., smoke development and flame spread)	✓			▪ Fire test not explicitly designed for wildfire exposures ▪ Fire test does not account for weathering of materials prior to fire exposure
Interior Finishes	ASTM E2768: Standard Test Method for Extended Duration Surface Burning Characteristics of Building Materials (Fire Retardant Treated Wood)	Measure burn characteristics (i.e., smoke development and flame spread)	✓			▪ Fire test not explicitly designed for wildfire exposures ▪ Fire test does not account for weathering of materials prior to fire exposure
Interior Finishes	NFPA 286: Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth	Determine the contribution of interior finish materials to room fire growth during specified fire exposure conditions	✓			Fire test does not account for weathering of materials prior to fire exposure

Building Component	Fire Test Standard	Main Purpose of Test(s)	Exposure Condition: Interior Fire	Exposure Condition: Hydrocarbon Fire	Exposure Condition: Exterior Fire	Known Wildfire Gaps
Exterior Finishes	NFPA 285: Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components	Determine the flammability characteristics of exterior non-load-bearing wall assemblies or panels			✓	▪ Fire test not explicitly designed for wildfire exposures ▪ Fire test does not account for weathering of materials prior to fire exposure
Exterior Finishes	NFPA 268: Standard Test Method for Determining Ignitability of Exterior Wall Assemblies Using a Radiant Heat Energy Source	Measure the ignitability characteristics of exterior wall assemblies and their potential of contributing to fire growth			✓	▪ Fire test not explicitly designed for wildfire exposures ▪ Fire test does not account for weathering of materials prior to fire exposure
Exterior Finishes	ASTM E2707: Standard Test Method for Determining Fire Penetration of Exterior Wall Assemblies Using a Direct Flame Impingement Exposure	Measure the ability of the exterior wall covering material or system to resist fire penetration from the exterior to the unexposed side of the wall assembly under the specified conditions of exposure			✓	▪ Fire test is specified for WUI ▪ Fire test does not account for weathering of materials prior to fire exposure
Doors	ASTM E2074: Standard Test Method for Fire Tests of Door Assemblies, Including Positive Pressure Testing of Side-Hinged and Pivoted Swinging Door Assemblies	Determine the ability of door assemblies to function as a fire-resistive barrier during a standard fire endurance test	✓		✓	▪ Fire test not explicitly designed for wildfire exposures ▪ Fire test does not account for weathering of materials prior to fire exposure

Building Component	Fire Test Standard	Main Purpose of Test(s)	Exposure Condition: Interior Fire	Exposure Condition: Hydrocarbon Fire	Exposure Condition: Exterior Fire	Known Wildfire Gaps
Doors	NFPA 252: Standard Methods of Fire Tests of Door Assemblies	Determine the ability of door assemblies to function as a fire-resistive barrier during a standard fire endurance test	✓		✓	▪ Fire test not explicitly designed for wildfire exposures ▪ Fire test does not account for weathering of materials prior to fire exposure
Doors	UL 10C: Positive Pressure Fire Tests of Door Assemblies	Determine the ability of door assemblies to function as a fire-resistive barrier during a standard fire endurance test	✓		✓	▪ Fire test not explicitly designed for wildfire exposures ▪ Fire test does not account for weathering of materials prior to fire exposure
Doors	UL 10B: Standard for Fire Tests of Door Assemblies	Determine the ability of door assemblies to function as a fire-resistive barrier during a standard fire endurance test	✓		✓	▪ Fire test not explicitly designed for wildfire exposures ▪ Fire test does not account for weathering of materials prior to fire exposure
Windows & Skylights	NFPA 257: Standard on Fire Test for Window and Glass Block Assemblies	Measure how well window and glass block assemblies prevent or slow the spread of fire			✓	▪ Fire test not explicitly designed for wildfire exposures ▪ Fire test does not account for weathering of materials prior to fire exposure

3.4.3. STRUCTURAL HARDENING GAPS IN CODES

In addition to structural hardening provisions that are already well-established (e.g., roof classifications, boxed eaves, façade materials, vent protection, decking requirements) in nationally recognized wildfire safety codes (e.g., IWUIC, NFPA 1140 or California Building Code (CBC) Chapter 7A), observations in the field highlighted a variety of new or not well-established vulnerabilities in the building envelope. These additional vulnerabilities are based on fundamental fire safety principles that are well known in building and fire codes for interior fire scenarios but are yet to be accounted for in exterior wildfire scenarios.

One main gap in current wildfire safety regulations is the critical importance of maintaining the integrity and continuity of the exterior building envelope to wildfires, especially as the wildfire risk expands into urban areas due to climate change. This means that the exterior features of the building should not only be comprised of fire-resistant exterior building elements, components, and assemblies, but also appropriate fire-resistant joint protection systems, interface details, and other membrane and through-penetration systems. It is at the joints and interfaces of exterior building elements/components where flames, hot gases and embers can readily enter the interior or interstitial spaces of a home or building leading to ignition.

Another gap in wildfire safety regulations is the need to address fire hazards, risks and associated mitigation approaches for new technologies such as residential solar panel installations and associated battery storage systems (which are often mounted/attached to the exterior of a home). Details about vulnerabilities of joint systems have been discussed in Sections 5.2.2, 0.0.0, and 5.2.5 above.

For more information, refer to Marshall Fire MAT documents *Homeowner's Guide to Risk Reduction and Remediation of Residential Smoke Damage* (Appendix D), *Homeowner's Guide to Reducing Risk of Structure Ignition from Wildfire* (Appendix E) and *Wildfire Resilient Detailing, Joint Systems, and Interfaces of Building Components* (Appendix J) for additional information.

3.4.4. OTHER RELEVANT GAPS IN WILDFIRE CODES AND STANDARDS

There are a number of additional regulatory gaps not focused on testing standards that have been previously identified in the FEMA White Paper on Community Wildfire Resilience (Volume 2). See Table 11 for information regarding these identified gaps.

Table 11. Additional Gaps in Relevant Wildfire Safety Codes, Standards and Guidance Documents

Wildfire-Specific Risk Control Measures	Identified Gap
Existing Building Hardening	Limited resources for retrofitting existing building stock.
Fire Department Access	▪ Limited road design criteria during evacuations to account for emergency vehicle access.

Wildfire-Specific Risk Control Measures	Identified Gap
	▪ Limited right-of-way access and/or exemptions to environmental reviews for vegetation management of primary and secondary access/egress roads.
Means of Egress	▪ Limited resources to support equitable and inclusive evacuation for all populations. ▪ Limited guidance on decision making and planning tools for evacuation orders/warnings vs. shelter in place. ▪ Lack of guidelines for planning and preparedness for evacuation. ▪ Limited guidance for number, capacity, and separation of evacuation roadways.
Suppression Systems	▪ Lack of design criteria, performance specification, operations, long-term maintenance, testing and inspections for exterior sprinkler systems, hydrants, and associated water supplies for wildland/WUI firefighting operations. ▪ Lack of design criteria and performance specifications for special suppression systems and associated water and chemical supplies.
Firefighting Water Supplies	▪ Design criteria, performance specification, operations, long-term maintenance, testing and inspections for independent water supplies. ▪ Lack of design criteria, guidance and standards for first aid firefighting equipment, water/power supplies and training.
Detection Systems	▪ Limited guidance on early warning detection systems design criteria, performance specification, operations, long-term maintenance, testing and inspections. ▪ Lack of wildfire detection systems test standard.
Emergency Power	Lack of regulations, designs standards and performance specifications, operations, long-term maintenance, testing and inspections for micro-grids.
Planning or Entitlement Phase	▪ Limited guidance on design principles for wildfire resilience community/urban planning. ▪ Limited guidance on communal defensible space best practices. ▪ Limited trauma informed principals for planners, engineers, and other technical professionals working with communities during post wildfire disaster recovery and re-building. ▪ Limited design guidance, performance criteria, construction practices and operational procedures for construction, use, and maintenance of temporary refuge areas or shelters-in-place.
Externally Applied Fire-Resistant Material(s)	Lack of wildfire testing standard for use of externally applied chemical retardants, foam gels and other similar materials to achieve fire resistance of exterior building components.

Chapter 4: Marshall Fire Observations –Community and Neighborhood/Subdivision Level

Observations in this report are scaled by overall community level, neighborhood/subdivision level and individual parcel/building level, as illustrated in Figure 15. This chapter focuses on community- and neighborhood/subdivision level observations.

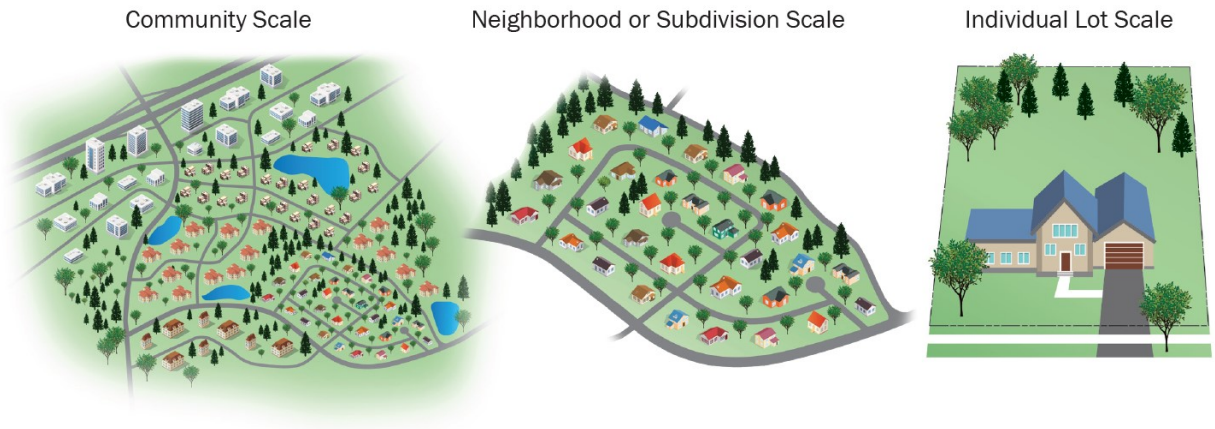


Figure 15. Visualization of community-, neighborhood- or subdivision-, and individual lot scale.

From a land use planning and design perspective, most of the homes and residential neighborhoods that were damaged or destroyed during the Marshall Fire had community-scale planning and design features that introduced unique wildfire vulnerabilities that increased their risk to wildfire hazards and impacts (Figure 15). These community-scale vulnerabilities can be grouped into three main categories:

- **Community-Scale Vulnerability #1:** Proximity to large, uninterrupted, mostly unmanaged open space.
- **Community-Scale Vulnerability #2:** Interwoven flood mitigation including water drainage ditches, greenbelts, and recreational spaces into urban development.
- **Community-Scale Vulnerability #3:** Semi-rural areas intermixed with grassland and shrubland vegetation.

Community-Scale Vulnerability #1 – The point(s) of origin of the Marshall Fire occurred in primarily rural, undeveloped lands in unincorporated Boulder County adjacent and intermixed with large, mostly unmanaged open space/wildlands on the outskirts of suburban Louisville and Superior. Due

to this remote and undeveloped nature of the ignition points, coupled with the extreme winds at the time (i.e., over 100 mph), the fire was able to rapidly spread at uncontrollable levels and with little warning, growing to thousands of acres over moderately flat terrain (Figure 16). Because of these conditions, there was also little opportunity for first responders to contain and suppress, the fire before reaching more densely populated areas. If fire is able to travel uninterrupted or uncontained, it is able to gain in intensity, making it more challenging for first responders to manage. This inherent vulnerability of mostly unmanaged open spaces directly adjacent to or in close proximity to the built environment (in other words, the WUI) was evident by the disproportionate devastation observed in those communities that bordered on these types of open spaces, as was the case in the Sagamore neighborhood of Superior.

Figure 16 shows the open space just west of the Sagamore neighborhood at the WUI, pre- and post-fire. It was along this interface between development and mostly unmanaged open space where the Marshall Fire directly ignited combustible fuel loads in a suburban-urban environment. Property line fences and wood decking, along with highly flammable vegetation, led to the ignition of houses in this neighborhood. It was also along this interface where the wildfire transitioned into an urban conflagration, leading to the destruction of the neighborhood, and contributing to subsequent ignitions in adjacent neighborhoods. Similar phenomena were also observed in other residential areas in Superior within the WUI.



Figure 16. Example of typical unmanaged open space in the WUI of the Sagamore neighborhood in Superior, Colorado.

Community-Scale Vulnerability #2 – In addition to more “traditional” vulnerabilities of WUI described above, other community-scale wildfire vulnerabilities were also observed. The MAT observed the presence of several natural and man-made vegetative planning features as discussed in Section 1.3.3 (i.e., water drainage ditches, greenbelts, and recreational spaces) that are contiguous with traditional wildlands/WUI, but also interwoven and extending into several communities throughout the impacted areas and adjacent neighborhoods. These planning features, while providing valuable services to communities (e.g., flood control and mitigation, recreation, scenic views), also created

pathways that readily channeled wildfire deeper into the built environment while also exacerbating localized wind speeds and fire intensities due to the natural topography (e.g., “chimney-like” conditions or steep slopes) and the density of biomass that typically flourishes in these natural or man-made features. These “fire superhighways” provided pathways for fire to readily spread into the urban-suburban landscape from the more traditional open/wildland spaces. This was observed in several neighborhoods in Louisville, Superior, and unincorporated Boulder County (Figure 17), including:

- In Louisville, wildfire travelled rapidly along Davidson Mesa into The Enclave and Centennial 6,7,8 neighborhoods and into Coal Creek neighborhoods via Coal Creek.
- In Superior, wildfire travelled rapidly along the Coal Creek drainage into Old Town and Discovery Park, and via multiple drainages that enter the Rock Creek neighborhood near McCaslin.
- In unincorporated Boulder County, wildfire travelled rapidly along Davidson ditch and Goodhue ditch into several neighborhoods.

These urban geographic features (e.g., drainages, greenbelts) can produce significant embers from burning vegetative fuels, including grasses, shrubs, and timber/woody plants. These areas can also be sources of surface and ladder fuels that provide wildfire flow paths which can ignite decks, fences, or other combustible fuels along the WUI and well into the urban-suburban environment, leading to urban conflagration (Figure 18).

This also illustrates the mitigation practices for one natural hazard, in this case flood, may affect the performance of the area in another natural hazard, in this case fire. Boulder County experienced a widespread flooding disaster due to extended periods of rain in September and October 2013. Significant flood mitigation activities were completed following the flood including positive drainage paths.

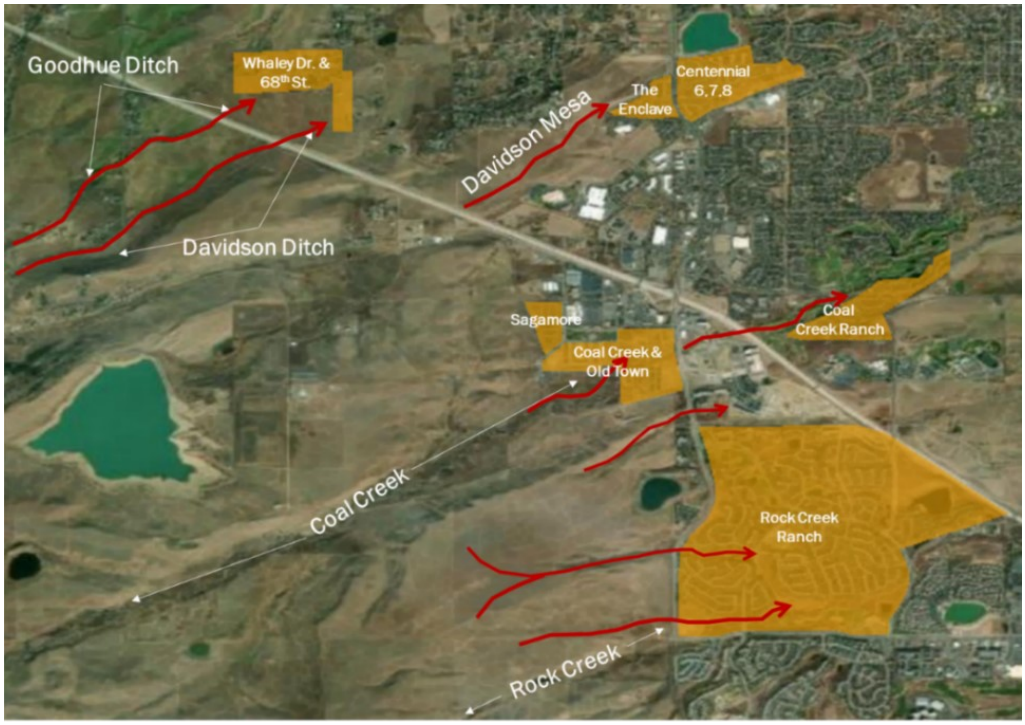


Figure 17. Neighborhoods with homes damaged/destroyed by fire spreading (red arrows) along observed drainage ditches & greenbelts.



Figure 18. Examples of Rock Creek drainage from Rock Creek Ranch (left) and Davidson Ditch (right).

Community-Scale Vulnerability #3 – In semi-rural areas of Unincorporated Boulder County intermixed with grassland and shrubland vegetation (as discussed in Section 1.3.3), the MAT observed significant residential building damage and destruction caused by the combination of wind-driven effects, drainage ditches, intermixed wildland fuels, and large, uninterrupted, mostly unmanaged open spaces with high amounts of biomass (Figure 19). This was observed in the neighborhoods off South Vale Road, along Marshall Road, in the Whaley Drive area, and around Spring Drive/Panorama Drive down into the Empire Drive area.




Figure 19. Examples of residences intermixed with wildland fuels in unincorporated Boulder County.

These three community-scale wildfire vulnerabilities, while observed in the impacted areas of the Marshall Fire, were also observed throughout adjacent communities/neighborhoods. Refer to Chapter 3 for how these land use planning and community-scale wildfire vulnerabilities are currently addressed in local land use planning codes, building and fire codes, standards and/or guidance documents.

4.1. Management of Parks and Other Common Spaces

The majority of the observed open spaces, drainage ditches, greenbelts and recreational spaces adjacent to, intermixed or interwoven with the rural and urban/suburban communities in the impacted areas of the Marshall Fire did not appear to have a long-term, wildfire-specific land resource management strategy. Such a strategy would help prevent, mitigate and/or manage vegetative fuel loads, particularly high hazard vegetation, adjacent to suburban/urban development.

Creating a long-term, wildfire-specific land resource management strategy may be a challenge due to the diverse set of stakeholders and jurisdictions responsible for managing these public and private land use spaces such as municipal parks, Boulder County open spaces, Boulder County conservation areas, and jointly managed county/city open space. Limited resources, limited wildfire-specific land use management and/or multi-hazard codes, and standards and guidance documents, etc. may also present challenges.

Regardless of the mixture of underlying financial, administrative, or legal constraints, the MAT observed that these natural and man-made land use features (i.e., mostly unmanaged, or minimally maintained vegetation in various open spaces, drainage ditches, etc.) amplified not only the intensity and behavior of the wildfire, but also the associated impacts to the surrounding communities. Conversely, where vegetation was well maintained (e.g., irrigated, mowed, trimmed back) fire intensity, spread, and associated damage were reduced.

Guidance on Best Management Practices & Recommended Plants

A range of best management practices (BMPs) for community-scale vegetation management are available through Colorado State University and the CSFS. While there is not a specific recommended fire-resistant plant list for Boulder County, the Colorado State University Cooperative Extension Service has developed a comprehensive Colorado list of fire- resistant plant, shrub, and tree species available at many nurseries which, combined with defensible space landscaping management practices, can reduce fire risk. The list includes species suggestions and maintenance requirements (Colorado Extension Service, 1999). It is always better to make native plant choices but even some native plants are highly flammable and will burn if they are not properly maintained.

While guidance resources are available (see reference box below), the MAT observed that application of these BMPs is not consistently implemented among land resource managers, homeowner associations (HOAs) and other managers of large open spaces and greenbelts.

Best Management Practices for Vegetation Management

- Colorado State Forest Service. (1999). Fire-Resistant Landscaping. https://extension.colostate.edu/docs/pubs/natres/06303.pdf
- Colorado State Forest Service. (2023). Urban and Community Forestry. https://csfs.colostate.edu/forest-management/community-urban-forestry/
- Colorado State University Extension. (2012). FireWise Plant Materials – 6.305. https://extension.colostate.edu/wp-content/uploads/2022/02/6.305-FireWise-Plant-Materials.pdf
- Boulder County. (2022). Prescribed Burn Projects. https://bouldercounty.gov/open-space/management/prescribed-burns/
- Wildfire Information Network Community of Practice - Surviving-Wildfire (2019). Selecting Firewise Plants. https://surviving-wildfire.extension.org/selecting-firewise-plants/

Invasive & Highly Flammable Plants

Invasive plants can have a higher potential for ignition than native vegetation because they often produce more flashy fuels which ignite and burn quickly (University of California Agriculture and Natural Resources, 2022). Invasive trees and shrubs typical within Boulder County include Trees of Heaven, Russian Olive, and Tamarix. Observed highly flammable tree species in eastern Boulder County include arborvitae, cedar, several species of juniperus and pinus, Douglas fir, spruce, cypress, and yew. Common ground covers such as cheat grass and pampas grass are also extremely flammable in dry conditions and were observed to be present. Many fire jurisdictions within high wildfire-prone areas have a list of common plants that are prohibited for use, but this local guidance is currently limited or unavailable in unincorporated Boulder County, Louisville and Superior, Colorado.

4.2. Local Wildland Interface and Multi-Hazard Conditions

The Marshall Fire exemplifies a multi-hazard wildfire event in which other natural hazards (i.e., high winds and drought conditions), influence the risk and behavior of the fire.

Traditionally, hazard mitigation plans such as the Boulder County Hazard Mitigation Plan approach natural hazards as singular, unrelated events; however, jurisdictions impacted by the Marshall Fire are beginning to integrate multi-hazard interactions into their wildfire recovery and mitigation strategies. Examples include:

- The Town of Superior plans to install fire and wind-resistant materials and hazard-resistant modifications to "harden" several public facilities (Boulder County Hazard Mitigation Plan, 2022).
- Boulder County co-developed the multi-jurisdictional Disaster Assistance Center in Lafayette, Colorado to support residents and businesses damaged by the fire and high winds. Approximately 16% of the $9,221,421 in financial assistance distributed to impacted households covers wind damage ("Marshall Fire Recovery Milestones", n.d.).

Jurisdictions impacted by the Marshall Fire are also exploring mitigation strategies that can be applied to the landscape, community, and parcel levels to provide comprehensive protection for buildings and reduce wildfire risk in grasslands, parks, and open space. Many of these strategies can be adapted to address the impacts of events like the Marshall Fire. These strategies include but are not limited to:

- Mechanical Fuel Maintenance
- Prescribed Fire
- Prescribed Grazing
- Fire and Fuel Breaks
- Defensible Space
- Ignition-Resistant Construction
- Fire-Resistant Construction
- Homeowner Flood and Debris Flow Mitigation Techniques

For example, parcel-level ignition-resistant construction can be combined with community fuel breaks and landscape-level fuel management, such as prescribed grazing, to combat the combined effect of dry fuels and strong winds. Louisville has combined several of these strategies. In addition to publishing a homeowner's guide to ignition-resistant construction, the city has also begun to mow high-risk public lands adjacent to private properties twice yearly ("City, Boulder County Continue to Make Progress on Fire Mitigation Efforts", n.d.). The Boulder County CWPP also details fuel break design recommendations specific to Colorado's arid climate; although not explicitly tied to multi-hazard events, this strategy is an example of adapting an existing wildfire mitigation technique to address a multi-hazard wildfire risk.

There are additional untapped opportunities to incorporate multi-hazard mitigation into comprehensive planning and wildfire mitigation including the 2023 update to the Boulder County

CWPP, Louisville's forthcoming Wildfire Mitigation Plan for City Public Lands, and other open space strategic and comprehensive plans. According to data and interviews collected by the MAT, high winds limited early firefighting operations, making traditional and advanced fire suppression options unsafe. While firefighters were able to employ effective alternatives, there may be additional opportunities to review and bolster fire suppression and response strategies for future high wind and fire events. Additionally, while they are not used extensively in the Western U.S., parcel-level windbreaks have been used in combination with other strategies to limit the speed and progression of low-intensity wildfires (South Australia County Fire Service; Country Fire Authority, n.d.).

Finally, while not a significant risk post-Marshall Fire, communities in wildfire-prone areas can use a combination of landscape maintenance and parcel-level building strategies to mitigate the risk of post-wildfire flooding and landslides. Following the Fourmile Canyon Fire, Boulder County proposed a combination of in-channel, slope stabilization, and erosion control techniques to reduce damage from flooding and debris flow across the burned areas ("Fourmile Canyon Fire Maps", n.d.).

Chapter 5: Marshall Fire Observations – Parcel and Building Level

As indicated in Chapter 2, most of the homes and neighborhoods damaged or destroyed in unincorporated Boulder County, Louisville and Superior were not required by local building and fire codes to satisfy WUI fire safety requirements. As such, well-established and well-known wildfire safety provisions for structural hardening (e.g., roof classifications, boxed eaves, façade materials, vent protection, decking requirements) and defensible space (or "landscaping") found in nationally recognized codes such as the IWUIC were not explicitly required or provided for most of the homes in the impacted areas. Additional vulnerabilities were also observed due to construction detailing that are not well-established and are known gaps in current WUI codes and standards.

5.1. Parcel-Level Wildfire Vulnerabilities

This section summarizes parcel-level observations of deficiencies in well-established defensible space practices that likely contributed to fire readily spreading from nearby wildland/open spaces or from adjacent structures to the home.

5.1.1. COMMON PARCEL-LEVEL LANDSCAPING ISSUES

Most of the damaged or destroyed homes and neighborhoods in unincorporated Boulder County, Louisville, and Superior were not required by local building and fire codes or planning ordinances to satisfy WUI fire safety requirements. As such, well-established and well-known wildfire safety provisions for defensible space found in nationally recognized codes such as the IWUIC were not explicitly required, enforced, or maintained for most of the residences.

Most homes and residences throughout the fire footprint had a range of defensible space deficiencies. Some of the more common deficiencies observed in the field, described in Table 12 included:

- Combustible mulches
- Woodpiles
- Trash and recycling receptacle storage locations
- Overgrown or unmanaged vegetation
- Hazardous plants and vegetative debris
- Clustering of trees and shrubs

Table 12. Examples of Common Landscape Issues.

Landscape Feature	Description	Observed Vulnerabilities
Combustible Mulches	Many parcels throughout the impacted communities contained combustible mulches immediately adjacent to structures (0–5 feet, HIZ Zone 0). Common landscape mulches included pine straw, shredded cypress wood and bark, and pine bark chunks. Use of combustible mulches were also observed in several communities actively in the recovery and rebuilding periods. Overgrown or minimally maintained landscaped beds with mulches may contribute to wildfire spread to structures or serve as an ignition source.	
Woodpiles	Firewood and other organic combustible materials (e.g., leaf piles) were frequently observed abutting or immediately adjacent to homes. Woodpiles and other organic materials are highly susceptible to ember ignition during a wildfire and present a major hazard for structure ignition when stored within the HIZ, particularly within 0–5 feet of the home.	
Trash and Recycling Receptacles	Stored waste, recycling receptacles and other non-organic fuel loads (e.g., plastic sheds, grills, lawnmowers) were observed immediately adjacent to structures. These receptacles and other high hazard fuel loads often contain combustible and flammable waste or fluids.	

Landscape Feature	Description	Observed Vulnerabilities
Overgrown Trees	Most neighborhoods in and immediately adjacent to the impacted areas of the fire did not have well maintained local landscaping or defensible space. Overgrown trees, grasses, and shrubs, as well as numerous high hazard plant species (e.g., juniper bushes, Italian cypress) were observed on a substantial number of properties within the HIZ, but particularly within the 0–5 feet of homes. Poorly maintained trees and shrubs (e.g., trees not "limbed-up" from surface fuels or hanging over roofs) directly adjacent to structures provide a path of fuel for wildfire to encroach on the home, leading to ignition.	
Hazardous Plants and Debris	Hazardous plants that had not been maintained were observed throughout the community. Plants that have not been watered or trimmed are vulnerable to ignition and are able to burn more readily when ignited.	
Clustering of Trees and Shrubs	Trees and shrubs that were densely clustered were found throughout many impacted or adjacent residential neighborhoods. Densely spaced vegetative fuels may contribute to wildfire spread by providing an uninterrupted path of fuel as well as ladder fuels which allow fire to spread to taller vegetation and structures.	

These common parcel-level landscaping features and vulnerabilities are also summarized in Table 13 based on the defensible zone in which they were observed.

Table 13. Examples of MAT observed hazardous landscaping by defensible zone.

Zone	Typical Features	Observed Vulnerabilities
Zone 0 (0–5 feet): "Ember-resistant Zone" or "Immediate Zone"	Defensible space within Zone 0 was rarely observed to be established	▪ Combustible mulches ▪ Overgrown trees adjacent to homes ▪ Woodpiles, trash, and recycling bins adjacent to homes
Zone 1 (5–30 feet): "Lean, Clean, and Green Zone" or "Intermediate Zone"	Defensible space within Zone 1 was not observed to be established throughout communities impacted by the Marshall Fire	▪ Combustible mulches, debris, and other ladder fuels ▪ Overgrown trees adjacent to homes ▪ Clustering of trees and shrubs ▪ Outbuildings within Zone 1
Zone 2 (30–100 feet): "Reduced Fuel Zone" or "Extended Zone"	▪ Fuel breaks in vegetation were not observed within Zone 2 ▪ Parcels commonly unable to accommodate 100 feet of defensible space	▪ Limitations in parcel sizes ▪ Adjacent to other properties ▪ Overgrown vegetation ▪ Closely spaced trees ▪ Little to no defensible space ▪ Outbuildings

Conversely, Figure 20 shows an example of an undamaged residence in Old Town Superior, which likely survived due to sufficient defensible space and structure-to-structure separation.



Figure 20. Example of a single-family home in Old Town in Superior, Colorado where ample defensible space and structure-to-structure separation likely contributed to its survival when numerous structures in the neighborhood were completely destroyed.

5.1.2. COMMUNAL DEFENSIBLE SPACE

Small parcel sizes were observed throughout the impacted and unimpacted neighborhoods of the Marshall Fire. Most of the impacted neighborhoods consisted of parcels/lots of sizes that precluded homeowners from satisfying best practices in defensible space on their own property. This resulted in numerous instances where residences were in close proximity (e.g., within 5–30 feet) of their property line or their neighbor's home with insufficient defensible space on their own property, compounded by a lack of fuel treatments or other forms of defensible space on the adjacent neighbor's property. Figure 21 shows an example of a residential neighborhood in Louisville, where numerous homes have small lot sizes preventing individual homeowners from achieving defensible space on their parcel. It also shows an example of overgrown vegetation between homes, which makes homes on either side of the property line susceptible to spot fire ignitions due to embers, which may lead to structure ignition and structure-to-structure fire spread.



Figure 21. Example of single-family residences in Louisville, Colorado with 5–8 feet to the respective property lines (right) and significant overgrown vegetation typical within Zone 0 and 1 of both homes' defensible space zones (left). Both homes are vulnerable to spot fires from embers or structure-to-structure fire spread due to poor vegetation management in the mutually shared defensible space.

5.1.3. PARCEL-SCALE STRUCTURE FIRE SEPARATIONS

Many of the communities impacted by the Marshall Fire featured structures and buildings that were densely spaced with limited fire separation distances (i.e., less than 30 feet of separation). At the time of the fire, local planning, building and fire codes did not recognize most of these communities as being within the WUI or incorporate wildfire hazard and risk assessments as part of the planning or development process. According to a study conducted by Colorado Division of Fire Prevention and

Control, approximately 25% of the residences in the impacted areas—those both directly exposed to wildland/open space fuels and those inboard of the wildland interface)—had less than 10 feet of separation from an adjacent property, while at least 78% of impacted residences had their entire Zones 0 and 1 (0–30 feet) of their defensible space shared with an adjacent property. Note: This overlap of sharing of defensible space increased to 91% for residences indirectly exposed to wildland or open space fuels (Colorado Division of Fire Prevention and Control, 2022).

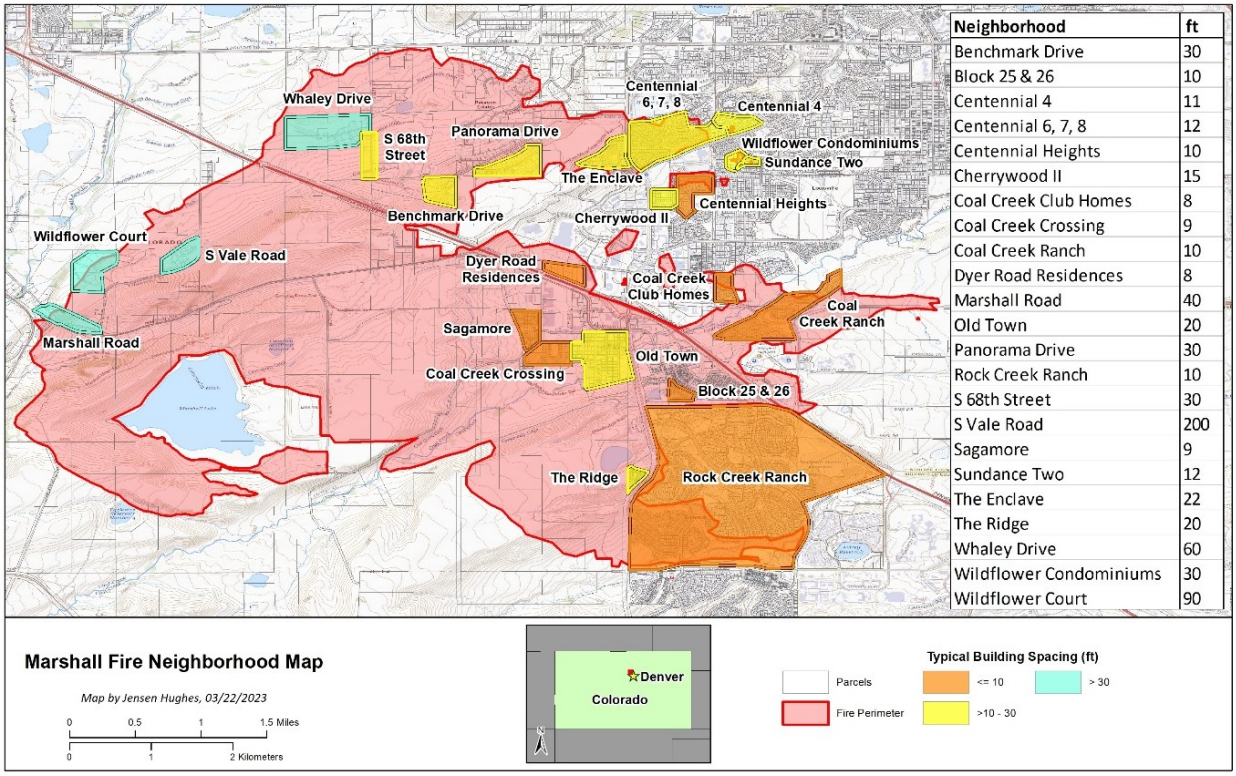
Figure 22 and Figure 23 show typical residential lot configurations where residential buildings are closely spaced (i.e., 8–30 feet apart). Figure 24 illustrates the minimum separation distances between residential buildings by impacted neighborhood.



Figure 22. Example of limited separation distances between residential buildings in Coal Creek Crossing in Superior Colorado.



Figure 23. Additional example of limited separation distances between residential buildings in the Sagamore neighborhood in Superior, Colorado.



Neighborhood	ft
Benchmark Drive	30
Block 25 & 26	10
Centennial 4	11
Centennial 6, 7, 8	12
Centennial Heights	10
Cherrywood II	15
Coal Creek Club Homes	8
Coal Creek Crossing	9
Coal Creek Ranch	10
Dyer Road Residences	8
Marshall Road	40
Old Town	20
Panorama Drive	30
Rock Creek Ranch	10
S 68th Street	30
S Vale Road	200
Sagamore	9
Sundance Two	12
The Enclave	22
The Ridge	20
Whaley Drive	60
Wildflower Condominiums	30
Wildflower Court	90

Figure 24. Minimum separation distances between residential buildings by impacted neighborhood in Superior and Louisville, Colorado.

Fire Ratings for Residential Exterior Walls

Current building codes do not typically require fire resistance ratings for exterior walls for single-family residences, almost regardless of fire separation distances to adjacent properties or structures. Fire rated exterior walls are required where the separation distance is five feet or less to the property line. This code exception on fire separation walls for single-family residences significantly increases the risk of structure-to-structure fire spread (or urban conflagration) particularly in a wind-driven wildfire incident.

Current building and fire codes are based on the presumption that fire suppression resources will provide structure protection to limit structure-to-structure fire spread under normal interior building fire scenarios. However, during a large wildfire or wind-driven fire incident, fire suppression strategies may be limited and unable to provide structure protection for many homes and businesses in the path of the wildfire due to limited road access, unsafe conditions for firefighters, and/or insufficient resources and staffing for the size of the fire.

5.2. Building-Level Wildfire Vulnerabilities

This section of the report summarizes observations of structural hardening vulnerabilities (from the top of the structure down) that are already well-established and well-known points of weakness, as

well as new areas of concern observed during the MAT in the exterior envelope of a building or home. Table 14 presents a summary of risk for each building component of the exterior envelope.

Table 14 . Summary of Risk for Each Building Component of the Exterior Envelope.

Category	Building Component of Exterior Envelope	Relative Risk Ranking	Section Reference
Roof Components	Roof construction and coverings	Very High	5.2.1
Roof Components	Roof Vents	Very High	5.2.1
Roof Components	Chimneys	Medium	5.2.1
Roof Components	Solar Panels	Medium	5.2.1
Roof Components	Gutters	Medium	5.2.1
Roof Joint Systems	Roof-to-roof joints	High	5.2.2
Roof Joint Systems	Skylight-, chimney-, and vent-to-roof joints	Medium-High	5.2.2
Roof-to-Exterior Wall Components	Edge of roof detailing	Very High	5.2.3
Roof-to-Exterior Wall Components	Soffit and Soffit Vents	Very High	5.2.3
Roof-to-Exterior Wall Components	Head-of-wall to joints	Very High	5.2.3
Exterior Wall Components	Exterior wall construction and cladding	Very High	5.2.4
Exterior Wall Components	Garage doors	Medium	5.2.4
Exterior Wall Components	Fenestration and glazing	High	5.2.4
Exterior Wall Components	Tenant separation walls	Medium	5.2.4
Exterior Wall Components	Vents in exterior walls, crawlspaces, and basements	Very High	5.2.4
Wall System Joints	Wall-to-wall interfaces	High	5.2.5
Wall System Joints	Window-to-wall joints	Medium	5.2.5
Wall System Joints	Door-to-wall joints	Medium	5.2.5
Wall System Joints	Bottom-of-wall to foundation joints	Very High	5.2.5
Bottom of Exterior Wall Detailing	Bottom of Exterior Wall Detailing	Very High	5.2.6
Foundations	Foundations	Low	5.2.7
Attachments	Patios, decks, and balconies	Very High	5.2.8
Attachments	Fences	Very High	5.2.8

Category	Building Component of Exterior Envelope	Relative Risk Ranking	Section Reference
Smoke and Ash Infiltrations	Smoke and Ash Infiltrations	Low-Medium	5.2.9
Energy Storage Systems	Energy Storage Systems	Low-Medium	5.2.10

5.2.1. ROOF COMPONENTS

As previously discussed in Chapter 3, Boulder County was and still is divided into two wildfire safety regulatory zones based on relative risk of wildfires in those geographies—Wildfire Zone 1 and Wildfire Zone 2 as shown earlier in Figure 14. Wildfire Zone 1 is generally the mountains and more forested portions of the County, while Wildfire Zone 2 generally consists of plains and grasslands. The areas impacted by the Marshall Fire were primarily in Wildfire Zone 2, and by regulation are required to achieve a minimum Class B roofing classification. Note: The City of Louisville and the Town of Superior required Class A roofs starting in 2013 to provide better protection against wildfire; however, these requirements did not apply retroactively to existing structures. In recent years, the area has experienced several severe hail events resulting in the replacement of many roofs. See Table 15 for a description of the different roof classifications in building/fire codes.

Table 15. Summary of Roof Classifications per Building/Fire Codes.

Roof Classification	Technical Description	Examples
Class A	This is the highest rating for roof coverings. Roof coverings in this classification are effective against severe fire exposures, provide a high degree of fire protection to the roof deck, do not slip from position, and do not present a flying brand hazard. Note: Coverings that pass the "noncombustible" standard no longer automatically achieve Class A and must be tested per E108 or UL 790.	▪ Clay and concrete tiles ▪ Metal panels, sheets, tiles, shingles on noncombustible decks/framing ▪ Brick or masonry ▪ Exposed concrete ▪ Most modern asphalt fiberglass composition shingles (Note: Cellulosic fiber asphalt singles, roughly pre-1980s, would not be included) ▪ Other noncombustible materials tested in accordance with ASTM E108 or UL 790 ▪ (Special) Fire-retardant wood shingles or shake with an additional fire-resistant underlayment as required to pass ASTM E108/UL 790
Class B	Roof coverings in this classification are effective against moderate fire test exposure, provide a moderate degree of fire protection to the roof deck, do not slip from position, and do not present a flying brand hazard.	▪ Fire-retardant shakes and shingles without the fire-resistant underlayment

Roof Classification	Technical Description	Examples
Class C	Class C roof coverings, which are effective against light fire test exposures. Under such exposures, the roof coverings afford a degree of fire protection to the roof deck, do not slip from position, and are not expected to produce flying brands.	▪ Aluminum roof coverings ▪ Recycled plastic/rubber roof covering
Non-rated	Roof coverings in this classification failed the fire test or have not been tested at all.	▪ Untreated wood shakes

Source: Society of Fire Protection Engineers (SFPE) WUI Handbook

Roof Construction and Coverings

The majority of residential roofs in the impacted areas were comprised of asphalt shingles or composite tiles with moderate slopes. A few metal roofs were also observed, but this was not typical (Figure 25). Most residential roofs appeared to have enclosed eaves. Many roof lines tended to be complex with multiple levels, peaks, gables, and joints (Figure 26) where vegetative debris and embers can accumulate leading to ignition of the debris and potentially the home.



Figure 25. Remains of a residential structure with a metal shingle roof system.



Figure 26. Typical roof system in the Boulder, Colorado area. Roofs tend to have multiple levels, peaks, gables, and joints where debris can accumulate and be ignited by embers.

Roof Vents

As local jurisdictions at the time and prior to the fire had not adopted a WUI code, most homes and other structures in the footprint of the fire were not required to provide ember protection for any vents throughout the exterior envelope of the building (inclusive of all types of attic vents, ridge vents, gable/dormer vents).

The intrusion of embers through roof vents is a major vulnerability leading to structure ignition during wildfires. The main concern with roof vents is that they can provide several openings where windborne embers, flames, and hot gases from wildfires can enter the attic space of a home leading to ignition of interior building contents. In addition, attic spaces in residential homes are typically not sprinklered (even if the home is provided with a residential sprinkler system) and can consist of exposed combustible building construction materials and flammable goods (e.g., cardboard boxes, old furniture, dust). Both roof inlets and outlets are considered vulnerable as wind-driven fire incidents can easily overcome outlet pressures, allowing embers and hot gases to readily enter a home or structure via these unprotected openings.

As the majority of destroyed homes had little evidence remaining for the MAT to observe the type and/or condition of roof vent protection provided, the MAT observed roof vent conditions for adjacent undamaged houses. In the field, several types of attic vents and roof openings (i.e., inlets and outlets for dryers, fireplaces, Heating, Ventilation and Air Conditioning (HVAC) systems, and other ducts) were observed to lack ember protection. Figure 27 shows typical conditions observed throughout the impacted residential neighborhoods, where most roof vents (e.g., attic vents, roof ridge, gabled roof) were not provided with ember protection.



Figure 27. Lack of vent protection in attic vents, gabled roof attics, and soffits in Superior and Louisville, Colorado.

Where screening was provided, the MAT observed that the screening materials were 1/4 inch, which would allow ember intrusion potentially leading to ignition of combustible materials in the attic space. In one case, attic vents or blocking between trusses was possibly blown out due to high winds, creating an opening for embers to enter the roof structure (Figure 28).



Figure 28. Wood blocking or attic vents blow out possibly due to high winds.

Chimneys

The majority of houses observed in pre-event aerial imagery, as well as during post-event data collection, had chimneys. Most chimney exteriors were either brick or stone, which are more fire-resistant than ones covered by exterior siding. Combustible wood chimney chases were also observed in surrounding neighborhoods. Chimneys not properly constructed with flashing and counterflashing materials can introduce a point of entry for embers at the interface of the roof the chimney chasing. See Section 5.2.2 for more details.

Solar Panels

Some homes had roof-mounted solar panel systems; several installations had mesh enclosures for the underside of the panel systems. These perimeter enclosures limit vegetative debris or embers from collecting below the solar panels and potentially providing an ignition source. The use of mesh enclosures was not consistently observed for all roof mounted solar panel systems (Figure 29).



Figure 29. Example of observed unprotected solar panel installation.

There are currently no fire test standards for solar panels exposed to wildfires. Photovoltaic (PV) systems are typically required to meet or exceed the fire classification of the roof assembly they are mounted to. As such, solar panels are addressed by code, but not at length in regard to wildfire exposures, particularly to ember accumulation and in-situ conditions.

Gutters

Most gutters on remaining houses as well as gutters observed among the debris appear to have been aluminum. Most gutters did not have guards to prevent accumulation of vegetative debris in the gutters. While gutter guards are not required by residential building codes for wildfire safety, they can limit the need to manually remove debris from gutters. In the Marshall Fire, debris that accumulated in gutters could have provided fuel for embers if the gutters were not cleaned out prior to the wildfire.

5.2.2. ROOF JOINT SYSTEMS

Roof-to-Roof Joints

Visual confirmation or inspection of roof joint systems were not feasible by the MAT; however, given the lack of limited wildfire regulations at the time and prior to the incident, it is likely that most homes in the impacted areas were not designed or provided with fire-resistant joint systems at the roof. This would include joints systems and construction detailing to limit the intrusion of embers, hot gases, and direct flames from burning vegetative debris often found at various roof joints (e.g., roof valleys, roof to dormer joints, roof to exterior wall joints, expansion joints).

Commonly observed roof joint vulnerabilities included:

- **Complex roof designs:** Many roofs were observed to have complex designs (Figure 30). These complex designs increased the number of joints between roof assemblies and wall systems, ultimately increasing the number of areas vulnerable to collection of vegetative debris, ember accumulation, and gaps where embers can penetrate the building exterior envelope. Though complex roofs can be designed to be resistant to ember intrusion from wildfires (e.g., overlapping roof covering, flashing at valleys/interfaces, overlapping underlayment, flashing, and counterflashing at roof-to-wall joints), it is unlikely that appropriate ember resistance joint detailing was provided at all locations. This is of concern particularly at the roof-to-wall joints, where unprotected joints/gaps at the interface of a roof assembly (even if Class A or B rated) and combustible wall siding can be vulnerable to ember intrusion or ignition of adjacent vegetative debris leading to structure ignition. See additional discussion below.



Figure 30. Example of an observed complex roof design.

- **Woven valleys:** Some roofs were observed using a woven-valley method to protect roof valleys (Figure 31). It is unknown if the underlayment below the woven valleys would be resistant to ember intrusion and ignition.



Figure 31. Example of a woven valley.

- **Limited use of metal flashing:** Where roof joints exist between walls and roof surfaces, there were very few visible examples of homes where metal flashing and counterflashing were installed to protect the joint (Figure 32). Most roof joints and interfaces adjacent to dormers and other wall systems (at roof level) accumulate vegetative debris throughout the year. During a fire event, embers will also accumulate in these locations, often leading to ignition of the vegetative debris and potential ignition of adjacent combustible dormer or wall siding.



Figure 32. Example of observed areas where use of metal flashing could provide additional protections.

Currently, there are no fire test standards to evaluate the resiliency of roof joints or joint systems to ember intrusion, direct flame impingement, or thermal transmission of heat via convection, or radiation from wildfires. Although there are a variety of fire test standards for joints in interior building fire components, none are applicable to the fire conditions presented by exterior wildfires. Because no test standards exist, this is unaddressed by current building codes.

Skylights-, Chimneys- and Vent-to-Roof Joints

Most skylight-, chimney-, and vent-to-roof joints were observed to be in decent condition. Some homes were observed to have chimney-to-roof joints that appear to have some gaps (Figure 33). There was an overall lack of use of metal flashing and counterflashing to protect these types of joints, leaving these areas more susceptible to ember intrusion, particularly for chimneys with combustible chases (Figure 34). For skylight- and vent-to-roof joints, the MAT team was unable to observe if the interface of these components with the roof system had appropriate flashing to limit ember intrusion at the joints.



Figure 33. Example of observed gaps at chimney-to-roof joint.



Figure 34. Example of metal flashing at joint between the skylight unit and the roof.

5.2.3. ROOF-TO-EXTERIOR WALL COMPONENTS

Roof Edge Detailing

Roof edge detailing appeared to be in good condition on most homes. There were a few observed homes that had some gaps at the roof edges. The following is a list of commonly observed vulnerabilities:

- **Open edges at profile-tiled roofs:** Some homes were observed to have profile-tiled roofs without any type of mortar or bird-stopping to protect the gaps created at roof edges (Figure 35). This leaves roof edges vulnerable to ember intrusion.



Figure 35. Example of observed profile-tiled roof with gaps at the roof edge.

- **Limited use of metal flashing:** Many homes had flat-tiled roofs with no visible metal flashing provided at the roof edge (Figure 36). Metal flashing at the roof edge provides another layer of protection from ember intrusion.



Figure 36. Example of observed vulnerable areas where metal flashing could provide additional protection.

Currently, no fire test standard to evaluate ember intrusion, direct flame impingement, or thermal transmission of heat via convection, or radiation from wildfires for roof edge detailing exists. Due to the lack of test standards, roof edge detailing protection from wildfires is largely unaddressed. NFPA 1144 does include considerations for roof edge detailing, but NFPA 1144 by definition is a Standard, and not a model code document. As such, it is rarely enforced by local jurisdictions.

Soffits and Soffit Vents

Most of the homes observed by the MAT appeared to have enclosed eaves. Soffits also were enclosed, and most had soffit vents. Homes throughout the impacted areas of the fire appeared to have a range of soffit vent types, opening sizes, soffit materials and soffit vent configurations. Of the range of soffit characteristics, the MAT was not able to confirm if appropriate soffit vent protection was provided. Unprotected soffit vents (i.e., openings larger than 1/8-inch) would readily allow the intrusion of embers into the attic space or combustible interstitial wall or roof spaces of the home.

Figure 37 shows typical conditions observed throughout the impacted residential neighborhoods, where most vents (e.g., attic vents, roof ridge, gabled roof) are not provided with ember protection.

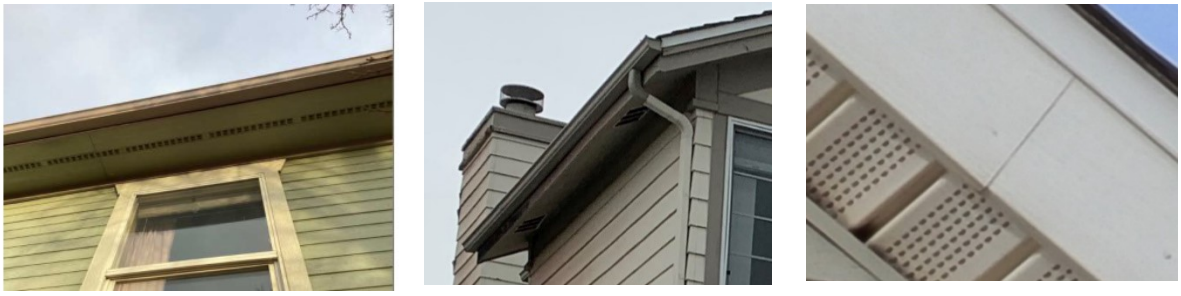


Figure 37. Observed vent protection for soffit eave vents in Superior and Louisville, Colorado.

Head-of-Wall to Roof Joints

Head-of-wall-to-roof joints were generally observed to be in good condition, but some gaps were present on homes. Currently, no fire test standard exists to evaluate ember intrusion, direct flame impingement, or thermal transmission of heat via convection or radiation from wildfires for head-of-wall to roof joints. While a variety of test standards for joints in interior building fire components exist, none are applicable to the fire conditions presented by wildfires. Because no test standards exist, this is unaddressed by current building codes.

5.2.4. EXTERIOR WALL COMPONENTS

Exterior Wall Construction and Cladding

Homes in the impacted area, both damaged and undamaged, generally were of light-timber framed construction. Most homes appeared to have a combination of siding, either brick or stone veneers around garages and brick or stone chimneys. Siding materials included fiber-cement board, vinyl, and composite board. Some homes were observed to have stucco exteriors.

Based on observations as well as information provided by firefighters, structures and portions of structures constructed from noncombustible materials such as brick, stone, and stucco fared reasonably well. While brick, stucco, or stone exposed to flames often appeared blackened, likely from smoke, soot, and ash (Figure 38 and Figure 39), exterior walls constructed from these materials often remained standing. In some cases, brick and stone facades appeared to fail, but this is likely due to the underlying structure failing.



Figure 38. While blackened by smoke, soot and ash, concrete and brick elements remained standing more often than most other exterior wall construction materials.





Figure 39. Concrete block and brick around garages often remained partially or fully standing.

Of the various types of siding that were observed, fiber cement board appeared to perform well. Some homes that remained standing had evidence of ember impacts to the exterior wall but did not lead to ignition (Figure 40).



Figure 40. Some homes with fiber cement siding showed evidence of ember impacts to the exterior facade but did not burn. In this case, the base of the wall system had little to no combustible fuels providing the embers a fuel bed for ignition.

In comparison with fiber cement siding, other siding types such as vinyl generally performed poorly. These other siding types did not offer good protection against embers, flames, and radiant heat. Some evidence of vinyl siding melting was observed. Homes with combustible siding on the full elevation were more likely to ignite than walls with a noncombustible material near the bottom and combustible material above (Figure 40).

Detailing at joints and interfaces of exterior wall systems introduced additional vulnerabilities in the exterior wall system, which are discussed in sections below and further in Marshall Fire MAT document *Wildfire Resilient Detailing, Joint Systems, and Interfaces of Building Components* included in Appendix J.

Garage Doors

Many garage doors that were observed were double-car size with some homes having another single-car garage for a third vehicle. The doors appeared to be constructed primarily of metal materials, although wood and composite material doors were also common. Many garage doors observed did not have weather seals around the perimeter of the garage door frame. Gaps between frames and exterior walls, frames and doors, doors and ground provided opportunities for ember entry.

Some two-car garage doors that remained standing were scorched and melted or buckled. Gaps were observed between the door and the frame, which may have allowed embers to enter and become trapped. Based on observations, tracks also may have separated from the door frames, which may have been the result of high wind pressures acting on the garage doors. This also would have allowed embers to enter garage spaces.

Fenestration and Glazing

Homes in the area were observed to have both single- and multi-pane windows. Observations in the field as well as reviews of pre-event aerial imagery indicate that skylights were not common, but the MAT did observe a few. Of the skylights that were present, it is unclear if they were properly designed to limit ember intrusion, if they may have been operable and left open, or if the frames failed and caused the skylight to fall out. Multi-pane windows showed evidence of the outer panes breaking (Figure 41). Some window frames that were observed appeared to have had the seals around the glass panes melted by the extreme heat, which would have caused the panes to drop out and allow embers and flames to enter the structure. There are also accounts of the wind blowing debris into windows, breaking the glass, and allowing embers to enter the structure. This phenomenon has been reported to have occurred at the Element Hotel (destroyed during the Marshall Fire) in Superior and may also have occurred in residential structures.



Figure 41. Some multi-pane windows showed evidence of the outer glass breaking.

Tenant Separation Walls

The UBC, which preceded the development of the IRC, provides requirements similar to the requirements of the IRC for fire-resistance-rated wall assemblies between building units. Since the

publication of the 2000 IRC, fire-resistance separation requirements for townhouses and two-family dwelling units have been specified separately from other building types. A common level of protection allowed throughout the various editions of the IRC is a tenant-separation wall with a 1-hour fire rating with exposure from both sides (i.e., the fire exposure could be applied from either side of the wall). These tenant separation walls are required to be continuous from the foundation to the underside of the roof sheathing, deck or slab and extend the full length of the common wall. Later editions of the IRC have been updated to allow exceptions to this requirement.

The 2006 IRC and later editions allow 2-family dwellings to have tenant-separation walls that do not extend through the attic in special cases (2021 R302.3, for example) where:

1. The ceiling is protected by a 5/8-inch (15.9 mm) Type X gypsum board.
2. There is an attic draft stop meeting Section R302.12.1 specifications above and along the wall assembly separating the dwellings.
3. The structural framing supporting the ceiling is protected by a 1/2-inch (12.7 mm) gypsum board or equivalent.

This exception could offer less protection than the tenant separation wall requirements for townhouses (i.e., a fire resistance-rated wall assembly that is continuous to the underside of the roof sheathing) due to the tendency for a fire to enter a roof system from the exterior and spread through attics. Additional research is needed to determine how this exception could contribute to structure-to-structure spread of fire.

The MAT observed cases of fire spreading between housing units where a tenant separation wall was not built to extend up and through attic spaces (Figure 42). Notably, there was an observed case of fire damage to a townhouse built in 1998 in Superior where the tenant separation wall did not extend up and through the attic; this construction violates the fire-resistance-rated wall requirements of the 1994 Uniform Building Code, in effect at the time of its construction. This case suggests that gaps in inspection and enforcement may have partly contributed to the lack of continuous tenant separation walls and its impact on unit-to-unit fire spread. Due to limited MAT observations on this topic, it is not clear whether all damage of this type was due to code enforcement gaps or because some buildings were built before formal code adoption and enforcement of tenant separation wall requirements.



Figure 42. A Marshall Fire-damaged townhome built in 1998 in Superior with tenant separation wall not extending to underside of roof sheathing.

Vents in Exterior Walls, Crawlspaces and Basements

As local jurisdictions at the time and prior to the Marshall Fire had not adopted the IWUIC or local wildfire building ordinances, most homes and other structures in the footprint of the fire were not required to have or provided with ember protection for any vents throughout the exterior envelope of the building (inclusive of vents in exterior walls, crawlspaces and basements). The intrusion of embers through exterior wall, crawlspace, or basement vents is a major vulnerability that can lead to structure ignition during wildfires. The main concern with exterior wall, crawlspace, or basement vents is that they can provide several openings where windborne embers and convective heat from wildfires can enter the structure leading to ignition of interior building contents and other building components. Both vent inlets and outlets are sources of vulnerability, particularly due to the overpressures caused by fire and high wind conditions adjacent to the building façade.

As the majority of destroyed homes had little evidence remaining for the MAT to observe the type or condition of vent protection provided, the MAT evaluated vent conditions for adjacent undamaged homes. Several types of wall vents, crawlspace, and basement openings (i.e., inlets and outlets for dryers, fireplaces, and HVAC systems) observed by the MAT did not have ember resistant opening protection. Figure 43 shows typical conditions observed throughout the impacted residential neighborhoods, where most vents (e.g., crawlspace, basement vents, dryer vents) were not provided with ember protection to limit the intrusion of embers during a wildfire, particularly a wind-driven fire.



Figure 43. Lack of vent protection in exterior walls, crawlspaces, and basements in Superior and Louisville, Colorado.

5.2.5. WALL SYSTEM JOINTS

Detailing at various wall system joints and interfaces throughout the exterior envelope of homes (e.g., foundation-to-wall siding interface, window-to-wall joints, wall-to-wall joints) often have gaps or spaces at the interfaces between them, leaving these areas vulnerable to ember accumulation or intrusion. These gaps can lead to embers penetrating combustible interstitial spaces of exterior walls (See Figure 44). These spaces do not typically contain any kind of fire detection to notify building occupants of a fire or suppression systems to extinguish a fire. As such, a fire in combustible interstitial spaces due to ember intrusion can go unnoticed for long periods, allowing the fire to grow to uncontrollable levels before being detected (Refer to the Marshall Fire MAT document *Wildfire Resilient Detailing, Joint Systems, and Interfaces of Building Components* in Appendix J for additional information). This was observed by firefighters in the field during the Marshall fire.

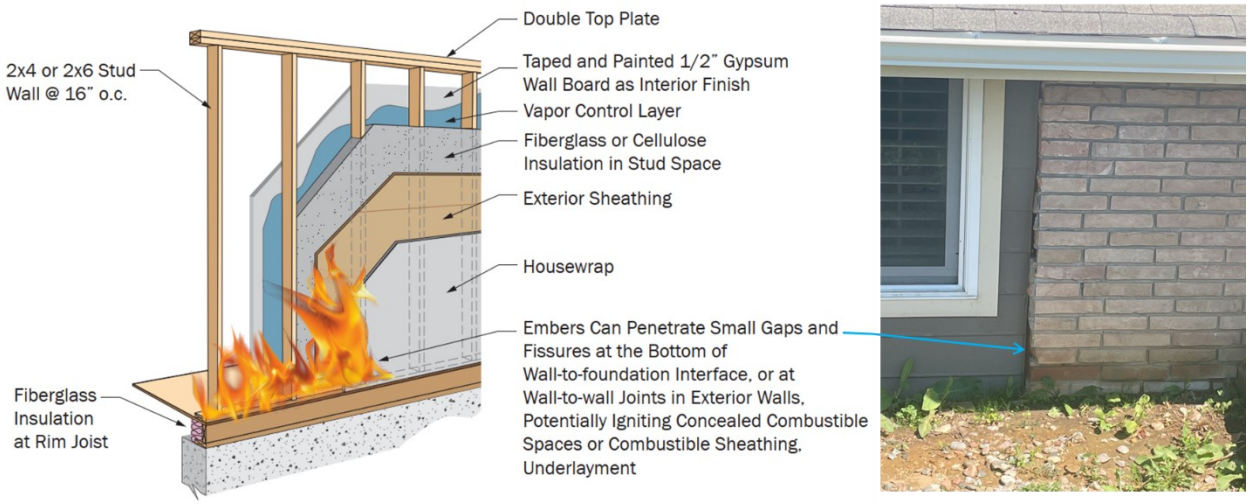


Figure 44. Example of gaps in common exterior wall construction (e.g., interfaces of wall systems, butt joints between siding, bottom-of-wall to foundation details) that can lead to ember penetration, and potential fire in combustible interstitial spaces. Note: At butt joints of exterior siding, embers may penetrate these joints leading to ignition of exterior combustible cladding before burning into the wall cavity.

Wall-to-Wall Interfaces

Of all the joint systems observed on the exterior of buildings, wall-to-wall interfaces were among those that appeared to have numerous gaps, cracks, or fissures present, particularly at the interface of different exterior cladding materials (e.g., brick façade with cement board siding). These gaps create spaces for combustible debris to accumulate (e.g., leaf litter, dust) over time, creating a fuel source within the interstitial spaces, gaps, or joints. These gaps can be in areas that are not easily accessible, which make it easier for combustible debris to accumulate unnoticed. During a wildfire event, embers can penetrate the gaps, readily igniting any combustible debris that may have accumulated. This could lead to ignition of the exterior cladding (where combustible) before burning into the interior wall cavity. Note: Even in joints or gaps where combustible debris does not readily accumulate (e.g., vertical gaps/joints), embers can still become lodged in the gaps and provide a potential source of ignition where combustible cladding or other combustible construction materials are present.

Currently, no fire test standard exists to evaluate ember intrusion, direct flame impingement, or thermal transmission of heat via convection or radiation from wildfires for wall-to-wall joints. While a variety of test standards for joints in interior building fire components exist, none are applicable to the fire conditions presented by wildfires. Because no test standards exist, this is unaddressed by current building codes.

Windows-To-Wall Joints

Window assemblies appeared to mostly be in good condition, with few observed gaps, cracks, or fissure at the joints between the window frame and wall assemblies. It should be noted that this was after the fire event where many windows may have been newly replaced.

Windows are required to comply with requirements to resist the effects of fire, but this does not necessarily address the joint between the window and the wall. Several NFPA test standards exist for the testing of window assemblies, however the mounting for the testing of the window assembly is often left up to the manufacturer. Therefore, any joint protections that the window manufacturer may provide in the field is not specifically being tested for wildfire exposures.

Doors-To-Wall Joints

Most door assemblies at the interface of the door frame and wall that the MAT was able to observe appeared to have minimal gaps or cracks. Some door assemblies had integrated “dog doors”, which typically do not come with ember protection systems. This is a gap in current codes and standards but is a major source for potential ember intrusion into a home.

Doors are required to comply with requirements to resist the effects of fire, but this does not necessarily address the joint between the door and the wall, the door undercut or the presence of “doggie doors”. The IWUIC and California Building Code both include special considerations for exterior doors, and several NFPA, Underwriters Laboratories (UL), and ASTM test standards exist for the testing of door assemblies. However, similar to tests for window assemblies, joint protections

that the manufacturer may install in the field are not specifically being evaluated for wildfire exposures.

Bottom-of-Wall to Foundation Joints

The MAT observed bottom-of-wall to foundation interfaces or joints to have large gaps between the exterior cladding and the wall sheathing, and in some cases, exposed flammable wall cavities. The bottom edge of the wall assemblies did not appear to be detailed or constructed to protect the bottom edge of the assembly from ember, flame, or hot gas intrusion. The gaps observed were assumed to be due to the shifting of foundations, weathering, or other wear-and-tear of the exterior building components. Little to no mitigation measures had been taken to fill these observed gaps.

Currently, no fire test standard exists to evaluate ember intrusion, direct flame impingement, or thermal transmission of heat via convection or radiation from wildfires for bottom-of-wall to foundation joints. Though a variety of test standards for joints in interior building fire components exist, none are applicable to the fire conditions presented by wildfires. Because no test standards exist, this is unaddressed by current building codes. See also Section 5.2.6.

5.2.6. BOTTOM OF EXTERIOR WALL DETAILING

For residential homes, a minimum level of protection at the bottom of exterior walls is required by code for wood members to limit decay damage in certain locations. One of these locations is where wood siding, sheathing, and wall framing on the exterior of a building has a clearance of less than 6 inches from the ground or less than 2 inches vertical from concrete steps, porch slabs, and patio slabs. Similarly, horizontal surfaces exposed to weather are vulnerable to decay except where siding, sheathing, and wall framing are of naturally durable or preservative-treated wood. While this requirement is intended to increase protection against decay and termites, where the clearance is provided to avoid additional protection requirements, it also provides a degree of fire protection against surface fires because blown embers may ignite flammable materials that might burn at the base of a home, such as mulch. For wildfire protection, a minimum of 6 inches vertical from any horizontal surface is typically required regardless of the materials used for the wall siding or for the horizontal surfaces to limit embers from igniting flammable materials, leading to ignition of the siding material (where combustible) or penetrating behind the exterior cladding and into the interstitial spaces of the wall system.

In the field, the MAT observed that some homes appeared to have adequate clearance at the bottom-of-wall-to foundation to avoid additional protection requirements (Figure 45); however, this clearance was not consistently provided around the entire perimeter of the home, or at all for other homes.



Figure 45. Example of a home provided with adequate bottom-of-wall clearance.

There were two main "non-compliant" conditions that were frequently observed:

1. **No clearance provided**: Many homes did not have 6 inches of non-combustible bottom of wall clearance (Figure 46). The MAT was unable to verify if siding was of naturally durable or preservative-treated wood by visual inspection alone, so it is possible that some homes fell under this exception. Homes where this clearance is not provided are vulnerable to directly contacting accumulated embers at the base of the wall or exposed to surface fire caused by the embers that can burn up to the building perimeter and enter interstitial spaces in the exterior wall envelope.



Figure 46. Example of a home without adequate bottom-of-wall clearance.

2. **Obstructions to clearance:** Some homes were provided with the required clearance but had decorative elements covering the clearance area (Figure 47). The presence of these decorative features does not meet the original intent of the requirement, leaving the home vulnerable to surface fires.



Figure 47. Example of home provided with adequate bottom-of-wall clearance but with obstructions.

5.2.7. FOUNDATIONS

Foundations of homes were generally slabs-on-grade, basements, or walk-out basements. Most of the observed foundations were constructed of cast-in-place concrete though a few were constructed of reinforced concrete masonry units (CMU). Walk-out basements had window and door openings. Full basements appeared to have window wells and window openings. Window wells can provide places for debris to accumulate if they are not cleaned out regularly.

GEER conducted studies of building foundations during field data collection that was completed primarily during January 24–29, 2022. Additional data collection occurred in February and April 2022 and throughout the preparation of their report, which was released May 2022. The GEER team estimated the temperature foundations reached during the fire by comparing the colors of concrete provided by Hager (2014) to the foundation itself (GEER, 2022). The GEER team determined the homes burned at temperatures ranging from 300˚Celsius to 900°Celsius (GEER, 2022). Damaged or destroyed homes nearest to still-standing homes with minimal damage were exposed to temperatures on the lower end of the range. The GEER team also observed spalling of concrete on walkways which typically coincided with homes exposed to the higher temperature ranges. Firefighters indicated that some foundations exploded, which may have been the result of the concrete heating rapidly.

5.2.8. ATTACHMENTS

Attachments to homes are on the exterior of the structure and include decks, patios, porches, balconies, exterior stairways, and fences. Combustible attachments can act as “wicks” that allow fire to travel along it to where it is attached to the home, potentially igniting the home.

Patios, Decks, and Balconies

Almost every home that was observed had at least one combustible attachment—usually a combustible deck or patio. Combustible balconies did not appear to be common but were observed on some of the remaining houses so may have been present on some of the houses that burned.

Patios

Patios are often hardened open spaces that contain flammable materials such as furniture with cushions, grill propane tanks, and planters. These spaces can provide plenty of oxygen and fuel to spread a fire. Patios were observed adjacent to some of the houses in the Marshall Fire area. Back patios were usually attached to the house at or near grade and most often were constructed of concrete, brick, or stone, although a few used wood or composite materials. Patios that were observed generally had furniture, grills, and other temporary items (Figure 48) which can contribute to fire spread. Furniture made of metal was occasionally observed to survive but some of these items were misshapen, potentially by the heat of the fire.



Figure 48. Patios often contained furniture and grill propane tanks which are known to contribute to fire spread.

Decks

Decks attached to the house were often elevated above ground, in some cases by one story and appeared to be primarily constructed from wood and/or composite materials. Many of these elevated decks had exterior stairways leading to the ground level. Both decks and patios were observed to have combustible materials or other fuel sources stored on and under them, such as furniture, grill fuel, grill covers and decorative pieces. Elevated decks were also observed to frequently have combustible materials and other fuel sources stored beneath them, including furniture, firewood, lawnmowers, chairs, and other equipment (Figure 49).



Figure 49. Elevated decks and concrete patios attached to homes were commonly observed. Many elevated decks had combustible materials stored beneath them.

Combustible decks can pose a significant fire hazard in the event of a wildfire. Many existing decks are constructed of combustible materials such as wood and wood-plastic composite products that are vulnerable to under deck flame exposure in a wildfire event. One of the main concerns associated with decks is the large surface area they present for collecting embers that lead to ignition of materials located on the deck or the deck itself. Similar to eave overhangs, unique fire-induced flows can lead to the accumulation of embers and hot gases in the underside of elevated decks, potentially leading to ignition of the deck where combustible construction framing elements are exposed. Decks that are near grade level are susceptible to direct flame impingement from surface fuels and other adjacent vegetation (Figure 50). Anecdotally, a resident of the Sagamore neighborhood was an eyewitness to the wood decking of his neighbor's house (which was the first structure to ignite in the southern portion of Sagamore at the WUI) catching fire and immediately igniting the home.



Figure 50. Combustible decking directly attached to a single-family residence in Old Town in Superior, Colorado.

Balconies

Balconies have the potential to serve as ember collectors which can then ignite the home. Because they are elevated, balconies also can catch fire from below, increasing the potential of spreading the fire to upper portions of the house (Figure 51). While balconies did not appear to be common on single-family homes, a few upper level and rooftop balconies and terraces were observed.



Figure 51. Balconies can catch on fire from below, which can result in spreading fire to upper levels of the house.

Fences

Many homes and properties throughout the impacted areas had combustible (primarily wood) fences, serving as both property line separations and privacy barriers (Figure 52). In most cases, these wood fences were observed to frame directly into the exterior walls of a home and were oftentimes shared fences with neighboring homes (Figure 53).



Figure 52. Combustible fencing directly attached to a single-family residence in Rock Creek Ranch in Superior, Colorado.



Figure 53. Additional examples of combustible fencing attached directly to single-family residences in Louisville, Colorado.

Combustible fences can become hazardous in the event of a wildfire, particularly if they connect directly to a structure. Typical wooden post-and-board fences, particularly when old and weathered, can provide a "wick" leading directly to the structure. The bottom of fences can collect debris that, when combined with combustible fencing, can become a fuel source to carry fire directly to the structure and ignite the building through radiant heat, convective heat, or direct flame contact. Because fences are often just below the eaves of a residential structure or near other vulnerable components such as windows, there is the potential to carry the fire up to the eaves and thus to the roof or break the windows and let embers and flames in. Additionally, fences can also create access

problems for fire crews attempting to enter a yard during a fire event. When coupled with other combustible fences (back-to-back), the potential fire load can be further exacerbated (NIST, 2022).

During site visits, the MAT observed numerous instances where wooden fences provided a major source of fire spreading either from wildland/open spaces (Figure 54) or from home-to-home (Figure 55). It is worth noting that the MAT observed a significant number of properties having timber property line fences and privacy fences reinstalled during rebuild.



Figure 54. Fences behind communities may have acted as wicks, drawing fire to the neighborhoods.



Figure 55. Sample evidence of combustible fencing attached directly to single-family residences in Louisville, Colorado, and serving as a fire pathway to an adjacent home.

5.2.9. SMOKE AND ASH INFILTRATION

The MAT did not enter any affected homes so information regarding smoke, ash, and soot could only be obtained through interviews. Many homes that were not burned by the fire still had to contend with smoke, soot, and ash infiltration. Smoke, soot, and ash damage cleanup and restoration can be expensive and often requires the removal of existing fiberglass batt insulation, porous materials, and replacement of damaged electronic equipment and fixtures that cannot otherwise be cleaned.

While there is no way to completely avoid smoke, soot, and ash infiltration, adding stronger door and window seals, shutting down air intakes, and using thicker insulation can help reduce the risk of infiltration. Such techniques can also make the home more energy efficient, but the flammability of sealants and non-fiberglass insulation must be examined to ensure code compliance and avoid increasing structural fire risk. For more information, refer to Marshall MAT document *Homeowner's Guide to Risk Reduction and Remediation of Residential Smoke Damage* (Appendix D).

5.2.10. ENERGY STORAGE SYSTEMS

Some parts of the U.S. are starting to see a shift to using some systems that are less reliant on fossil fuels, such as solar power and electric vehicles. In some instances, these systems can store their energy on site in Li-ion batteries. These batteries are known to pose an environmental and potential explosion hazard if they ignite. Though not widespread, the MAT observed evidence of the potential for some of these ESS to be present in commercial and residential facilities.

Firefighters indicated some firefighting priorities were determined based on the need to protect areas containing known Li-ion battery ESS, including rooftop solar arrays, electric vehicles, and battery backup systems for homes. While the location of all energy storage systems was not known, firefighters defended areas of known concentration of these systems (e.g., electric vehicle dealerships) due to concerns about potential environmental contamination, potential explosions, and to reduce the likelihood of re-ignitions.

An electric vehicle dealership in Superior was one location identified as having had multiple Li-ion batteries on-site in the vehicles for sale and service. Several homes were observed to have rooftop solar panels, which suggests that these homes may also have Li-ion battery storage systems on the property (though not common).

Li-ion battery ESS damaged by fire can exhibit thermal runaway, allowing battery units to ignite or re-ignite even after fire has been extinguished. Product enclosures, especially vehicle battery packs, prevent means for delivering extinguishing agents to cells in thermal runaway; this factor prevents the effectiveness of traditional automatic and manual fire suppression approaches. No singular best approach has been developed for extinguishing fires involving the ignition of Li-ion battery ESS. In addition, current model code fire safety provisions for installation and storage of ESS do not explicitly consider the potential risks associated with wildfire exposure. WUI codes and best practices for wildfire hazard-resistant construction may also contain gaps in protections for ESS. For example, wall-mounted ESS are at risk of ignition during a wildfire but are not prohibited by common defensible space standards.

Chapter 6: Conclusions and Recommendations

The MAT uses observations to draw conclusions and make actionable recommendations. The conclusions and recommendations presented in this report are based on the MAT's field observations; evaluation of relevant codes, standards and regulation; as well as information gathered from interviews with first responders and subject matter experts. They are intended to guide homeowners and building owners, community planners, design professionals, contractors, state, and local officials, building code professionals, and standards organizations. Some additional recommendations are directed to FEMA and other industry partners. Chapter 6 provides detailed information on the conclusions and recommendations, including a summary table. The recommendations have been summarized and grouped into overarching concepts here:

- Section 6.1 – Standardized Wildfire Terminology Recommendations
- Section 6.2 – Wildfire Hazard and Risk Recommendations
- Section 6.3 – Overall Community and Neighborhood/Subdivision Level Recommendations
- Section 6.4 – Parcel/Building Level Recommendations
- Section 6.5 – Summary of the Conclusions and Recommendations

The recommendations are presented as actionable guidance to the state, affected communities, and those who are involved with the design, construction, and maintenance of the built environment across the state. The state and the entities involved in reconstruction and mitigation efforts should consider these recommendations in conjunction with their existing priorities and resources when determining how they can or will be implemented.

Many of the conclusions and recommendations center on encouraging state and local governments to assess their code development and enforcement programs and implement a code and standards program that will withstand the elements over time. In addition, the conclusions and recommendations provide guidance on ensuring that the buildings provide robust systems to withstand fire events.

The MAT Conclusions and Recommendations are prioritized within each section as those that may be most important to implement by the state, community or interested party.

6.1. Standardized Wildfire Terminology and Public Education Recommendations

Conclusions and recommendations in this section generally fall under the Standardized Wildfire Terminology and Public Education concept.

Conclusion CO-1

Current WUI definitions do not accurately reflect the diversity of wildfire environmental settings and community designs that are prone to wildfire threats, including the area impacted by the Marshall Fire. The definition of "WUI" is not comprehensive enough in that it typically only describes environmental conditions such as vegetation and not explicitly the hazard, risk or vulnerabilities that is presents. This has led to the perception of "wildland" as sparsely populated, heavily wooded areas in rugged, mountain terrain with steep slopes.

Recommendation CO-1a

The NWCG, in coordination with FEMA and the United States Fire Administration (USFA), should update and expand upon the definition of "wildland-urban interface" to clarify that "wildland" includes a range of environments such as grasslands, shrublands and not just forests and trees. Guidance should be provided for local and state governments to adopt and adapt the NWCG's definition to meet specific needs, such as defining "interface," "intermix" and "occluded" space. For example, the definition of WUI published in the Federal Register on January 4, 2001, by the U.S. Forest Service, Bureau of Indian Affairs, Bureau of Land Management, Fish and Wildfire Service and National Park Service begins by using the definition, "The urban wildland interface community exists where humans and their development meet or intermix with wildland fuel." It then identifies three categories of communities: interface, intermix and occluded. (See Section 1.3.2 for additional information.) Alternatively, develop additional terminology that reflects the different environments where catastrophic fires can occur so people who do not live in what is commonly perceived by the public as the "wildland" better understand their risk especially as the wildfire risk expands into urban areas due to climate change.

Recommendation CO-1b

Local and state governments should raise awareness and provide educational programs for their citizens about the various local conditions that define the "WUI." Communication regarding the definition should include categories of communities, types of natural and built environment fuels, and natural or man-made topographic features (such as ridgelines, steep slopes, drainage ditches etc.) that introduce fire flow paths into the community and increase wildfire behavior (e.g., intensity, rate of spread). Community education and understanding of the definition of "WUI" could support adoption of the IWUIC with local amendments, and integration of Colorado State fire hazard and risk maps into the development of local WUI maps.

6.2. Wildfire Hazard and Risk Recommendations

Conclusions and recommendations in this section generally fall under the Wildfire Hazard and Risk Considerations concept.

Conclusion CO-2

Though various forms of wildfire hazard and risk mapping layers have been developed by some state and federal agencies to address a variety of applications (e.g., land use management), a national, **consensus-based** wildfire risk mapping for community planning and building wildfire safety does not currently exist. The lack of such hazard delineation limits an understanding of wildfire "risk," with respect to both wildfire hazard severity levels and associated **return intervals at a national scale**, which are already provided for other hazards (e.g., wind, seismic, flooding). In turn, there is limited appreciation of how developing and adopting community wildfire planning, building codes and standards, and other wildfire programs can help mitigate WUI fire impacts to communities and structures.

Recommendation CO-2a

The USFA, NFPA, USFS and NIST should consider partnering with architectural and engineering standards development organizations to create a national, consensus-based wildfire hazard severity map that includes mean recurrence intervals for at-risk areas (i.e., wildfire "risk" map). The wildfire risk map should follow a similar structure to the ASCE 7-22 Basic Wind Speeds Maps or ICC-500 (2020) Design Wind Speeds for Tornadoes map for storm shelters. The intent is to provide a wildfire "risk" map akin to those provided for other hazards (e.g., seismic, flooding) such that national level policymakers can make risk-informed decisions using equivalent hazard risk mapping.

Recommendation CO-2b

The USFA should work with federal interagency and SLTT partners to explore development of national, consensus-based wildfire hazard severity zone maps with mean recurrence intervals that guide community and parcel-level decision making and trigger the use of fire safety requirements prescribed in the IWUIC or other model WUI, building or fire codes.

Recommendation CO-2c

Where wildfire hazard or risk maps already exist, local jurisdictions should consider using those maps for creating or updating local regulatory WUI maps. This effort should include an evaluation of the need to develop new or update existing WUI risk zones. Local jurisdictions should incorporate these WUI maps into their comprehensive plans, local hazard mitigation plans, zoning ordinances, and any local building and fire code requirements.

Conclusion CO-3

Current practices in assessing wildfire risks to the built environment are not based on risk-informed approaches analogous to other hazards (e.g., seismic, wind), where recurrence intervals and damage

potentials are quantified at the national level. This limits cross comparisons for national level decision-making. There is no standard threshold for meeting building code requirements to reduce wildfire risk. For example, since 2000 there has been an average of over 70,000 wildfires per year in the U.S. impacting 7.0 million acres annually (Congressional Research Service, 2022). These fires have cost nearly $39 billion in suppression costs alone (National Interagency Fire Center, no date). The ten costliest wildfires in the U.S., nine of which have occurred since 2000, have resulted in estimated insured losses of an additional $44 billion (Insurance Information Institute, 2023). By comparison, five of the ten most expensive earthquakes to strike the U.S. have occurred since 2000 have resulted in approximately $14.4 billion in damages (Statista, no date).

Recommendation CO-3

Similar to the risk-informed approaches used for other hazards such as flood, wind, and earthquake, NFPA and ICC should consider working together to standardize development of acceptable wildfire risk thresholds based on risk-informed methods. Tie the risk levels that are developed to code requirements based on graduated levels of risk and importance. Identify other stakeholders that can contribute, such as insurance providers.

6.3. Community and Neighborhood/Subdivision Level Recommendations

Conclusions and recommendations in this section generally fall under the Holistic Wildfire Resiliency concept.

Conclusion CO-4

The Marshall Fire demonstrates how characteristics in the natural environment that markedly influence the behavior of wildfires (i.e., topography, weather, fuel) can interact with other natural hazards such as long-term drought and high wind to exacerbate the risk and behavior of a wildfire. Traditional hazard mitigation plans identify hazards as singular events and neglect the interactions between them.

Recommendation CO-4

AHJs in wildfire-prone areas should consider adopting approaches to wildfire mitigation that identify multi-hazard risks and collectively address risk reduction through land management and building mitigation practices. To be most effective, local hazard mitigation plan strategies should include the adoption and enforcement of hazard-resistant building codes (i.e., ICC model codes).

Conclusion CO-5

Historically, national- and state-level wildfire mitigation planning and preparedness have primarily targeted forest and woodland areas in the WUI. Many community plans, including the Boulder County Community Wildfire Protection Plan, focus on wildfire mitigation in forested and woodland landscapes within the WUI. However, a growing understanding of *wildland fire* risk calls for more wildfire mitigation strategies and programs targeting grasslands, shrublands and various man-made

land uses and designs that interact with the natural environment (e.g., greenbelts, recreational spaces, flood control measures). For example, the Marshall Fire readily spread from wildlands to and within suburban and urban settings via undeveloped grasslands, open spaces, drainage channels and other flood control areas, and mostly unmanaged greenbelts.

Recommendation CO-5

Community planners should assess opportunities to apply landscape and parcel-level hazardous fuel maintenance and defensible space strategies to publicly owned outdoor, recreational, and open space, as well as undeveloped grassland and shrubland adjacent to the community. Comprehensive wildfire mitigation should address the different pathways for wildfire to spread through the landscape, including intermix and occluded zones and both natural and developed areas not traditionally understood or perceived to be associated with the WUI (e.g., grasslands, shrublands). This should include development of wildfire-specific land use planning, zoning restrictions, subdivision planning, and associated guidance, policies, and procedures to limit development in high-wildfire hazard areas without appropriate holistic wildfire risk assessment and mitigation planning.

Conclusion CO-6

While jurisdictions impacted by the Marshall Fire have taken steps to incorporate and coordinate multi-hazard planning, open space management, and community design into their wildfire risk assessments and mitigation strategies, these strategies are not yet consistent across all levels of planning and planning resources. The inconsistent and coordination-limited application of these strategies across all planning agencies, documents, and resources limits comprehensive strategy implementation and interagency coordination.

Recommendation CO-6

Community planners, building code and fire officials should consistently incorporate and coordinate comprehensive wildfire management strategies across all planning codes, standards, policy and guidance documents, including comprehensive or long-range planning, CWPP, hazard mitigation plans, building and fire safety codes/standards/local ordinances, energy codes, landscaping codes, unit strategic plans, forest, and open space plan. These plans should include all tiers of wildland fire mitigation, including landscape-level management, community planning, zoning, and parcel-level design.

Conclusion CO-7

During the Marshall Fire, water collection and diversion features (e.g., drainage ditches) and greenbelts overgrown with vegetation provided pathways for wildland fire to spread along the ground surface into urbanized areas. These “wildfire superhighways” have topographic features that channel and facilitate fire direction and flow. Dense vegetation provided additional fuel that led to more severe conditions. Although they currently have limited use in the Western U.S., parcel-level,

vegetative fuel breaks have been demonstrated to be effective in impacting wind-driven fire behavior and providing time for residents to evacuate homes or structures during an impending fire.

Recommendation CO-7a

AHJs should consider requiring vegetated water collection and diversion features, greenbelts, parks and vegetated islands/bioswales that interact or interconnect wildland spaces with the built-environment in high fire prone areas to be regularly maintained through adoption of ordinances and provisions in maintenance contracts. Ordinances and maintenance contract provisions should indicate frequency of maintenance and time(s) of year that different techniques can be used. These ordinances and contracts also should require debris to be cleared from the banks of the water collection and diversion features and flood fringe areas.

Recommendation CO-7b

Local ordinances should require the use of diverse native, fire-resistant vegetation species in water collection and diversion features, greenbelts, parks and vegetated islands/bioswales that interact or interconnect wildland spaces with the built environment in high fire prone areas. The ordinances should address types and placement of species, as well as horizontal and vertical densities of species.

Recommendation CO-7c

State foresters should consider working with authorities having jurisdiction and other subject matter experts to evaluate the effectiveness of community and parcel-level vegetative fuel breaks and make recommendations for priority local areas to incorporate science-based vegetation management best practices. Create fuel management strategies such as vegetation breaks in greenbelts and grasslands adjacent to critical infrastructure (i.e., primary/secondary evacuation routes, communication systems, water supplies and associated equipment, electrical infrastructure) and populated areas to create defensible spaces. This may also include various integrated design (e.g., perimeter golf courses, agriculture belts, walkways) and "green" strategies (e.g., prescribed grazing), beyond traditional fuel breaks (e.g., mastication, prescribed burning) between these areas and populated areas. These breaks between communities and grasslands, shrublands and unmanaged open spaces can help to slow the spread of fire.

Conclusion CO-8

Current community and neighborhood level planning and design requirements in many high wildfire risk areas do not sufficiently incorporate wildfire safety considerations for landscaping. Local governments do not feature "approved" or "prohibited" plant lists or BMPs specific to local environmental settings and wildfire risks. Pervasive use of non-native, non-fire adapted, easily ignitable plants, ornamental vegetation, and inconsistent design and management practices (e.g., significant use of wood mulch, juniper bushes) contributed to the fire fuel hazard.

Recommendation CO-8a

AHJs should consider adopting zoning, codes and ordinances that integrate wildfire safety concepts into landscape planning, design, construction, long-term maintenance, and inspection. Requirements should address landscaping and residential planning concepts such as setback distances and having multiple entrances/exits to subdivisions for evacuation purposes.

Recommendation CO-8b

Local governments and community planners should coordinate with entities such as the Cooperative Extension Service, universities, and State forestry agencies to develop and socialize "approved" wildfire-resistant plant lists and landscaping strategies for use by developers, homeowners' associations, and homeowners.

Recommendation CO-8c

HOAs and local governments should consider partnering with wildfire education providers such as Firewise USA®, Wildfire Partners, IBHS Wildfire Prepared Home Program and Fire Adapted Communities Learning Network to educate landscapers and homeowners about ways to develop and implement mitigation strategies that decrease wildfire risk at the parcel and neighborhood level. The strategies that are developed should provide guidance on landscaping layouts, particularly with respect to the home ignition zone.

Conclusion CO-9

Local subdivision regulations do not include provisions that adequately address wildfire risk.

Recommendation CO-9a

AHJs in wildfire risk areas should consider working with their local fire departments to develop and adopt subdivision regulations that address wildland fire risk, including structure density in the WUI, appropriate access/egress capacity and separation, adequate water supply, requirements for fire protection and vegetation management plans, and procedures for subdivision evaluation and approval.

Recommendation CO-9b

AHJs should consider incorporating WUI terminology into local codes and ordinances to improve understanding of WUI concepts. This approach provides uniformity in messaging between communities, which can lead to a broader understanding of wildland fire risk and mitigation approaches.

Conclusion CO-10

The combined impact of natural hazards and weather conditions (e.g., high wind, combustible vegetation, and cold temperatures) can create disproportionate risks for disadvantaged communities. Several manufactured home communities in Boulder County sustained substantial

damage or were permanently destroyed by high winds that accompanied the Marshall Fire ("Marshall Fire Recovery Milestones", n.d.). Rocky Mountain PBS also noted that residents of manufactured homes were vulnerable to cold temperatures when utility companies turned off electricity and natural gas to prevent ignition by power lines (Moore, 2022). Boulder County has developed an Equity Map to identify residents in need of additional recovery aid due to racial or socioeconomic disparity.

Recommendation CO-10

Communities with moderate to very-high wildfire risk should investigate and incorporate the vulnerabilities of disadvantaged communities (such as access to support recovery services) into multi-hazard wildfire mitigation planning, response, and recovery efforts.

Conclusion CO-11

Parcel/lot sizes in densely spaced neighborhoods may limit homeowners' abilities to satisfy best practices in defensible space. Because these lot sizes generally are fixed and cannot be changed, defensible space needs to be established at the neighborhood or community level.

Recommendation CO-11a

AHJs should consider working with fire departments, planning departments, and wildfire experts to develop local ordinances, standards and guidance documents for communal defensible space in overlapping ignition zones. Guidance documents should include audiences such as homeowners' associations and individual homeowners.

Recommendation CO-11b

AHJs should consider integrating and mainstreaming wildland fire safety concepts throughout the regulatory life cycle from planning and zoning to design and permitting to construction to long-term maintenance and inspection. This may include wildfire protection planning, environmental impact reports that include wildfire risks, zoning, general plans, landscaping codes, and safety elements. This may also include increasing structure separation distances in residential zoning ordinances in high wildfire risk areas.

6.4. Parcel/Building Level Recommendations

Conclusions and recommendations in this section generally fall under the Building Codes and Standards concept.

Conclusion CO-12

The current version of the IWUIC does not fully address needs at the building-, parcel- and community-levels.

Recommendation CO-12a

The ICC should consider working with the National Institute of Building Sciences (NIBS) and NIST to develop and include two performance objectives for the IWUIC—one for life-safety and one for structure survivability without the benefit of firefighting. Develop requirements to meet each of the performance objectives. This approach allows communities to understand and adopt a version of the IWUIC that most closely meets their needs.

Recommendation CO-12b

The ICC should consider revising the IWUIC to address wildfire planning and mitigation at different physical levels, including the building, parcel, neighborhood/subdivision, and community scales. Incorporating mitigation measures at different scales will provide a more comprehensive approach to addressing community wildfire risk.

Conclusion CO-13

Many of the current fire testing standards were not developed for wildland fire and therefore do not comprehensively address the risk of wildfire to structures.

Recommendation CO-13

The USFA should consider collaborating with ICC, fire testing laboratories, NIST, and other interested parties to develop wildfire-specific fire test standards for building construction and materials, exterior building components and details, exterior fire protection systems, interior suppression systems, etc. These fire test standards should consider the development of a standard wildfire exposure (including ember exposure), performance criteria, pre-fire testing weathering standards, the use of various exterior building construction materials, products, and systems on the exterior of buildings and suppression systems (both interior and exterior)

Conclusion CO-14

The I-Codes such as the IBC, IRC and the ICC lack a coordinated approach to addressing the risk of wildland fire to structures in the WUI. Some provisions in one of the I-Codes may not fully consider the risk of another hazard addressed by another of the International Codes.

Recommendation CO-14a

The ICC should consider evaluating exceptions in current codes and standards that allow fire spread, such as exceptions that allow for fire separation walls to not extend to the roofline. Identify which exceptions should be modified or eliminated to strengthen current codes and standards against the impacts of wildfire.

Recommendation CO-14b

The ICC should consider reviewing the intent of the different International Codes to ensure they address multiple hazards consistently. For example, consider the interrelationship between the fire codes, flood provisions of codes, and green construction codes with respect to insulation. Consider the flammability of different types of insulation having the same R-values and incorporate insulation requirements consistently across all codes.

Recommendation CO-14c

Similar to other language in the codes, AHJs should consider mandating that the more conservative, fire-resistant requirements must be followed if there is a conflict between other codes and fire-resistant codes and standards.

Conclusion CO-15

The timing of the ICC model code updates is not consistent with the evolution of best available science for wildfire hazard-resistant construction and WUI planning. AHJs with limited capacity and resources often rely on the ICC model codes to adopt and enforce the latest construction and design standards. As a result, local governments may not be knowledgeable of the most up-to-date best practices for wildfire resilient and hazard-resistant construction.

Recommendation CO-15

NIBS should consider collaborating with national organizations such as NIST, IBHS and UL Research Institutes and industry professionals to synthesize the best available science on WUI construction into short, digestible publications for local governments. The publication of these documents could be used to develop a threshold determined by a technical committee and the format could parallel FEMA flood map advisories.

Conclusion CO-16

Because many jurisdictions do not adopt the IWUIC and do not include WUI provisions in local codes and zoning requirements, structures in the WUI continue to be designed and built without incorporating wildland fire risk reduction measures. While the number of wildland fire events in the U.S. over the past several decades has remained fairly constant, the number of acres affected by wildfires in the U.S. has increased and likely will continue to do so. The average number of acres burned by wildfires annually since 2000 has more than doubled the average annual acreage burned in the 1990s (CRS, 2022), which is an indicator of increased wildfire severity (EPA, 2022).

Recommendation CO-16a

FEMA's Building Science Branch, in coordination with the USFA, should consider proposing a code amendment to incorporate the IWUIC into the IBC and IRC by reference for high wildfire risk areas similar to how ASCE 7 and ASCE 24 are incorporated by reference. This approach would require local jurisdictions to adopt local amendments to exclude IWUIC provisions,

which could increase homeowner awareness of risks associated with wildland fire and mitigation measures that can be incorporated to address them.

Recommendation CO-16b

FEMA's Building Science Branch, in coordination with the USFA, should consider working with ASCE to develop a resistant design and construction standard incorporating wildland fire as a unique hazard rather than as part of "extraordinary events" because "extraordinary events" are defined as those having "low probability."

Conclusion CO-17

Adoption of stricter building code standards often compete with desires for local communities to quickly, efficiently, and affordably rebuild post-event or for long-term growth. This conflict in interests has resulted in jurisdictions adopting codes and ordinances that do not require adherence to IWUIC or wildland fire-resistant design principles, which can result in increased wildfire risk to residents.

Recommendation CO-17a

AHJs should carefully review all short-term financial, social, and other costs against long-term wildfire risks and mitigation benefits associated with decreased risk from improved codes when considering weaker or "opt-out" amendments for homeowners affected by the Marshall Fire. Where model code provisions are intended to safeguard public health and the safety of building occupants, consider reviewing and removing temporary exclusions to the codes.

Recommendation CO-17b

Local governments located in high wildland fire risk areas where WUI codes and standards are not mandated by the state or local governments should consider providing homeowner incentives for voluntary adoption of wildland fire-resistant design principles, such as tax incentives, rebate programs or "mini grants", and free chipping and hauling programs.

Conclusion CO-18

Adoption of different fire and building codes at the local government level can lead to gaps in fire protection of the built environment in adjacent communities. The State legislature recently followed the recommendation of the Colorado Fire Commission's 2022 Annual Report to create a Wildfire Resiliency Code Board, tasking it identifying and adopting model codes, requiring governing bodies with jurisdiction in an area within the wildland-urban interface to adopt codes that meet or exceed the standards set forth in the model codes, and making an appropriation.

Recommendation CO-18a

The State of Colorado should consider the adoption of a statewide unified building code and allow for jurisdictions to amend for more stringent requirements if needed. Establishing a minimum statewide building code would provide a standard basis when rendering mutual aid across jurisdictional boundaries. Taking this action is also consistent with updated guidance

provided in FEMA's State Mitigation Planning Policy Guide, which requires building codes to be addressed in all standard plans and encourages states with enhanced plans to develop a strategy for statewide building code adoption and implementation. In the absence of a statewide building code, local jurisdictions should adopt the latest versions of the IBC, IWUIC, IRC, IEBC, and IFC. Adoption of modern building codes and standards is consistent with the National Initiative to Advance Building Codes.

Recommendation CO-18b

The State of Colorado should consider adopting the IEBC or enacting legislation that requires taking an all-hazards approach to building retrofits and incorporates different levels of hazard resistance based on the hazard. In the absence of a statewide requirement, local jurisdictions should consider requiring an all-hazards approach to building retrofits and, as appropriate, include amendments to improve the protections provided against certain hazards. Additionally, local jurisdictions should consider incorporating passive fire resistive measures from the WUI codes as they customize their adoption of the model IBC, IRC, and IEBC into their ordinances.

Conclusion CO-19

Above-code requirements may provide additional protections for townhouses and 2-family dwellings in wildland fire-prone areas.

Recommendation CO-19

Where not already required, AHJs should consider requiring a Class A fire rated roof cover installation to include materials and construction methodology, as well as the extension of the parapet above the tenant separation wall unless the roof deck is made of noncombustible materials, as defined by the 2021 IWUIC.

Conclusion CO-20

Local code exceptions and potential code enforcement gaps may have resulted in the use of some local building practices that decrease the fire resistance of homes, such as fire walls not extending fully through attics of townhouses.

Recommendation CO-20a

AHJs should review and implement ways to improve code enforcement, such as hiring additional code inspectors and providing additional or recurring training. In high wildland fire risk areas, ensure the training includes provisions in the codes and local amendments that specifically address risk to structures from wildfire. Consider obtaining or improving the community's Building Code Effectiveness Grading Schedule (BCEGS®) score.

Recommendation CO-20b

In areas with high to extreme wildfire risk, AHJs should consider adopting ordinances to require that common walls separating townhouse and 2-family dwelling units meet the standards for exterior walls as described by the 2021 IWUIC Chapter 5 (Class 1 and 2 Ignition-Resistant Construction).

Conclusion CO-21

Local government agencies do not have adequate information, resources and/or training to effectively understand wildland fire risk, how to mitigate it, and methods to comprehensively regulate and enforce wildland fire safety provisions.

Recommendation CO-21a

FEMA, in coordination with the USFA, should consider providing additional information, resources, incentives, and training to assist state and local governments to better understand, adopt, regulate and enforce relevant wildland fire safety codes, standards and best practices. Some approaches may include completing updates to existing FEMA handbooks (e.g., P-737, P-754), developing regulatory guidance documents, updating Emergency Management Institute coursework, funding national level wildland fire risk mapping, including WUI in Building Code Adoption Tracking (BCAT) statistics, and partnering with wildfire organizations to promote and deliver wildland fire mitigation workshops at conferences and other similar events.

Recommendation CO-21b

FEMA, in coordination with the USFA, should explore working with Congress to extend the provisions of Section 1206 of the Disaster Recovery Reform Act of 2018 to provide funding for additional code inspectors for 365 days after a disaster (rather than 180 days as is currently stipulated).

Conclusion CO-22

Closely spaced houses (e.g., less than 15-foot setback) in medium- to high-density housing developments that were constructed in accordance with non-WUI codes and mitigation practices are more likely to be damaged by and contribute to structure-to-structure fire spread. Current building codes do not typically require fire resistance ratings for exterior walls for single-family residences, almost regardless of fire separation distances to adjacent properties or structures. This significantly increases the risk of structure-to-structure fire spread (or urban conflagration) particularly in a wind-driven wildfire incident.

Recommendation CO-22a

To reduce the likelihood of structure-to-structure fire spread, AHJs should consider if closely spaced homes (e.g., property line setback distances of less than 30 feet) in high wildfire risk areas should have a) one-hour or greater fire rated exterior walls b) either no windows, fire-rated opening-protection, or a specific lateral offset between windows on exterior walls facing adjacent buildings, as well as other provisions to reduce the likelihood of structure-to-structure fire spread. Consider partnering with engineers, code officials, firefighters, and wildfire experts to obtain multiple expert viewpoints.

Recommendation CO-22b

The ICC should consider updating national fire codes and standards (e.g., IFC, IRC, IWUIC, etc.) to require fire resistance ratings for exterior walls for single-family residences.

Conclusion CO-23

Planning, design, and construction professionals working in high wildfire risk areas lack adequate information and training regarding wildfire resilience practices at the building and neighborhood scales. Most homes in the impacted neighborhoods and adjacent neighborhoods had numerous well-known structural hardening and defensible space vulnerabilities, as well as lesser known vulnerabilities in the exterior building envelope. This included wildfire resilient designs and detailing at joints or interfaces of building components (e.g., a lack of proper detailing of bottom-of-wall to foundation joints, window-to-wall joints, wall-to-foundation joint, roof joints, wall-to-wall panel joints, edge of roof joints) throughout the exterior building envelope. These joints provided avenues for ember intrusion into the interstitial spaces, which are often constructed of combustible materials, leading to concealed fires and/or direct ignition of interior building contents.

Recommendation CO-23a

FEMA's Building Science Branch, in coordination with the USFA, should consider revising the internal Community Wildfire Resilience white paper collaboratively with IBHS and NIST and other fire science engineers as needed and make it publicly available.

Recommendation CO-23b

FEMA's Building Science Branch, in coordination with the USFA, should explore working with IBHS and NIST to identify construction joints and assemblies that are particularly susceptible to ember and/or flame intrusion. Based on this information, FEMA Building Science Branch should develop standard detailing guidance for particular construction joints and assemblies to improve the residential structure wildfire resistance.

Recommendation CO-23c

FEMA's Building Science Branch, in collaboration with the USFA, NIST, IBHS and other wildfire science engineers should consider designing and constructing a multi-hazard mitigation house to demonstrate how mitigation strategies can be incorporated to address

multiple hazards. Several other entities have constructed demonstration homes, including IBHS's Fortified home for hurricanes and wildfire, and Disney's partnership with the Federal Alliance for Safe Homes (FLASH) to develop the StormStruck exhibit at Epcot. FEMA could build upon and incorporate the concepts included in these demonstration homes to design and construct a multi-hazard-resistant demonstration home or smaller scale model.

Conclusion CO-24

Vent covering requirements in the IWUIC, while consistent with requirements in the other International Codes, are not consistent with recent research findings and recommendations from other building protection entities with respect to wildland fire mitigation, and as written provide for subjectivity on behalf of the code official for what is "approved."

Recommendation CO-24

FEMA's Building Science Branch, in coordination with the USFA, should consider developing a code amendment proposal to the IWUIC to require 1/16-inch corrosion-resistant, noncombustible wire mesh openings instead of the current 1/4-inch requirement or "approved" design to prevent flame and ember penetration into the structure, where "approval" is determined by the designated code official. This amendment would make the IWUIC consistent with research findings from NIST and recommendations and requirements from other entities such as IBHS, NFPA, and California Building Code Chapter 7A. This amendment also would provide greater consistency in requirements across jurisdictions.

Conclusion CO-25

Vent openings in attics, roofs, walls, crawlspaces, and foundations that were not protected against wildfire provided pathways for embers to enter homes and structures.

Recommendation CO-25a

AHJs should consider adopting local ordinances to require vents made from noncombustible materials. Vents should be a maximum size of 144 square inches in conformance with IWUIC Section 504.10 and IBC Section 714.1.4 and provided with 1/8-inch to 1/16-inch, noncombustible mesh screens or ember resistant vent protection. Corrosion-resistant wire mesh should have openings 1/8-inch to 1/16-inch consistent with NFPA 1140 25.3.3(2) and California Building Code Chapter 7A Section 706A.2.2.1.

Recommendation CO-25b

For existing construction that includes gable-end vents, state and local AHJs should consider amending building codes and ordinances to require use of a wildfire-resistant gable vent that has passed ASTM E2886.

Recommendation CO-25c

AHJs in wildfire risk areas should consider adopting local ordinances to require decks, porches, and balconies to have walking surfaces constructed from noncombustible materials for at least 1 foot away from the home (NIST, 2022) for boards that are oriented parallel to the exterior wall. The rest of the attached structure should be constructed from fire-retardant-treated wood or noncombustible, ignition-resistant, or other materials having at least a 1-hour fire rating.

Conclusion CO-26

Single-pane windows, windows with aluminum or plastic framing and windows with plastic screens are vulnerable to wildfire exposures (e.g., cracking and fallout) due to radiant heat or large debris impact in high winds, fallout due to softening of aluminum or plastic framing, or ignition of plastic screens leading to ignition of combustibles in the interior. They are also susceptible to damage from high winds such as those that occurred during the Marshall Fire.

Recommendation CO-26

AHJs should consider adopting IWUI codes and standards. Alternatively, local jurisdictions can adopt local ordinances to require double-pane window systems (preferably with one tempered-laminated pane), metal or fiberglass screening, metal window frames or metal covering be used. Vegetation should also be excluded within 5–10 feet of glazed openings. New and existing structures should also consider high wind requirements when selecting new window systems. Ensure windows can demonstrate impact resistance via testing or ICC Evaluation Service approval.

Conclusion CO-27

Combustible fences, decks and patios attached to structures acted as wicks and helped to spread the fire from structure-to-structure. This is a well-known and codified wildland fire vulnerability, but was pervasive throughout the impacted neighborhoods, adjacent neighborhoods, and reconstructed locations, in part due to some requirements of local homeowners' associations.

Recommendation CO-27

AHJs should consider adopting WUI codes and standards. Alternatively, local jurisdictions and homeowners' associations can partner to adopt local ordinances that require a) new and refurbished decks and patios to be constructed of noncombustible materials; b) all fences (regardless of height) connected to homes/structures be constructed of noncombustible materials at least within the first 5 feet from the structure; and c) all fences (regardless of height) parallel to and within 10 feet of homes/structures should be constructed from noncombustible materials. Parallel fences along property lines separating two pieces of property should be disallowed, as NIST research has shown that this configuration is highly combustible (NIST, 2022).

Conclusion CO-28

Building owners do not understand measures they can take to decrease the impacts of smoke, soot, and ash from wildland fires on their structures, which can result in extensive damage and expensive clean up.

Recommendation CO-28a

Local governments should consider working with insurance companies, restoration contractors, and local fire departments to develop guidance for building owners on how to prepare their buildings to reduce the risk of smoke and ash infiltration, such as shutting down HVAC systems and taping door and window seals shut. Additionally, building owners need to be made aware of the potential contents damage and health risks associated with not addressing smoke and ash infiltration.

Recommendation CO-28b

Homeowners and contractors should make efforts to minimize the risk of contamination entering the actual living spaces of the house. When remediating against existing smoke and ash damages, homeowners should consider using techniques to reduce the risk of future smoke, soot, and ash damage, such as improving door and window sealants and replacing fiberglass batt insulation with thicker sprayed foam/closed cell insulation. Such techniques can also make the home more energy efficient, but the flammability of sealants and non-fiberglass insulation must be examined to ensure code compliance and avoid increasing structural fire risk.

Conclusion CO-29

Photovoltaic energy systems, electric vehicles, and other systems that store energy in Li-ion batteries pose an environmental and fire hazard if ignited. NFPA 855 and the 2021 International codes provide fire separation standards for some Li-ion battery systems, but additional protections against wildfire may be needed as this technology becomes more prevalent.

Recommendation CO-29a

AHJs with moderate to high wildland fire risk areas should adopt the latest published editions of the IRC, IFC, and IBC that provide expanded protections for battery storage systems and solar arrays.

Recommendation CO-29b

NFPA, in coordination with the USFA and ICC, should consider collaborating with a recognized fire testing laboratory (e.g., UL, Southwest Research Institute, Intertek) to evaluate provisions in the International Codes that provide mandatory protection for energy storage systems and augment as appropriate to provide protection against damage and ignition of these systems resulting from wildfire.

Conclusion CO-30

Current building codes and standards do not adequately address protection of photovoltaic systems and Li-ion battery storage systems in high wildfire risk areas. While NFPA 855 addresses the storage of Li-ion batteries in a stationary situation, it does not specifically consider wildland fire risk.

Recommendation CO-30

FEMA, in coordination with the USFA, should consider proposing code changes to the ICC and NFPA to require special safety provisions for photovoltaic and Li-ion battery storage systems in high wildfire risk areas. The provisions should consider not only stationary situations but also Li-ion batteries in electric vehicles operating in high wildland fire risk areas.

Conclusion CO-31

Li-ion batteries damaged by fire pose the risk of igniting or reigniting even after the fire has been extinguished. No approved method has yet been developed for extinguishing fires involving Li-ion battery ESS. The ignition and re-ignition potential of Li-ion batteries was cited during interviews as one factor in determining firefighting priorities.

Recommendation CO-31

The NFPA and the Occupational Safety and Health Administration (OSHA), in coordination with the USFA, should consider developing a placard or adopt and modify as appropriate the current OSHA Li-ion storage placard and make it available to vendors of products that include Li-ion battery storage systems. Homeowners with Li-ion battery storage systems such as solar PV arrays and electric vehicles should be encouraged to post these placards in their windows or other places on their houses to enable firefighters to recognize the presence of such a system in the home. This will allow firefighters to take appropriate actions with respect to such battery storage systems.

6.5. Summary of Conclusions and Recommendations

Table 16 is a matrix listing the conclusions and recommendations cross-referenced to the sections of the report that describe the supporting observations.

Table 16. Summary of Conclusions and Recommendations

Observations	Conclusions	Recommendations	Suggested Agency Lead
Section 1.3.2	**CO-1:** Current WUI definitions do not accurately reflect the diversity of wildfire environmental settings and community designs that are prone to wildfire threats, including the area impacted by the Marshall Fire. The definition of "WUI" is not comprehensive enough, in that it typically only describes environmental conditions such as vegetation and not explicitly the hazard, risk or vulnerabilities that is presents. This has led to the perception of "wildland" as sparsely populated, heavily wooded areas in rugged, mountain terrain with steep slopes.	**CO-1a:** The NWCG, in coordination with FEMA and USFA, should update and expand upon the definition of "wildland-urban interface" to clarify that "wildland" includes a range of environments such as grasslands, shrublands and not just forests and trees. Guidance should be provided for local and state governments to adopt and adapt the NWCG's definition to meet specific needs, such as defining "interface," "intermix" and "occluded" space.	NWCG
Section 1.3.2		**CO-1b:** Local and state governments should raise awareness and provide educational programs for their citizens about the various local conditions that define the "WUI."	Local and state governments
Section 1.3.2	**CO-2**: Though various forms of wildfire hazard and risk mapping layers have been developed by some state and federal agencies to address a variety of applications (e.g., land use management), a national, consensus-based wildfire risk mapping for community planning and building wildfire safety does not currently exist. The lack of such hazard delineation limits an understanding of wildfire "risk," with respect to both wildfire hazard severity levels and associated return intervals at a national scale, which are already provided for other hazards (e.g., wind, seismic, flooding).	**CO-2a:** The USFA, NFPA, USFS and NIST should consider partnering with an architectural and engineering standards development organizations to create a national, consensus-based wildfire hazard severity map that includes mean recurrence intervals for at-risk areas (i.e., wildfire "risk" map).	USFA, NFPA, USFS and NIST
Section 1.3.2		**CO-2b:** The USFA should work with federal interagency and SLTT partners to explore development of national, consensus-based wildfire hazard severity zone maps with mean recurrence intervals that guide community and parcel-level decision making and trigger the use of fire safety requirements prescribed in the IWUIC or other model WUI, building or fire codes.	USFA
Section 1.3.2		**CO-2c:** Where wildfire hazard or risk maps already exist, local jurisdictions should consider using those maps for creating or updating local regulatory WUI maps.	Local governments
Section 1.3.2	**CO-3:** Current practices in assessing wildfire risks to the built environment are not based on risk-informed approaches analogous to other hazards (e.g., seismic, wind), where recurrence intervals and damage potentials are quantified at the national level.	**CO-3:** Similar to the risk-informed approaches used for other hazards such as flood, wind, and earthquake, NFPA and ICC should consider working together to standardize development of acceptable wildfire risk thresholds based on risk-informed methods.	NFPA and ICC

Observations	Conclusions	Recommendations	Suggested Agency Lead
Section 1.3.3 Section 2.2 Section 4.3	**CO-4:** The Marshall Fire demonstrates how characteristics in the natural environment that markedly influence the behavior of wildfires (i.e., topography, weather, fuel) can interact with other natural hazards such as long-term drought and high wind to exacerbate the risk and behavior of a wildfire. Traditional hazard mitigation plans identify hazards as singular events and neglect the interactions between them.	**CO-4:** AHJs in wildfire-prone areas should consider adopting approaches to wildfire mitigation that identify multi-hazard risks and collectively address risk reduction through land management and building mitigation practices.	AHJs
Section 4.1 Section 4.2 Section 5.1.1	**CO-5:** Historically, national- and state-level wildfire mitigation planning, and preparedness have primarily targeted forest and woodland areas in the WUI. Many community plans, including the Boulder County Community Wildfire Protection Plan, focus on wildfire mitigation in forested and woodland landscapes within the WUI.	**CO-5:** Community planners should assess opportunities to apply landscape and parcel-level hazardous fuel maintenance and defensible space strategies to publicly owned outdoor, recreational, and open space, as well as undeveloped grassland and shrubland adjacent to the community.	Local governments and community planners
Section 3.5 Section 4.1	**CO-6:** While jurisdictions impacted by the Marshall Fire have taken steps to incorporate and coordinate multi-hazard planning, open space management, and community design into their wildfire risk assessments and mitigation strategies, these strategies are not yet consistent across all levels of planning and planning resources.	**CO-6**: Community planners, building code and fire officials should consistently incorporate and coordinate comprehensive wildfire management strategies across all planning codes, standards, policy and guidance documents, including comprehensive or long-range planning, CWPP, hazard mitigation plans, building and fire safety codes/standards/local ordinances, energy codes, landscaping codes, unit strategic plans, forest, and open space plan.	Local governments and community planners
Section 2.2 Section 4.1 Section 4.2	**CO-7:** During the Marshall Fire, water collection and diversion features and greenbelts overgrown with vegetation provided pathways for wildland fire to spread along the ground surface into urbanized areas.	**CO-7a:** AHJs should consider requiring vegetated water collection and diversion features, greenbelts, parks and vegetated islands/bioswales that interact or interconnect wildland spaces with the built-environment in high fire prone areas to be regularly maintained through adoption of ordinances and provisions in maintenance contracts.	AHJs
Section 4.2		**CO-7b:** Local ordinances should require the use of diverse native, fire-resistant vegetation species in water collection and diversion features, greenbelts, parks and vegetated islands/bioswales that interact or interconnect wildland spaces with the built environment in high fire prone areas	AHJs

Observations	Conclusions	Recommendations	Suggested Agency Lead
Section 4.1 Section 4.3		**CO-7c**: State foresters should consider working with authorities having jurisdiction and other subject matter experts to evaluate the effectiveness of community and parcel-level vegetative fuel breaks and make recommendations for priority local areas to incorporate science-based vegetation management best practices.	State Foresters
Section 4.1 Section 4.2	**CO-8**: Current community and neighborhood level planning and design requirements in many high wildfire risk areas do not sufficiently incorporate wildfire safety considerations for landscaping.	**CO-8a**: AHJs should consider adopting zoning, codes and ordinances that integrate wildfire safety concepts into planning, design, construction, long-term maintenance, and inspection.	AHJs
Section 4.1		**CO-8b:** Local governments and community planners should coordinate with entities such as the Cooperative Extension Service, universities, and State forestry agencies to develop and socialize "approved" wildfire-resistant plant lists and landscaping strategies for use by developers, homeowners' associations, and homeowners.	Local governments and community planners
Section 3.1.3 Section 4.1 Section 4.2		**CO-8c:** Homeowners' associations and local governments should consider partnering with wildfire education providers such as Firewise USA®, Wildfire Partners, IBHS Wildfire Prepared Home Program and Fire Adapted Communities Learning Network to educate landscapers and homeowners about ways to develop and implement mitigation strategies that decrease wildfire risk at the parcel and neighborhood level.	Homeowners' associations and local governments
Section 3.2 Section 4.1 Section 4.2	**CO-9:** Local subdivision regulations do not include provisions that adequately address wildfire risk.	**CO-9a:** AHJs in wildfire risk areas should consider working with their local fire departments to develop and adopt subdivision regulations that address wildland fire risk, including structure density in the WUI, appropriate access/egress capacity and separation, adequate water supply, requirements for fire protection and vegetation management plans, and procedures for subdivision evaluation and approval.	AHJs
Section 1.3.2 Section 3.2		**CO-9b:** AHJs should consider incorporating WUI terminology into local codes and ordinances to improve understanding of WUI concepts.	AHJs
Section 2.3	**CO-10:** The combined impact of natural hazards and weather conditions (e.g., high wind, combustible vegetation, and cold temperatures) can create disproportionate risks for disadvantaged communities.	**CO-10:** Communities with moderate to very-high wildfire risk should investigate and incorporate the vulnerabilities of disadvantaged communities (such as access to support recovery services) into multi-hazard wildfire mitigation planning, response, and recovery efforts.	Local governments

Observations	Conclusions	Recommendations	Suggested Agency Lead
Section 5.1	**CO-11:** Parcel/lot sizes in densely spaced neighborhoods may limit homeowners' abilities to satisfy best practices in defensible space. Because these lot sizes generally are fixed and cannot be changed, defensible space needs to be established at the neighborhood or community level.	**CO-11a:** AHJs should consider working with fire departments, planning departments, and wildfire experts to develop local ordinances, standards and guidance documents for communal defensible space in overlapping ignition zones.	AHJs
Section 5.1		**CO-11b:** AHJs should consider integrating and mainstreaming wildland fire safety concepts throughout the regulatory life cycle from planning and zoning to design and permitting to construction to long-term maintenance and inspection.	AHJs
Section 3.1 Section 3.2	**CO-12:** The current version of the IWUIC does not fully address needs at the building-, parcel- and community-levels.	**CO-12a:** The ICC should consider working with the NIBS and NIST to develop and include two performance objectives for the IWUIC—one for life-safety and one for structure survivability without the benefit of firefighting.	ICC
Section 3.1 Section 3.2		**CO-12b:** The ICC should consider revising the IWUIC to address wildfire planning and mitigation at different physical levels, including the building, parcel, neighborhood/subdivision, and community scales.	ICC
Section 3.3	**CO-13:** Many of the current fire testing standards were not developed for wildland fire and therefore do not comprehensively address the risk of wildfire to structures.	**CO-13:** The USFA should consider collaborating with ICC, fire testing laboratories, NIST and other interested parties to develop wildfire-specific fire test standards for building construction and materials, exterior building components and details, exterior fire protection systems, interior suppression systems, etc.	USFA
Section 3.1 Section 3.2 Section 5.1.3	**CO-14:** The I-Codes such as the IBC, IRC and the ICC lack a coordinated approach to addressing the risk of wildland fire to structures in the WUI. Some provisions in one of the I-Codes may not fully consider the risk of another hazard addressed by another of the International Codes.	**CO-14a:** The ICC should consider evaluating exceptions in current codes and standards that allow fire spread, such as exceptions that allow for fire separation walls to not extend to the roofline.	ICC
Section 2.2 Section 3.1 Section 3.2		**CO-14b:** The ICC should consider reviewing the intent of the different International Codes to ensure they address multiple hazards consistently.	ICC
Section 3.1 Section 3.2		**CO-14c:** Similar to other language in the codes, AHJs should consider mandating that the more conservative, fire-resistant requirements must be followed if there is a conflict between other codes and fire-resistant codes and standards.	AHJs

Observations	Conclusions	Recommendations	Suggested Agency Lead
Chapter 3	**CO-15:** The timing of the ICC model code updates is not consistent with the evolution of best available science for wildfire hazard-resistant construction and WUI planning.	**CO-15:** NIBS should consider collaborating with national organizations such as NIST, IBHS and UL Research Institutes and industry professionals to synthesize the best available science on WUI construction into short, digestible publications for local governments.	NIBS
Chapter 3	**CO-16:** Because many jurisdictions do not adopt the IWUIC and do not include WUI provisions in local codes and zoning requirements, structures in the WUI continue to be designed and built without incorporating wildland fire risk reduction measures.	**CO-16a:** FEMA's Building Science Branch, in coordination with the USFA, should consider proposing a code amendment to incorporate the IWUIC into the IBC and IRC by reference for high wildfire risk areas similar to how ASCE 7 and ASCE 24 are incorporated by reference.	FEMA's Building Science Branch
Chapter 3		**CO-16b:** FEMA's Building Science Branch, in coordination with the USFA, should consider working with ASCE to develop a resistant design and construction standard incorporating wildland fire as a unique hazard rather than as part of "extraordinary events" because "extraordinary events" are defined as those having "low probability."	FEMA's Building Science Branch
Section 3.2	**CO-17:** Adoption of stricter building code standards often compete with desires for local communities to quickly, efficiently, and affordably rebuild post-event or for long-term growth.	**CO-17a:** AHJs should carefully review all short-term financial, social, and other costs against long-term wildfire risks and mitigation benefits associated with decreased risk from improved codes when considering weaker or "opt-out" amendments for homeowners affected by the Marshall Fire.	AHJs
Section 3.1 Section 3.2		**CO-17b:** Local governments located in high wildland fire risk areas where WUI codes and standards are not mandated by the state or local governments should consider providing homeowner incentives for voluntary adoption of wildland fire-resistant design principles, such as tax incentives, rebate programs or "mini grants" and free chipping and hauling programs.	Local governments
Chapter 3	**CO-18:** Adoption of different fire and building codes at the local government level can lead to gaps in fire protection of the built environment in adjacent communities. The State legislature recently followed the recommendation of the Colorado Fire Commission's 2022 Annual Report to create a Wildfire Resiliency Code Board, tasking it identifying and adopting model codes, requiring governing bodies with jurisdiction in an area within the wildland-urban interface to adopt codes that meet or exceed the standards set forth in the model codes, and making an appropriation.	**CO-18a:** The State legislature should follow the recommendation of the Colorado Fire Commission's 2022 Annual Report to create a Wildland-Urban Interface Code Board.	Colorado State Legislature
Chapter 3		**CO-18b:** The State of Colorado should consider the adoption of a statewide unified building code and allow for jurisdictions to amend for more stringent requirements if needed.	State of Colorado
Chapter 3		**CO-18c:** The State of Colorado should consider adopting the IEBC or enacting legislation that requires taking an all-hazards approach to building retrofits and incorporates different levels of hazard resistance based on the hazard.	State of Colorado

Observations	Conclusions	Recommendations	Suggested Agency Lead
Section 2.5 Section 3.2 Section 5.2.1	**CO-19:** Above-code requirements may provide additional protections for townhouses and 2-family dwellings in wildland fire-prone areas.	**CO-19:** Where not already required, AHJs should consider requiring a Class A fire rated roof cover installation to include materials and construction methodology, as well as the extension of the parapet above the tenant separation wall unless the roof deck is made of noncombustible materials, as defined by the 2021 IWUIC.	AHJs
Chapter 3 Chapter 5	**CO-20:** Local code exceptions and potential code enforcement gaps may have resulted in the use of some local building practices that decrease the fire resistance of homes, such as fire walls not extending fully through attics of townhouses.	**CO-20a:** AHJs should review and implement ways to improve code enforcement, such as hiring additional code inspectors and providing additional or recurring training.	AHJs
Section 5.1.3 Section 5.2.7		**CO-20b:** In areas with high to extreme wildfire risk, AHJs should consider adopting ordinances to require that common walls separating townhouse and 2-family dwelling units meet the standards for exterior walls as described by the 2021 IWUIC Chapter 5 (Class 1 and 2 Ignition-Resistant Construction).	AHJs
Section 5.1 Section 5.2	**CO-21:** Local government agencies do not have adequate information, resources and/or training to effectively understand wildland fire risk, how to mitigate it, and methods to comprehensively regulate and enforce wildland fire safety provisions.	**CO-21a:** FEMA, in coordination with the USFA, should consider providing additional information, resources, incentives, and training to assist state and local governments to better understand, adopt, regulate and enforce relevant wildland fire safety codes, standards and best practices.	FEMA
Section 5.1 Section 5.2		**CO-21b:** FEMA, in coordination with the USFA, should explore working with Congress to extend the provisions of Section 1206 of the Disaster Recovery Reform Act of 2018 to provide funding for additional code inspectors for 365 days after a disaster (rather than 180 days as is currently stipulated).	FEMA
Section 5.1 Section 5.2	**CO-22:** Closely spaced houses (e.g., less than 15-foot setback) in medium- to high-density housing developments that were constructed in accordance with non-WUI codes and mitigation practices are more likely to be damaged by and contribute to structure-to-structure fire spread. Current building codes do not typically require fire resistance ratings for exterior walls for single-family residences, almost regardless of fire separation distances to adjacent properties or structures. This significantly increases the risk of structure-to-structure fire spread (or urban conflagration) particularly in a wind-driven wildfire incident.	**CO-22a:** To reduce the likelihood of structure-to-structure fire spread, AHJs should consider if closely spaced homes (e.g., property line setback distances of less than 30 feet) in high wildfire risk areas should have a) one-hour or greater fire rated exterior walls b) either no windows, fire-rated opening-protection, or a specific lateral offset between windows on exterior walls facing adjacent buildings, as well as other provisions to reduce the likelihood of structure-to-structure fire spread.	AHJs

Observations	Conclusions	Recommendations	Suggested Agency Lead
Section 5.1.3 Section 5.2		**CO-22b:** The ICC should consider updating national fire codes and standards (e.g., IFC, IRC, IWUIC, etc.) to require fire resistance ratings for exterior walls for single-family residences.	ICC
Section 4.1 Section 4.2 Section 5.1 Section 5.2	**CO-23:** Planning, design, and construction professionals working in high wildfire risk areas lack adequate information and training regarding wildfire resilience practices at the building and neighborhood scales.	**CO-23a:** FEMA's Building Science Branch, in coordination with the USFA, should consider revising the internal Community Wildfire Resilience white paper collaboratively with IBHS and NIST and other fire science engineers as needed and make it publicly available.	FEMA's Building Science Branch
Section 5.2		**CO-23b:** FEMA's Building Science Branch, in coordination with the USFA, should explore working with IBHS and NIST to identify construction joints and assemblies that are particularly susceptible to ember and/or flame intrusion.	FEMA's Building Science Branch
Section 1.3.3 Section 2.2		**CO-23c:** FEMA's Building Science Branch, in collaboration with the USFA, NIST, IBHS and other wildfire science engineers should consider designing and constructing a multi-hazard mitigation house to demonstrate how mitigation strategies can be incorporated to address multiple hazards.	FEMA's Building Science Branch
Section 2.3.2 Section 5.2	**CO-24:** Vent covering requirements in the IWUIC, while consistent with requirements in the other International Codes, are not consistent with recent research findings and recommendations from other building protection entities with respect to wildland fire mitigation, and as written provide for subjectivity on behalf of the code official for what is "approved."	**CO-24:** FEMA's Building Science Branch, in coordination with the USFA, should consider developing a code amendment proposal to the IWUIC to require 1/16-inch corrosion-resistant, noncombustible wire mesh openings instead of the current 1/4-inch requirement or "approved" design to prevent flame or ember penetration into the structure, where "approval" is determined by the designated code official.	FEMA's Building Science Branch
Section 5.2	**CO-25:** Vent openings in attics, roofs, walls, crawlspaces, and foundations that were not protected against wildfire provided pathways for embers to enter homes and structures.	**CO-25a:** AHJs should consider adopting local ordinances to require vents made from noncombustible materials.	AHJs
Section 5.2		**CO-25b:** For existing construction that includes gable-end vents, state and local AHJs should consider amending building codes and ordinances to require use of a wildfire-resistant gable vent that has passed ASTM E2886.	AHJs
Section 5.2.11		**CO-25c:** AHJs in wildfire risk areas should consider adopting local ordinances to require decks, porches, and balconies to have walking surfaces constructed from noncombustible materials for at least 1 foot away from the home (NIST, 2022) for boards that are oriented parallel to the exterior wall.	AHJs

Observations	Conclusions	Recommendations	Suggested Agency Lead
Section 5.2.7	**CO-26:** Single-pane windows, windows with aluminum or plastic framing and windows with plastic screens are vulnerable to wildfire exposures (e.g., cracking and fallout) due to radiant heat or large debris impact in high winds, fallout due to softening of aluminum or plastic framing, or ignition of plastic screens leading to ignition of combustibles in the interior. They are also susceptible to damage from high winds such as those that occurred during the Marshall Fire.	**CO-26:** AHJs should consider adopting IWUI codes and standards. Alternatively, local jurisdictions can adopt local ordinances to require double-pane window systems (preferably with one tempered-laminated pane), metal or fiberglass screening, metal window frames or metal covering be used.	AHJs
Section 5.2.11	**CO-27:** Combustible fences, decks and patios attached to structures acted as wicks and helped to spread the fire from structure-to-structure.	**CO-27:** AHJs should consider adopting WUI codes and standards. Alternatively, local jurisdictions and homeowners' associations can partner to adopt local ordinances that require a) new and refurbished decks and patios to be constructed of noncombustible materials; b) all fences (regardless of height) connected to homes/structures be constructed of noncombustible materials at least within the first 5 feet from the structure; and c) all fences (regardless of height) parallel to and within 10 feet of homes/structures should be constructed from noncombustible materials.	AHJs
Section 5.2.13	**CO-28:** Building owners do not understand measures they can take to decrease the impacts of smoke, soot, and ash from wildland fires on their structures, which can result in extensive damage and expensive clean up.	**CO-28a:** Local governments should consider working with insurance companies, restoration contractors, and local fire departments to develop guidance for building owners on how to prepare their buildings to reduce the risk of smoke and ash infiltration, such as shutting down HVAC systems and taping door and window seals shut.	Local governments
Section 5.2.13		**CO-28b:** Homeowners and contractors should make efforts to minimize the risk of contamination entering the actual living spaces of the house.	Homeowners
Section 5.2.4 Section 5.2.14	**CO-29:** Photovoltaic energy systems, electric vehicles, and other systems that store energy in Li-ion batteries pose an environmental and fire hazard if ignited. NFPA 855 and the 2021 International codes provide fire separation standards for some Li-ion battery systems, but additional protections against wildfire may be needed as this technology becomes more prevalent.	**CO-29a:** AHJs with moderate to high wildland fire risk areas should adopt the latest published editions of the IRC, IFC, and IBC that provide expanded protections for battery storage systems and solar arrays.	AHJs
Section 5.2.4 Section 5.2.14		**CO-29b:** NFPA, in coordination with the USFA and ICC, should consider collaborating with a recognized fire testing laboratory (e.g., UL, Southwest Research Institute, Intertek) to evaluate provisions in the International Codes that provide mandatory protection for energy storage systems and augment as appropriate to provide protection against damage and ignition of these systems resulting from wildfire.	NFPA and ICC

Observations	Conclusions	Recommendations	Suggested Agency Lead
Section 5.2.4 Section 5.2.14	**CO-30**: Current building codes and standards do not adequately address protection of photovoltaic systems and Li-ion battery storage systems in high wildfire risk areas. While NFPA 855 addresses the storage of Li-ion batteries in a stationary situation, it does not specifically consider wildland fire risk.	**CO-30:** FEMA, in coordination with the USFA, should consider proposing code changes to the International Code Council and NFPA to require special safety provisions for photovoltaic and Li-ion battery storage systems in high wildfire risk areas.	FEMA
Section 5.2.4 Section 5.2.14	**CO-31:** Li-ion batteries damaged by fire pose the risk of igniting or reigniting even after the fire has been extinguished. No approved method has yet been developed for extinguishing fires involving Li-ion battery ESS.	**CO-31:** The NFPA and the Occupational Safety and Health Administration (OSHA), in coordination with the USFA, should consider developing a placard or adopt and modify as appropriate the current OSHA Li-ion storage placard and make it available to vendors of products that include Li-ion battery storage systems.	NFPA and OSHA

Appendix A: Acknowledgements

The Federal Emergency Management Agency (FEMA) would like to acknowledge and heartily thank the many people whose countless contributions enabled the Marshall Fire Mitigation Assessment Team (MAT) to develop this Report and associated documents, as well as provide numerous briefings, training, and outreach efforts in supporting the affected areas impacted by the Marshall Fire. Below is our attempt to list as many individuals by name as possible, with regret to those we may have missed.

Katherine Baum, FEMA Region 8

Faith Berry, U.S. Fire Administration

Anne Cope, PhD, PE, Institute for Building and Home Safety

Zach Corcoran, J.D., Stantec

Erica Fischer, PhD, PE, Oregon State University

Karl Fippinger, CEM, PMP, International Code Council

Faraz Hedayati, PhD, Institute for Building and Home Safety

Matthew Holland, PE Stantec

Nicole LaRosa, U.S. Fire Administration

Hussam Mahmoud, PhD, Colorado State University

Robert MacKay, PE, FEMA Region 8

Brian Metzger, U.S. Fire Administration

Molly Mowery, AICP, Community Wildfire Planning Center

Andrew Notbohm, CO-CEM, Pikes Peak Regional Office of Emergency Management

Stephen Quarles, PhD, Institute for Building and Home Safety

Peter Reinhardt, CFM, FEMA Region 8

Tim Reinhold, PhD, Stantec

Mark Thompson, State of Colorado

Yana Tukvachinski, FEMA Region 2

Brad Wham, PhD, University of Colorado, Boulder

Appendix B: References

Bell, C.E., J.G. Gonzales, V.J. Mellano, M. Nakamura, S.L. Quarles, T.P. Salmon, and D.A. Shaw. 2007. Wildfire Preparedness and Recovery in San Diego County: A Review and Analysis White Paper of Data and Research Studies Relevant to Wildfire. Farm and Home Advisor's Office, University of California Cooperative Extension, County of San Diego. San Diego, CA.

Bernard, A. 2020. Home Rule Governance in Colorado. Legislative Council Staff Issue Brief Number 20-16. Available at: https://leg.colorado.gov/publications/home-rule-governance-colorado-20-16

Boulder County Community Planning and Permitting Department. 2017. Boulder County Building Code Amendments: Resolutions 2015-104 & 2016-96: Amendments to Boulder County Building Code Effective January 1, 2016.

Boulder County Community Planning and Permitting Department. 2022. Boulder County Building Code Amendments: Resolutions 2015-104, 2016-96 and 2022-040 Amendments to Boulder County Building Code Effective June 6, 2022. Available at: https://assets.bouldercounty.gov/wp-content/uploads/2017/03/building-code-2015.pdf

Boulder County Land Use Department. 2017. Boulder County BuildSmart Code. Available at: https://assets.bouldercounty.gov/wp-content/uploads/2017/03/buildsmart-code-2015.pdf

Boulder County Land Use Department. N.d. Fire Sprinkler System Plan. Available at: https://assets.bouldercounty.gov/wp-content/uploads/2017/03/b44-fire-sprinkler-system-plan.pdf)

Boulder County Office of Emergency Management. 2022. 2022 – 2027 Boulder Hazard Mitigation Plan. Available at: https://assets.boulderoem.com/wp-content/uploads/2020/12/hazard-mitigation-plan.pdf

Boulder County. 2011. Boulder County Community Wildfire Protection Plan. Available at: https://bouldercounty.gov/disasters/wildfires/mitigation/community-wildfire-protection-plan/

Boulder County. 2018. Boulder County Environmental Sustainability Plan. Available at: https://assets.bouldercounty.gov/wp-content/uploads/2018/08/2018-sustainability-plan.pdf

Boulder County. 2020. Boulder County Comprehensive Plan. Available at: https://assets.bouldercounty.gov/wp-content/uploads/2018/10/bccp-boulder-county-comprehensive-plan.pdf

Boulder County. 202. Boulder County Hazard Mitigation Plan. Available at: https://assets.boulderoem.com/wp-content/uploads/2020/12/hazard-mitigation-plan.pdf

Boulder County. N. d. *Wildfire Mitigation FAQ*. Available at: Wildfire Mitigation FAQ - Boulder County

Bowman et. al. 2009. *Fire in the Earth System*. Science, vol. 324, no. 5926

Building Energy Codes. N.d. Colorado Energy Office. Available at: https://energyoffice.colorado.gov/climate-energy/energy-policy/building-energy-codes

Building in Bushfire-prone Areas. N.d. South Australia County Fire Service. Available at: https://www.cfs.sa.gov.au/plan-prepare/building-planning/building-in-bushfireprone-areas/

City, Boulder County Continue to Make Progress on Fire Mitigation Efforts. 2022. City of Louisville. Available at: https://www.louisvilleco.gov/Home/Components/News/News/6218/

City of Louisville. N.d. Ignition Resistant Construction Guide. Available at: https://www.louisvillefire.com/wp-content/uploads/2022/05/Guide-4.27.22.pdf

City of Louisville. N.d. Strategic Planning Framework 2023-2024. Available at: https://www.louisvilleco.gov/home/showpublisheddocument/22025/638095618431500000

City of Louisville. 2022. Ordinance No. 1824. Available at: https://www.louisvilleco.gov/home/showpublisheddocument/34312/637821560275770000

City of Louisville. 2022. Ordinance No. 1838. Available at: https://www.louisvilleco.gov/home/showpublisheddocument/36317/637989298617570000

City of Louisville. 2022. Recovery Plan for Marshall Fire. Available at: https://www.louisvilleco.gov/home/showpublisheddocument/34565/637844998923630000

Colorado Division of Fire Prevention and Control. 2022. Facilitated Learning Analysis. Available at: https://storymaps.arcgis.com/stories/83af63bd549b4b8ea7d42661531de512

Colorado Forest Atlas. Available at: https://coloradoforestatlas.org/

Colorado State Forest Service. (1999). Fire-Resistant Landscaping. https://extension.colostate.edu/docs/pubs/natres/06303.pdf

Community Planning & Permitting Department. 2022. *Boulder County Land Use Code.* Available at: https://assets.bouldercounty.gov/wp-content/uploads/2017/02/land-use-code.pdf

Community Planning & Permitting Department. 2022. *Marshall Fire Rebuilding and Repairs in Unincorporated Boulder County.* https://assets.bouldercounty.gov/wp-content/uploads/2022/02/m1-marshall-fire-rebuilding.pdf

Country Fire Authority. N.d. Landscaping for Bushfire. Available at: https://www.landcarevic.org.au/assets/Uploads/landscaping-for-bushfire.pdf

Federal Emergency Management Agency. 2021. *Community Wildfire Resilience- Landscape Analysis Volume 1.*

Federal Emergency Management Agency. 2021. *Community Wildfire Resilience- White Paper Volume 2.*

Fourmile Canyon Fire Maps. N.d. Boulder County. Available at: https://bouldercounty.gov/disasters/wildfires/fourmile-canyon-fire-maps/

Geotechnical Extreme Events Reconnaissance Association. 2022. The 2021 Marshall Fire, Boulder County, Colorado. Available at: https://geerassociation.org/index.php/component/geer_reports/?view=geerreports&layout=build&id=103

Green Building Program. N.d. Town of Superior. Available at: https://www.superiorcolorado.gov/departments/building-department/green-building-program

Halford, M. (2023, January 30). *Boulder County Community Wildfire Protection Plan* [PowerPoint slides]. City of Louisville. Available at: https://www.louisvilleco.gov/home/showpublisheddocument/37591/638112735305830000

Hedayati, F., Quarles, S., and Standohar-Alfano, C. 2022. Evaluating Deck Fire Performance – Limitations of the Test Methods Currently Used in California's Building Codes. Available at: https://www.mdpi.com/2571-6255/5/4/107

Insulation Replacement. N.d. City of Louisville. Available at: https://www.louisvilleco.gov/local-government/government/departments/building-safety/rebuilding-resources-following-marshall-fire/insulation-replacement

Knott, E. "Common firestop code violations". February 2019. https://www.iccsafe.org/building-safety-journal/bsj-technical/common-firestop-code-violations-2/

Land Use Tool: Building Codes. N.d. Planning for Hazards. Available at: https://planningforhazards.com/building-code#:~:text=Building%20code%20regulations%20in%20Boulder%20County%20were%20first,loss%2C%20and%20have%20continued%20to%20evolve%20since%20then.

Louisville, Colorado Code of Ordinances. Municode. Available at: https://library.municode.com/co/louisville/codes/code_of_ordinances

Louisville Fire Protection District. N.d. Louisville Fire Protection District 2021-2026 Strategic Plan. Available at: https://www.louisvillefire.com/wp-content/uploads/2021/08/Louisville-Fire-Protection-District-Strategic-Plan-2021-2026-FinalV1.pdf

Majority of Permitted Rebuilds in Superior Choose Energy Efficiency. 2023. Town of Superior. Available at: https://www.superiorcolorado.gov/Home/Components/News/News/4132/17?backlist=%2fcommunity%2fsuperior-recovers

Marshall Fire Finances and Rebates. N.d. Boulder County. Available at: https://bouldercounty.gov/finances-and-rebates/

Marshall Fire Recovery Milestones. N.d. Boulder County. Available at: https://bouldercounty.gov/marshall-fire-recovery-milestones/

Marshall Fire Use Tax Credit Program. N.d. City of Louisville. Available at: https://www.louisvilleco.gov/local-government/government/departments/building-safety/rebuilding-resources-following-marshall-fire/marshall-fire-use-tax-credit-program

Miller, Blair. National Weather Service analysis identifies factors that caused Marshall Fire to spread so quickly. January 12, 2022. https://www.thedenverchannel.com/news/marshall-fire/national-weather-service-analysis-identifies-factors-that-caused-marshall-fire-to-spread-so-quickly

National Fire Protection Association. 2021. *NFPA 101®,* Life Safety Code Handbook. Available at: https://catalog.nfpa.org/NFPA-101-Life-Safety-Code-Handbook-P15695.aspx?icid=W003

National Institute for Standards and Technology. 2022. Wind-Driven Fire Spread to a Structure from Fences and Mulch. https://www.nist.gov/publications/wind-driven-fire-spread-structure-fences-and-mulch

National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information (NCEI), U.S. Billion-Dollar Weather and Climate Disasters, 2022. https://www.ncei.noaa.gov/access/billions/

National Weather Service. 2022. *Marshall Fire and High Wind on December 30, 2021.* Available at: https://www.weather.gov/bou/MarshallFire20211230

National Wildfire Coordination Group (2019) *Wildland Urban Interface Wildfire Mitigation Desk Reference Guide* Permit Fees and Tax Rates. N.d. Town of Superior. Available at: https://www.superiorcolorado.gov/departments/planning/marshall-fire-community-planning-and-rebuilding-effort/permit-fees-and-tax-rebates

Phillips, Noelle. (2022). “Marshall fire destroyed 1,084 homes worth a combined half-billion dollars, new assessment shows”. Denver Post. January 6, 2022. Available at: https://www.denverpost.com/2022/01/06/marshall-fire-damage-estimates/

Rebuilding Better. N.d. Boulder County. Available at: https://rebuildingbetter.org/

Rocky Mountain Fire Protection District. 2010. Rocky Mountain Fire Community Wildfire Protection Plan. Available at: https://static.colostate.edu/client-files/csfs/documents/RockyMountainFPDCWPP_2010.pdf

Schmidt, L. 2023. The Science of Fire Behavior: Training Fire Analysts in a Time of Rapidly Changing Forests. Rocky Mountain Research Station. https://www.fs.usda.gov/research/rmrs/news/featured/science-fire-behavior-training-fire-analysts-time-rapidly-changing-forests

Scott, Michon. Wet, then dry extremes contributed to devastating Marshall Fire in Colorado. January 7, 2022. https://www.climate.gov/news-features/event-tracker/wet-then-dry-extremes-contributed-devastating-marshall-fire-colorado

Stein, Andy. "Marshall fire explained: How we got 115 mph winds in Boulder County on a December winter day". Denver Post. December 31, 2021." Available at: https://www.denverpost.com/2021/12/31/marshall-fire-explained-firestorm-colorado-weather/#:~:text=The%20Marshall%20Fire%20continues%20to%20burn%20out%20of,60%20to%20100-plus%20mph%20at%20times%20on%20Thursday.

Society of Fire Protection Engineers and SFPE Foundation. "WUI Virtual Handbook for Property Fire Risk Assessment & Mitigation." SFPE.org. 2023. Available at: https://www.sfpe.org/wuihandbook/home

Superior, Colorado Code of Ordinances. Municode. https://library.municode.com/co/superior/codes/municipal_code

Texas A&M Forest Service. 2022. State Fire Assistance for Hazard Mitigation 2022 Vegetative Fuel Break Grant Application. Available at: https://tfsweb.tamu.edu/uploadedFiles/TFSMain/Preparing_for_Wildfires/Prepare_Your_Home_for_Wildfires/Contact_Us/2022%20Vegetative%20Fuel%20Break%20GrantApplication.pdf

Town of Superior. 2012. Town of Superior Comprehensive Plan. Available at: https://www.superiorcolorado.gov/home/showpublisheddocument/32/635548384058770000

Town of Superior. 2021. Town of Superior Parks, Recreation, Open Space and Trails Master Plan. Available at: https://shapesuperior.com/parks-recreation-open-space-trails-master-plan

Town of Superior. 2022. Information for Meeting of the Superior Board of Trustees. Available at: https://townofsuperior.granicus.com/MetaViewer.php?view_id=4&clip_id=2095&meta_id=100082

Town of Superior. 2022. Ordinance No 0-2. Available at: https://www.superiorcolorado.gov/home/showpublisheddocument/20253/637820007978330000

Town of Superior. 2022. Ordinance No. O-3. Available at: https://townofsuperior.granicus.com/MetaViewer.php?view_id=4&clip_id=2013&meta_id=96260

Town of Superior. 2022. Ordinance No. O-5. Available at: https://library.municode.com/co/superior/ordinances/municipal_code?nodeId=1153315

Town of Superior. 2022. Ordinance No. O-7. Available at: https://www.superiorcolorado.gov/home/showpublisheddocument/20830/637928760251900000

Town of Superior. 2022. Ordinance No. O-8. Available at: https://www.superiorcolorado.gov/home/showpublisheddocument/20585/637892544871670000

Town of Superior. 2022. Ordinance No. O-13. Available at: https://www.superiorcolorado.gov/home/showpublisheddocument/20872/637945203903776352

Town of Superior. 2023. Majority of Permitted Rebuilds in Superior Choose Energy Efficiency. Available at: https://www.superiorcolorado.gov/Home/Components/News/News/4132/17?backlist=%2fcommunity%2fsuperior-recovers

Town of Superior. N.d. Permits for Insulation Replacement. Available at: https://www.superiorcolorado.gov/departments/planning/marshall-fire-community-planning-and-rebuilding-effort/permits-for-insulation-replacement

University of California Agriculture and Natural Resources (UCANR). (2022a). Landscape Restoration. https://ucanr.edu/sites/fire/Recovery/Revegetation/

U.S. Global Change Research Program. 2018. National Climate Assessment 4 Vol II: Impacts, Risks, and Adaptation in the United States.

Westerling and Bryant. 2008. Climate change and growth scenarios for California wildfire. Climatic Change. 109 (Suppl 1): S445 S463.

What's New with Parks and Open Space. 2022. Town of Superior. Available at: https://www.louisvilleco.gov/Home/Components/News/News/6131/ (louisvilleco.gov)

Windows Have Impact-Rated Glass, Fire-Resistant Glass, or Protective Coverings. 2022. U.S. Department of Energy. Available at: https://basc.pnnl.gov/resource-guides/windows-have-impact-rated-glass-fire-resistant-glass-or-protective-coverings

Appendix C: Glossary

- **Community** – A group of people living in the same locality and under the same government, or a political subdivision of a state or other authority that has zoning and building code jurisdiction over a particular area.
- **Communal Defensible Space** – The area or space around a collection of properties where the minimum defensible space distances (30–100 feet) is achieved by the sharing of vegetation management and fuel treatments across neighboring property lines. This is in lieu of individual property owner's ability to achieve the requisite defensible distances for setbacks and defensible space within their own parcel. Also known as overlapping ignition zones.
- **Communal or Common Space** – Land or space that is intended for common ownership or use by the residents of surrounding dwelling units.
- **Community Wildfire Protection Plan** (CWPP) – A plan developed in the collaborative framework established by the Wildland Fire Leadership Council and agreed to by state, tribal, and local government, local fire department, other stakeholders and federal land management agencies managing land in the vicinity of the planning area. A CWPP identifies and prioritizes areas for hazardous fuel reduction treatments and recommends the types and methods of treatment on Federal and non-Federal land that will protect one or more at-risk communities and essential infrastructure and recommends measures to reduce structural ignitability throughout the at-risk community. A CWPP may address issues such as wildfire response, hazard mitigation, community preparedness, or structure protection or all of the above.
- **Conflagration** – A large destructive fire that causes substantial destruction (NFPA 101®, Life Safety Code Handbook).
- **Critical infrastructure** – The systems, networks, and assets, whether physical or virtual, that are so essential that their continued operation is required to ensure the security of the state, nation, its economy, and the public's health and/or safety.
- **Defensible space** – The area around a structure where the location, selection, and maintenance of vegetation and other combustible materials are managed to reduce the structure's exposure to radiation (heat), direct flame impingement and spot fires from embers, which are considered the three principal mechanisms leading to structure ignition. (Bell et al., 2007).
- **Ember** – Smoldering or flaming particles of vegetation from tree branches, pieces of chaparral shrubs, or other combustibles (such as structures) that ignite and burn during a wildfire and are carried by winds in front of the wildfire at varying distances. Flaming or glowing fuel particles that can be carried naturally by wind, convection currents, or by gravity into unburned fuels.

- **Exposure** – The people, property, systems, or functions that could be lost to a hazard.
- **Fire break** – A natural or constructed barrier used to stop or check fires that may occur, or to provide a control line from which to work.
- **Fire resistance** – The fire resistance of a building element characterizes its ability to confine a fire or to continue to perform a given structural function, or both.
- **Fire-resistance rating –**The period of time a building element, component or assembly maintains the ability to confine a fire, continues to perform a given structural function, or both, as determined by fire tests or methods based on fire tests.
- **Fire-resistant joint system –** An assemblage of specific materials or products that are designed, tested and fire-resistance rated in accordance with a standard fire test to resist for a prescribed period of time through joints made in or between fire-resistance rated assemblies (IBC).
- **Fire-resistive construction –** Fire-resistive construction is construction that has been designed and tested to withstand a certain amount of fire exposure. Fire-resistive construction is typically given a fire-resistance rating as determined by fire tests or methods based on fire tests.
- **Firestopping Product** – Firestopping is a component of a firestop system, which is designed to seal an opening into or through a fire-resistance rated assembly. These products help to reduce the amount of smoke and embers that could potentially penetrate walls (Knott, 2019).
- **Fuel** – A material that will maintain combustion under specified environmental conditions. A material used to produce heat or power by burning (NFPA).
- **Fuel break** – A natural or manmade change in fuel characteristics which affects fire behavior so that fires burning into them can be more readily controlled.
- **Fuel loading** – The amount of fuel present expressed quantitatively in terms of weight of fuel per unit area. This may be available fuel (consumable fuel) or total fuel and is usually dry weight.
- **Fuel management** – Act or practice of controlling flammability and reducing resistance to control of wildland fuels through mechanical, chemical, biological, or manual means, or by fire, in support of land management objectives.
- **Fuel modification** – Manipulation or removal of fuels to reduce the likelihood of ignition and/or to lessen potential damage and resistance to control (e.g., lopping, chipping, crushing, piling, and burning). *Synonym: Fuel treatment*
- **Fuel treatment** – Manipulation or removal of fuels to reduce the likelihood of ignition and/or to lessen potential damage and resistance to control (e.g., lopping, chipping, crushing, piling, and burning). *Synonym: Fuel modification*

- **Hazard** – A natural or human-caused act or phenomenon that has the potential to produce harm or other undesirable consequences to a person or thing.
- **Intensity** – A measure of the energy expected from a wildfire. It is largely a condition of the vegetative landscape and vegetative fuel available to burn.
- **Interface** – The interface community exists where structures directly abut wildland fuels.
- **Intermix** – The intermix community exists where structures are scattered throughout a wildland area.
- **Likelihood** – The annual probability of an event occurring in a specific location.
- **Membrane-penetration firestop system** – An assemblage consisting of a fire-resistance-rated floor-ceiling, roof-ceiling or wall assembly, one or more penetrating items installed into or passing through the breach in one side of the assembly and the materials or devices, or both, installed to resist the spread of fire into the assembly for a prescribed period of time.
- **Mitigation** – Modifying the environment, structures, or human behavior to reduce potential adverse impacts from a natural hazard.
- **Neighborhood** – The region near some place; an adjoining or surrounding district; a more immediate vicinity.
- **Occluded** – The occluded community generally exists in a situation, often within a city, where structures abut an island of wildland fuels (e.g., park or open space).
- **Open space** – Undeveloped land, a naturally landscaped area, or formal or man-made landscaped area that provides a connective link or buffer between other resources. In Colorado, each community defines open space in its own way, but generally open space is set aside for preservation with the idea that it will not be developed.
- **Passive Fire Protection** – A series of built-in fire-resistant features such as firewalls and fire doors to limit the spread of fire, heat, and smoke by containing it in a single compartment in its area of origin.
- **Prescribed fire** – A wildland fire originating from a planned ignition in accordance with applicable laws, policies, and regulations to meet specific objectives.
- **Risk** – The chance of fire starting as determined by the presence and activity of causative agents.
- **Through-penetration firestop system –** An assemblage consisting of a fire-resistance-rated floor, floor-ceiling, or wall assembly, one or more penetrating items passing through the breaches in

both sides of the assembly and the materials or devices, or both, installed to resist the spread of fire through the assembly for a prescribed period of time.

- **Undeveloped land** – A vacant area without any utilities, infrastructure, or buildings.
- **Vulnerability** – Susceptibility to injury, harm, damage, or economic loss.
- **Wildfire** – An unplanned, unwanted fire burning in a natural area.
- **Wildland** – A natural environment that has not been significantly modified by human activity.
- **Wildland-Urban Interface** (WUI) – The line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetation fuels.

An official website of the United States government Here's how you know



FEMA's Mitigation Assessment Team Releases First Report in the Aftermath of a Wildfire

Posted: Aug. 10, 2023

1 min read Find similar articles: Wildfire and WUI Data Codes and Standards Fire Investigation Leadership Planning Share on:

A newly released Federal Emergency Management Agency (FEMA) Mitigation Assessment Team (MAT) report on the 2021 Marshall Fire is the first FEMA publication to evaluate building performance and share observations in the aftermath of a wildfire.

FEMA studied this fire because the weather conditions and impacts on the built environment in the nontraditional wildland urban interface highlight risks that need to be better understood by planners, developers, government officials and the public at large both locally in Colorado and nationwide.

Several factors have been attributed to the devastation caused by the Marshall Fire:

extreme winds (some at 115 mph)	long-term drought
unseasonably high temperatures	limitations in existing wildfire safety and planning regulations

The fire destroyed 1,000 single- and multifamily homes and commercial structures in Louisville, Superior, and unincorporated Boulder County, Colorado. Because of the unique nature of the incident, a fast-moving grass fire became a highly destructive urban conflagration that directly and indirectly impacted several communities and the greater Boulder County area.

As a result, the FEMA Building Science Disaster Support Program deployed its first-ever wildfire MAT to evaluate building performance during the fire.

In the report, learn more about some unique observations made by the team:

- how building components prevented or contributed to the spread of fire to structures,
- how neighborhoods with homes that had less than 30 feet of separation suffered greater losses,
- how unmanaged drainage ditches throughout the area acted as "wildfire superhighways," facilitating the rapid spread of wildfire through the community.

The report and 7 accompanying documents can be used by planners, fire departments and community leaders to help create better wildfire planning documents, as well as develop and implement more effective wildfire mitigation projects including structure and landscape improvements.

Related articles



Lahaina Fire Incident Analysis Report released by the attorney general of Hawaii

Read the detailed report that examines the tragic fire that devastated much of Lahaina, Hawaii on Aug. 8 and 9, 2023.



Lahaina Hawaii fire timeline report

Now available: The Lahaina Fire Comprehensive Timeline Report on the devastating August 2023 fire that lead to 101 fatalities, widespread destruction and devastating community impacts.



Preliminary After-Action Report: 2023 Maui Wildfire

Maui PD's preliminary after-action report makes 32 recommendations to improve Maui's police response to future natural disaster response efforts.

Page last reviewed: Aug. 10, 2023

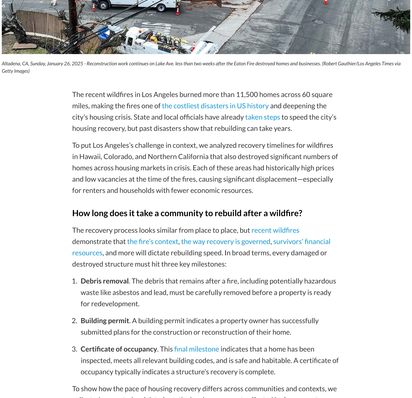
Support research that powers smarter, more effective, and more just policies. DONATE

URBAN WIRE

When Will Los Angeles Rebuild? Comparing Housing Recovery Timelines after Four Recent Wildfires

Andrew Rumbach, Sara McTarnaghan, Kameron Lloyd, Aleszu Bajak

February 19, 2025



Altadena, CA, Sunday, January 26, 2025 - Reconstruction work continues on Lake Ave. less than two weeks after the Eaton Fire destroyed homes and businesses. (Robert Gauthier/Los Angeles Times via Getty Images)

The recent wildfires in Los Angeles burned more than 11,500 homes across 60 square miles, making the fires one of the costliest disasters in US history and deepening the city's housing crisis. State and local officials have already taken steps to speed the city's housing recovery, but past disasters show that rebuilding can take years.

To put Los Angeles's challenge in context, we analyzed recovery timelines for wildfires in Hawaii, Colorado, and Northern California that also destroyed significant numbers of homes across housing markets in crisis. Each of these areas had historically high prices and low vacancies at the time of the fires, causing significant displacement—especially for renters and households with fewer economic resources.

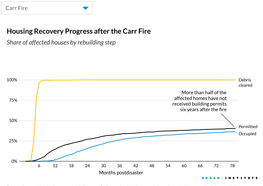
How long does it take a community to rebuild after a wildfire?

The recovery process looks similar from place to place, but recent wildfires demonstrate that the fire's context, the way recovery is governed, survivors' financial resources, and more will dictate rebuilding speed. In broad terms, every damaged or destroyed structure must hit three key milestones:

1. **Debris removal**. The debris that remains after a fire, including potentially hazardous waste like asbestos and lead, must be carefully removed before a property is ready for redevelopment.
2. **Building permit**. A building permit indicates a property owner has successfully submitted plans for the construction or reconstruction of their home.
3. **Certificate of occupancy**. This final milestone indicates that a home has been inspected, meets all relevant building codes, and is safe and habitable. A certificate of occupancy typically indicates a structure's recovery is complete.

To show how the pace of housing recovery differs across communities and contexts, we collected property-level data from the local governments affected by four recent wildfires:

- **The Carr Fire** (July–August 2018) damaged or destroyed nearly 1,300 homes in Shasta and Trinity Counties in Northern California, including in the city of Redding.
- **The Camp Fire** (November 2018) destroyed nearly 14,000 homes in Butte County, California, including the near-complete destruction of the town of Paradise.
- **The Marshall Fire** (December 2022) damaged or destroyed nearly 1,300 homes in Boulder County, Colorado.
- **The Maui Wildfires** (August 2023) destroyed more than 2,000 homes and caused widespread destruction in the town of Lahaina.



Source: Property-level private and public (through CalFire) jet on debris removal date of completion, date of building permit issuance, and date of final building permit data were provided by Shasta County staff.
Notes: The number of houses destroyed was pulled from the number of properties cleared of debris in the above datasets. This analysis does not include data from Redding.

The Carr Fire destroyed 876 homes in Shasta County (and an additional 266 in Redding, where we don't have data), and debris clearance concluded in May 2020, approximately 21 months after the fire. Today, about 40 percent of properties have received a building permit and 36 percent have been issued a certificate of occupancy, meaning a significant number of homes in Shasta County (59 percent) haven't even applied for a permit after 6.5 years.

The Camp Fire, which broke out just months later, remains one of the largest and most destructive fires in US history. Rebuilding data show debris clearance was completed in November 2019, a year after the fire, but that building permits have only been issued for 29 percent of properties and certificates of occupancy were issued for just 23 percent. The scale of destruction to Paradise and surrounding communities, the fire's remote and rural context of the fire, challenging terrain, and the unavailability of skilled contractors and tradespeople, among other factors, have all made rebuilding especially challenging.

Three years after the Marshall Fire, most lots have been cleared of debris and building permits have been issued for 75 percent of the affected houses. Among those, 63 percent have been issued a certificate of occupancy. The relative quickness of the Marshall Fire recovery demonstrates the importance of streamlining permitting and other building requirements and maintaining close personal contact with survivors. It also shows that rebuilding in a major metropolitan region comes with advantages, such as a robust construction industry and a housing market that can absorb survivors awaiting permanent housing recovery.

Maui, where wildfires broke out 18 months ago, is still in the early stages of recovery. The US Army Corps of Engineers began clearing debris in January 2024, approximately five months after the fire, and completed their work seven months later. However, several hundred additional lots (17.5 percent) are still scheduled for debris clearance by private contractors. Of the 1,898 housing units destroyed by the fire, building permits have been issued for just 14 percent and only 6 homes have been rebuilt.

Besides the unique challenges that come from rebuilding in an isolated island state, numerous local experts have explained that progress is slow because of the displacement of survivors, complex and cumbersome environmental and building regulations, delayed delivery of federal resources like Community Development Block Grant Disaster Recovery funds, and the complexities that arise from the destruction of so many nonconforming buildings.

Rebuilding is only part of the story

This analysis helps us to understand the broad contours of these communities' rebuilding progress but misses important details. Most importantly, it focuses on the recovery of structures, not people. A substantial body of research demonstrates that recovery is uneven: some groups, like renters, tend to recover more slowly and have a higher likelihood of being displaced after a disaster.

This analysis also does not detect situations where properties are selectively purchased (or "bought out") to intentionally stop redevelopment and is less sensitive to important jurisdictional differences in recovery. For example, the Marshall Fire affected both housing-dense suburban communities—where recovery has been quicker—and more-rural and forested areas at higher risk to fires—where recovery has been slower because of differences in permitting, building code requirements, and the need for customized home designs to fit the challenging terrain.

As California policymakers set goals for rebuilding the affected areas of Los Angeles, they should track not only the speed of housing unit recovery but also the quality and equity. The aftermath of past disasters shows the importance of tracking outcomes for property and people to ensure the groups often left behind—those with low incomes, renters, people living in unincorporated areas or less resourced jurisdictions—are part of the recovery.

Let's build a future where everyone, everywhere has the opportunity and power to thrive

Urban is more determined than ever to partner with changemakers to unlock opportunities that give people across the country a fair shot at reaching their fullest potential. Invest in Urban to power this type of work.

DONATE

RESEARCH AND EVIDENCE

Housing and Communities

EXPERTISE

Climate Change, Disasters and Community Resilience

TAGS

Climate adaptation and resilience | Climate displacement and migration | Climate impacts and community resilience | Climate mitigation, sustainability, energy and land use | Climate-resilient housing | Climate safety net | Planning for climate change | Land use and zoning

RELATED CONTENT

URBAN WIRE
How the Los Angeles Fires Are Compounding the Risk of Homelessness
January 15, 2025

URBAN WIRE
Promoting Equitable Wildfire Recovery in Lahaina: Four Lessons for Local Leaders, from Colorado's Marshall Fire
November 29, 2023

URBAN WIRE
After the Marshall Fire, Households with Fewer Financial Resources Are Falling Behind
April 5, 2023

 Copyright © Urban Institute

National Fire News

National Preparedness Level 2

as of March 4 at 7:30 a.m. MDT (on a scale from 1 to 5)

Current hours for the National Fire Information Center are
(MST) 8:00 am - 4:30pm, Monday - Friday
208-387-5050

This report is currently updated on Fridays only.
Please check the IMSR for more information.

March 14, 2025

The Wildland Fire Safety Training Annual Refresher, or WFSTAR, 2025 core component module packages are here! As we look back to move forward, the 2024 Year in Review highlights key events, critical stats, and lessons learned from the past fire season. This module revisits key events and statistics from the 2024 fire season, identifies lessons learned to enhance future preparedness, and explores intelligence sources to improve big-picture situational awareness. Together, we strengthen wildland firefighter readiness and safety.

In the past week, 11 new large wildfires have been reported in the Southern, Rocky Mountain, and Northern Rockies areas. Wildland firefighters contained five large wildfires. A complex incident management team is assigned to the Covington Drive Fire in South Carolina. More than 1,100 wildland firefighters and support personnel are assigned to incidents across the nation.

So far in 2025, 9,520 wildfires have burned 269,986 acres across the United States. This is above the 10-year average of 6,629 wildfires and below the 10-year average acreage of 431,052.

Red Flag Warnings are in effect today across much of eastern New Mexico and southeast Colorado northeast into northern Illinois, and eastward into much of Texas and Oklahoma.

The National Significant Wildland Fire Potential Outlook is available for the period of March through June 2025. Significant wildfire potential will be seen throughout most of Texas and parts of New Mexico and Arizona, and several southeastern states through March and into April.

Weather

A strong storm will develop over the Plains with west to southwest sustained winds exceeding 20 mph will be common as minimum relative humidity falls to 5-25%. A corridor of extremely strong west to southwesterly winds of 30-50 mph with gusts of 60-85 mph are forecast from West Texas into central Oklahoma and southeast Kansas with minimum relative humidity in the single digits. Poor overnight humidity recovery of less than 30% is expected for much of central, South, and West Texas. Winds are likely to remain elevated at 15-25 mph in some areas before winds increase across central and South Texas tomorrow. Lighter winds are expected on the Plains Sunday. Ahead of the dry line in the Lower/Mid-Mississippi Valley, strong to severe thunderstorms will develop, with tornadoes most likely in the Lower Mississippi Valley and widespread strong straight-line winds in the Mid- Mississippi Valley. Farther east in the Appalachians, southerly downslope winds of 15-25 mph with higher gusts amid RH of 15-30% are likely to develop from northern Alabama to eastern Kentucky and western Virginia, creating areas of elevated conditions into Saturday afternoon. Severe thunderstorms are likely in the Appalachians and Southeast this weekend, with wetting rainfall also likely from the Appalachians to the East Coast. In the West, another storm will move into the northern two-thirds of the West this weekend, with widespread rain and mountain snow.

Daily statistics

Number of new large fires or emergency response ** New fires are identified with an asterisk*	13	States currently reporting large fires:
Total number of large fires under full suppression strategies	30	• Oklahoma (17) • Texas (3) • South Dakota (2)
Acres from all active fires	112,785	• North Carolina (2) • South Carolina (1) • Massachusetts (1)
Fires contained	7	• West Virginia (1) • Colorado (1) • Kentucky (1) • New Mexico (1)

Year-to-date statistics

2025 (1/1/25-3/14/25)	Fires: 9,520	Acres: 269,986
2024 (1/1/24-3/14/24)	Fires: 4,443	Acres: 1,420,655
2023 (1/1/23-3/14/23)	Fires: 5,842	Acres: 76,166
2022 (1/1/22-3/14/22)	Fires: 12,088	Acres: 304,185
2021 (1/1/21-3/14/21)	Fires: 6,403	Acres: 133,457
2020 (1/1/20-3/14/20)	Fires: 4,796	Acres: 100,598
2019 (1/1/19-3/14/19)	Fires: 2,790	Acres: 53,560
2018 (1/1/18-3/14/18)	Fires: 8,487	Acres: 247,349
2017 (1/1/17-3/14/17)	Fires: 10,328	Acres: 1,631,947
2016 (1/1/16-3/14/16)	Fires: 6,158	Acres: 277,912
2015 (1/1/15-3/14/15)	Fires: 6,827	Acres: 104,029

10-year average Year-to-Date

2015-2024	Fires: 6,629	Acres: 431,052

Current Wildfires

Expand All

Colorado	**Fires:** 1	**Acres:** 2,540	**New:** 0	**Contained:** 0
Florida	**Fires:** 0	**Acres:** 0	**New:** 0	**Contained:** 1
Kentucky	**Fires:** 1	**Acres:** 169	**New:** 1	**Contained:** 2
Louisiana	**Fires:** 0	**Acres:** 0	**New:** 0	**Contained:** 1
Massachusetts	**Fires:** 1	**Acres:** 179	**New:** 0	**Contained:** 0
New Mexico	**Fires:** 1	**Acres:** 11,000	**New:** 1	**Contained:** 0
North Carolina	**Fires:** 2	**Acres:** 526	**New:** 0	**Contained:** 0
Oklahoma	**Fires:** 17	**Acres:** 33,297	**New:** 7	**Contained:** 0
South Carolina	**Fires:** 1	**Acres:** 2,059	**New:** 0	**Contained:** 0
South Dakota	**Fires:** 2	**Acres:** 39,759	**New:** 2	**Contained:** 1
Tennessee	**Fires:** 0	**Acres:** 0	**New:** 0	**Contained:** 2
Texas	**Fires:** 3	**Acres:** 22,806	**New:** 2	**Contained:** 0
West Virginia	**Fires:** 1	**Acres:** 450	**New:** 0	**Contained:** 0

The National Interagency Fire Center is committed to making its information and communication technologies accessible to individuals with disabilities by meeting or exceeding the requirements of Section 508 of the Rehabilitation Act of 1973, as amended. To meet this commitment, we continue to monitor and update our content to make sure our documents meet these standards.

National Fire News

National Preparedness Level 2

as of March 4 at 7:30 a.m. MDT (on a scale from 1 to 5)

Current hours for the National Fire Information Center are
(MST) 8:00 am - 4:30pm, Monday - Friday
208-387-5050

This report is currently updated on Fridays only.
Please check the IMSR for more information.

March 28, 2025

26 large uncontained fires are currently being managed with full suppression strategies nationwide, with 22 located in the southern geographic area, three in the eastern geographic area, and one in the Rocky Mountain geographic area. Evacuations are in effect on the Table Rock Complex in South Carolina and the Black Cove and Deep Woods Fires in North Carolina. The Fernadez Fire in Florida is currently the only large incident nationally being managed under a strategy other than full suppression.

In 2025 thus far, 14,849 wildfires have burned 707,228 acres across the United States. This is well above the 10-year averages of 8,773 wildfires and 617,931 acres.

The 2025 core component module package for RT-130, Wildland Fire Safety Training Annual Refresher (WFSTAR), is now available! This week, we're highlighting the Bench Lake Fire case study, which examines the successful response to wildfire threatening many values in and around the town of Stanley, Idaho in 2024.

A fuels and fire behavior advisory has been issued for the Southern Appalachian Mountains and Foothills, which includes portions of eastern Tennessee, northern Georgia, northwest South Carolina, and western North Carolina. This area has experienced unusually low relative humidity, resulting in critical fuel moisture levels; even the greening live fuels are burning aggressively with just a small amount of preheating. In addition, the area has high concentrations of larger fuels left by Hurricane Helene last year, which continue to dry aggressively. This new advisory and other current advisories can be found on the NICC Fuels and Fire Danger webpage.

The National Significant Wildland Fire Potential Outlook is available for the period of March through June 2025. Significant wildfire potential will be seen throughout most of Texas and parts of New Mexico and Arizona, and several southeastern states through March and into April.

The 2025 national fire year themes focus on keeping firefighters, support personnel, and the public safe, working together to fight wildfires, using new technology, understanding how homes and wildfires are connected, reducing smoke impacts, and being responsible when enjoying public lands.

Weather

Breezy and dry southwesterly winds of 10-20 mph gusting to 30 mph amid relative humidity of 15-30% will develop on the eastern slopes of the southern Appalachians to the Piedmont tomorrow, while dry conditions continue across the rest of the Southeast and Mid-Atlantic. Easterly winds are expected to increase across Florida to 15-20 mph tomorrow, as well. Breezy south to southwest winds are also likely to continue on the Plains into the Mid-Mississippi Valley, but minimum relative humidity is likely to remain above 20%, except across eastern Colorado where 7-15% is forecast. Farther west, breezy westerly winds are expected across the Southwest where temperatures will remain above normal, and minimum relative humidity will fall to 5-20%. The lowest humidity is expected across southeast Arizona into southern and eastern New Mexico where elevated to locally critical conditions are forecast. In the rest of the West, breezy southwest winds will continue in the Great Basin, but temperatures will be cooler along with increased humidity. Precipitation will continue in northern California and the Northwest, mainly west of the Cascades, with light precipitation into the northern Rockies. Mainly dry conditions are expected in Alaska except for isolated snow showers in far western Alaska. A period of moderate trade winds continue in Hawai'i with isolated windward showers.

Daily statistics

Number of new large fires or emergency response ** New fires are identified with an asterisk*	6	States currently reporting large fires: • Oklahoma (5) • North Carolina (4) • Florida (2) • West Virginia (2) • Kansas (2) • Georgia (1) • Missouri (1)
Total number of large fires under full suppression strategies	17	
Acres from all active fires	20,020	
Fires contained	9	

Year-to-date statistics

2025 (1/1/25-3/28/25)	Fires: 14,849	Acres: 707,228
2024 (1/1/24-3/28/24)	Fires: 5,351	Acres: 1,662,718
2023 (1/1/23-3/28/23)	Fires: 7,613	Acres: 111,310
2022 (1/1/22-3/28/22)	Fires: 14,781	Acres: 517,839
2021 (1/1/21-3/28/21)	Fires: 9,579	Acres: 255,177
2020 (1/1/20-3/28/20)	Fires: 6,124	Acres: 126,892
2019 (1/1/19-3/28/19)	Fires: 5,056	Acres: 116,196
2018 (1/1/18-3/28/18)	Fires: 10,902	Acres: 430,947
2017 (1/1/17-3/28/17)	Fires: 12,947	Acres: 2,158,298
2016 (1/1/16-3/28/16)	Fires: 8,673	Acres: 708,505
2015 (1/1/15-3/28/15)	Fires: 9,023	Acres: 152,775

10-year average Year-to-Date

2015-2024	Fires: 8,773	Acres: 617,931

Current Wildfires

Expand All

Florida	**Fires:** 2	**Acres:** 1,035	**New:** 1	**Contained:** 1
Georgia	**Fires:** 1	**Acres:** 1,936	**New:** 0	**Contained:** 0
Kansas	**Fires:** 2	**Acres:** 1,850	**New:** 2	**Contained:** 0
Missouri	**Fires:** 1	**Acres:** 394	**New:** 0	**Contained:** 0
North Carolina	**Fires:** 4	**Acres:** 6,980	**New:** 1	**Contained:** 0
Oklahoma	**Fires:** 5	**Acres:** 6,808	**New:** 0	**Contained:** 5
South Carolina	**Fires:** 0	**Acres:** 0	**New:** 1	**Contained:** 1
South Dakota	**Fires:** 0	**Acres:** 0	**New:** 1	**Contained:** 1
Tennessee	**Fires:** 0	**Acres:** 0	**New:** 0	**Contained:** 1
West Virginia	**Fires:** 2	**Acres:** 1,017	**New:** 0	**Contained:** 0

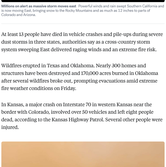
The National Interagency Fire Center is committed to making its information and communication technologies accessible to individuals with disabilities by meeting or exceeding the requirements of Section 508 of the Rehabilitation Act of 1973, as amended. To meet this commitment, we have standards to maintain and update our content to make sure our documents meet these standards.



At least 13 dead in crashes during dust storms; homes destroyed in Oklahoma wildfires

Red flag and high wind warnings were in effect for several states.

By Meredith Deliso, Nadine El-Bawab and Jack Morris
March 15, 2023, 8:42 PM

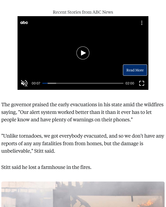


Williams on alert as massive storm moves east Powerful winds and rain swept Southern California and the Southwest, with blizzard-like raging scenes in the Rocky Mountains and as much as 2.5 inches in parts of Colorado and Arizona.

At least 13 people have died in vehicle crashes and pile-ups during severe dust storms in three states, authorities say as a cross-country storm system sweeping East delivered raging winds and an extreme fire risk.

Wildfires erupted in Texas and Oklahoma. Nearly 300 homes and structures have been destroyed and 170,000 acres burned in Oklahoma after several wildfires broke out, prompting evacuations amid extreme fire weather conditions on Friday.

In Kansas, a major crash on Interstate 70 in western Kansas near the border with Colorado, involved over 50 vehicles and left eight people dead, according to the Kansas Highway Patrol. Several other people were injured.



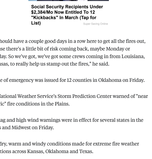
A dust storm obtained by the Texas Department of Safety on March 14, 2023, debris from a storm moves along the highway after cars crashed during low visibility and high winds across the Amarillo District's metro area, including Potter, Randall, and Oldham County at the time the photo was posted. Texas DPS - Northwest Texas Region/Facebook

MORE: Tornado outbreak live updates: 30 tornadoes reported in several states, 28 dead

In the Texas panhandle, four people were killed in car crashes caused by a dust storm, according to Sgt. Cindy Barkley, with the Texas Department of Public Safety.

One person died in a vehicle accident after driving into smoke, according to Gov. Kevin Stitt.

Recent Stories from ABC News



The governor praised the early evacuations in his state amid the wildfires saying, "Our alert system worked better than it ever has to let people know and have plenty of warnings on their phones."

"Unlike tornadoes, we get everybody evacuated, and so we don't have any reports of any any fatalities from from homes, but the damage is unbelievable," Stitt said.

Stitt said he lost a farmhouse in the fires.



Firefighters battle a wildfire in Oklahoma City, March 14, 2023. Nick Oxford/Reuters

The same storm system that brought the heavy winds to the Plains states is also responsible for the outbreak of tornadoes across the Midwest and South this weekend.

"It was just a perfect storm. The humidity levels went down to kind of record lows, below 10%, and then with the winds where they were just dried everything out," Stitt said.



Social Security Recipients Under $2,364/Mo Now Entitled To 12 "Lockbacks" In March (Tap for List)
Sponsored | The Motley Fool

"We should have a couple good days in a row here to get all the fires out, because there's a little bit of risk coming back, maybe Monday or Tuesday. So we've got, we've got some crews coming in from Louisiana, Arkansas, to really help us stamp out the fires," he said.

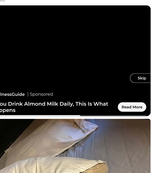
A state of emergency was issued for 12 counties in Oklahoma on Friday.

The National Weather Service's Storm Prediction Center warned of "near historic" fire conditions in the Plains.

Red flag and high wind warnings were in effect for several states in the Plains and Midwest on Friday.

Very dry, warm and windy conditions made for extreme fire weather conditions across Kansas, Oklahoma and Texas.

Recent Stories from ABC News



"Several large wildfire complexes" were burning Friday evening across central, northern, and western Oklahoma, the National Weather Service in Norman said.



A residence burns during a wildfire in Stillwater, Oklahoma, U.S., March 14, 2023. REUTERS/Nick Oxford/File Photo

The NWS advised residents to evacuate due to a "complex of extremely dangerous fires is located along the southern and eastern parts of Lake Carl Blackwell."

MORE: Rare tornado warning issued for South as dangerous weather moves in: What to know

In Texas, the Windmill Fire ignited in Roberts County, growing to an estimated 11,000 acres, Texas A&M Forest Service said. It was 50% contained as of Friday evening, with forward progression stopped, it said.

Parts of Gray County, Texas, were temporarily under a mandatory evacuation due to the Rust Area Fire, the Texas A&M Forest Service said. The fire has burned an estimated 3,000 and was 30% contained as of Friday evening, it said.

Several crashes were reported in northwest Texas on Friday amid low visibility from blowing dust, the Texas Department of Public Safety said while warning of "dangerous conditions."

Recent Stories from ABC News

The NWS in Norman also warned of low visibility in parts of northwest Oklahoma due to a dust storm.

Related Topics

Wildfires

abc NEWS

Ad Notice

Popular Reads



Those states can expect to see a 17-year periodical cicada emergence this spring
Mar 14, 2023, 7:45 AM



American influencer apologizes for snatching Australian baby wombat following outrage
Mar 14, 2023, 1:30 PM



A river 'died' in Zambia after an acidic waste spill at a Chinese-owned mine
Mar 13, 2023, 5:00 AM



Severe storms in multiple states leave dozens dead and injured
Mar 13, 9:11 AM



Fans notice viral bald eagle appears to be missing from Jackie and Shadow's nest
Mar 14, 12:45 PM

ABC News Live



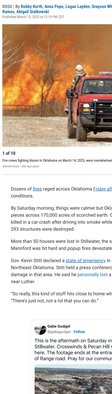
24/7 coverage of breaking news and live events



Local News

Fires ravage Oklahoma leading to disaster declaration in 12 counties, hundreds of homes lost

KOSU | By Robby Korth, Anna Pope, Logan Layden, Grayson Wheeler, Lionel Ramos, Abigail Siatkowski
Published March 19, 2024 at 12:17 PM CDT



1 of 10
Fire crews fighting blazes in Oklahoma on March 14, 2025, were overwhelmed by extreme winds.
Mitchell Hunter / OK Firefighter

Dozens of fires raged across Oklahoma Friday afternoon, fueled by high winds and dry conditions.

By Saturday morning, things were calmer but Oklahomans were left picking up the pieces across 170,000 acres of scorched earth. Gov. Kevin Stitt said one person was killed in a car crash after driving into smoke while disaster officials said an estimated 293 structures were destroyed.

More than 50 houses were lost in Stillwater, the small Northeast Oklahoma town of Mannford was hit hard and groups like Red Cross prepared shelters.

Gov. Kevin Stitt declared a state of emergency in 12 counties in Western, Central and Northeast Oklahoma. Stitt held a press conference in Mannford after touring the damage in that area. He said he personally lost a home to fire on a plot of land he owns near Luther.

"So really, this kind of stuff hits close to home when those fires come through," he said. "There's just not, not a lot that you can do."



Destruction in Stillwater

Stillwater residents saw waves of evacuations as multiple wildfires broke out on the south and southwest sides of the city.

At a press conference Saturday morning, Stillwater fire chief Terry Essary said the area is still being surveyed. About 50 homes and structures are estimated to be impacted or lost, with the number potentially rising.

Though several neighboring departments also responded, Essary said firefighters were quickly overwhelmed due to high winds and low humidity.

"So we did the best we could with what we had. It's... to be honest with you, seeing your community on fire is a very unsettling thing, and it's something a fire chief never wants to experience," Essary said. "But we as a group, collectively, we went to work and we started doing the best we could for as many people as possible."

Firefighters were still on the ground Saturday, working to suppress hot spots and keep fires contained.

He said there have been a few firefighter injuries reported, largely because of smoke inhalation and dehydration, but those individuals have been treated and released. Essary said he was unaware of civilian injuries or fatalities.

"We're not done with this yet," Essary said. "We're going to still have hot spots. We're going to have embers in the burn area, and this could continue for the next few days. So we're still out there working, and we're not done."

For community members, he said it is critical to watch their surroundings and call 911 if they see a fire. City officials urged residents to take proper health precautions because of the poor air quality.

Churches and organizations opened their doors to people as wildfires blazed. City officials said about 115 people from Stillwater, Cushing, Yale and other areas stayed at the Payne County Expo Center, the city's designated shelter.

As of Saturday morning, city officials said the center was empty because people who stayed at the shelter were taken to their desired destinations.

Relief efforts are underway. The city has established an email for people who need resources and a donation drop off at the Stillwater Armory. The Payne County United Way also set up a specific donation page. The Red Cross has been providing support, food and other resources for shelters.

As residents return to their homes to gauge their situations, Brady Moore, Stillwater city manager, said neighborhoods have unsafe conditions. Power lines are being monitored, and crews have been dispatched to turn off water and gas lines. If residents see hazards, Moore said they should call 911.

Mannford damages

Evacuations were necessary in Mannford — a small town 25 miles west of Tulsa — Friday afternoon as the blaze spread. Several buildings were destroyed, and Stitt toured the damage Saturday morning, saying it "breaks your heart."

Mayor Clay Abercrombie said that the widespread nature of the fires around Oklahoma limited the local response because first responders were working in so many communities.

"What we usually rely upon is municipal aid," Abercrombie said. It "wasn't available last night, so it's no kind of 'to each his own.' And I know there are a lot of people around the state suffering right now."


Firefighters battle a blaze in Oklahoma City.
Mitchell Hunter / OK Firefighter

OKC, Tulsa sustain damages

Oklahoma City's Fire Department reported responding to almost 1,000 calls. That included 19 structure fires, 115 grass fires, and 34 downed power lines.

Traffic was also snarled by high winds, as interstate 240 was shut down for part of the afternoon.

In Tulsa, crews battled multiple fires and similar difficult, dry weather.

High winds, dry conditions

Oklahoma's Department of Emergency Management estimates 150 fires in 44 counties. Almost 300 structures were destroyed.

But the full impact of the damaging firestorm that swept through the state yesterday is not fully assessed, according to the Oklahoma Forestry Services' most recent Fire Situation Report. More than a dozen fires continued to burn into Saturday.

Officials say while the strength of the windstorm prevented the use of firefighting aircraft, fire behavior and the demand for protection on the ground outpaced the capability of resources to suppress the fires.

Although Oklahoma Forestry Services officials said fire weather would be less intense Saturday, Red Flag Warnings remain in part of western Oklahoma. New wildfire activity will continue, compounded by the workload to contain active fires.

As of Saturday morning, Red Flag Warnings were in effect in 13 counties in the Panhandle, northwestern and western Oklahoma. Fire behavior relaxed overnight but is expected to rear its head Saturday afternoon. Forestry officials said green the recent rapid dryness, weather conditions must improve to reduce fire risks.

"Marginal overnight moisture recovery tonight will support active burning conditions well into the night although much calmer winds are expected offering some opportunities for improving containment ongoing fires," according to the most recent Fire Situation Report.

Elected officials, community leaders respond

Stitt praised the fast action by people evacuating their homes as flames approached. He credited emergency responders and the communications in place with saving lives.

Senate Pro Tempore Lonnie Paxton said in a statement he appreciates the work of first responders.

"We urge all Oklahomans to remain vigilant, follow emergency directives and support those in need during this difficult time," Paxton said. "Together, we will recover and rebuild stronger than ever."

House Speaker Kyle Hilbert, who represents the area around Bristow, also thanked first responders and urged community support in a statement.

"The devastation across my House district and the state is hard to put into words," Hilbert said. "My heart breaks for those Oklahomans who have lost their homes and had damage to their property."

State Rep. Trish Ranson, D- Stillwater, said in a statement she is grateful for the Stillwater Emergency Management, Stillwater Police Department and the Stillwater Fire Department for safely evacuating the area. She said their efforts saved lives, and relief efforts are underway at the state, city and county levels.

"I am praying for Stillwater and urge everyone to utilize the resources available to them," Ranson said in the statement. "We must continue to look out for one another and support each other where we can. We will do whatever we can to heal from this devastation. We are Stillwater strong."

Dr. Jim Hess, interim president of Oklahoma State University, said in a statement the university's campus remains safe and the outbreak of wildfires has not directly impacted core campus grounds.

"Like Stillwater, so many communities across the state have been severely impacted," Hess said in the statement. "The pain and uncertainty so many are facing today is unimaginable, and my deepest sympathies go out to all those who have lost their homes, been displaced or are struggling."

The Colvin Center Annex on the campus was opened as a shelter for students and employees. Hess thanked first responders and the transit team for their swift action, and urged people to be vigilant and follow the guidance of emergency officials.

Sen. Markwayne Mullin posted resources and information for people displaced by the fires Saturday morning. Mullin also warned his constituents the danger wasn't over yet.

"While fire weather conditions improved overnight, we're expecting near-critical conditions this afternoon in NW OK where a Red Flag Warning is in effect," Mullin said. "Stay vigilant, stay informed, stay safe. Many have lost everything. We're in touch with local officials, and praying with you."

Sign up for The KOSU Daily newsletter!
Get the latest Oklahoma news in your inbox every weekday morning.
* indicates required
Email Address *
Subscribe

Tags: Local News, wildfires, severe weather, Stillwater, Oklahoma Forestry Services, rural issues

Robby Korth
Robby Korth joined KOSU as the news director in November 2022.
See stories by Robby Korth

Anna Pope
Anna Pope is a reporter covering agriculture and rural issues at KOSU as a corps member with Report for America.
See stories by Anna Pope

Logan Layden
Logan Layden is a reporter and managing editor for StateImpact Oklahoma.
See stories by Logan Layden

Grayson Wheeler
Grayson Wheeler is a reporter covering water issues at KOSU as a corps member with Report for America.
See stories by Grayson Wheeler

Lionel Ramos
Lionel Ramos covers state government at KOSU. He joined the station in January 2024.
See stories by Lionel Ramos

Abigail Siatkowski
Abigail Siatkowski is KOSU's digital producer. She joined the newsroom in August 2024.
See stories by Abigail Siatkowski

Your Planned Gift Keeps Us ON AIR
Click For More Info

Sign up for The KOSU Daily newsletter!
Get the latest Oklahoma news in your inbox every weekday morning.
* indicates required
Email Address *
Subscribe


Support KOSU during our spring membership drive and take home this hi-viz, KOSU/NPR-brand tumbler mug!
Get Yours Today!

The Mean Minute Brass Choir
SUNDAYS AT 9PM
KOSU

The Latest From KOSU

Over 50 universities are under investigation as part of Trump's anti-DEI crackdown

High winds, dozens of wildfires wreak havoc across Oklahoma

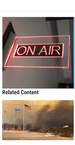
Oklahoma Ethics Commission is pursuing Sean Mahoney for campaign finance violations

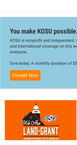
KOSU
Podcasts: Enhanced!
Spend less time scrolling, focus on what matters and get the streaming podcasts — totally a lot of time.
Get Here

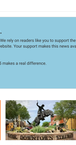
Donate Your Car to KOSU!
Get Started Here

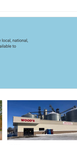
You make KOSU possible.
KOSU is nonprofit and independent. We rely on readers like you to support the local, national, and international coverage on this website. Your support makes this news available to everyone.
Join today. A monthly donation of $5 makes a real difference.
Donate Now

Related Content


Local News
High winds, dozens of wildfires wreak havoc across Oklahoma
March 14, 2025


Local News
'We Are Land-Grant': Jim Hess on his role as OSU's interim president
March 13, 2025


Local News
Google will operate massive data center development in Stillwater
March 27, 2025


Business
Small town grocery stores face unique challenges. Some Midwest states are trying to help
March 10, 2025

International Journal of Disaster Risk Reduction 58 (2021) 102177



Contents lists available at ScienceDirect

International Journal of Disaster Risk Reduction

journal homepage: http://www.elsevier.com/locate/ijdrr





Preparing for wildfire evacuation and alternatives: Exploring influences on residents' intended evacuation behaviors and mitigations

Amanda M. Stasiewicz [a,*], Travis B. Paveglio [b]

[a] Department of Environmental Studies, San Jose State University, 1 Washington Square Hall, San Jose, CA, 95192, United States
[b] Department of Natural Resources and Society, College of Natural Resources, University of Idaho, 875 Perimeter Drive, Moscow, ID, 83844, USA

ARTICLE INFO

Keywords:
Evacuation
Wildfire
Alternatives to evacuation
Home ignition zone
Mitigation

ABSTRACT

Understanding residents' intended evacuation behaviors is an increasingly important component of managing complex wildfire events in the United States and elsewhere. Growing evidence suggests that local populations consider a range of potential evacuation behaviors during fire events, yet fewer efforts explore rural residents' evacuation intentions or their relationship to wildfire mitigations that reduce risk or aid in fire suppression. This study explores evacuation intentions among wildland-urban interface residents in Pend Oreille County, Washington, USA. We explore how mitigation performance (e.g., fuel reduction efforts, structure improvements, active firefighting preparation) differs across three emergent categories of evacuation intentions and evaluate whether a range of factors correlate with participants' evacuation intentions. Our results suggest that a relatively high proportion of residents in the study area intend to stay and defend their property from a wildfire, with smaller proportions intending to evacuate or shelter in place. Individuals who intend to stay and defend are more likely to implement fuel reduction and property mitigation strategies when compared to those intending to evacuate or shelter in place. We found that elements of residency status, sex, age, presence of children in the home, and perceptions of personal efficacy and whether the property was prepared enough to not need firefighting were significant influences on group affiliation. For instance, part-time residency was significantly correlated with intending to evacuate, while full-time residents were more likely to stay and defend. Greater agreement that firefighting was not needed because a property was well-prepared was significantly related to staying and defending over evacuating.

1. Introduction

Fire and emergency management professionals across several countries promote resident evacuation during wildfire events to prioritize resident safety and minimize the complexity of wildfire management decision-making. Early evacuation from an area threatened by a wildfire event is widely promoted as the safest course of action for populations threatened by wildfire. However, existing research and lessons from wildfire events demonstrate that an early and safe evacuation response may not always be possible for residents (e.g., fast-moving fires, limited ingress and egress). Occasions where residents delay evacuation or do not have enough time to evacuate safely can lead to injuries or fatalities during evacuation (e.g., Black Saturday Fires 2009, AUS; Cedar Fire 2004, USA; Camp Fire 2018, USA) [1–5]. Furthermore, there is a tradition of research and evidence suggesting that residents may choose to remain on their property during wildfire events [6–8], and that they can safely do so if they have made significant preparations (e.g., equipment, training, infrastructure) to implement specific plans [9,10]. Consequently, citizens, managers, and policy makers also discuss various alternatives to evacuation, including: (1) stay and defend (SD), where residents prepare and defend their property from a wildfire by actively putting out spot fires or reducing the probability of structure ignition throughout the fire; and (2) shelter in place (SIP), where residents safely shelter in their home or a common area (e.g., community shelter, school) that protects them from exposure to heat and flames during the primary flame front. Prevailing research on divergent approaches to wildfire mitigation and management in fire-prone areas of the United States suggests that populations characterized by particular patterns of social characteristics (e.g., self-reliance, distrust of government, ties to working landscapes) may be more likely to consider SD as a viable option during fire events [11,12]. Several studies have noted that support for SD actions is particularly prevalent in rural areas [6,13],

* Corresponding author.
E-mail address: amanda.stasiewicz@sjsu.edu (A.M. Stasiewicz).

https://doi.org/10.1016/j.ijdrr.2021.102177
Received 27 August 2020; Received in revised form 1 March 2021; Accepted 7 March 2021
Available online 23 March 2021
2212-4209/© 2021 The Author(s). Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).

while both wildland fire management policies and wildfire studies have highlighted increased interest in enabling certain populations to contribute to wildfire suppression in the U.S. [14–16].

Evacuation intentions (including alternatives to evacuation) require varying degrees of individual preparation to execute safely and effectively. Preparation for such actions may include reducing wildland fuels near structures or across the larger property; home and structure modifications; identifying evacuation routes; delineating temporary lodging; or acquiring and maintaining equipment, skills, and the personal fitness and mental preparedness to safely engage in fire suppression activities [10]. Existing research demonstrates that most individuals living in fire-prone areas are aware of wildfire risk where they live and have created a plan for evacuation or alternatives when fires threaten their property [7,8,17,18]. However, critiques of evacuation policies in the United States (i.e., Ready, Set, Go!) and Australia (i.e., Stay and Defend or Leave Early) contend that such guidance is underdeveloped in outlining the preparatory action, skills, or equipment necessary for effective resident evacuation behaviors [19]. It is still unclear to what extent residents execute various mitigation actions when preparing their property for intended evacuation behaviors, including whether there are distinct differences in the ways that residents prepare their properties across a range of potential options (e.g., evacuation, SD, SIP) [20].

The work presented here builds from select studies to explore the relationship between residents' intended wildfire evacuation behaviors and performance of wildfire mitigations. We use data from a self-reported survey of residents in northeastern Washington state, USA, to examine intended evacuation behaviors across a range of rural populations and determine which structure and vegetation mitigation actions those populations have undertaken to prepare for wildfire events. We also explore the relationship between evacuation preferences and resident characteristics (e.g., residency, age, sex, perceptions of defensibility of property, nearest neighboring property line) to explore factors related to evacuation preferences in rural areas.

2. Literature review

2.1. Evacuation and alternatives to evacuation

Government entities involved in emergency management and wildfire response predominately support resident evacuation during a wildfire event. However, able-bodied adult residents in the United States often retain the right to execute a variety of actions on their private property during a fire event and cannot be required to evacuate [21,22]. Exceptions exist if individuals are less than 18 years old or considered to be a member of a vulnerable population (e.g., sick, unable to make decisions regarding their safety). Resident evacuation during a wildfire event can simplify fire managers' decision-making considerations through the removal of populations who are not actively involved in suppression actions. It can reduce the need for resident rescue, road congestion, or the need to re-evaluate suppression tactics for structure protection due to concerns about civilians being in the area (e.g., backburns, felling trees) [23].

The International Association of Fire Chiefs adopted the "Ready, Set, Go!" (RSG) program across the United States in 2011 to enhance wildfire evacuation planning among fire departments and communities. RSG instructs residents to be: (1) "ready" for evacuation by implementing vegetation management and structure improvements that enhance home survivability and firefighter safety; (2) "set" with provisions, pets, and documents necessary for a short or longer-term evacuation; and (3) for residents to "go" (i.e., evacuate) early during a fire that is likely to threaten their property [24]. The Australian "Stay and Defend or Leave Early" (SDLE) approach and the inclusion of "early" to the US "Ready, Set, Go!" approach both highlight the importance of leaving early if a resident intends to evacuate [25]. There are multiple examples across wildfire and broader natural hazards literature where late evacuations led to congested roadways, exposing evacuees to conditions that increase their inherent risk, including heat stroke, car accidents, or being overtaken by the hazard event (e.g., fire, flood, volcanic eruption) [26].

Several wildfire response and evacuation researchers have raised concerns about mismatches between the pace of residential development in the wildfire-prone areas constituting the wildland urban interface (WUI) and improvement of road networks necessary for evacuating from a wildfire [21,27–31]. Single-lane dirt or gravel roads, limited ingress and egress points, reduced visibility due to smoke and switchbacks, and evacuation of large animals (e.g., horses) or livestock can complicate evacuation dynamics in rural areas around the world [3,5,32–36]. Such challenges highlight a need for increased understandings of rural resident evacuation behaviors in the United States. There is some evidence that rural residents also anticipate an evacuation notice from an official [8,21,37], which can be challenging to deliver in low-density residential areas given that fewer emergency personnel are available in rural areas and cell phone reception can be unreliable (thus impacting Reverse 911 or instant alert texts) [14,38,39]. Multi-stage approaches to evacuation (including RSG) may help perpetuate a notion that US residents can count on advanced notice and multiple warnings when making evacuation decisions. However, fire conditions can create circumstances where risk exposure is too rapid for emergency managers to issue timely warnings or necessitates immediate evacuation. Residents may not be prepared for such circumstances, and dissemination of evacuation notices may be particularly unrealistic among rural properties.

Residents who intend to implement alternatives to evacuation (i.e., SD or SIP) also must conduct significant preparations to successfully implement their strategy and reduce potential risk [9,13]. SIP is commonly considered a last resort and is often contingent on performance of comprehensive mitigations actions such as creating defensible space (e.g., reducing the amount of vegetation within 100–200 ft (~30–61 m) of the home), reducing the ignitability of the home (e.g., using fire-resistant siding, clearing gutters and roofs of debris), and reducing risks to individual safety (e.g., closing windows to keep smoke out, having a drinking water supply). SIP is only possible under high levels of mitigation or in very safe zones because it includes passive resident sheltering from the flame front and toxic fumes with no active resident actions [4,32].

Several studies have noted an increased chance of home survival if someone is present to defend the property during a wildfire event [40–42] and this is one reason for residents' decisions to stay and defend their property [43]. Others intend to SD in cases where evacuation is too dangerous, the intent being to preserve life safety rather than to protect homes or possessions [44]. Governments supporting SDLE often generate information and consultation opportunities to maximize resident and firefighter safety during wildfire response [45], although SD-supportive consultation opportunities are less frequently promoted in U.S. contexts. Individuals planning to stay and defend their property need to be mentally prepared and physically capable of engaging in strenuous fire suppression activities [10]; purchase or establish water sources, generators and equipment (e.g., sprinklers, hoses, rakes, ladders); and have appropriate personal protective equipment (e.g., boots, fire resistant clothing) [9,46,47]. Alternatives to evacuation are not widely promoted in many U.S. contexts, although conversations about incorporating civilians into wildland fire response and community planning for SIP have been increasing in recent years [15,35,48–52].

Existing wildfire research suggests that evacuation behaviors can sometimes be conceived of as a spectrum ranging from evacuation to waiting and seeing and then to staying and defending. The "wait and see" group tends to remain on their property until they feel threatened, which conflicts with messages around leaving early. Rural residents may be more apt to "wait and see" during fire events due to a lack of short- or long-term housing options [53], disruptions to livelihoods (e.g., potential loss of crops, equipment or infrastructure), difficulty finding places to board or keep livestock and large animals [33,54,108], and concerns

about accessing health care or other services in rural regions [55]. Those same considerations also may lead them to consider alternatives to evacuation. Strong cultural ties to the land [56], possession of local knowledge that could be useful in firefighting [14–16,57], an inability to evacuate without assistance [35,109], and the belief or past experience that well-prepared residents can reduce losses to their private property while ensuring life safety are additional reasons threatened populations may choose to employ alternatives to evacuation [40–42].

Individuals with wait and see intentions may reflect intentions to SD unless certain criteria (e.g., fire proximity, smoke) are met [8,13,58,59]. Wait and see intentions also could reflect additional safety risks residents anticipate encountering during the evacuation process (e.g., narrow roads). Additionally, evacuated residents can be denied entry into evacuated areas during wildfires. Such denials can lead to conflict between residents and security personnel; an inability to return from other locations to prepare or defend property from wildfire; and challenges for evacuating pets, animals, or dependents [16,60,61].

2.2. Intended evacuation behavior, mitigation actions, and resident characteristics

Recent and historic wildfires resulting in resident fatalities (e.g., Black Saturday Fires 2009, AUS; Camp Fire 2018, USA) highlight the complexity of evacuation decision-making and executing intended behaviors (i.e., SD, SIP, evacuate) safely. Those fires underscore how intended evacuation plans can become difficult to implement during changing fire circumstances and their contingency on others' actions before or during the wildfire event. Such understandings highlight a broader need to explore the mitigations individuals with different evacuation preferences are preforming to prepare their property to survive the fire event. Vegetation mitigations in the home ignition zone (HIZ)—the 100 to 200-foot (~30–60 m) area surrounding a structure—are often a focal point of preparing properties for any evacuation behavior. Paveglio et al. [6] found several significant differences in performance of vegetation mitigations across groups of individuals intending to evacuate, SD or SIP, the latter of which also included residents uncertain of their intended evacuation behavior (hereafter "SIP/I don't know"). For instance, the SD group was significantly more likely than the SIP/I don't know group to implement vegetation mitigation actions in the HIZ. Differential performance of mitigations among evacuation groups also extended across actions in different "zones" outlined for the HIZ (e.g., 0–30 feet (~0–10 m), 30–100 feet (~10–30 m) and 100–200 feet (~30–60 m)) [6,58]. These actions include: (1) stacking firewood and lumber more than 30 feet (10 m) from the structure; (2) clearing leaves and other debris from roofs, gutters, or decks; and (3) using non-combustible materials in structure construction, among others. Additional measures, such as installing sprinklers on structure roofs or around a home could also facilitate active or passive home defense by decreasing property ignition potential without requiring an individual to actively engage in fire suppression. Edgeley and Paveglio [58] found that individuals intending to evacuate in McCall, Idaho, USA, were significantly more likely to establish a water supply for firefighting than members of the SIP/I don't know group. The authors also found that SD individuals were more likely to utilize fire-resistant plants in their landscaping than individuals who intended to evacuate [58].

Existing wildfire literature illuminates some potential explanations surrounding residents' preferences for evacuation or alternatives to evacuation. For instance, several studies indicate that men are generally more likely than women to remain during a wildfire event to defend property [7,62–65]. Children under the age of 18, elderly individuals, pregnant women, or individuals with health concerns (e.g., asthma) often are inclined and encouraged to evacuate early [7,43,66–69] with other adults often feeling compelled to accompany them [62]. Some have found that part-time residents are more likely to evacuate when compared to full-time residents, the latter of which are more likely to SD [6,58]. Additionally, individuals' perceptions of their capabilities and efficacy, and those of firefighters to defend their home, also have a variable influence on resident decision-making surrounding evacuation [8,54,70,71].

The research presented here builds from and replicates portions of the preceding research by investigating rural residents' intended evacuation behaviors, their performance of mitigations, and potential influences on their choice of a particular evacuation preference category. We investigate the utility of an existing measurement scale for assessing evacuation preferences categories across a gradient of residential development. We explore performance of mitigation actions across intended evacuation behaviors to examine how rural residents are preparing for future wildfires. Our geographically stratified sample and focus on rural WUI populations allows us to expand investigation to less studied populations with regards to evacuation planning in the U.S. We use the following research questions to guide our investigation:

1) What types of actions do residents intend to implement during a wildfire event?
2) How does property-level wildfire risk mitigation vary across emergent evacuation groups?
3) What resident characteristics and perceptions of individual and firefighter efficacy correlate with evacuation preferences?

3. Methods and materials

3.1. Study area and sample frame

We selected Pend Oreille County in northeastern Washington, USA, as our study area due to previous research indicating that populations in the county were "socially fragmented," indicating the presence of socially diverse populations featuring individuals who were likely to select and implement a range of approaches to wildfire risk mitigation or evacuation [72]. Pend Oreille County is predominately comprised of rural populations that are not affiliated with a census-designated city and has a high proportion of public lands inducing historical ties to natural resource industries, recreation or tourism, and amenity migration. Participants in Paveglio et al.'s [72] study noted that dense residential development around multiple lakes in the southern portion of the county raised potential challenges regarding quick and effective evacuation. They also noted how select populations in the area with a long history of resource extraction and utilization (i.e., timber and agriculture) or personal independence meant that some residents prefer to stay and defend their properties or contribute equipment and skills during active wildfire suppression. Participants also noted dramatic variation in residential development patterns (e.g., parcel size and dimensions), residency status, and a continued influx of amenity migrants and retirees, all of which might influence evacuation dynamics [72]. As such, the area presented a strong opportunity for a study exploring differential approaches to evacuation across a range of development types (e.g., developed-to-rural) and a variety of socio-demographic characteristics.

The sample frame for this research effort began with four lakes identified by key informants and study participants as representative of the areas of dense development within the predominately rural area [72]. We sampled across three distinct geographic zones extending from each lake in order to capture potential geographic variation across populations ranging from dense lakeside development to larger, more rural properties near large tracts of public lands. We used waterbody shapefiles acquired from the Washington National Hydrography Dataset Area or NHD Waterbody Layers [107] as a geographic reference for delineating geographic zones. More specifically, we used waterbody layers and GIS parcel data acquired from the Pend Oreille County Assessor's Office to identify potential study participants across three distinct zones extending from each lake. The region 1 buffer extended 500 feet from a lake edge and was comprised of any residential parcels

(e.g., homes, cabins, mobile homes) with a centroid within that 500-foot (~152 m) zone. The region 2 buffer encompassed all residential parcels with a centroid up to 1.5 miles (~2.4 km) from the outer edge of region 1. The region 3 buffer consisted of all residential parcels with a centroid within 1.5 miles of the outer edge of region 2. The 1.5-mile (~2.4 km) buffer distance represents a commonly referenced measure for delineating the WUI and the distance an ember can travel from a forest fire and ignite flammable materials at a distant location [73]. Our distance buffer and sampling approach also mirrors existing research exploring resident evacuation and private landowner performance of wildfire mitigations (e.g., Refs. [58,74]. Parcels associated with land trusts, businesses or commercial use, apartments, or condominiums were removed from the sample frame to ensure that recruited participants represented residential property owners who might be evacuated during a wildfire event, and who have the ability to make decisions about mitigating wildfire risk on the property. Surveys were only delivered to the primary tax mailing address of owners to ensure that residents in the study area were asked to respond to only one survey about their primary residential property in the region.

We administered a survey to the sample frame in August 2018 using a mixed-mode approach tailored to residential types in the region. More specifically, we (1) sent a mail survey to second homeowners (what others sometimes refer to as part-time residents or recreational property owners) using the methods recommended by Dillman et al. [75] (i.e., the "Tailored Design Method") and (2) conducted a drop-off, pick-up approach among primary residential property owners [76,77]. We used GIS parcel and tax data to assign each parcel in the sample frame as primary or secondary and determine the most appropriate administration method. Members of the research team visited primary residences in-person as part of the drop-off, pick-up administration mode to deliver, discuss, and collect the survey. We elected to use a drop-off, pick-up approach to administer the survey to primary residents because of its documented propensity for yielding higher response rates than mail surveys when in rural areas, especially when implemented in geographically distinct areas [76,77]. A team of five researchers visited primary residences (n=600) during 15 consecutive days to deliver and collect surveys using a shared protocol. Each researcher arranged to return to collect the completed survey within 24 hours. If surveys were not completed at the agreed upon pick-up time, researchers revisited properties in a systematic fashion to ensure adequate opportunities to contact participants and ample time for participants to complete surveys. We elected to focus our drop-off, pick-up efforts on two lakes with the highest populations to maximize opportunities for response to permit the research team to make multiple return trips when necessary.

Mail survey administration was extended to populations across all four lakes to compensate for potential lower survey response rates from second homeowners across the sample. We administered the mail survey to 957 second homeowners in August 2018. We utilized sequential mailing phases adapted from Dillman et al. [75] to administer the mail survey to remote participants, including: (1) an introductory letter; (2) a survey booklet and a prepaid return envelope; (3) a thank you/reminder postcard with the option complete the survey online using Qualtrics; and (4) a final reminder letter with second invitation to complete the online survey. Each mailing was sent approximately 1-week apart.

We administered surveys to a total of 1513 residential landowners. We collected or received a combined total of 770 completed surveys for a collective response rate of 49.5%. The response rate for the drop-off, pick-up effort was considerably higher (470 completed surveys, 78.3% response rate) than the mail/online effort (300 completed surveys, 31.3% response rate).

3.2. Select survey measures

The survey instrument for this research adapted and expanded questionnaires used to study intended evacuation behaviors and wildfire mitigation efforts in McCall, Idaho, and Flathead County, Montana (e.g., Refs. [6,58,74]). The 16-page survey used in this study included questions regarding the performance of parcel-level wildfire mitigation actions, intended behaviors during a wildfire event, perspectives about wildfire management and suppression, and respondents' sociodemographic characteristics.

We explored respondents' intended evacuation behaviors using nine, 5-point, agree-disagree Likert scale questions. Statements covered a variety of related actions observed across wildfire evacuation events, and were replicated from past studies (see Refs. [6,58]) and were also informed by wildfire preparedness check-lists or other studies (e.g., Refs. [78,79]; Price et al., 2016; [80]). Those measures are outlined in Table 2. We asked each respondent whether they had performed various mitigation actions in different zones of the HIZ or as broader means to improve firefighter safety using a series of dichotomous (i.e., yes/no) measures. Mitigation questions were grouped by HIZ zone. Six mitigation statements related to home survivability and the immediate HIZ zone (0–5 feet or ~1.5 m from the home), four addressed typical fuel reduction actions related to tree and shrub management and dispersion in HIZ 1, three focused on vegetation mitigations in HIZ 2, and two addressed vegetation mitigations in HIZ 3 (see Tables 2 and 3 for mitigations included). An additional group of measures implicated actions often promoted as necessary to safely defend properties or provide firefighters with opportunities to safely protect private property (see Table 2).

Respondents were asked a series of sociodemographic questions referenced in broader literature as salient indicators of intended evacuation behaviors. These sociodemographic variables included residency status (i.e., full-time, part-time), sex, age, and whether there were children under the age of 18 living on the property during the wildfire season (i.e., May–October). Participants also were asked to indicate their level of agreement or disagreement with three statements concerning their perceived efficacy to address wildfire risk and that of professional firefighters due to past research indicating potential influence of such beliefs on evacuation behaviors [8,9,33,70,81]. More specifically, statements covered: (1) residents' perceived ability to protect their property from fire impacts; (2) perceived ability of professionals to prevent damages to their property; and (3) whether firefighting would be less necessary on their property because it is well prepared.

Table 1
Description of independent variables for multinomial logistic regression.

Variable	N	Range (response frequency)	Mean (SD)
Residency	755	1= Full time (63.7%) 0= Part time (36.3%)	
Sex	702	1= Male (57.4%) 0= Female (42.6%)	
Age	683	Range: 20-96	62.67 (12.59)
Children <18 years old present during fire season	692	1= present during fire season (May–October) (34.4%) 0= not present (65.6%)	
My ability to protect my property from fire impacts	717	−2= Strongly disagree −1= Moderately disagree 0= Neutral 1= Moderately Agree 2= Strongly Agree	0.67 (1.31)
The ability of professionals to prevent damages to my property	729	−2= Strongly disagree −1= Moderately disagree 0= Neutral 1= Moderately Agree 2= Strongly Agree	0.92 (1.26)
Firefighting would be less necessary on my property because it is well prepared	719	−2= Strongly disagree −1= Moderately disagree 0= Neutral 1= Moderately Agree 2= Strongly Agree	−0.34 (1.11)

Table 2
Mean Likert response by evacuation preference category. Higher mean values are associated with greater agreement with the statement based on a 5-point scale where 5= strongly agree and 1=strongly disagree.

Evacuation statement	Evacuate	Stay and defend	Shelter in place/I don't know
I would remain at home and help defend my home by putting out spot fires	2.06	**4.34**	3.59
I would evacuate as soon as I hear about a fire that may impact my property	**4.14**	2.04	2.93
I would wait to see how bad the wildfire is and evacuate if I think it is too dangerous	2.22	**4.02**	3.67
Some members of this household would evacuate and others would remain to protect the property	1.47	**3.47**	2.72
I would evacuate when the authorities tell me to do so	**4.73**	3.94	4.36
My neighbors and I would work together to evacuate promptly	**3.99**	3.32	3.50
I would remain on my POC property regardless of authorities' evacuation orders	1.07	**2.23**	1.72
I would remain at home and safely shelter in my home without putting out spot fires	1.18	1.23	**2.12**
I would not know what to do during a wildfire	1.94	1.51	**3.28**
n=	200	289	186

3.3. Analysis

Analysis of survey responses was conducted using the quantitative data analysis software package SPSS 26 (IBM, 2020). We began by performing an exploratory principal components analysis with a Varimax rotation and Kaiser normalization on data associated with the nine evacuation preference measures (see left column of Table 1). Principal components analysis provides the means to derive a smaller set of variables (i.e., principal components) from a larger list while still explaining a similar amount of observed variance. Principal components analysis is one strategy for informing the creation of composite variables as it partitions the variance explained by the larger set into independent linear combinations of associated measures. Principal components that had eigenvalues greater than one were retained for continued analysis [82,83]. We used results from the principal components analysis to inform a k-means cluster analysis [84]; we calculated individual average scores for each resident for each component. K-means cluster analysis is an algorithm that groups similar individuals into "clusters" that are distinct from each other. Individuals classified as a group are broadly similar based on distance from the cluster mean (i.e., centroid). Respondents who did not answer all nine evacuation-related statements were excluded from sample and subsequent analysis.

We used Pearson's Chi square tests to explore whether there were statistically significant differences in performance of various wildfire mitigations across the three evacuation preference classes that emerged from our principal components and k-means cluster analyses. Post-hoc z-tests with a Bonferroni correction were used in concert with the Pearson's Chi square to evaluate significant differences in performance across each evacuation group.

We used multinomial logistic regression [85,86] to estimate the relationships between individual respondent characteristics (e.g., sex, residency status, age) or their perceptions about efficacy, and their dominant evacuation intention (i.e., evacuate, SD, SIP). Multinomial logistic regression is appropriate when the dependent variable is categorial, as is the case with our evacuation intention groupings. We used evacuation as the reference category in the regression, as it is the most commonly advocated strategy during wildfire events.

4. Results

4.1. Population descriptive statistics

Descriptive statistics for the independent variables utilized in our multinomial logistic regression are presented in Table 1. Nearly two-thirds of our sample was comprised of full-time residents (full time=63.7%; part-time=36.3%) and 57.4% of the population was male (female=42.6%). Participants were 20–96 years old with an average age of 62.67 years (SD=12.59). Approximately one-third of respondents (34.4%) had at least one child under the age of 18 years old on premises during the fire season (May–October). Study participants reported slight agreement that they had the personal ability to protect their property from fire impacts (M=0.67; SD=1.31) and that firefighters had the ability to prevent damages on their property (M=0.92; SD=1.26). On average, residents also reported slight disagreement with the statement that firefighting would be less necessary on their property because it is well prepared for wildfire (M=−0.34; SD=1.11).

Table 3
Percentage performance and significant differences in Home Ignition Zone (HIZ) property defense and HIZ 0/immediate zone mitigations across evacuation preference categories.

Property defense mitigation	Evacuate (a)	Stay and defend (b)	Shelter in place/I don't know (c)	X^2
Designated a safe zone on my property (e.g., structure, pool, bare ground) where people could safely shelter as a fire passed	35.4%	45.3%	37.4%	.064
Purchased a generator to help power water pumps or provide electricity during a wildfire event	32.5%$_a$	57.0%$_b$	41.7%$_b$	<.001***
Established a water supply for firefighting	42.8% $_a$	57.2% $_b$	45.9% $_a$	.004**
Ensured that the driveway meets access requirements for emergency vehicles	62.6% $_a$	84.0% $_b$	70.9% $_a$	<.001***
Installed external (outdoor) sprinklers on my home	22.2%	24.6%	24.4%	.813
Installed external sprinklers that can reach up to 50 ft (15 m) away from my house	15.0% $_a$	25.5% $_b$	23.2% $_{a,b}$	.021*
HIZ 0/immediate zone mitigation (0–5 feet, ~1.5 m)	Evacuate (a)	Stay and defend (b)	Shelter in place/I don't know (c)	X^2
Used non-flammable siding materials such as tile, slate, brick, heavy timber or stone	30.6%	31.9%	31.4%	.952
Stacked firewood/lumber at least 30 feet from the residence	61.9% $_a$	74.1% $_b$	68.2% $_{a,b}$	.017*
Planted fire-resistant plants around the residence	16.3%	22.1%	18.5%	.284
Regularly removed the accumulation of needles and leaves from roofs, gutters, or decks	90.9% $_{a,b}$	93.4% $_b$	86.3% $_a$	.036*
Removed any flammable materials or vegetation within 5 feet of your home	71.9% $_a$	82.2% $_b$	76.7% $_{a,b}$	.026*

Subscripts indicate which evacuation preference categories differ at the 0.05 error level.
Probabilities are significant at: *, $P < .05$; **, $P < .01$; ***, $P < .001$.

4.2. Stated evacuation preferences

Table 2 provides mean responses to the nine evacuation statements included in our analysis. More than half of our study participants moderately (33.9%) or strongly agreed (26.9%) that they would remain on their Pend Oreille County property and help defend their home by putting out spot fires. Thirty-six percent of residents (19.7% moderately agreed, 16.3% strongly agreed) indicated that they would evacuate as soon as they heard about a fire that may impact their property. Many residents demonstrated support for a wait and see approach, with 32.0% moderately agreeing and 26.2% strongly agreeing that they would wait and see how bad a wildfire was and evacuate if they thought it was too dangerous. Approximately one-third of respondents reported that household members would split their response, with some evacuating and some remaining to protect the property (20.8% moderately agreed, 14.7% strongly agreed). Study participants indicated an overall intention to comply with authorities' evacuation orders, with 62.4% strongly and 18.9% moderately agreeing that they would evacuate when authorities told them to do so. A relatively high proportion of respondents indicated moderate agreement (29.2%) or strong agreement (24.4%) that they would work with their neighbors to evacuate promptly. Few in the study population intended to remain on their property regardless of authorities' evacuation orders (moderately agreed=5.1%, strongly agree= 5.1%). Overall, study participants did not indicate an intent to passively shelter in place, with only 2.7% of participants moderately agreeing and 2.5% strongly agreeing they would implement passive SIP. Few residents indicated that they had not considered their wildfire plans, with 9.7% moderately agreeing and 4.9% strongly agreeing that they would not know what to do during a wildfire event.

Results of the principal components analysis revealed three principal components with eigenvalues greater than 1. These three principal components explained 59.1% of the variance in the nine evacuation behaviors (see Table 2). The Kaiser-Meyer-Olkin measure resulting from the principal components analysis was 0.726, which indicates that our survey size was adequate for the analysis. Rotated factor loadings for individual measures ranged from 0.63 to 0.86. The Bartlett's test of sphericity was highly significant ($p < .001$) resulting in a rejection of the null hypothesis [82] and support for deriving components from our data. The resulting components generally reflected three evacuation preference categories matching past studies using similar measures, specifically: (1) evacuate, (2) stay and defend (SD), and (3) shelter in place (SIP)/I don't know. Subsequent classification of respondents using the k-means cluster analysis resulted in 29.6% of respondents' preferences most closely aligning with the evacuate category, 42.8% aligning with the SD category, and 27.6% with the SIP/I don't know category.

Residents in the SD category reflected intentions to remain at home and help defend their properties by putting out spot fires (rotated factor loading= 0.80) and to not evacuate immediately (rotated factor loading= −0.74). Members of the SD category also had a propensity to wait and see how bad the fire was and evacuate if they thought it was too dangerous (rotated factor loading=0.75), They also were more likely to indicate that their households would implement a split evacuation response, with some members evacuating and others staying to protect the property (rotated factor loading= 0.66). Participants in the evacuate category indicated intentions to evacuate when authorities told them to do so (rotated factor loading=0.86), to work with neighbors to evacuate promptly (rotated factor loading=0.63), and to not ignore authorities' recommendations (rotated factor loading= −0.75). Members of the SIP/I don't know category were most likely to remain at home and not suppress spot fires (rotated factor loading= 0.76) or indicate that they do not know what to do during a wildfire event (rotated factor loading=0.67). Mean Likert responses for each group are provided in Table 2.

4.3. Evacuation preference and wildfire mitigations

Comparisons across intended evacuation behavior categories suggest significant differences in performance of property-level wildfire risk mitigation across zones of the HIZ. The Chi square test revealed significant or highly significant differences in the performance of four property defense mitigations (see Table 3). More specifically, there were significant differences between evacuation groups with regards to purchasing a generator, establishing a water supply for firefighting, ensuring that the driveway meets emergency vehicle access requirements, and installing external sprinklers that reach up to 50 feet (15 m) from the home. Tests of proportions between groups revealed that respondents in the evacuate category were least likely to purchase a generator to help power water pumps or provide electricity during a wildfire event ($p < .001$), with members of the SD group and SIP group both significantly more likely to have performed those mitigations. Members of the SD group were more likely to establish a water supply for firefighting ($p=.004$) and ensure their driveway met access requirements for emergency vehicles ($p < .001$) in comparison to the other evacuation preference groups. The SD group was also more likely to install external sprinklers that could reach up to 50 feet (15 m) from the home when compared to the evacuate group, but not the SIP/I don't know group ($p=.021$).

Chi square tests for mitigations in the immediate HIZ zone (i.e., HIZ 0) revealed three significant differences in mitigation performance across evacuation groups (see Table 3). Individuals in the SD group were more likely to stack firewood/lumber 30 feet (~9 m) from their home ($p=.017$) and remove flammable materials within 5 feet (~1.5 m) of their home ($p=.026$) when compared to members of the evacuate group, but not the SIP/I don't know group. Respondents affiliated with the SD group were more likely to regularly remove the accumulation of needles and leaves from roofs, gutters, or decks than members of the SIP/I don't know group, but not the evacuate group ($p=.036$).

Results of the Chi square tests and subsequent tests of proportions among evacuation groups for vegetation mitigations in the HIZ are provided in Table 4. For HIZ 1 vegetation mitigations, members of the SD group were more likely to remove branches of trees lower than 10 feet (~3 m) from the ground than members of the SIP/I don't know group, but could not be distinguished from the evacuate group ($p=.002$). Members of the SD group were also more likely to clear or maintain a 30 foot (~9 m) "green space" around their home ($p < .001$) and space trees or shrubs at least 10 feet (~3 m) apart ($p < .001$) when compared to either of the other groups. There were also highly significant differences in performance of vegetation mitigations in HIZ 2 and HIZ 3 across evacuation groups. Respondents in the SD category were more likely to perform all five mitigations in the HIZ 2 and 3 categories when compared to members of the evacuate or SIP/I don't know groups. For HIZ 2 specifically, SD individuals were more likely than members of both the evacuate and SIP/I don't know groups to (1) remove/thin trees and shrubs to reduce the density of vegetation ($p < .001$), (2) remove branches of trees less than 10 feet (~3 m) from the ground ($p < .001$), and (3) maintain thinning of trees and shrubs performed more than 10 years ago ($p < .001$). Members of the SD group also were significantly more likely to remove/thin trees and shrubs to reduce the density of vegetation in HIZ 3 ($p < .001$) and maintain thinning of trees and shrubs in HIZ 3 performed more than 10 years ago ($p < .001$).

4.4. Influences on intended evacuation behavior during wildfire

Results of our multinomial logistic regressions are outlined in Table 5. The final model explains a significant amount of variation in evacuation group affiliation (likelihood ratio $X^2= 186.085$, $p < .001$), and a relatively high amount of variance in the sample. Full-time residents were more likely than part-time residents to be in the SD category when compared to the evacuate category (B=1.176, $p < .001$), all else constant. The odds ratio associated with the multinomial logistic

Table 4
Percentage performance and significant differences across HIZ zones for vegetation mitigations across evacuation preference categories.

HIZ 1 vegetation mitigations (0–30 feet, ~9 m from home)	Evacuate (a)	Stay and defend (b)	Shelter in place/I don't know (c)	X^2
Removed trees less than 10 ft from your home	59.1%	68.2%	58.2%	.042*
Removed branches of trees lower than 10 feet from the ground	70.3% $_{a,b}$	76.7% $_{b}$	61.5% $_{a}$	.002**
Cleared or maintained a 30 ft "green space" around home	46.7% $_{a}$	69.8% $_{b}$	44.7% $_{a}$	<.001***
Spaced trees or shrubs at least 10 feet apart	25.2% $_{a}$	53.0% $_{b}$	21.8% $_{a}$	<.001***
HIZ 2 vegetation mitigations (30–100 feet, ~9–30 m, from home)	Evacuate (a)	Stay and defend (b)	Shelter in place/I don't know (c)	X^2
Removed/thinned trees and shrubs to reduce the density of vegetation	58.6% $_{a}$	73.3% $_{b}$	56.8% $_{a}$	<.001***
Removed branches of trees lower than 10 feet from the ground	52.0% $_{a}$	63.0% $_{b}$	44.5% $_{a}$	<.001***
Maintained thinning of trees and shrubs performed more than 10 years ago	44.9% $_{a}$	59.4% $_{b}$	38.0% $_{a}$	<.001***
HIZ 3 vegetation mitigations (100–200 feet, ~30–60 m from home)	Evacuate (a)	Stay and defend (b)	Shelter in place/I don't know (c)	X^2
Removed/thinned trees and shrubs to reduce the density of vegetation	34.4%$_{a}$	53.0%$_{b}$	37.4%$_{a}$	<.001***
Maintained thinning of trees and shrubs performed more than 10 years ago	65.6%$_{a}$	47.0%$_{b}$	62.6%$_{a}$	<.001***

Subscripts indicate which evacuation preference categories differ at the 0.05 error level.
Probabilities are significant at: *, $P < .05$; **, $P < .01$; ***, $P < .001$.

regression indicates that as residency status changes from part-time (0) to full-time (1) the change in the odds of being in the SD category rather than the evacuate category is 3.241. Put another way, the odds of a full-time resident being in the SD category is approximately 3.24 times more likely than for part-time residents. The sex of the respondent significantly influenced whether a respondent was affiliated with the SD or evacuate group, all else constant. Male residents were approximately 3.53 times more likely to be in the SD category than the evacuate category (B= 1.260, p<.001) and nearly twice as likely to be in the SIP/I don't know category than the evacuate category when compared to females (B=0.687, p=.005). Older respondents were significantly more likely to be in the SIP category rather than the evacuate category (B=0.020, p=.045), all else constant.

Initial regressions and exploration of collinearity diagnostics led us to explore additional interactions between conceptually related independent variables. Specifically, we introduced an interaction term for the presence of children during wildfire season and age variables. We found a significant and negative interaction effect between these two variables when comparing the SD and evacuate categories (B=−0.049, p=.011). The odds ratio tells us that as age increases in combination with having children present on site during fire season (May–October) the change in the odds of staying and defending rather than evacuating was 0.95. Put another way, as the presence of children changes from none (0) to present (1), younger residents become less likely to stay and defend and more likely to evacuate.

Respondents who indicated that their decision to evacuate would be influenced by personal ability to protect their property from wildfire impacts were two times more likely to be in the SD category (B=0.751, $p < .001$) when compared to the evacuate category. Individuals who displayed higher levels of agreement that their personal ability to protect their property from wildfire impacts would influence their decision to evacuate were also nearly two times more likely to be in the SIP/I don't know evacuation intention category when compared to the evacuation group (B=0.474, $p < .001$). Study participants reporting higher levels of agreement that firefighting would be less necessary on their property because it is well prepared were significantly more likely to be affiliated with the SD category (B=0.440, $p < .001$) when compared to the evacuate group.

5. Discussion

This research sought to explore intended wildfire evacuation behaviors in a rural U.S. setting and their relationship with residents' performance of structural, vegetative, and property defense actions in the home ignition zone (HIZ). We also were interested in whether select respondent attitudes help explain evacuation preferences. We found significant differences in wildfire preparation activities performed by respondents across the evacuation groups that emerged from our analysis, with the greatest number of differences occurring between the SD category and the evacuation/SIP groups. This finding corroborates existing research suggesting that individuals' planned evacuation behavior during wildfire can correspond with the mitigation actions they are willing to undertake [6,58,67,87,88]. For instance, performance of nearly all vegetation mitigations in the HIZ gauged for this research differed across at least two of the evacuation groups that resulted from our analysis. However, it appears that actions related to HIZ 0 were less likely to differ among groups and these patterns are more inconsistent. Finally, we found that select respondent characteristics significantly correlated with evacuation preferences, including residency, sex, age, the interaction between age and the presence of children on site during fire season, and perceptions of personal self-efficacy related to fire suppression.

The three evacuation preference categories emerging from our principal components analysis match commonly reported approaches outlined in existing literature on wildfire evacuation behavior [8,18,54,68,89]. They also reflect the evacuation preference patterns and factor loadings found in other studies utilizing a similar survey instrument and evacuation statements, suggesting the scale used provides a reliable means for understanding intended evacuation behavior [6,58]. In particular, the consistent performance of the evacuation scale across three studies— (1) sampling across a rural county [6], (2) a small city [58], and (3) our study of rural lake populations further demonstrates the integrity of these prompts as a base scale for exploring wildfire evacuation behaviors across populations. We found few significant differences between the SIP/I don't know and evacuate groups in our study area, which suggests that these groups may have more in common in this location when compared to other study sites. A potential explanation is that there may be overlap around the "wait and see" approach to evacuation where respondents' are hesitating between leaving early and staying and defending. Another potential explanation is that members of our rural study population who largely do not intend to SD may be reluctant to evacuate early due to the distance they may have to evacuate to find short or longer-term housing and the need to evacuate and board pets and livestock [33,53,54,108]. Like Edgeley and Paveglio [58], additional measures could be incorporated into the suite of evacuation prompts to examine the existence of more nuanced descriptions outlined in evacuation "archetypes" emerging in broader evacuation literature (see Ref. [68]).

Residents in our Pend Oreille County, WA, sample displayed several similarities when compared with results from an evacuation study in McCall, ID [58]. The population in the Flathead County, MT study [6] was more likely to agree or strongly agree that they would stay and defend or wait and see how bad the fire was before evacuating. All three populations displayed a high preference (i.e., moderately agree or

Table 5
Results of multinomial logistic regression for variables influencing intended behavior during a wildfire. Variable coding provided in Table 1.

	Stay and Defend vs. Evacuate					SIP/I don't know vs. Evacuate				
	95% CI for Odds Ratio					95% CI for Odds Ratio				
	Lower	Odds Ratio	Upper	B (SE)	Sig	Lower	Odds Ratio	Upper	B (SE)	Sig
Demographics										
Residency	1.979	3.241	5.307	1.176 (0.252)	<.001***	1.048	1.705	2.775	0.534 (0.248)	.032*
Sex	2.190	3.527	5.679	1.260 (0.243)	<.001***	0.687	1.987	3.193	0.687 (0.242)	.005**
Age	0.985	1.012	1.040	0.012 (0.014)	.382	1.001	1.031	1.062	0.020 (0.015)	.045*
Children under 18 years old present during fire season	0.832	8.281	82.397	2.114 (1.172)	.071	0.384	2.689	57.230	1.545 (1.276)	.226
Children*Age	0.917	0.952	0.989	−0.049 (0.019)	.011*	0.931	0.969	1.009	−0.31 (0.020)	.123
How influential or uninfluential are the following factors in your decision to evacuate										
My ability to protect my property from fire impacts	1.639	2.045	2.551	0.715 (0.113)	<.001***	1.298	1.606	1.987	0.474 (0.209)	<.001***
The ability of professionals to prevent damages to my property	0.805	1.005	1.255	0.005 (0.113)	.967	0.838	1.046	1.305	0.045 (0.113)	.694
Please indicate the extent to which you agree or disagree with the following statements about firefighting in Pend Oreille County										
Firefighting would be less necessary on my property because it is well prepared	1.257	1.553	1.918	0.440 (0.108)	<.001***	0.997	1.235	1.529	0.221 (0.109)	.053

Note: R^2= 0.274 (Cox and Snell), R^2= 0.310 (Nagelkerke). Model $X^2(16) = 186.085$, $p < .001$. Alkaike Information Criteria (AIC): Intercept only= 1241.121, final= 1087.036.
*$p < .05$; **$p < .01$; ***$p < .001$.
Evacuate is the reference category

strongly agree) for evacuating when authorities told them to do so (MT: 77.5%, ID: 81.2%, WA: 81.3%). Concurrently, all three populations indicated low levels of agreement with the statement that they would evacuate as soon as they heard about a fire that may impact their property (MT: 27.2%, ID: 32.9%, WA: 36.0%). These consistencies may begin to underscore that populations in the region are generally responsive to evacuation orders from authorities, but may not be as likely to evacuate promptly during wildfire in the absence of explicit directions from professionals. Expectations of evacuation orders from authorities in rural areas, including our study area, may pose additional problems for resident safety during a fire event because evacuation cues can be challenging to deliver to dispersed, rural homes serviced by few emergency personnel. Inconsistent internet and cell service can also represent an obstacle to fire and evacuation information delivery via social media, email, or text alert in remote areas [14,38,55,90]. The convergence of expected evacuation notices from authorities and difficulties communicating with rural populations may exacerbate a need for adaptive evacuation plans and alternatives to evacuation in rural, fire-prone areas.

Our research broadens understandings about planned evacuation behavior by linking them to a broader set of mitigations or attitudes. This includes a focus on preparations related to the SD and SIP evacuation categories, including home defense actions or those that facilitate fire suppression response effectiveness. We found that members of the SD group were significantly more likely to establish a water supply for firefighting and to clear their driveways for emergency vehicle access than the other two evacuation groups emerging from our data, potentially hinting at an elevated consciousness of potential water resource scarcity, a need for support from fire professionals during their stay and defend effort, and/or a need for a safe evacuation route if they become overwhelmed and unable to shelter in their home. SD and SIP/I don't know members were more likely to purchase a generator than evacuate group members, which may imply that these groups are thinking about how to enable their remaining on site during a wildfire if electricity was lost. Expansion of the evacuation prompts described above, and their pairing with motivations for performing different mitigation actions in future studies could help explore these linkages further. SD group members were more likely to install sprinklers that can reach up to 50 feet (15 m) from the home—a strategy increasingly heralded as a benefit for home defense during active suppression or for mitigating property damage in the absence of firefighter response [91,92]. Overall, SD group members were frequently more likely to implement home defense actions than members of the evacuate group and SIP/I don't know groups. Similarly, Edgeley and Paveglio [58] found that members of the evacuate group in McCall were more likely to implement various preparations for evacuation than both the SD and SIP/I don't know group (i.e., identify a place to stay, identify an evacuation route). Collectively, these results demonstrate that residents interested in more active forms of evacuation behavior, such as SD, are more likely to take on additional mitigation responsibilities recommended for private property owners to enhance firefighter safety and effectiveness in the wildland-urban interface, potentially because they perceive of themselves as being in a firefighter's position.

We found that performance of several actions related to home survivability and mitigations in the immediate zone (i.e., HIZ 0) also were significantly different across evacuation categories. For instance, our results indicate that members of the SD category were more likely to perform wildfire-related landscaping and home maintenance tasks (removing flammable vegetation within 5 feet (1.5 m) of the home; stacking firewood/lumber at least 30 feet (~9 m) from the home) than members of the evacuate category and more likely to remove needles and leaves from roofs, gutters, and decks than members of the SIP/I don't know category. This contrasts the findings of Paveglio et al. [6], who did not uncover significant differences in performance of these actions across similar evacuation groups among Flathead county participants. For example, Paveglio et al. [6] did not find significant differences between evacuation groups with regard to stacking firewood at least 30 feet (~9 m) from the home or regularly removing the

accumulation of needles and leaves from roofs, gutters, or decks. Since Paveglio et al. [6] collected their data in 2011, the "fire-adapted community" messaging now associated with the National Cohesive Management Strategy (2014) and Firewise/USA program in the U.S. has become increasingly widespread. This may be one reason why the proportion of our study population that performed many of the HIZ 0 tasks (e.g., using fire-resistant plants in landscape, using non-flammable siding materials) was more than twice those who reported performing the mitigations in Flathead, Montana, USA in 2011. Differences in local culture, engagement with outreach efforts, and trust in local officials also may be reasons for these differences. Such trends may also highlight temporal shifts in national conversations about private landowner responsibility for mitigating wildfire risk and the influence of large, highly impactful wildfires in the western U.S. since the Flathead study (i.e., Camp Fire, Thomas Fire, Carlton and Okanogan Complex fires).

The categorization of many fire risk mitigations in HIZ 0 as "routine housekeeping" and landscaping chores can make it challenging to identify factors that make individuals more likely to implement those actions specifically to reduce fire risk. Likewise, socio-demographic indicators can be inconsistent predictors of such actions [93]. The emergence of several statistically significant differences between evacuation groups around our suite of HIZ 0 actions and the general lack of significant relationships found by others suggests it is a topic that warrants future consideration in other evacuation studies. Many of the actions our SD group members performed are less likely to overlap with housekeeping or landscaping tasks and may be more of a direct resident response to concerns about fire risk. Future research should explore these linkages in more depth and/or confirm that such actions were taken to facilitate potential evacuation strategies. Such studies could explore respondents' interactions with fire department or emergency professionals about their intended evacuation behavior and what resources or support they accessed to implement their decision, especially as conversations around increasing local suppression capacities increase in the U.S. context [14–16,94].

Individuals in the SD category were often significantly more likely to implement vegetation mitigations in HIZ 1, 2, and 3, with the exception of maintaining thinning of trees and shrubs in HIZ 3 performed more than 10 years ago (100–200 feet, ~30–60 m, from the home). However, SD group members were more likely than the other groups to *themselves* remove/thin trees and shrubs in HIZ 3, which suggests that SD group members are the ones actually performing fuel reduction/vegetation mitigation activities in HIZ 3 that were not previously performed on their property. Thus, our results suggest that individuals intending to stay and defend are much more likely to have performed mitigations that are suggested for active defense, home survivability or decreased burden on firefighters, and therefore are taking more responsibility for their personal contributions to landscape-level wildfire management [67,88,95]. Meanwhile, individuals intending to evacuate and not be on site during a wildfire event are less likely to perform the vegetation mitigations recommended by fire professionals that enhance suppression success, home defensibility, and which enable fire to play a more natural role in ecosystems. This finding corroborates concerns that the legacy of predominately successful fire suppression efforts in the U.S. has contributed to the dampening of WUI resident initiative to prepare their property for wildfire [96–99].

We found few differences in performance of HIZ vegetation mitigations among the evacuate and SIP/I don't know groups. There are a few potential explanations for that finding, including those already discussed above. For one, the evolving message about shared fire management among professionals and residents is increasingly about private responsibility in addressing home protection from large fire events. That narrative can be somewhat at odds with the historical focus on early and prompt evacuation so that residents are "out of the way," leaving responsibility for fire suppression to fire service organizations who respond to events. The result, some claim, has been the fostering of populations who expect or are reliant on broader society to protect their property through the funding of government firefighting resources [100,101]. The removal of civilians from active fire management spaces may intensify the separation between what WUI residents perceive as fire managers' and their own personal responsibility during and leading up to a wildfire event, including in active (i.e., stay and defend) or passive (e.g., installing sprinklers) roles. Overall, the apathy of evacuate and SIP/I don't know group members towards wildfire risk reduction activities, especially vegetation management and home defense actions related to first responder safety, echoes concerns raised by others that certain segments of at-risk property owners are not doing their part to address increasing wildfire risk. That lack of comprehensive mitigation action among populations fails to address wildfire risk concerns across property boundaries [93].

We found that full-time residents and men were significantly more likely to plan for stay and defend as an evacuation option, while and women and part-time residents were more likely to intend to evacuate [8,23,37,67]. These results substantiate similar findings across multiple countries. However, we also found that older residents were slightly more likely to be in the SIP/I don't know category than the evacuate category, which is not as typical of existing results and may reflect the caution of rural populations who do not intend to SD but hesitate to evacuate due to infrastructure concerns. We also discovered a significant interaction between age and presence of younger children that helps explain why younger residents were less likely to SD [26,54]. That is, younger families with children were more likely to evacuate, potentially to protect younger populations from risks associated with SD.

Finally, the work presented here extends existing research on evacuation intentions by considering the influence of various perceptions on categories of intended behavior. Perceptions of self-efficacy have been highlighted as a major influence on resident performance of mitigation actions and select evacuation intentions [8,102,103]. In fact, McLennan et al. [70] noted that self-efficacy and susceptibility to threat (which is similar to our need for firefighters measure) were instrumental in predicting the intention to stay and defend. Our work also helps to verify that relationship and extend it to a new context in the rural U.S. West. Respondent perceptions of their ability to protect their property from wildfire impacts was a highly significant influence on SD or SIP intentions when compared to evacuation intentions. This relationship hints that SIP/I don't know group members may be waiting to see whether the fire is going to overwhelm their abilities before deciding to evacuate, a similar mindset (in this case) that many SD members might have but in a more active (e.g., intending to engage the fire front) context. Similarly, individuals who believed their property was well prepared and would not need firefighting were less likely to evacuate and more likely to stay and defend, which substantiates existing literature [6,8,21]. We also found that perceptions of professional firefighter capabilities was not a significant influence on evacuation intentions. This suggests a decoupling between the capabilities of firefighters and residents' evacuation intentions, reflecting a local culture of self-reliance documented in other studies of the rural U.S. West [34,72]. However, the lack of relationship between perceptions of firefighting capabilities and evacuation intention may also hint at obstacles for collaborative fire adaptations among fire departments or managers and a residential population who view private property protection or wildfire risk mitigation as an individual responsibility. Future research could investigate the potential occurrence and influence of these dynamics to better link evacuation planning or intention with a broader suite of considerations surrounding wildfire management.

The practical outcomes of our results for practitioners and emergency mangers begin with a reaffirmation that significant numbers of residents in this area are considering alternatives to evacuation. This means that messages surrounding early evacuation, including the Ready, Set. Go! Program, may not have reached or convinced residents that early evacuation is the best course of action during fire events. It also is possible that this population would prefer to take the additional risk of remaining at home to protect their property, or that they are well

prepared to ensure their personal safety [8]. While our results do not assess which of these outcomes are the case for individuals in our sample, emergency managers should acknowledge the preference for alternatives to evacuation by presenting more comprehensive information about the significant preparations (mentally, physically, and in terms of infrastructure/equipment) that would be necessary to implement SD as viable option for life safety and property protection during fire events. That information should likely be presented alongside evacuation messages so that residents can consider the tradeoffs between approaches.

Examples of specific information to be provided in expanded evacuation communications could include video examples of the fire conditions that might be experienced in area vegetative conditions should residents decide to SD, the necessary HIZ vegetation clearance and other mitigations necessary to provide residents with shelter protection during the initial flame front, clothing and breathing apparatus recommendations, and best practices for putting out spot fires prior to or following the flame front. Another key communication would stress the importance of sticking to a SD plan, and to avoid late evacuation that might occur when using a "wait and see" approach. Formal presentation of such information might achieve multiple strategic outcomes, including: (1) better preparing the significant population of residents who are considering SD approaches, and (2) promoting evacuation as a safer and somewhat simpler choice for those not willing to take the significant effort necessary to SD, which could serve as a deterrent for populations who may be poorly suited for the latter. Presentation of SD requirements and preparation alongside evacuation messaging such as the Ready, Set, Go! Program could allow residents to assess the tradeoffs between such choices and make fully reasoned decisions. This may be especially important among rural populations, such as those in our study area, who often respond poorly to mandatory evacuations or directorates from government entities [11,104].

Another practical implication of this work concerns our finding that residents considering SD are much more likely to perform vegetative mitigations on their properties. Performance of such actions are a significant focus of national efforts to reduce the significant burden facing wildfire management and suppression agencies driven in no small part by the increasing need to protect private property owners who choose to live in fire-prone conditions. Our results suggest that the increasing number of part-time residents in this region and plans to evacuate may serve as a disincentive for addressing the personal responsibility for managing private property as part of ongoing efforts to manage wildfire across ownership boundaries. As such, it seems important to emphasize the importance of mitigation actions for protection of property *and* provision of safer evacuation. It also should be made clear that it is not firefighters' sole responsibility to protect property, especially property that is not well maintained [9]. Our results suggest some initial populations these messages could be targeted to, including those with second or vacation homes in the area, households with children, and those in the SIP category who had not performed vegetative mitigations.

Finally, results such as ours suggest a practical need for emergency managers, fire professionals, and communities to more comprehensively consider and catalog residents who may be considering different evacuation strategies [6,8]. For instance, fire districts could collect information about those individuals who are considering SD to be more efficient with their evacuation notifications, and to better understand where potential liabilities (e.g., need for rescue) or resources (equipment, water sources, sheltering points) exist during a fire event. Likewise, populations who intend to evacuate could be encouraged to develop trigger points, confirm their enrollment in notification systems, work with likeminded neighbors to plan evacuation drills, and ensure they have a destination for long-term evacuation. Collection and aggregation of data about area residents plans for evacuation or alternatives can serve as a useful exercise for engaged community members and help provide professionals with geospatial data that they might not have the time to collect themselves.

6. Conclusion

Facilitating safe and effective response to wildfire events among residential populations requires nuanced understandings of intended evacuation behaviors. While wildfire and emergency managers often seek to facilitate quick and early evacuation of all populations in areas at immediate risk from wildfire, results of our research and past literature indicate that residential populations may pursue a broader range of evacuation strategies. For instance, we found that nearly 42.8% of our respondents most closely aligned with intentions to stay and defend their property from wildfire risk—an action that is not always recommended by fire departments and emergency professionals. Our research extends past work suggesting that individuals who intend to stay and defend may be taking more responsibility for their personal wildfire risk through the performance of wildfire risk mitigation activities such as implementing defensible space or retrofitting their home with fire resistant materials. More specially, our unique focus on performance of mitigations in HIZ 0, or the immediate zone (0–5 m) around structures, indicates that residents most closely aligning with intentions to stay and defend their properties were more likely to perform several activities in the immediate zone around their home than other evacuation groups.

Acknowledgement that resident evacuation intentions and associated property mitigations vary significantly across residents in the same landscape continues to raise interesting challenges regarding the best ways to ensure both firefighter and resident safety during fire events that continue to grow in size and severity. Our results suggest that there are opportunities to address those challenges by striking a balance between trying to protect at-risk populations and encouraging them to be partners in reducing potential risks during complicated wildfire evacuations. Potential solutions revolve around careful presentation of best practices and uncertainties surrounding the dynamic and divergent nature of risk that populations might face during a wildfire event. For instance, firefighting, agency, and emergency management professionals could expand their programs to provide additional information about the high level of preparation necessary to implement stay and defend plans as a means to empower select WUI residents, while also discouraging those not willing to adequately prepare and for whom evacuation is a safer option. Likewise, our results suggest that providing information about options to stay and defend, or the critical need to perform mitigations to aid firefighters in the protection of structures owned by evacuees, provide tailored ways to encourage the performance of mitigations that reduce future burdens of wildfire suppression. In short, evacuation planning may need to better embrace the reality of diverse evacuation planning (or lack thereof) by better gauging resident expectations ahead of significant fire events and experiment with updated guidance that allows residents to make informed choices that support their safety and effective response.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

Partial funding for this research came from the National Science Foundation (Hazard SEES 1520873) and the United States Forest Service Rocky Mountain Research Station (15-JV-11221636-121 and 18-JV-11221636-078).

References

[1] J. Gledhill, Community self-reliance during bushfires: the case for staying at home, in: Pap. Presented at the 3rd Int. Wildland Fire Conf, 2003, October, pp. 2–3.

[2] R.W. Mutch, FACES: The story of the victims of Southern California's 2003 Fire Siege. Wildland Fire Lessons Learned Center, 2007. Available online at, https://pdfs.semanticscholar.org/d5d0/006fcfee8cb866e837cfd4940d5ffd24a81d.pdf. (Accessed 12 July 2020).
[3] A. Tibbits, J. Handmer, K. Haynes, T. Lowe, J. Whittaker, Prepare, stay and defend or leave early: evidence for the Australian approach, in: J. Handmer, K. Haynes (Eds.), Community Bushfire Safety, CSIRO Publishing, Melbourne, 2008, pp. 59–71.
[4] J. Handmer, M. Van der Merwe, S. O'Neill, The risk of dying in bushfires: a comparative analysis of fatalities and survivors, Progress in Disaster Science 1 (2019) 100015.
[5] K. Haynes, K. Short, G. Xanthopoulos, D. Viegas, L.M. Ribeiro, R. Blanchi, Wildfires and WUI fire fatalities, in: Samuel L. Manzello (Ed.), Encyclopedia of Wildfires and Wildland-Urban Interface (WUI) Fires, Springer, Cham, Switzerland, 2020, p. 16.
[6] T. Paveglio, T. Prato, D. Dalenberg, T. Venn, Understanding evacuation preferences and wildfire mitigations among Northwest Montana residents, Int. J. Wildland Fire 23 (3) (2014) 435–444.
[7] J. Whittaker, C. Eriksen, K. Haynes, Gendered responses to the 2009 Black Saturday bushfires in victoria, Australia, Geogr. Res. 54 (2) (2016) 203–215.
[8] S. McCaffrey, R. Wilson, A. Konar, Should I stay or should I go now? Or should I wait and see? Influences on wildfire evacuation decisions, Risk Anal. 38 (7) (2018) 1390–1404.
[9] R.W. Mutch, M.J. Rogers, S.L. Stephens, A.M. Gill, Protecting lives and property in the wildland–urban interface: communities in Montana and southern California adopt Australian paradigm, Fire Technol. 47 (2011) 357–377.
[10] C. Eriksen, T. Prior, Defining the importance of mental preparedness for risk communication and residents well-prepared for wildfire, International Journal of Disaster Risk Reduction 6 (2013) 87–97.
[11] T.B. Paveglio, M.S. Carroll, T.E. Hall, H. Brenkert-Smith, 'Put the wet stuff on the hot stuff': the legacy and drivers of conflict surrounding wildfire suppression, J. Rural Stud. 41 (2015) 72–81.
[12] T.B. Paveglio, M.S. Carroll, A.M. Stasiewicz, D.R. Williams, D.R. Becker, Incorporating social diversity into wildfire management: proposing "pathways" for fire adaptation, For. Sci. 64 (5) (2018) 515–532.
[13] A. Tibbits, J. Whittaker, Stay and defend or leave early: policy problems and experiences during the 2003 Victorian bushfires, Environ. Hazards 7 (4) (2007) 283–290.
[14] J. Abrams, E.J. Davis, K. Wollstein, Rangeland Fire Protection Associations in Great Basin rangelands: a model for adaptive community relationships with wildfire? Hum. Ecol. 45 (6) (2017) 773–785.
[15] A.M. Stasiewicz, T.B. Paveglio, Factors influencing the development of Rangeland Fire Protection Associations: exploring fire mitigation programs for rural, resource-based communities, Soc. Nat. Resour. 30 (5) (2017) 627–641.
[16] A.M. Stasiewicz, T.B. Paveglio, Wildfire management across rangeland ownerships: factors influencing Rangeland Fire Protection Association establishment and functioning, Rangel. Ecol. Manag. 71 (6) (2018) 727–736.
[17] E. Niall, A. Rhodes, S. Russell, Community Safety (Wildfire) Post Incident Analysis, Part 2: Community Information Flow, Preparedness and Response, Country Fire Authority, Burwood East, 2004.
[18] J. McLennan, G. Elliott, M. Omodei, J. Whittaker, Householders' safety-related decisions, plans, actions and outcomes during the 7 February 2009 Victorian (Australia) wildfires, Fire Saf. J. 61 (2013) 175–184.
[19] J. Cohen, The wildland-urban interface fire problem: a consequence of the fire exclusion paradigm, Forest History Today. Fall 20–26 (2008) 20–26.
[20] T.B. Paveglio, A.D. Boyd, M.S. Carroll, Alternatives to evacuation in a post Black Saturday landscape: catchy slogans and cautionary tales, Environ. Hazards: Human and Policy Dimensions 11 (1) (2012) 52–70.
[21] P. Mozumder, N. Raheem, J. Talberth, R.P. Berrens, Investigating intended evacuation from wildfires in the wildland–urban interface: application of a bivariate probit model, For. Pol. Econ. 10 (2008) 415–423.
[22] S.M. McCaffrey, A. Rhodes, Public response to wildfire: is the Australian 'stay and defend or leave early' approach an option for wildfire management in the United States? J. For. 107 (1) (2009) 9–15.
[23] B.S. Roberson, D. Peterson, R.W. Parsons, Attitudes on wildfire evacuation: exploring the intended evacuation behavior of residents living in two Southern California communities, Journal of Emergency Management 10 (5) (2012) 335–346.
[24] International Association of Fire Chiefs (IAFC), Ready, Set, Go!, 2020. https://www.wildlandfirersg.org/s/?language=en_US. (Accessed 25 August 2020).
[25] Australian Fire Authorities Council, Position paper on bushfires and community safety, AFAC, East Melbourne Australia, 2005. http://royalcommission.vic.gov.au/getdoc/fe3ec0fe-04a0-4ee7-8ef0-29a245d0ad96/TEN.001.001.0077.pdf. (Accessed 25 August 2020).
[26] R.R. Thompson, D.R. Garfin, R.C. Silver, Evacuation from natural disasters: a systematic review of the literature, Risk Anal. 37 (4) (2017) 812–839.
[27] P.J. Cohn, M.S. Carroll, Y. Kumagai, Evacuation behavior during wildfires: results of three case studies, West. J. Appl. For. 21 (1) (2006) 39–48.
[28] N. Dash, H. Gladwin, Evacuation decision making and behavioral responses: individual and household, Nat. Hazards Rev. 8 (3) (2007) 69–77.
[29] B. Wolshon, E. Marchive III, Emergency planning in the urban-wildland interface: subdivision-level analysis of wildfire evacuations, J. Urban Plann. Dev. 133 (1) (2007) 73–81.
[30] A.M. Gill, S.L. Stephens, Scientific and social challenges for the management of fire-prone wildland–urban interfaces, Environ. Res. Lett. 4 (3) (2009), 034014.
[31] T.J. Cova, Evacuation, in: Samuel L. Manzello (Ed.), Encyclopedia of Wildfires and Wildland-Urban Interface (WUI) Fires, Springer, Cham, Switzerland, 2020, p. 8.
[32] J. Handmer, A. Tibbits, Is staying at home the safest option during bushfires? historical evidence for an Australian approach, Global Environ. Change B Environ. Hazards 6 (2) (2005) 81–91.
[33] D.W. Cote, T.K. McGee, An exploration of residents' intended wildfire evacuation responses in Mt. Lorne, Yukon, Canada, For. Chron. 90 (4) (2014) 498–502.
[34] S. McCaffrey, A. Rhodes, M. Stidham, Wildfire evacuation and its alternatives: perspectives from four United States' communities, Int. J. Wildland Fire 24 (2) (2015) 170–178.
[35] T.J. Cova, F.A. Drews, L.K. Siebeneck, A. Musters, Protective actions in wildfires: evacuate or shelter-in-place? Nat. Hazards Rev. 10 (4) (2009) 151–162.
[36] J. Whittaker, M. Taylor, C. Bearman, Why don't bushfire warnings work as intended? Responses to official warnings during bushfires in New South Wales, Australia, International Journal of Disaster Risk Reduction 45 (2020) 101476.
[37] I.M. McNeill, P.D. Dunlop, J.B. Heath, T.C. Skinner, D.L. Morrison, Expecting the unexpected: predicting physiological and psychological wildfire preparedness from perceived risk, responsibility, and obstacles, Risk Anal. 33 (10) (2013) 1829–1843.
[38] K. Dow, S.L. Cutter, Emerging hurricane evacuation issues: hurricane Floyd and South Carolina, Nat. Hazards Rev. 3 (1) (2002) 12–18.
[39] J. Dellemain, S. Hodgkin, J. Warburton, Time, terrain and trust: impacts of rurality on case management in rural Australia, J. Rural Stud. 49 (2017) 50–57.
[40] R. Blanchi, J.E. Leonard, R.H. Leicester, Lessons learnt from post-bushfire surveys at the urban interface in Australia, For. Ecol. Manag. 234 (1) (2006) S139.
[41] B. Pool, Do-it-yourself fire crew saves California neighborhood, *The Christian Science Monitor* Nov 26 (2007), 2007.
[42] A.D. Syphard, J.E. Keeley, Factors associated with structure loss in the 2013–2018 California wildfires, Fire 2 (3) (2019) 49.
[43] P.F. Johnson, C.E. Johnson, C. Sutherland, Stay or go? Human behavior and decision making in bushfires and other emergencies, Fire Technol. 48 (1) (2012) 137–153.
[44] Wilderness Ranch Fire Protection District [WRFPD], When wildfire approaches... alternatives to Evacuation, 2008. Available online at: http://www.wroa.org/document_library/wrfpd_mailing_2008_aug.pdf.
[45] Victorian Bushfires Royal Commission, Final Report: Summary, 2010. http://www.royalcommission.vic.gov.au/Commission-Reports/Final-Report. (Accessed 12 July 2020).
[46] Y. Cao, B.J. Boruff, I.M. McNeill, Defining sufficient household preparedness for active wildfire defense: toward an Australian baseline, Nat. Hazards Rev. 17 (1) (2016), 04015021.
[47] Tasmania Fire Service, Bushfire Action Plan, 2020. http://www.fire.tas.gov.au/Show?pageId=colbushfirePrepareActSurvive. (Accessed 22 August 2020).
[48] T.J. Cova, P.E. Dennison, F.A. Drews, Modeling evacuate versus shelter-in-place decisions in wildfires, Sustainability 3 (10) (2011) 1662–1687.
[49] T.B. Paveglio, M.S. Carroll, P. Jakes, Alternatives to evacuation during wildland fire: exploring adaptive capacity in one Idaho Community, Environ. Hazards: Human and Policy Dimensions 9 (2010) 379–394.
[50] T.B. Paveglio, M.S. Carroll, P.J. Jakes, Adoption and perception of shelter-in-place in California's Rancho Santa Fe fire district, Int. J. Wildland Fire 19 (2010) 677–688.
[51] A.S. Fu, The facade of safety in California's shelter-in-place homes: history, wildfire and social consequence, Crit. Sociol. 39 (2013) 833–849.
[52] K. Steer, E. Abebe, M. Almashor, A. Beloglazov, X. Zhong, On the utility of shelters in wildfire evacuations, Fire Saf. J. 94 (2017) 22–32.
[53] A.C. Christianson, T.K. McGee, W.L.F. Nation, Wildfire evacuation experiences of band members of whitefish lake first nation 459, alberta, Canada, Nat. Hazards 98 (1) (2019) 9–29.
[54] J. McLennan, B. Ryan, C. Bearman, K. Toh, Should we leave now? Behavioral factors in evacuation under wildfire threat, Fire Technol. 55 (2) (2019) 487–516.
[55] J.C. Kulig, D. Edge, S. Smolenski, Wildfire disasters: implications for rural nurses, Aust. Emerg. Nurs. J. 17 (3) (2014) 126–134.
[56] H.W. Asfaw, T. McGee, A.C. Christianson, The role of social support and place attachment during hazard evacuation: the case of Sandy Lake First Nation, Canada, Environ. Hazards 18 (4) (2019) 361–381.
[57] G. Setten, H. Lein, "We draw on what we know anyway": the meaning and role of local knowledge in natural hazard management, International Journal of Disaster Risk Reduction 38 (2019) 101184.
[58] C.M. Edgeley, T.B. Paveglio, Exploring influences on intended evacuation behaviors during wildfire: what roles for pre-fire actions and event-based cues? International Journal of Disaster Risk Reduction 37 (2019) e101182-e101182.
[59] K. Strahan, J. Gilbert, The wait and see literature: a rapid systematic review, Fire 4 (1) (2021) 4.
[60] P.J. Jakes, E.L. Langer, The adaptive capacity of New Zealand communities to wildfire, Int. J. Wildland Fire 21 (6) (2012) 764–772.
[61] C. Wilkinson, C. Eriksen, T. Penman, Into the firing line: civilian ingress during the 2013 "Red October" bushfires, Australia, Nat. Hazards 80 (1) (2016) 521–538.
[62] M. Proudley, Fire, families and decisions, Aust. J. Emerg. Manag. 23 (2008) 37–43.
[63] C. Eriksen, N. Gill, Bushfire and everyday life: examining the awareness-action 'gap' in changing rural landscapes, Geoforum 41 (2010) 814–825.
[64] K. Haynes, J. Handmer, J. McAneney, A. Tibbits, L. Coates, Australian bushfire fatalities 1900–2008: exploring trends in relation to the 'prepare, stay and defend or leave early' policy, Environ. Sci. Pol. 13 (2010) 185–194.

[65] J. Whittaker, K. Haynes, J. Handmer, J. McLennan, Community safety during the 2009 Australian 'Black Saturday' bushfires: an analysis of household preparedness and response, Int. J. Wildland Fire 22 (6) (2013) 841–849.
[66] R.T. Graham, Technical Editor, Hayman Fire Case Study. Gen. Tech. Rep. RMRS-GTR-114, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Ogden, UT, 2003, p. 396.
[67] C. Eriksen, T. Penman, B. Horsey, R. Bradstock, Wildfire survival plans in theory and practice, Int. J. Wildland Fire 25 (4) (2016) 363–377.
[68] K. Strahan, J. Whittaker, J. Handmer, Self-evacuation archetypes in Australian bushfire, International Journal of Disaster Risk Reduction 27 (2018) 307–316.
[69] T.K. McGee, Mishkeegogamang Ojibway Nation, A.C. Christianson, Residents' wildfire evacuation actions in mishkeegogamang ojibway nation, ontario, Canada, International Journal of Disaster Risk Reduction 33 (2019) 266–274.
[70] J. McLennan, S. Cowlishaw, D. Paton, R. Beatson, G. Elliott, Predictors of south-eastern Australian householders' strengths of intentions to self-evacuate if a wildfire threatens: two theoretical models, Int. J. Wildland Fire 23 (8) (2014) 1176–1188, https://doi.org/10.1071/WF13219.
[71] L.N. Dupéy, J.W. Smith, Close but No cigar: How a Near-Miss wildfire Event Influences the Risk perceptions and Mitigation behaviors of Residents who Experienced a Recent, Nearby wildfire, Institute of Outdoor Recreation and Tourism, Logan, UT, 2019. Retrieved from: https://digitalcommons.usu.edu/extension_curall/1959.
[72] T.B. Paveglio, M.S. Carroll, A.M. Stasiewicz, C.M. Edgeley, Social fragmentation and wildfire management: exploring the scale of adaptive action, International Journal of Disaster Risk Reduction 71 (74) (2019) 12–23.
[73] V.C. Radeloff, R.B. Hammer, S.I. Stewart, J.S. Fried, S.S. Holcomb, J.F. McKeefry, The wildland-urban interface in the United States, Ecol. Appl. 15 (3) (2005) 799–805.
[74] T.B. Paveglio, C.M. Edgeley, A.M. Stasiewicz, Assessing influences on social vulnerability to wildfire using surveys, spatial data and wildfire simulations, J. Environ. Manag. 213 (2018) 425–439.
[75] D.A. Dillman, J.D. Smyth, L.M. Christian, Internet, Phone, Mail and Mixed-Mode Surveys: The Tailored Design Method, fourth ed., John Wiley & Sons, Hoboken, NJ, 2014.
[76] J. Steele, L. Bourke, A.E. Luloff, P.S. Lian, G.L. Theodori, R.S. Krannich, The drop-off/pick-up method for household survey research, Community Dev. 32 (2) (2001) 238–250.
[77] C. Trentelman, J. Irwin, K. Petersen, N. Ruiz, C. Szalay, The case for personal interaction: drop-off/pick-up methodology for survey research, Journal of Rural Social Sciences 31 (3) (2016) 68–104.
[78] H. Brenkert-Smith, J.R. Meldrum, P.A. Champ, Climate change beliefs and hazard mitigation behaviors: homeowners and wildfire risk, Environ. Hazards 14 (4) (2015) 341–360.
[79] K. Dickinson, H. Brenkert-Smith, P. Champ, N. Flores, Catching fire? Social interactions, beliefs, and wildfire risk mitigation behaviors, Soc. Nat. Resour. 28 (8) (2015) 807–824.
[80] National Fire Protection Association (NFPA), Preparing Homes for Wildfire, 2020. https://www.nfpa.org/Public-Education/Fire-causes-and-risks/Wildfire/Preparing-homes-for-wildfire. (Accessed 12 November 2020).
[81] J. Handmer, S. O'Neill, Examining bushfire policy in action: preparedness and behaviour in the 2009 Black Saturday fires, Environ. Sci. Pol. 63 (2016) 55–62.
[82] J.P. Stevens, Applied Multivariate Statistics for the Social Sciences, fifth ed., Routledge, Taylor & Francis Group, New York, 2009.
[83] A. Field, Discovering Statistics Using IBM SPSS Statistics, Sage, London, 2013.
[84] J. Lattin, J.D. Carroll, P.E. Green, Analyzing Multivariate Data, Brooks/Cole-Thomson Learning, Pacific Grove, OR, 2003.
[85] C.A. Cameron, P.K. Trivedi, Microeconometrics: Methods and Applications, Cambridge University Press, New York, 2005.
[86] C.A. Cameron, P.K. Trivedi, Microeconometrics Using Stata, Stata Press, College Station, TX, 2009.
[87] J. McLennan, D. Paton, L. Wright, At-risk householders' responses to potential and actual bushfire threat: an analysis of findings from seven Australian post-bushfire interview studies 2009–2014, International Journal of Disaster Risk Reduction 12 (2015) 319–327.
[88] J. McLennan, D. Paton, R. Beatson, Psychological differences between south-eastern Australian householders' who intend to leave if threatened by a wildfire and those who intend to stay and defend, International Journal of Disaster Risk Reduction 11 (2015) 35–46.
[89] H.D. Walpole, R.S. Wilson, S.M. McCaffrey, If you love it, let it go: the role of home attachment in wildfire evacuation decisions, Environment Systems and Decisions 40 (1) (2020) 29–40.
[90] Parliament of Victoria, 2009 Victorian Bushfires Royal Commission: Final Report Summary, 2010. Retrieved from, http://www.royalcommission.vic.gov.au/finaldocuments/summary/PF/VBRC_Summary_PF.pdf.
[91] J.F. Johnson, T. Downing, K.C. Nelson, External sprinkler systems and Defensible space: Lessons Learned from the Ham Lake Fire and the Gunflint Trail, University of Minnesota, College of Food, Agricultural and Natural Resource Sciences, 2008, p. 31.
[92] T.J. Venn, J. Quiggin, Early evacuation is the best bushfire risk mitigation strategy for south-eastern Australia, Aust. J. Agric. Resour. Econ. 61 (3) (2017) 481–497.
[93] T.D. Penman, C.E. Eriksen, B. Horsey, R.A. Bradstock, How much does it cost residents to prepare their property for wildfire? International Journal of Disaster Risk Reduction 16 (2016) 88–98.
[94] Wildland Fire Executive Council [WFEC], The National strategy: The Final phase in the Development of the National Cohesive Wildland Fire Management Strategy, 2014. http://www.forestsandrangelands.gov/leadership/WFEC/index.shtml.
[95] S.L. Stephens, M.A. Adams, J. Handmer, F.R. Kearns, B. Leicester, J. Leonard, M. A. Moritz, Urban–wildland fires: how California and other regions of the US can learn from Australia, Environ. Res. Lett. 4 (1) (2009), 014010.
[96] T.W. Collins, Households, forests, and fire hazard vulnerability in the American West: a case study of a California community, Global Environ. Change B Environ. Hazards 6 (1) (2005) 23–37.
[97] T.W. Collins, What influences hazard mitigation? Household decision making about wildfire risks in Arizona's White Mountains, Prof. Geogr. 60 (4) (2008) 508–526.
[98] B.E. Goldstein, Skunkworks in the embers of the Cedar Fire: enhancing resilience in the aftermath of disaster, Hum. Ecol. 36 (2008) 15e28.
[99] B.L. McFarlane, T.K. McGee, H. Faulkner, Complexity of homeowner wildfire risk mitigation: an integration of hazard theories, Int. J. Wildland Fire 20 (8) (2012) 921–931.
[100] C. Kousky, S. Olmstead, R. Sedjo, In harm's way: homeowner behavior and wildland fire policy, in: K.M. Bradshaw, D. Lueck (Eds.), Wildfire Policy: Law and Economics Perspectives, Resources for the Future, New York, New York, USA, 2012, pp. 178–199.
[101] R. Gorte, The Rising Cost of Wildfire Protection, Headwaters Economics, Bozeman, MT, 2013.
[102] W.E. Martin, I.M. Martin, B. Kent, The role of risk perceptions in the risk mitigation process: the case of wildfire in high risk communities, J. Environ. Manag. 91 (2) (2009) 489–498.
[103] H. Brenkert-Smith, P.A. Champ, N. Flores, Trying not to get burned: understanding homeowners' wildfire risk–mitigation behaviors, Environ. Manag. 50 (6) (2012) 1139–1151.
[104] L. Strawderman, A. Salehi, K. Babski-Reeves, T. Thornton-Neaves, A. Cosby, Reverse 911 as a complementary evacuation warning system, Nat. Hazards Rev. 13 (1) (2012) 65–73.
[107] Washington State Department of Ecology, Washington geospatial open data portal. http://geo.wa.gov/datasets, 2018. (Accessed 20 June 2020).
[108] Dodd, W., Scott, P., Howard, C., Scott, C., Rose, C., Cunsolo, A., & Orbinski, J. (2018). Lived experience of a record wildfire season in the Northwest Territories, Canada. Can. J. Public Health, 109(3), 327-337.
[109] C.A. Kolden, C. Henson, A socio-ecological approach to mitigating wildfire vulnerability in the wildland urban interface: a case study from the 2017 Thomas fire, Fire 2 (1) (2019) 9.

Access through your organization
View Open Manuscript
Purchase PDF

Fire Safety Journal
Volume 154, March 2025, 104329

Evacuation decision-making and behavior in wildfires: Past research, current challenges and a future research agenda

Erica Kuligowski [1]
Show more

+ Add to Mendeley
Share
Cite
https://doi.org/10.1016/j.firesaf.2025.104329
Get rights and content

Highlights

- Current research is presented on evacuation decision-making and behavior in wildfires.
- Multiple gaps in our understanding of human behavior in wildfires are identified.
- A research roadmap is provided to identify future research in this area.

Abstract

Wildfires are becoming more common around the world, and households are frequently advised to evacuate when these fires threaten nearby communities. Effective evacuation requires an understanding of human behavior in wildfires, which is an area that needs further exploration. The purpose of this article is to present current research performed and data collected on evacuation decision-making and behavior during wildland-urban interface (WUI) fires, identify gaps in the research, and develop a future research agenda for further data collection of important WUI fire evacuation topics. Research in this area can improve predictions of evacuation timing, which can inform emergency management in education programs, planning, decision-making, and design requirements for community-wide WUI fire evacuation.

Introduction

The International Association for Fire Safety Science (IAFSS) agenda 2030 for a fire safe world recognizes wildland fires as an important area of research and action [1]. Environmental changes, such as warmer temperatures and increased drought, are contributing to an increased wildfire threat, a longer fire season, and an increased likelihood of more extreme weather [2]. In some scenarios, fuel management strategies have led to a build-up of fuels which contribute to the increased risk of wildfire [3]. The number of large wildfires continues to increase in many parts of the world as a result of these factors, including areas not typically exposed to wildfire events (e.g., the Nordic countries) [1].

A growing proportion of these wildfires threaten communities adjacent to or within the wildlands, known as the wildland-urban interface (WUI). WUI communities are locations "where humans and their development meet or intermix with wildland fuel" [4], and consist of diverse groups of people and geographical areas. Given their proximity to the wildland, WUI communities are generally the most vulnerable to wildfires and the subsequent physical, social, environmental, and economic psychological impacts that result [5]. In addition, other vulnerabilities often exist within WUI communities such as transportation infrastructure and services that lag behind urban development and population growth [6,7] and can cause significant challenges during large-scale evacuations. Wildfires also disproportionately affect certain populations, e.g., each year, at least one-third of all wildfire evacuees in Canada are Indigenous [8].

A number of deaths have also been documented as occurring during evacuations from WUI fires [9]. The factors associated with these deaths, including delayed disseminations of warnings or delays in implementation of evacuation advice, can result in evacuees leaving areas at risk with only minutes to spare and in turn encountering dangerous conditions in the process [10].

In the design of new communities or developments within existing communities, it is important for urban and regional planners and emergency managers, as examples, to consider such factors when developing evacuation timing for evacuation. These needs include increased route capacity, limited density of land use (i.e., reduced demand), and accurate information delivery to travelers before and during evacuation [11]. However, many existing WUI communities do not sufficiently meet evacuation-related travel needs, including suburbs built with only one road in and out [11]. Therefore, both new and existing WUI communities rely on evacuation planning to ensure life safety during a fire.

While not standard practice, simulation models are increasingly used to inform the development of evacuation plans for WUI communities [12,13]. These models can be used to predict evacuation outcomes, including departure and arrival patterns, travel times, average speeds, queuing lengths, and traffic flow rates.[1] The benefit of these evacuation models is that they allow for flexibility and the ability to examine evacuation behavior to support and configure these models. Most wildfire studies, although still limited in scope, have focused on predicting who will evacuate and how to estimate traffic demands. Evacuation models also require data on decisions and behaviors during the evacuation movement, including which and how many vehicles will be used, which routes evacuees will take to safety, what destinations will be used as safe locations, and many other evacuation movement concepts [13]. In the absence of these data, most models default to behaviors that are not optimal e.g., [14] and/or focus only on one mode of transportation (e.g., by foot [20] or transit vehicles [21]). The result is the potential for inaccurate behavioral elements that limit only on users' judgement or defaults not necessarily grounded in fire evacuation data [22,23]; since evacuation data from WUI fires are limited.

Research has shown that clearance times and other outcomes estimated by conventional evacuation simulation models may be overly optimistic [24]. Hurricane research, for example, has demonstrated that evacuees are unlikely to distribute themselves optimally over available routes [26]. Simulating realistic behaviors (e.g., evacuees delaying before evacuation and/or taking familiar routes) [28] can significantly decrease evacuation "effectiveness" [27] when compared with simulations incorporating optimal assumptions. Inaccurate assumptions made about evacuation behavior in WUI fires can be detrimental to a WUI community's safety. Models that inaccurately account for evacuee decision-making and behavior can underestimate evacuation outcomes (e.g., clearance time), and in turn, can lead emergency officials to impose inadequate traffic management solutions or delay warning until it is too late.

The purpose of this article is to review evacuation decision-making and behavior of community residents during WUI wildfires, with a focus on current and needed data related to evacuation simulation models. First, current research and data on evacuation decision-making and behavior during WUI fires is presented. This article then identifies research gaps and develops a future research plan for further data collection of important WUI fire evacuation concepts. Research in this area can support improvements of evacuation models and in turn improvements to communities' pre-event wildfire evacuation planning, real-time decision-making, and land use/configuration requirements. In general, evacuation research can help WUI community residents of safe evacuation procedures and educate future practicing engineers on ways to account for human behavior in fire in their projects.

Section snippets

Background on evacuation modeling concepts

The household evacuation process consists of multiple time periods. Ronchi et al. [25] provides a description of a general WUI fire evacuation timeline, placing in order both actions of emergency officials and actions of households/evacuees. Once notified and a decision to evacuate is made, an evacuation timeline for households can include time to complete preparations, time to move on foot, time to move via vehicle, and time to be on-boarded at a place of safety.

To simulate household[s'] ...

Past research

This article presents a review of past research conducted on community evacuation, with a focus on WUI fires. Web of Science was used to identify and collect articles published after 2000 and before August 2019 using the following keywords: "wildfire", "bushfire", "WUI fire", "hurricane", and "evacuation". Additionally, Google Scholar and backward citation searches were used to identify additional articles not captured by this search. This review builds upon Folk et al. [29] where over 200 ...

Current challenges

Based on the results highlighted above, several challenges exist related to our understanding of evacuation decision-making and behavior in wildfires. These challenges include an incomplete understanding of evacuation decision-making, a lack of data on evacuation movement, and the assumptions made by current models in lieu of evacuation data. Each of these challenges will be described in Sections 4.1–4.3. ...

Future research agenda

As illustrated above, research is needed on evacuation decision-making and behavior in WUI fires, in particular as it relates to evacuation modelling. This section outlines a research agenda for future work in this field, differentiated by research topics, stakeholder collaboration, populations/community involvement in research, and research methods. ...

Summary

This article presents current research performed and data collected on evacuation decision-making and behavior during WUI fires. The article then discusses gaps in the research and develops a future research plan for further data collection of important WUI fire evacuation concepts. Newly improved wildfire evacuation simulation models (that incorporate the data suggested in this article) would better reflect real world evacuation behaviors and, in turn, produce more realistic evacuation results, ...

Author statement

Erica Kuligowski: I am the sole author of this article, and therefore, the work is mine alone. I acknowledge the people who have reviewed the article and thank them for their comments/insights. ...

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. ...

Acknowledgments

The author would like to thank Emily Wolpin, Jiann Yang, and Nelson Bryson from NIST; Steve Gwynne from Movement Strategies (UK); Enrico Ronchi from Lund University (Sweden); Daniel Nilsson from the University of Canterbury (New Zealand); and the two peer reviewers from the Fire Safety Journal for your insights on this article. ...

References (63)

M. McNamee et al.
IAFSS agenda 2030 for a fire safe world
Fire Saf. J. (2020)

Y. Liu et al.
Trends in global wildfire potential in a changing climate
For. Ecol. Manag. (2010)

K. Haynes et al.
Australian bushfire fatalities 1900–2008: exploring trends in relation to the 'Prepare, stay and defend or leave early' policy
Environ. Sci. Pol. (2010)

S. Whittaker et al.
Experiences of sheltering during the Black Saturday bushfires: implications for policy and research
Int. J. Disaster Risk Reduct. (2017)

M. Murray-Tuite et al.
Evacuation transportation modeling: an overview of research, development, and practice
Transport. Res. C Emerg. Technol. (2013)

A. Veeraswamy et al.
The simulation of urban-scale evacuation scenarios with application to the Swinley forest fire
Saf. Sci. (2018)

S. Shahparvari et al.
Fleet routing and scheduling in bushfire emergency evacuation: a regional case study of the Black Saturday bushfires in Australia
Transport. Res. Transport Environ. (2019)

H.-C. Wu et al.
Logistics of hurricane evacuation in hurricanes katrina and rita
Transport. Res. F Traffic Psychol. Behav. (2012)

N. Golshani et al.
Analysis of evacuation destination and departure time choices for no-notice emergency events
Transportmetrica: Transport. Sci. (2019)

R. Luongila et al.
A modelling framework for householder decision-making for wildfire emergencies
Int. J. Disaster Risk Reduct. (2019)

View more references

Cited by (77)

The state of wildfire and bushfire science: Temporal trends, research divisions and knowledge gaps
2022, Safety Science
Show abstract

Estimating wildfire evacuation decision and departure timing using large-scale GPS data
2022, Transportation Research Part D: Transport and Environment
Show abstract

Modeling evacuation decisions in the 2019 Kincade fire in California
2022, Safety Science
Show abstract

An interdisciplinary agent-based multimodal wildfire evacuation model: Critical decisions and life safety
2022, Transportation Research Part D: Transport and Environment
Show abstract

Data-driven investigations of using social media to aid evacuations amid Western United States wildfire season
2021, Fire Safety Journal
Show abstract

Modelling evacuation decision-making in the 2016 Chimney Tops 2 fire in Gatlinburg, TN
2020, International Journal of Wildland Fire

View all citing articles on Scopus

View full text

Published by Elsevier Ltd.

Part of special issue

Fire Safety Science: Proceedings of the 13th International Symposium
Edited by Sara Mulholland, Nelson Liu, Bart Merci, Luke Bisby

Other articles from this issue

Compatibility of aqueous film-forming foams (AFFF) with st...
March 2025
Bogdan E. Dlugogorski, Stef W. Schaefer

The wildland fire system and challenges for engineering
March 2025
Mark A. Finney

Learning from fire investigations and research – ...
March 2025
Anne Steen-Hansen, ..., Christian Sesseng

View PDF

View more articles

Recommended articles

Cross-cultural comparison of behavioural itinerary actions...
Safety Science, Volume 130, 2020, 104842
Sandra Heliyoka, ..., Edwin R. Galea

Exploring influences on intended evacuation behavior...
International Journal of Disaster Risk ...
Cairn M. Edgeley, Travis B. Paveglio

Incorporating human factors in emergency evacuation – An...
International Journal of Disaster Risk ...
Yi Wang, ..., Vicki N. Dong

Show 3 more articles

Article Metrics

Citations
Crossref Citations 77
Policy Citations 1

Captures
Readers 122
Mendeley Readers 122

Mentions
News Mentions 21
References 1

plumx Most recent blog

View details

About ScienceDirect
Remote access
Advertise
Contact and support
Terms and conditions
Privacy policy
Cookies are used by this site. Cookie Settings
All content on this site: Copyright © 2026 Elsevier B.V., its licensors, and contributors. All rights are reserved, including those for text and data mining, AI training, and similar technologies. For all open access content, the relevant licensing terms apply.



Transportation Planning and Technology

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/gtpt20

Systematic review and research gaps on wildfire evacuations: infrastructure, transportation modes, networks, and planning

Syeda Narmeen Zehra & Stephen D. Wong

To cite this article: Syeda Narmeen Zehra & Stephen D. Wong (2024) Systematic review and research gaps on wildfire evacuations: infrastructure, transportation modes, networks, and planning, Transportation Planning and Technology, 47:8, 1364-1398, DOI: 10.1080/03081060.2024.2348713

To link to this article: https://doi.org/10.1080/03081060.2024.2348713

© 2024 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group

Published online: 03 May 2024.

Submit your article to this journal

Article views: 2611

View related articles

View Crossmark data

Citing articles: 1 View citing articles

Full Terms & Conditions of access and use can be found at
https://www.tandfonline.com/action/journalInformation?journalCode=gtpt20

TRANSPORTATION PLANNING AND TECHNOLOGY
2024, VOL. 47, NO. 8, 1364–1398
https://doi.org/10.1080/03081060.2024.2348713

Routledge
Taylor & Francis Group

OPEN ACCESS Check for updates

Systematic review and research gaps on wildfire evacuations: infrastructure, transportation modes, networks, and planning

Syeda Narmeen Zehra [a,b] and Stephen D. Wong [a,b]

[a]Department of Civil and Environmental Engineering, University of Alberta, Edmonton, Canada; [b]Resilient and Sustainable Mobility and Evacuation Group, University of Alberta, Edmonton, Canada

ABSTRACT

Wildfires pose significant threats to communities, requiring robust pre-event planning for efficient evacuations. Transportation systems are crucial for these efforts, yet global research gaps persist, especially those related to transportation assets and transportation modes beyond privately owned automobiles. This study conducts a systematic review of four under-researched areas – infrastructure, modality, networks, and planning – to build a more comprehensive understanding of wildfire evacuations. Initial research is emerging in these domains, related to post-fire debris flows, air and transit evacuations, network analysis, and shelter planning. However, systematic analyses, evidence, and recommendations remain lacking. This includes wildfire's direct impact on transportation infrastructure, multi-modal evacuations, routing strategies, and community-driven evacuation plans. We underscore the need for empirical evacuation strategies to foster resilience for wildfire-threatened communities, offering valuable context-specific insights, identifying key actions, and highlighting ongoing research gaps.

ARTICLE HISTORY
Received 7 September 2023
Accepted 24 April 2024

KEYWORDS
Wildfires; evacuations; multi-modal; transportation infrastructure; disasters; transportation networks; evacuation planning

1. Introduction

Wildfire disasters are recurrent seasonal events that have grown in prominence in recent years. Spreading quickly under high wind speeds and causing significant damage to life and property, wildfires require prompt actions and resilient infrastructure to ensure minimal loss of life during a short or no-notice evacuation. Some of the most destructive wildfires have taken place this past decade, leading to substantial evacuations. For example in California, over one million people were ordered to evacuate between 2017 and 2019 (Wong, Broader, and Shaheen 2020a). In Australia, the 2020 January wildfires required the evacuation of tens of thousands of people from seaside towns (Gralow and Paul 2020). Canadian fires have also led to significant evacuations of major population centers (Woo et al. 2017), First Nations and Indigenous communities

CONTACT Syeda Narmeen szehra@ualberta.ca 6-362 Donadeo Innovation Centre For Engineering, 9211 116 St, Edmonton, AB T6G 2H5, Canada

© 2024 The Author(s). Published by Informa UK Limited, trading as Taylor & Francis Group
This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivatives License (http://creativecommons.org/licenses/by-nc-nd/4.0/), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited, and is not altered, transformed, or built upon in any way. The terms on which this article has been published allow the posting of the Accepted Manuscript in a repository by the author(s) or with their consent.

(McGee 2021; McGee and Christianson 2021), and small towns (Cecco and Burston 2021). Wildfire evacuations have also impacted many other countries in recent years including Portugal, Spain, France, Greece, South Africa, New Zealand, and Chile (Cambero and Miranda 2023; Imbach, Romain, and Breteau 2022; Rodrigues and Santiago 2022; Ronchi et al. 2021; Roy and de Jong 2020; Sgqolana 2021; Strickland 2018; West 2022). Mass evacuations, significant damage, and tragic fatalities from the Marshall Fire in Colorado (2021) and the Maui Wildfires in Hawaii (2023) underscore the particular challenges of rapid-spread fires.

Globally, these wildfire evacuations point toward transportation and logistics problems which are heavily dependent on (1) the existing state of infrastructure, (2) the multiple forms of modality available (or lack thereof) to evacuees, (3) the transportation network's performance (including identification and communication of egress routes, shelters, and network reliability), and finally, (4) evacuation planning that supports resource allocation, strategies, and policies. Despite the continued threat of wildfires, transportation systems and its associated infrastructure remain largely unprepared to cope with these evacuations. We set out to uncover key insights to describe and link these four under-researched areas and craft directions that can help devise and improve wildfire evacuation plans. This review addresses four research questions based on the limitations of the literature and practice:

(1) How is transportation infrastructure impacted before, during, and after wildfire evacuations?
(2) Which modes of transport other than privately owned automobiles can be (or have been) used during wildfire evacuations?
(3) What role do road networks play during wildfire evacuations?
(4) What transportation planning actions have been taken and what needs still exist?

The above questions are designed to uncover a clearer picture of the role of transportation engineering in wildfires, from a perspective beyond more established research in simulations (see for example, (Beloglazov et al. 2016; Grajdura, Borjigin, and Niemeier 2022; Intini et al. 2019; Pel, Bliemer, and Hoogendoorn 2012; Wahlqvist et al. 2021; Zhao and Wong 2021)) and human behavior (see for example, (Grajdura, Qian, and Niemeier 2021; Kuligowski 2021; Kuligowski et al. 2022; Lovreglio et al. 2019; McCaffrey, Wilson, and Konar 2018; McLennan et al. 2019; Wong, Chorus, et al. 2020; Wong, Broader, et al. 2022)). While these research areas are valuable to evacuation planning, we chose to focus our attention on other aspects of the transportation system to develop key takeaways and find critical gaps in the field.

This paper is organized as follows. First, we present the current research on the resilience of infrastructure to wildfires, modality, transportation networks, and planning. Our choice to focus on these four specific areas stems from a deliberate consideration of critical and overlooked areas within wildfire evacuation literature and practice. While we acknowledge the need for a review of human-centered topics (e.g. equity, management, decision-making) within the larger wildfire evacuation research, existing literature and practical experiences have shown that challenges in infrastructure resilience, diverse transportation modes, network functionality, and effective planning pose substantial barriers to efficient wildfire evacuations. By focusing on these four underexplored

areas, we aim to shed light on critical gaps in current understanding and offer insights that can directly inform more comprehensive and effective wildfire evacuation plans. Next, we present an analysis of the four key areas by discussing gaps and overlapping concepts. Finally, we conclude the paper with future research directions and policy recommendations.

2. Methodology

We conducted a systematic review of the literature between 2000 and 2022 to capture recent developments and advancements in the field of wildfire evacuation. This time frame allowed us to focus on studies that reflect the most current understanding of the four key areas we wanted to explore in this review, while also being inclusive of major wildfires in the Western U.S. and Canada during the early 2000s (e.g. Okanagan Mountain Park Fire, Cedar Fire, etc.). We used a combination of keywords in four indexed and peer-reviewed databases – Scopus, Taylor Francis, Web of Science, and TRID (Transportation Research Index). These four databases were chosen for their combined inclusion of wildfire evacuations as a topic, wide range of articles, and ease of keyword searching. Regarding the last point, the databases provided a structured platform for targeted searches, improving the reliability of our systematic review. The keyword search used the following logic to capture English language articles:

- 'bushfire' OR 'forest fire' OR 'vegetation fire' OR 'wildfire' OR 'wildland fire'
  AND
- 'evacuation engineering' OR 'evacuation infrastructure' OR 'evacuation planning' OR 'evacuation resilience' OR 'evacuation transportation' OR 'multimodal transport' OR 'infrastructure damage.'

Initially, the search query returned a total of 7040 documents, which were screened for relevance based on their titles and abstracts. We found that the greatest number of results were generated for keyword searches that were a combination of a – fire (e.g. bush fire, vegetation fire, etc.), and 'infrastructure damage' and 'evacuation planning.' Cited references within the articles were also checked for relevance and included if warranted. Multiple synonyms for wildfire were included due to the non-standardization of the term associated with wildland-urban interface (WUI) fires and the need to incorporate as many relevant searches as possible. For instance, most of the literature produced by Australian researchers refers to the hazard as bushfires whereas most American literature cites them as wildfires. Studies were eliminated if they were written in a language other than English, published before 2000, or largely concerned with other disasters (e.g. earthquakes, tsunamis). We supplemented the review by conducting a similar keyword search in Google Scholar to capture reports and other literature with digital object identifiers (DOIs). Our inclusion of Google Scholar broadened the scope of the review by encompassing a wider range of sources that might not have been indexed in traditional databases. We also included news sources and relevant websites to further help describe recent events. We found 82 relevant literature resources as part of the systematic review, which was supplemented by 116 other resources (Figure 1).

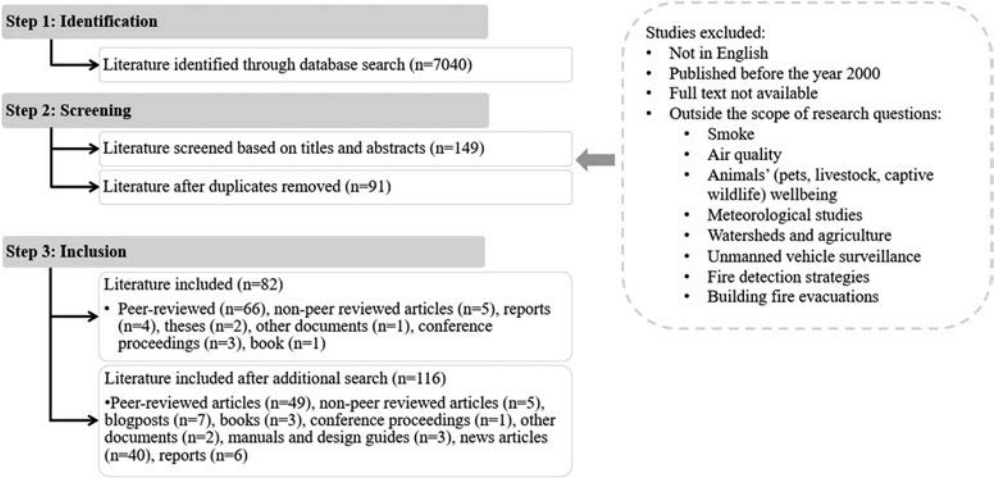


Figure 1. Breakdown of the systematic review and additional resources.

The primary limitation of the review is that our keywords were focused on transportation infrastructure, networks, modality, and planning in wildfire evacuations. This focus was deliberate and informed by the findings of recent reviews and research on simulations (e.g. Intini et al. 2019) and evacuation behavior (e.g. Kuligowski 2021). We chose against searching for and including papers on simulations and behavior in wildfire evacuations to focus on understudied areas and to avoid overlap with recent reviews in the past five years. Another limitation is that some related literature was eliminated from the final review as it focused on elements outside the scope of the research questions. This included smoke, air quality, animals (including pets, livestock, and captive wildlife) wellbeing, meteorological studies, studies on watersheds and agriculture, unmanned aerial vehicle surveillance, fire detection strategies, and building fire evacuations. Another limitation is that we likely did not capture all relevant literature, including all wildfires and their relation to our topics of inquiry. Specific case studies of large outdoor fires can be found in Ronchi et al. (2021), though more global and regular tracking will be needed to capture all relevant and large outdoor fires. In addition, our literature review did not focus on emerging topics in wildfire evacuations related to equity, strategic management, and leadership (i.e. decision-making by officials). As an important limitation of this paper, these human-centered topics will require a thorough analysis and review in the near future.

3. Literature review

We organized our literature review by general area of inquiry – infrastructure, modality, networks, and planning. As a note, the lack of literature in many of these areas prevented us from establishing a strong narrative in some sub-sections.

3.1. Infrastructure

Transportation infrastructure can be directly and indirectly affected by wildfires, both during and after a wildfire event (see Figure 2). Aging transportation infrastructure in

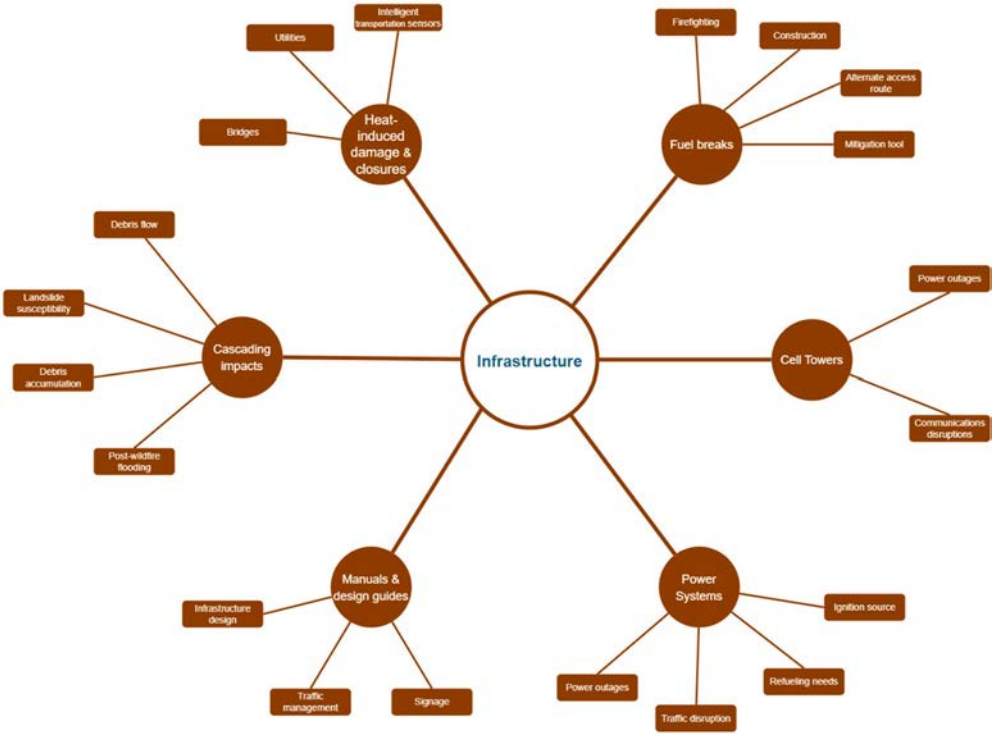


Figure 2. Interconnected themes and tags in 'Infrastructure'.

a wildfire-prone area is especially susceptible to damage. This damage can be caused by a variety of reasons including extreme heat, flooding (due to burned/reduced vegetative cover), fallen vegetation, and other circumstances. Even if the wildfire hazard of a community is lower, limited road networks coupled with the above-mentioned damages increase the overall evacuation vulnerability during a nearby wildfire event.

Robust transportation infrastructure is essential for efficient wildfire evacuations. Kurowski and Bradley (2022) provide a comprehensive listing of vulnerable road infrastructure and the expected types of wildfire impacts. The research also includes industrial infrastructure such as utility towers, poles, and transmission lines, and nearby road infrastructure such as livestock fencing, road signage, and lighting (Kurowski and Bradley 2022). To better document infrastructure, some work has built inventory databases of structures and their fire vulnerability parameters in WUI communities (Abo El Ezz et al. 2022; Maranghides et al. 2014). For resilient functionality, a study focusing on transport infrastructure's recovery time to a flooding event (caused by vegetation loss from a wildfire) indicated a plateauing of recovery time around the 40-day mark (Mojtahedi, Newton, and Meding 2017). With long infrastructure recovery times, research has found that jurisdictions should more closely consider and implement mitigation and rehabilitation strategies for infrastructure assets (Valentin and Stormont 2019). These varied research articles indicate a wide range of topics within the infrastructure field, which we expand on in more defined sub-sections.

3.1.1. Heat-induced damage and closures

Wildfires have caused significant disruptions to surface transportation infrastructure such as bridges, which are not designed to withstand extreme temperatures. In some cases, intense heat from wildfires has melted and damaged infrastructure, such as car wheels and a railway bridge (Cecco and Burston 2021; Fuller and Pérez-Peña 2017). Heat damage from wildfires also extends to buried utilities, such as service lateral pipes and water distribution systems (Richter et al. 2022). Moreover, vehicle sensors on highways are also susceptible to wildfire heat-induced damage. A study looked at the impact of wildfires on traffic data for the 2018 Woolsey wildfire and found a correlation between the damage of vehicle sensors on ramps and the occurrence of wildfires (Menon, Staes, and Bertini 2020). Additionally, past wildfires have led to the closure of access routes during evacuations due to factors such as fire jumps, high proximity to fires, and low road visibility (Sfetsos et al. 2021).

3.1.2. Fuel breaks

Apart from enabling evacuations, surface infrastructure can actively (or passively) function as fuel breaks (Greenwood Sustainability LLC 2011). These breaks in vegetation are purposefully constructed or exist in the form of roads and unpaved access routes to reduce the likelihood of fire spread. Other forms of barriers include non-flammable land cover, recent burns, and ridgelines (Jin et al. 2015). In one example of the use of fuel breaks, the Oregon Ridge fuel break provided a safe place for firefighters to work in the 2006 Marysville fire in Yuba County, USA (Nader and De Lasaux 2015). From a policy perspective, fuel breaks are becoming an important tool for wildfire mitigation. The Wildfire and Forest Resilience Action Plan for California proposed investment for the year 2021–2022 of $335 million (USD) to complete 45–60 strategic fuel break projects across the state (Thorne et al. 2021). These breaks can also provide alternate access routes toward and away from fire.

3.1.3. Debris, landslides, post-wildfire flooding, and vegetation management

Wildfires can result in accumulated debris, such as burned branches, fallen trees, rocks, and sediments (Fuller and Pérez-Peña 2017; Guth et al. 2019; Lancaster et al. 2021), which can disrupt roadways, damage infrastructure, and cause short to long term road closures. Debris flow events usually depend on the burn severity of vegetation and the topography of the area. A study reported that high debris flow risk persists for up to three years after wildfires due to reduced vegetative cover and ash-laden soil, especially during intense precipitation events (Jordan 2015). This is because wildfires create hydrophobic soil conditions that prevent infiltration of water and thus result in larger runoff during rains (French, Miller, and Dettling 2005; Jordan 2015; Moody and Ebel 2012). Another study investigated the risk of debris flows to California's roadways after wildfires and revealed that areas with high burn severity, steep slopes, and low vegetation cover were more susceptible to post-wildfire debris flows, which pose a significant threat to transportation infrastructure in the state (Li and Chester 2023).

The aftermath of wildfires followed by precipitation events can lead to increased soil erosion and landslides due to debris flow (De Graff and Gallegos 2012). In addition, landslide susceptibility has been linked to vegetation loss severity (Abbate et al. 2019;

Carabella et al. 2019; De Graff and Gallegos 2012; Lainas, Depountis, and Sabatakakis 2021; Rengers et al. 2020), leading to localized damage to mobility routes and disruptions in the supply chain, such as fuel (KPMG 2017). Most of the information about landslide locations is collected through a combination of field analysis, satellite imagery, and more recently seismic monitoring (Porter et al. 2021). Cases of these debris flows have also occurred with devastating consequences. In Santa Barbara County after the Thomas Fire in 2017, debris flows killed 21 people and significantly damaged infrastructure including bridges and culverts (Tiwari et al. 2020). Some roads were impassable for weeks, even requiring the start of an ad hoc ferry service between Santa Barbara and Ventura (Boone 2018).

Post-wildfire precipitation can also result in the flooding of roadways due to reduced soil permeability (Moody and Ebel 2012). These flooding events can inundate miles-long routes, cutting off essential supplies and affecting regional mobility and commerce (a common occurrence during hurricanes (IFRC 2022; Williamson 2022)). The closure of US Highway 101 after the 2017 Thomas Fire highlights the infrastructure vulnerability to such events (Golembo and Winsor 2018). An analysis of post-wildfire flooding in Arizona showed serious disruptions within the regional transportation system, including rural roadways and highways (Fraser, Chester, and Underwood 2022). Research to manage and mitigate these events has included exit route protocols for flash floods (Ortega-Becerril et al. 2022).

The spread of wildfires is influenced by various natural factors (e.g. fuels, weather) as well as the geography of the area. To reduce wildfire risk, Indigenous communities, government agencies, and residents have used prescribed burns, forest/brush thinning, and clearing for defensible space (Christianson et al. 2022; Hankins 2013). This practice is also used around roads in wildfire-prone areas to create fire breaks and reduce the likelihood of blocked roadways. Research has noted that residents with different evacuation preferences exhibit varying behavior in vegetation management, with those intending to remain at home and defend their residences showing higher rates of forest thinning (Paveglio et al. 2014). In the wildfire-prone state of California, Caltrans has spent more than $590 million from 2015 to 2020 to repair highways damaged by 81 wildfires. Caltrans has also focused on reducing wildfire risk along roadways by removing some vegetation (Thorne et al. 2021).

3.1.4. Manuals and design guidelines for disasters and transportation infrastructure

Manuals and guides provide engineers and planners with mechanisms and instructions based on research and practice to construct and evaluate infrastructure. However, the majority of manuals and design recommendations for surface infrastructure (roadways, railways, and runways) do not explicitly address hazardous events or provide mitigation strategies. Most disaster-related design guidelines are available for buildings (vertical structures) and other similar superstructures for tsunamis, earthquakes, and floods (American Society of Civil Engineers 2017) or occupant and building fire safety (ISO 2018).

Wildfires have received limited attention in design guidelines. Impact load design considerations on transport infrastructures such as roads and bridges are mostly limited to automobile axle loads, not from possible disaster events (e.g. boulders from

landslides or heat from wildfires). Some guidance exists on traffic incident management areas and signage (FHWA 2009), while other guides list the hazards that could impact transportation systems (Pande and Wolshon 2016). AASHTO's section on risk assessment lists adverse events that may cause service disruption to evaluate potential damage and serviceability issues of critical links (AASHTO 2018). Similarly, Meyer (2016) listed the potential impacts of climate change and extreme weather on roads and highways, noting that the expected impacts on infrastructure design from extreme heat can result in premature deterioration and closure of roads due to wildfires from operations and maintenance perspectives. Based on this review, guidance for surface transportation that considers wildfire evacuations during road or infrastructure design remains largely missing.

3.1.5. Power systems

The transportation sector is significantly impacted by the interaction of wildfires with electrical infrastructure. In the California context, several past wildfires have been started by electrical systems (Eavis and Penn 2019; Gold, Blunt, and Smith 2019). Concurrently, transportation can be heavily impacted by power outages that are caused by disasters. To mitigate wildfire risk, California has begun implementing public safety power shutoff (PSPS) events, which de-energize the grid during periods of high fire danger (Jahn, Urban, and Rein 2022; Wong, Broader, and Shaheen 2022). While helping to reduce wildfire ignition sources, these events can be inconvenient and disruptive, creating additional challenges for transportation by disrupting traffic signals, impeding the refueling and recharging of vehicles, and altering travel behavior (Wong, Broader, and Shaheen 2022). In light of these challenges, communities require preparation for shutoffs or load-shedding plans (Sfetsos et al. 2021), especially in the context of evacuations. At the same time, power systems can impact evacuation routes and escape options. Early reports from the Maui Wildfires in Hawaii (2023) indicate that downed power lines and poles from high winds blocked key roads leading out from the town of Lahaina (CBS News 2023).

3.1.6. Cell towers

Cell tower infrastructure can also be impacted by wildfires. Direct damage from fires, power outages, weak networks, or high volumes of calls and data can cause communication interruptions during evacuation processes (Thériault et al. 2021). Cell towers that remain operational during a wildfire serve as a vital source of information, providing up-to-date information about the fire's location and facilitating the dissemination of evacuation orders to the general public (Kuligowski et al. 2022). However, due to geographical limitations, this method of information gathering may not be accessible to everyone, such as those without technology experience, those with medical conditions, or those who cannot access cell reception due to mobility issues (Spayne 2021; Wong 2020).

In addition to these limitations, WUI areas that serve as recreational hubs, attracting seasonal visitors and tourists, may pose a greater risk to these transient populations in the event of a wildfire. These populations may not be as familiar with local communication networks as residents or may have limited access to mobile phone services in the area due

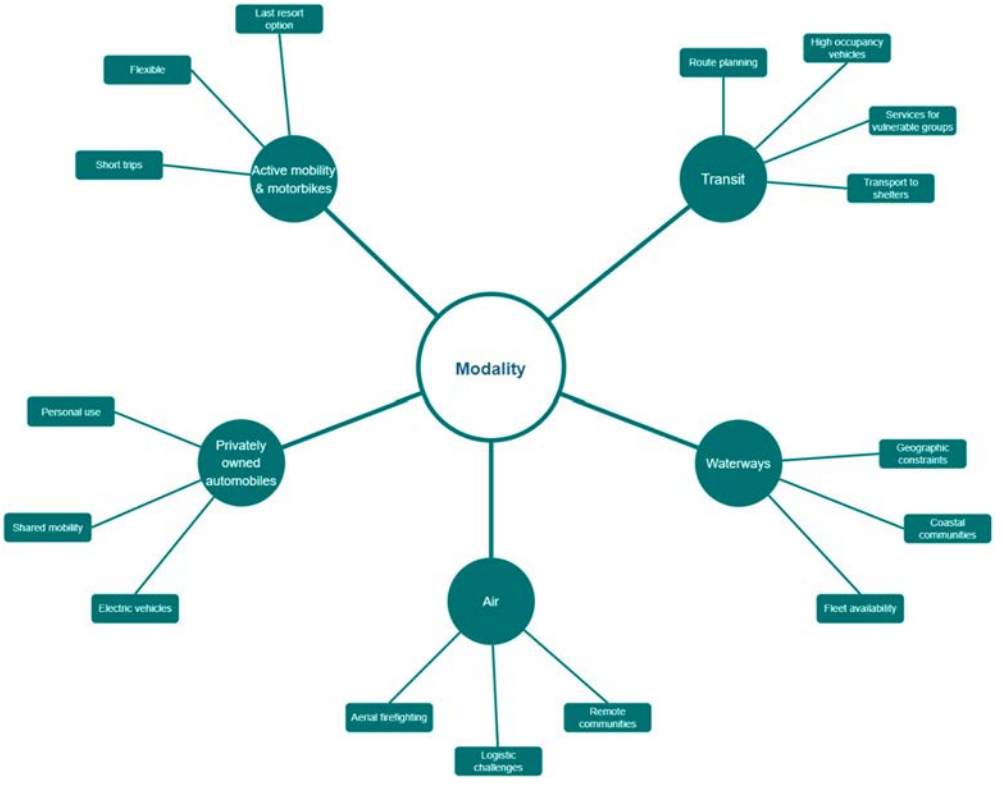


Figure 3. Interconnected themes and tags in 'Modality'.

to poor coverage (Soga et al. 2021). Furthermore, their unfamiliarity with egress points may increase their vulnerability to wildfires.

3.2. Modality

Evacuees choose their mode of transportation based on a variety of factors. Factors can include when an evacuation order is issued, the location of the evacuee, the distance to a safe place, the severity of the disaster, mode availability, mode speed, and perceived safety (Wong, Broader, et al. 2022). Figure 3 provides a visual for each discussed mode. The following sub-sections review the literature on the multiple transportation modes that have been used and studied for wildfire evacuations.

3.2.1. Privately owned automobiles

3.2.1.1. Cars, pickup trucks, and recreational vehicles (RVs). Most evacuations, especially in the U.S., Canada, and Australia, are conducted using privately owned automobiles (e.g. cars, pickup trucks, and recreational vehicles (RVs)). For example, hurricane evacuation studies have found that many evacuees use a privately owned automobile, ranging from 87% to 96% of evacuees (Lindell, Kang, and Prater 2011; Wilmot and Gudishala 2013; Wong, Shaheen, and Walker 2018; Wu, Lindell, and Prater 2012). In the case of three California wildfires, Wong, Broader, and Shaheen

(2020a) reported that between 34% and 45% of evacuees took one privately owned automobile, and 49% to 62% took two or more privately owned automobiles. For each fire studied, the lowest privately owned automobile mode choice rate was 94% (Wong, Broader, and Shaheen 2020a). Moreover, Kearns (2017) reported that 91% of the 2016 Fort McMurray wildfire evacuees evacuated using either their privately owned automobile or someone else's.

3.2.1.2. Electric vehicles (EVs). Most evacuating vehicles are powered by gasoline and diesel. More recently, the rising market share of EVs introduces several new opportunities and difficulties in the process of planning for a wildfire evacuation. Problematically, EVs require electricity as a fuel source which may not be readily available in a disaster. The lack of public charging infrastructure and the incompatibility of charging infrastructure and manufacturer's make and model also presents a challenge. Currently, EVs are perceived as more of a liability than an asset (Erskine, Seipel, and Seipel 2022; MacDonald, Kattan, and Layzell 2021; Purba, Kontou, and Vogiatzis 2022) during evacuations. The research recommends future work in incorporating behavioral dynamics of charging or refueling before evacuations to better understand arrival times to stations and queueing behavior.

Additionally, Erskine, Seipel, and Seipel (2022) note that perceived environmental benefits and at-home charging leisure of battery electric vehicles (BEVs) may erode during evacuations due to refueling challenges such as longer charge times when compared to fossil-fuel-powered vehicles. Similarly, research by Purba, Kontou, and Vogiatzis (2022) noted that evacuation routing plans for each vehicle fuel type naturally change as heterogenous driving ranges and different refueling needs on the path to reach safety are considered. Moreover, research has found that using EVs during wildfires causes stress on systems even at 20% penetration (Donaldson, Alvarez-Alvarado, and Jayaweera 2022), noting the first few hours of evacuation as the most challenging.

Research has indicated the need to improve planning for future emergencies involving EVs. While benefits have not been fully studied, EVs could become a power source, offering the opportunity to charge electronic devices, home systems, and medical equipment (Oloriz, Vangala, and Sadowicz 2022; Romo 2019; Wong 2020). Paired with microgrids and battery technology, EVs could be more resilient to a disaster than internal combustion engine (ICE) vehicles, which require the transportation of liquid fuel. Moving forward, critical efforts toward guaranteeing public safety during emergencies include advancing battery technology and integrating electrification goals in evacuation plans (Oloriz, Vangala, and Sadowicz 2022).

3.2.1.3. Shared mobility. Shared mobility often leverages privately owned automobiles and automobile-based sharing has been employed during some wildfire evacuations. About three percent of evacuees from the 2017 Northern California Wildfires were reported to have used rental car service, and 1.1% and 1.2% of evacuees carpooled with strangers (non-household members) during the 2017 Southern California Wildfires and 2018 Carr Wildfire, respectively (Wong, Broader, and Shaheen 2020a). Current research has also indicated that there is a general willingness of residents to share transportation in a wildfire evacuation, with elements of social capital playing a key role in increasing willingness (Wong, Walker, and Shaheen 2021). Based on focus

groups of people impacted by wildfires, research has also found that vulnerable populations could gain significant equity benefits from shared transportation, though key barriers remain in implementation (Wong, Broader, and Shaheen 2020b). Other research on sharing in evacuations and disasters (Ahmed, Sadri, and Hadi 2020; Borowski et al. 2022; Borowski and Stathopoulos 2020; Wang, Ozbay, and Bian 2021; Wong, Broader, and Shaheen 2020b; Wong, Yu, et al. 2022) presents some feasibility for this transportation option.

3.2.2. Public transit

The use of public transit, including subways, light rail transit, buses, and trams, during evacuations, has been explored in several studies. Buses have been employed in major hurricane evacuations in the US (Bian and Wilmot 2018; Garnham and Pablo 2020; South Florida Times 2017; Urbina and Wolshon 2003; Vera et al. 2022), wildfire evacuations in the U.S. (Afshar 2022; Sallinger 2022), and wildfire evacuations in Canada (Drinkwater 2022; French 2016; Kearns 2017; McGee 2021). Buses are especially important for transient, low-mobility, low-income, carless, and other underserved populations who do not have reliable access to vehicles or cannot drive an automobile. Public transit (and charter bus companies) have the potential to play an important role during evacuations. For example, research indicates that British Columbia (BC) Transit buses in Canada could be used as an accessible transportation option during a wildfire evacuation, especially for those who would be unable to secure alternative transportation (Metcalfe 2021; Vespaziani 2019). This was the case for the 2021 Marshall Fire in the U.S. where school bus drivers volunteered to help people evacuate (Sallinger 2022).

Research on route planning problems for buses during emergency evacuations has been conducted in different regions as well. For instance, a study looked at bus evacuation problems in the case study of the Great Fire of Valparaiso in Chile (Vitali, Riff, and Montero 2017), finding the best route: (1) for each vehicle in a public transportation system, (2) to move people from a risk zone to open shelters located in safe zones, and (3) to minimize evacuation time. Similarly, Shahparvari and Abbasi (2017) presented a robust stochastic vehicle routing and scheduling model for emergency bus evacuation during bushfires in Australia. The model considered various uncertainties such as road closures and changing traffic conditions, to ensure efficient and effective evacuation planning. Literature generally points toward a need to involve local transit agencies, emergency managers, and researchers to best leverage public transit for more efficient and equitable evacuations.

3.2.3. Waterways

Coastal evacuation during wildfires can be challenging due to modal availability and geographic constraints. Despite the relatively lower wildfire hazard of many coastal towns, wildfires have occurred in these locations and communities face high wildfire evacuation vulnerability due to a limited road network (CBS News 2023; Dye et al. 2021). Evacuation success through water-based modes can be highly dependent on fleet availability and mainland route connections. Islands may face additional challenges during wildfire events due to limited infrastructure capacity to handle multiple catastrophes and the presence of a transient population during the summer season (Vaiciulyte et al. 2019). Multiple events of tourists being evacuated from coastal towns and vacation hotspots

have been reported in Italy, Turkey, Canada, Australia, and the US (BBC 2017; CBS News 2023; Connett 2021; Gralow and Paul 2020; Hooper 2019; Kurjata 2017). Krutein, McGowan, and Goodchild (2022) investigated a case study of Bowen Island in western Canada and applied a routing model to minimize the evacuation time by up to 3 hours. Such studies are important in highlighting the intricate challenges that come with not only a single mode of evacuation, such as privately owned automobiles and ferries, but also the development of plans that consider multi-modality.

3.2.4. Air

Air evacuations are common for remote communities, islands, or when egress routes are blocked. Taking place in stages due to limited capacity and resources, air evacuations can be a quick but logistically challenging mode to remove people from high-risk zones. These evacuations are conducted in conjunction with ground transportation at a destination. In addition, aircraft assist during wildfire events through aerial firefighting and operations (Cambero and Miranda 2023; Connett 2021; Ellis, Kanowski, and Whelan 2004; Nihad 2022; Press 2022; Roy and de Jong 2020; Shahparvari et al. 2021).

The 2016 Fort McMurray fire prompted the largest air evacuation in Canada, with 33 aircraft and 40 flights used to evacuate patients, residents, and staff members to other cities (Matear 2017). Kearns (2017) reported that 3% of the evacuees evacuated via plane. The evacuation was a multi-modal effort, with some hospitals using a combination of air evacuation, ground ambulances, and buses to overcome the challenges of take-off locations. Air transportation was conducted with the assistance of the Canadian Armed Forces (KPMG 2017). For the same wildfire, Woo et al. (2017) described a challenging airlift process and presented the importance of multi-modal evacuation plans for regions with sparse networks.

Several other instances of air-based evacuations have occurred in Canada, the U.S., and Australia. Air transport has been frequently employed for remote First Nation communities such as the Sandy Lake First Nation (Asfaw, McGee, and Christianson 2020; McGee 2021; McGee, Nation, and Christianson 2019), the Mishkeegogamang Ojibway Nation (McGee, Nation, and Christianson 2019), and others (McGee 2021). In the U.S., people have been helicoptered to safety in various wildfires in California such as the 2017 Northern California Wildfires (ABC News 2020; Dastin 2017; Gralow and Paul 2020; Lewis 2018), the 2018 Atlas Peak fire (Lewis 2018), and the 2019 Creek Fire in California (ABC News 2020). More recently during the 2023 Maui Wildfires, evacuees were airlifted from the island with the help of added flights by commercial airlines (Sampson 2023). Older adults and those in medical need in southeastern towns in Australia were also airlifted during the bushfires in 2020 (Gralow and Paul 2020).

From a management perspective, adaptive air traffic routing can play a significant role during such wildfire evacuations since air transportation is a centralized system. Yang et al. (2021) optimized airport coordination for dispatching evacuation flights and developed a delay prediction model. In Canada, the municipality of Whistler and the District of Squamish in British Columbia have a multi-modal evacuation plan that considers all hazards. The plan explores opportunities and limitations to mass evacuations through rail, air, marine, and ground transport (Resort Municipality of Whistler and District of Squamish 2019).

3.2.5. Active mobility and motorbikes

Pedestrian-based evacuations remain relatively rare for wildfire events as they can increase heat-induced risks to evacuees. However, a few examples exist including those who faced an imminent threat from the heat (either due to slow traffic or entrapment in a vehicle or shelter) (Vonberg, Bell, and Vandoorne 2018) or faced road blockages and tried to outrun the fire (Rosato 2018). A study looked at various scenarios that considered either walking or driving for the 2018 wildfires in Mati, Greece and provided insight into the mortality rates of choosing these modes (Siam et al. 2022). Using a series of models, the research reported a minimized mortality rate when the mode split was 70% pedestrian to 30% driving (Siam et al. 2022). Another study assessed ways to improve the safety conditions for wildland firefighters by collecting hiking data from firefighters totaling over 200 km (Sullivan et al. 2020). The results indicated that firefighters hike relatively consistently and exhibit faster travel rates than non-firefighting personnel, especially in steeper terrain (Sullivan et al. 2020).

Walking has been reported in additional wildfires, such as when some residents resorted to quickly walking toward the ocean since privately owned automobiles were blocking the roads during the 2018 Attica Wildfire in Greece (Vonberg, Bell, and Vandoorne 2018). Some other instances include the 2017 British Columbia wildfire where campers had to trek to be evacuated by boats (Kurjata 2017). While some data has found that less than 1% of evacuees left by walking in three California wildfires (Wong, Broader, and Shaheen 2020a), the road network, disaster conditions, and community design may lead to higher walking rates, especially if a flexible mode is needed. For example, pedestrians can make use of public paths, shortcuts, and narrow roads, thereby increasing the number of egress points and allowing people to avoid congestion on roadways (Wong, Martin, and Halpern 2020).

Other alternative and smaller modes of transport have also been used by people to evacuate from critical areas with difficult terrains to traverse faster. For example, one man in Greece evacuated multiple people out of the danger zone by giving them a ride on his motorcycle (Smith 2019). In two separate instances, two women fled from the devastating 2017 Northern California wildfires on their bikes (Bevilacqua 2017). Motorcycles have also been employed as a quick means of deploying personnel to fight fires in remote or difficult terrain. Chinese off-road bikers have volunteered to help the firefighters in Chongqing, and Australian firefighters have used dirt bikes and portable water guns to contain remote bushfires (Firehouse 2015; Whitworth 2022). While these reports are anecdotal, they provide a glimpse of the flexible (and sometimes critical) nature of active transportation and smaller modes in disasters.

3.3. Transportation networks

Recent research has identified that the breakdown of transportation road networks (either through congestion or blocked routes) can significantly increase evacuee risks (Chen, Shafi, and Chen 2020). This section will explore network-related studies, insights generated from evacuation curves of past evacuations, and the role of GPS data in congestion identification (refer to Figure 4 for a quick overview).

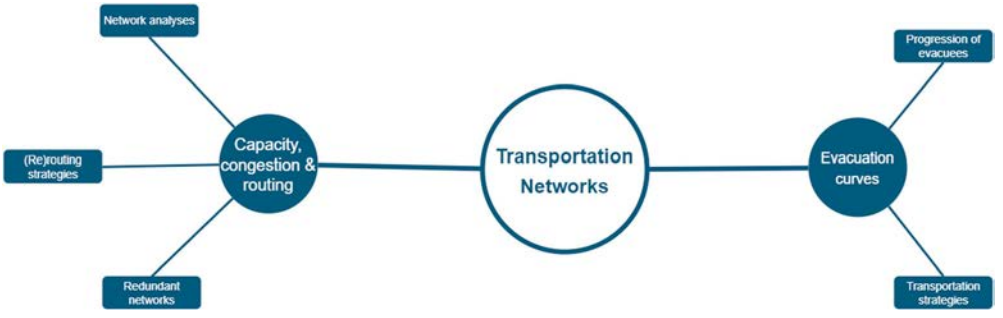


Figure 4. Interconnected themes and tags in 'Transportation Networks'.

3.3.1. Network capacity, congestion, and routing

Multiple studies have examined the vulnerability of road networks during wildfire evacuation (Chen, Shafi, and Chen 2020; Mahajan and Kim 2020; Ohi and Kim 2021). Networks in wildfire evacuations are often assessed through network analysis (i.e. remoteness, accessibility, and connectivity). Studies have investigated the importance of evacuation paths with connectivity and redundancy to reduce fatalities (Mahajan and Kim 2020; Niu et al. 2022) and explored the adoption of traffic management strategies to alleviate bottlenecks (Chen, Shafi, and Chen 2020; Mahajan and Kim 2020; Ohi and Kim 2021). Several studies propose ways to enhance traffic flow and reduce evacuation times (Gan et al. 2016; Parr et al. 2022). Concurrently, emerging practice has begun to offer designs that can temporally increase evacuation capacity during emergencies (Caltrans 2021).

During a wildfire evacuation, traffic and delays can be further exacerbated by road closures and rerouting. Reported congestion along major arterials, such as during the 2016 Fort McMurray Fire (Thériault et al. 2021), indicated the need for more robust optimization strategies to ensure the flow of evacuees. Similarly, firefighters and fire trucks can be trapped due to limited egress points, capacity issues, blocked passageways, or dangerous fire exposure (Campbell et al. 2019; Kourmpa and Tsigdinos 2020). Evacuation research has shown that even minor changes to an arterial road or intersection can significantly improve traffic flow and reduce average delay times (Parr, Wolshon, and Murray-Tuite 2016). Traffic growth uncertainties emphasize the need for adjustments and upgrades during the infrastructure's lifetime (Fawcett et al. 2015). Effective evacuation routing (and rerouting) can help to avoid excessive traffic congestion during a wildfire. This has been studied through spatiotemporal computation (Li, Cova, and Dennison 2019) and modeling realistic situations (Hou, Darr, and Zhang 2022; Shahparvari and Abbasi 2017). For instance, a 2009 Australian bushfire case study applied a rerouting problem model to determine the safest routes and shelter assignments for late evacuees in different scenarios (Shahparvari et al. 2019). Additionally, a post-fire survey for the 2009 Jesusita fire in Santa Barbara found that 70% of evacuees chose longer routes, suggesting that the elevation and gradient of routes may be factors that influence this decision (Brachman et al. 2020). In addition, one longitudinal community assessment study in Texas identified route

accessibility and traffic as the two biggest challenges during wildfire evacuations (Kirsch et al. 2016).

In an emerging area of inquiry, studies are leveraging large-scale GPS and cellular datasets to analyze network performance and understand human behavior. These datasets can provide transportation agencies with information on the most used routes (travel demand), reconstruct traffic densities, identify bottleneck situations, study the behavior of a community, and be used to monitor activity on routes (Melendez, Ghanipoor Machiani, and Nara 2021; Wu et al. 2022; Zhao et al. 2022). GPS data can be especially helpful for sparse networks that lack traffic-counting devices.

3.3.2. Evacuation curves

Evacuation departure curves represent the progression of people leaving a specific area during an emergency evacuation. These curves provide insights into the timing and progression of people loading onto a road network, including how quickly people leave the area and how evacuation patterns change over time..

For wildfire evacuations, Woo et al. (2017) found that an evacuation curve can display a sudden surge in the number of evacuees at the beginning, followed by a slower but steady increase until reaching a cumulative peak. Similarly, Grajdura, Qian, and Niemeier (2021) developed detailed response curves for departure time, awareness (of the wildfire) time, when evacuation notice was received, and when a code red message was received for the 2018 Camp Fire in California. Other studies have analyzed these curves for different evacuation times (Wolshon and Marchive 2007) and electric vehicles (MacDonald, Kattan, and Layzell 2021), though gaps exist for curves that specifically represent wildfires.

3.4. Planning

Evacuation planning is region-specific and requires communication and collaboration between multiple stakeholders (Matherly et al. 2014). Planning tasks typically involve coordination among entities to protect lives, allocation of resources in a disaster, and preparation for multiple risk scenarios. While goals for evacuation planning can be varied, several more regular goals include congestion reduction, effective communication, and shelter management (as seen in Figure 5). Though emergency response plans are widely developed across North America, a large number of the largest cities in the U.S. do not have publicly available evacuation plans that specifically focus on vulnerable populations (Renne and Mayorga 2022).

Research has also indicated that wildfire evacuation planning should incorporate and consider the unique factors at the community level (Asfaw, McGee, and Christianson 2020). At a finer scale, neighborhood-level evacuation plans can provide more customizable guidance that considers housing density and generates insight into localized traffic (Cova and Johnson 2002; Wolshon and Marchive 2007). Planning and preparedness activities can also improve awareness. In communities where wildfire management was performed, homeowners were more likely to discuss wildfires, perceive a high risk, and describe a higher sense of awareness (Faulkner et al. 2009). Together, these studies indicate how planning requires community-centered details to reach key evacuation goals.

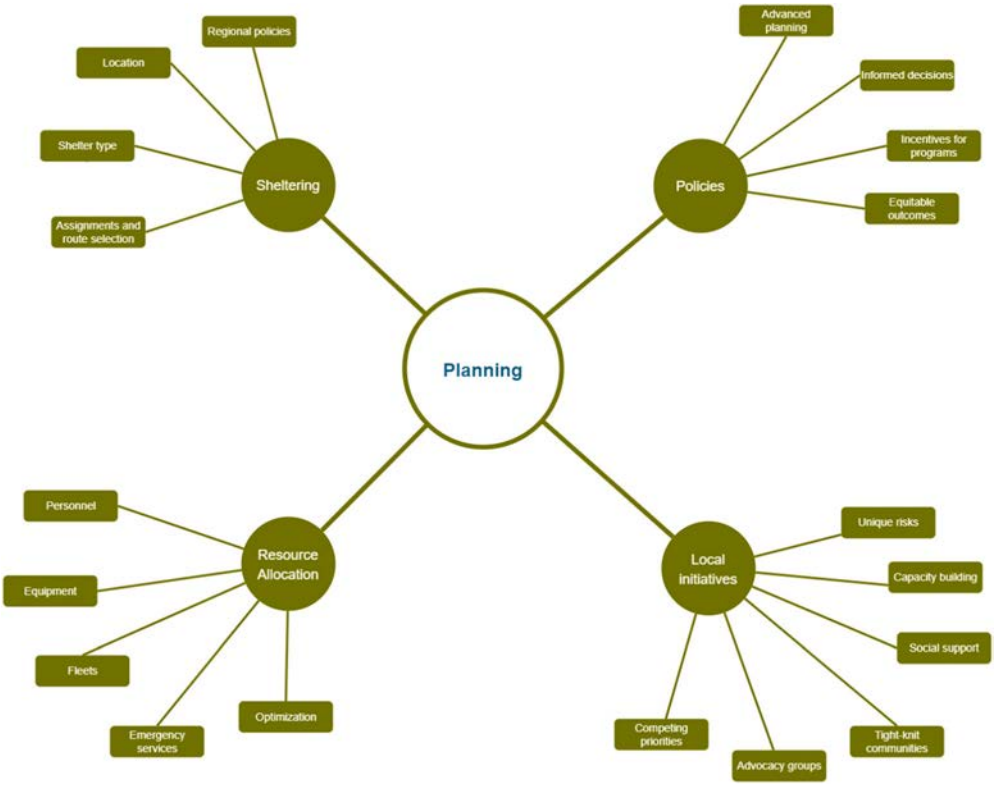


Figure 5. Interconnected themes and tags in 'Planning'.

3.4.1. Sheltering strategies during wildfire evacuations

Sheltering during wildfire evacuations typically involves evacuees traveling to temporary locations away from fires. Most people decide to shelter with friends/family, stay at hotels/motels, or go to public shelters, though a select few also shelter in recreational vehicles or at home-sharing options such as Airbnb (Wong, Broader, and Shaheen 2020a). Wong et al. (2020a) reviewed 11 wildfires in California from 2017 to 2019 and noted key similarities between them, finding that local organizations and non-profit humanitarian organizations played a critical role in sheltering evacuees. The same review also found public shelters to be one of the least popular sheltering preferences for evacuees based on limited resources (accessible facilities, medical supplies, trained staff), the potential for the spread of illness, and reaching capacity.

Some regions, such as Australia, have promoted a 'leave early or stay and defend' policy in the past. Reviews and discussions of this policy, including its benefits and drawbacks, can be found in McCaffrey and Rhodes (2009), Paveglio, Boyd, and Carroll (2012), and McLennan et al. (2019). Recent literature has also reported that in the southern regions of France, a distinct preference for 'confinement' (also widely known as shelter-in-place) instead of evacuation (as studied by Vaiciulyte et al. (2022)) exists. These staying and shelter-in-place policies are not generally recommended by governments and inadequately prepared individuals are more likely to be forced into dangerous responses (such as late evacuation and passive shelter) (Whittaker et al. 2013). However,

shelter-in-place may become a necessity in select situations, such as when roads become impassable due to debris, low visibility, and closures (Soga et al. 2021).

Recent research has focused on improving evacuation planning in dynamic environments, stressing the importance of addressing various constraints when devising sheltering strategies. Some studies have looked at shelter assignment and route selections in wildfire conditions (Shahparvari et al. 2016; Shahparvari, Abbasi, and Chhetri 2017; Shahparvari et al. 2019). Two studies, Shahabi and Wilson (2018) and Afkham, Ramezanian, and Shahparvari (2022), developed approaches to improve evacuation planning in different dynamic environments for shelter assignments. The first study created a scalable evacuation routing algorithm on a directed graph that considered road capacity and evacuation time limits to update an evacuation plan in real time (Shahabi and Wilson 2018). Afkham, Ramezanian, and Shahparvari (2022) focused on optimizing traffic flow and minimizing congestion in mass self-evacuation networks through a bi-level model and presented a sensitivity analysis of evacuation time to the number of shelters and routes. The studies recommended that the highest priority in disaster preparation should be establishing safe and effective evacuation routes to shelters.

From a wildfire evacuation behavior perspective, Wong, Yu, et al. (2022) developed multiple models (binary choice and portfolio choice models) to determine the dependencies and joint behavior for multiple choice dimensions that included departure time, transportation mode, and shelter type among others. The research found a joint preference by evacuees for traveling to private shelters and evacuating nearby (within the same county) for the 2017 Southern California Wildfires and the 2018 Carr Wildfire.

The effectiveness of designated wildfire 'shelters' depends on the unique characteristics of the fire, such as the location of the ignition point and environmental conditions. For example, the placement of shelters should remain effective across several likely wildfire-spread scenarios (Steer et al. 2017). To avoid hazardous conditions, shelters will need to be designed to withstand intense heat and embers, similar to resilient homes in wildfire-prone areas (Cova, Dennison, and Drews 2011; Quarles et al. 2010). These building improvements are necessary for shelters that are used closer to the fire front, especially for late evacuees (Cova et al. 2009).

Moving away from traditional shelters, ongoing research has identified an opportunity to build resilience hubs, which can operate in both normal and disaster conditions. A comprehensive review of resilience hubs by Ciriaco and Wong (2022) provides insights into the need for planning and integrating essential services (especially transportation) to these hubs.

3.4.2. Resource allocation

To minimize the damage caused by wildfires, efficient resource allocation, which includes personnel, equipment, fleets, and other emergency services can help improve safety and efficiency. For example, Bodaghi et al. (2020) and Shahparvari et al. (2016; 2021) proposed probabilistic approaches to allocate personnel and equipment for bushfire emergencies, optimizing response and outcomes. A study by Pérez, Maldonado, and López-Ospina (2016) aimed to address fleet allocation problems of fire departments. To achieve this, the study used mixed integer formulations as a means of mitigating disparities in service based on response times. In addition, Fragkos et al. (2022) addressed emergency supply using a heterogeneous fleet problem (ESHFP), which minimized the

time to supply resources (i.e. consumable and non-consumable goods as emergency supplies) to evacuees and intervention groups.

Focusing more on the road network, Ohi and Kim (2021) developed a systematic approach for resource allocation during an area-wide disruption by identifying critical corridors. This approach evaluated the network bottleneck capacity and routing needs of the affected area and allocated emergency planning resources to the most important corridors to improve evacuation efficiency. Meanwhile, a review by Lessan and Kim (2022) outlined network optimization-based evacuation planning studies for various disaster types and the decision choices involved, including destination, route, departure time, departure location, and shelter selection. Other ways to consider the allocation of resources include prioritizing based on community feedback (to share mobility and sheltering resources) (Wong, Walker, and Shaheen 2021), identifying communities at higher risk for evacuation problems (Ohi and Kim 2021), determining vulnerable segments on a highway network (Mahajan and Kim 2020), and focusing on equitable outcomes in disaster evacuation processes (Menon, Staes, and Bertini 2020). Research has also shown benefits to policymakers that inform the allocation of resources (such as emergency service resources for medical assistance) to effectively reduce waiting times by improving communication and bolstering residents' preparedness (Vaiciulyte et al. 2022).

3.4.3. Policies

Wildfires are a growing concern for many communities, and clear and flexible policies are needed to accommodate the wide-ranging demands of evacuations. For example, Wong (2020) highlighted the benefits of advanced planning, including reduced evacuation time estimates (ETEs), improved life safety, and more equitable outcomes. Programs such as FireSmart Canada, Firewise in the U.S., and Community Fireguard in Australia provide recommendations based on physical science and are designed to help residents make informed decisions, maintain fire-resistant homes and gardens, and promote community collaboration in reducing the risk of wildfires (Country Fire Authority 2023; NFPA 2022; Partners in Protection 2003; Thompson 2016). For example, the FireSmart manual focuses on three key themes to reduce wildfire threats: assessing the situation, resolving existing problems, and avoiding future problems (Partners in Protection 2003). Despite the benefits associated with the adoption of these programs, participation of WUI communities remains far from universal. A study of over 2,000 survey responses showed that respondents preferred positive strategies with incentives to increase participation in the FireSmart program, with the strongest support for tying insurance premiums to program compliance (Ergibi and Hesseln 2020).

3.4.4. Locally-led initiatives

Locally-led initiatives can be valuable for specific communities and their unique risks. Through interaction between residents and emergency managers, communities can determine their existing ability to handle fire risk, build capacity, and decide how to approach evacuations (Paveglio, Carroll, and Jakes 2010). Researchers have suggested that locally-led initiatives influenced by the lived experiences of wildfire-impacted communities can bring benefits to these communities and lead to future resilience (Christianson, McGee, and L'Hirondelle 2012; Jakes and Langer 2012; Slowikowski and Motion

2021). During the 2011 wildfire evacuation of the Dene Tha' First Nation, several community-centered decisions (e.g. keeping families together, providing social support, and using familiar host communities) helped the evacuation and improved community resilience (Mottershead, McGee, and Christianson 2020). Tight-knit communities and advocacy groups can also influence policies. In one example, members of a wildfire-awareness advocacy group in Colorado asked the planning commission to include a study on emergency evacuation on the west side of the city in the final master plan of the city (Jent 2023). On the other hand, if external agencies are leading an evacuation and the priorities of the governing body and the impacted community do not align, challenging evacuation experiences can arise and negatively impact evacuees (Asfaw, McGee, and Christianson 2019b). For example, residents of a remote community in the Yukon Territory in Canada did not evacuate due to the fear of losing harvested meat, sled dog teams, and livestock (Cote and McGee 2014).

Importantly, recent research in Canada on recent wildfire evacuations in First Nations communities has focused on improving communication mechanisms and governmental policies to increase local capacity and community resilience (McGee and Christianson 2021). Finally, local leadership should be prioritized in improving evacuation outcomes, which can keep members of large households together (Christianson and McGee 2019),

Table 1. Summary of key recommendations.

Key Areas	Key Recommendations
Infrastructure	● Agencies should create an easy-to-use tracking list for wildfire-related infrastructure damage, debris removal, and subsequent repair works to ensure comprehensive documentation. ● Jurisdictions should consider designs that could protect critical or flammable transportation infrastructure to reduce wildfire impacts. ● The implementation of ITS with sensors for real-time data on traffic, damage, wildfire location, and evacuation progress could aid decision-making and post-disaster evaluations. ● Interdependencies of transportation infrastructure with other systems (e.g. power, communications) require further study and preparedness to reduce cascading failures.
Modality	● Evacuation plans require modifications that consider the emerging EV market, including the planning of fixed and mobile charging stations. ● Jurisdictions should develop shared mobility and transit-based evacuation plans to increase transportation options and equity. ● Governments should explore the potential of water and air-based evacuations for coastal and remote communities, factoring in operational needs, costs, geography, and planning requirements. ● Certain geographies may benefit from evacuations on foot or micromobility options, though further research is recommended to assess safety, efficiency, and use cases.
Networks	● Further development of computational models at the local and regional scale can help assist in devising system-optimal rerouting strategies and coordinating traffic across a region. ● Researchers and agencies should coordinate on data-sharing practices and develop departure curves for communities with previous wildfire evacuation experience.
Planning	● Evacuation strategies should be designed to be adaptable to varying wildfire conditions across jurisdictions, while actively involving NGOs, CBOs, and underserved populations in planning. ● Jurisdictions should also plan for other key needs, including shelter locations, relief supply transportation, personnel needs, and wildfire response partners. ● Engineers, planners, and decision-makers should continue to work together to enhance local capacity, identify innovative financial sources, and build dynamic evacuation plans for a range of scenarios.

plan accommodations and health care for identified persons in advance (Asfaw et al. 2019a), and designate multiple pick-up locations for both abled and disabled persons (Baou et al. 2018).

4. Discussion

This literature review uncovered key concepts related to recent research conducted at the intersection of wildfires and transportation. In this section, we discuss each key area and connect them, highlighting interdisciplinary research needs and recommendations for future directions. At the end, Table 1 summarizes the key takeaways and recommendations from this review.

4.1. The missing component of infrastructure

First, we found minimal literature related to damaged infrastructure, in particular how wildfires affect infrastructure and what designs could mitigate wildfires and associated hazards. This gap likely results from the rarity of large wildfire evacuations, differing sizes of large wildfire evacuations, low or non-continuous media coverage, and/or the relative resilience of roadway infrastructure to fires. Given the sometimes localized impacts of wildfires, information on infrastructure damage and debris removal may not have been recorded. We recommend that researchers and governments create an easy-to-use tracking list of damages and recovery efforts related to infrastructure. Special attention should be given to potentially flammable infrastructure, including infrastructure that could melt or experience reduced functionality when exposed to intense heat.

Aging infrastructure coupled with wildfire exposure could lead to increased damage over time. Our review found that damages could be direct or indirect, such as strength degradation due to heat and impact loads due to debris flow (following a wildfire). The risk of hazards that are exacerbated by wildfires, especially flooding, landslides, and mudslides, presents one of the larger threats to infrastructure (Fraser, Chester, and Underwood 2022). Nevertheless, these related hazards have not been fully researched or considered, especially related to the design, maintenance, and operation of roads and highways. The seasonal occurrence of wildfires likely warrants a more comprehensive design and rehabilitation strategy. We also note the lack of documentation available for post-disaster maintenance, operations, and repair for chosen transportation routes. Sharing this information, including best practices, could be useful for varied regions.

Another issue that requires further attention is the usage of different sensors to actively monitor infrastructure and wildfires in real time. Our review found only minimal research on sensors and infrastructure monitoring (Menon, Staes, and Bertini 2020). A variety of intelligent transportation systems (ITS) focusing on sensors could be useful for real-time data on traffic, damage, wildfire location, and evacuation progress. Opportunities might exist to integrate this monitoring with a traffic management center or an emergency operations center. Existing sensing technology, such as the Road Weather Information System (RWIS) (Kwon and Fu 2013), could also be re-purposed for wildfires. This data would be helpful for decision-making and post-disaster evaluations.

Even if road infrastructure remains operational and undamaged, two key issues persist related to other infrastructure. First, our review found that there are broad concerns related to communication systems. For example, individuals may struggle to evacuate, especially if they do not have mobile phone coverage (Gralow and Paul 2020; Soga et al. 2021). Their unfamiliarity with traditional or advanced communication channels could also present a problem. Second, transportation infrastructure is linked to power systems, which makes it susceptible to other system failures. Our review found only minimal research in connecting these systems, beyond a few examples related to communication issues (e.g. Thériault et al. 2021) and PSPS events (e.g. Wong, Broader, and Shaheen 2022). We recommend that future research and practice consider how people interact with communication systems and develop linkages among different infrastructure systems to highlight interdependent failures and opportunities.

4.2. Thinking beyond privately owned automobiles

Our review indicates that wildfire evacuations require multimodal coordination, despite the emphasis on privately owned automobiles in existing studies and plans (see Kearns (2017) and Wong, Broader, and Shaheen (2020b) as examples). However, organizing multiple modes poses significant challenges for government agencies. For instance, privately owned automobiles are difficult to coordinate (e.g. departure time, destination, etc.) in an emergency and are the most dominant form of evacuation mode in most evacuations. We also note that shared mobility (mostly from privately owned automobiles) could increase transportation capacity and offer equity benefits for vulnerable groups without access to any other mode of transportation during evacuations (see for example Wong, Broader, and Shaheen 2020b). Local ride-hailing companies have an opportunity to partner with communities and enhance capacity, but a rapid matching system for demand and supply remains undeveloped in research and practice.

Limited cases of transit-based responses during wildfires tend to be ad-hoc (Wong, Broader, and Shaheen 2020a; Woo et al. 2017). Transit-based evacuation planning could be developed based on strategies from hurricane evacuations, including pick-up locations, evacuation registries, registration centers, and improved public shelters. Transparent sharing of pick-up and drop-off locations in advance, along with community-needs analyses, can optimize resource utilization (fleet, drivers, and any emergency services).

Evacuations using marine and air transportation are still emerging as viable modes. Past evacuations suggest success under certain circumstances, but limitations exist due to costs, operational needs, departure/landing requirements, geography, and planning needs. Government agencies should explore the role of water – and air-based evacuations for coastal and remote communities, especially when the road network is impeded by fire, debris, or congestion.

Though safety is questionable in wildfires, active transportation and micromobility could be a flexible and redundant option for evacuees, especially those without access to a privately owned automobile or public transit. While new studies are beginning to emerge (Fitch-Polse, Chen, and Wong 2023), we recommend further research and consideration of these modes in wildfire evacuations, including use cases, best practices, and equity-building opportunities.

4.3. Navigating traffic and capacity challenges

Our review found some studies related to community design, especially related to networks. During evacuations, peak demand on roadways (and other transportation infrastructure) leads to a capacity issue, resulting in congestion, delays, and potential exposure to smoke and wildfire heat. Multiple studies have explored rerouting problems to address this issue (Hou, Darr, and Zhang 2022; Shahparvari and Abbasi 2017). Putting these rerouting strategies into practice during typical roadway congestion can be the first step in familiarizing people with the potential of an efficient travel experience and for transportation agencies to test evacuation strategies. We recommend the development of computational models at local/regional scales to account for concurrent wildfires. These models could provide insights into how major egress routes could be overwhelmed and assist in devising system-optimal rerouting strategies that coordinate traffic with all neighboring wildfire-prone communities.

Moreover, we discovered minimal work on developing and studying departure curves for wildfires. These graphs can provide transportation, planning, and emergency communication agencies with rich travel behavior trends that are community-specific. More importantly, the curves can provide insight into when an evacuation surge is likely to take place. For example, Grajdura, Qian, and Niemeier (2021) developed a detailed account of the departure time of evacuees with additional information about when residents were officially notified of the 2018 Camp Wildfire. There is a critical need for similar studies that analyze other wildfire events at this granular level to identify community and agency response. This can lead to more efficient deployment of resources and reduce overall evacuation time. We recommend researchers and agencies coordinate on data sharing practices (traffic and GPS data) and develop curves for communities and nearby jurisdictions.

4.4. Enhancing advanced evacuation planning

Comprehensive wildfire evacuation planning is essential for preparing jurisdictions for these scenarios, reducing injuries and fatalities, alleviating congestion on evacuation routes, and moving more people to safety under resource and time constraints (Gan et al. 2016; Ohi and Kim 2021; Wong, Walker, and Shaheen 2021). Effective planning requires collaboration among decision-makers and should consider the community's unique characteristics (e.g. culture, resources) (Brachman et al. 2020; Zhao et al. 2022). These community-specific plans tend to generate tailored guidance for residents and consider housing density and local traffic. Despite this localized value, evacuation planning remains under-resourced and missing in many jurisdictions. Consequently, there remains a need to build evacuation strategies that are more generalizable yet still adaptable across different jurisdictions faced with varying wildfire characteristics. We found that successful evacuation planning is more than drafting plans and performing analyses: planning also engages non-governmental organizations (NGOs), community-based organizations (CBOs), and underserved populations (Asfaw, McGee, and Christianson 2019b; Baou et al. 2018; McGee 2021; Paveglio, Carroll, and Jakes 2010).

Information on evacuees' sheltering preferences can assist agencies in assigning and setting up a dedicated number of shelters during a wildfire evacuation. We found that

several studies looked at the allocation of resources such as shelters, fleets, personnel, and other emergency services. However, our systematic review failed to determine if these optimized allocation strategies have been implemented yet. This indicates that evacuation responses for wildfires may currently rely on ad hoc strategies and responses, which could lead to inefficiency and safety problems. We recommend that communities formally draft plans that identify key shelter locations, methods to transport relief supplies, personnel allocation and staff needs, and partners for wildfire response. Moreover, new shelter development projects and existing shelter upgrades should aim to serve the communities equitably, accounting for the needs of vulnerable residents (Ciriaco and Wong 2022).

Enhanced local capacity can also help address key evacuation challenges. Our review indicated that local leadership played a key role in some major evacuation events and encouraged residents to evacuate. We recommend providing communities with well-researched policies and innovative financial resources to stimulate planning at the local level and foster initiative to test new strategies, gain insight from residents, and build connections between engineers and planners. Table 1 summarizes the key recommendations from this discussion across the four topical areas.

5. Conclusion

Wildfire evacuations are complex processes that require holistic planning, engineering, and operations. Within this challenge, transportation is a vital support element as it facilitates the rapid movement of people away from danger and resources into a hazardous area. In this review, we focused on four key areas related to wildfire evacuations: infrastructure; modality; transportation networks; and planning. Our review found significant gaps in understanding and implementing wildfire evacuation planning, especially in the areas of modality beyond privately owned automobiles and network analysis for congestion management. First, there is limited research on direct and indirect damages to infrastructure and interdependent infrastructural failures. Hazard mapping and sensing technologies along critical corridors could help reduce infrastructure failures and improve road design guidelines. Second, minimal evidence exists on how to incorporate multi-modality in wildfire evacuations, despite its widespread usage among carless populations. More research and strategic planning can increase the viability of public transit, active transportation, and shared mobility to improve equitable outcomes for underserved populations. Third, there is scarce application of rerouting strategies to eliminate congestion during evacuations. However, recent work focusing on wildfire travel behavior (departure curves) at the community level and the location of shelters could help inform rerouting, especially by mapping services (e.g. Google Maps, Waze). Last, there is limited evidence of advanced and collaborative evacuation planning in many jurisdictions. Practice-oriented policies and financial assistance to communities with strong local leadership can encourage wildfire evacuation planning that considers the unique characteristics of the community, accounts for the underserved/underrepresented groups, and facilitates resource management. By considering transportation analyses beyond decision science and simulations, the resilience benefits of well-rounded and empirically-based evacuation planning and response can be more realized across wildfire-prone geographies.

Acknowledgements

This study was made possible through funding received by Infrastructure Canada. Infrastructure Canada is a Government of Canada department that makes significant investments in public infrastructure, builds public-private partnerships, develops policies, and delivers programs to improve the lives of all Canadians. We would like to thank Dr. Amy Kim from the University of British Columbia and Dr. Jennifer Beverly from the University of Alberta for their on-going support of this work.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This work was supported by Infrastructure Canada.

ORCID

Syeda Narmeen Zehra http://orcid.org/0009-0000-1767-9791
Stephen D. Wong http://orcid.org/0000-0002-3638-3651

References

AASHTO. 2018. *AASHTO - The Manual for Bridge Evaluation*. 3rd ed. Washington, D.C.: American Association of State Highway and Transportation Officials.

Abbate, Andrea, Laura Longoni, Vladislav Ivov Ivanov, and Monica Papini. 2019. "Wildfire Impacts on Slope Stability Triggering in Mountain Areas." *Geosciences* 9 (10): 417. https://doi.org/10.3390/geosciences9100417.

ABC News, A. B. C. 2020. "Inside the Daring Helicopter Flights That Rescued 200 from a California Fire." ABC News. 2020. https://abcnews.go.com/US/inside-daring-helicopter-flights-rescued-200-california-fire/story?id=72869187.

Abo El Ezz, Ahmad, Jonathan Boucher, Anne Cotton-Gagnon, and Alexandre Godbout. 2022. "Framework for Spatial Incident-Level Wildfire Risk Modelling to Residential Structures at the Wildland Urban Interface." *Fire Safety Journal* 131: 103625. https://doi.org/10.1016/j.firesaf.2022.103625.

Afkham, Maryam, Reza Ramezanian, and Shahrooz Shahparvari. 2022. "Balancing Traffic Flow in the Congested Mass Self-Evacuation Dynamic Network Under Tight Preparation Budget: An Australian Bushfire Practice." *Omega* 111: 102658. https://doi.org/10.1016/j.omega.2022.102658.

Afshar, Claudia Dominguez, Paradise. 2022. "Florida Expands State of Emergency to 3 Counties Affected by Wildfires." CNN. March 5, 2022. https://www.cnn.com/2022/03/05/us/florida-bay-county-wildfire-saturday-desantis/index.html.

Ahmed, Md Ashraf, Arif Mohaimin Sadri, and Mohammed Hadi. 2020. "Modeling Social Network Influence on Hurricane Evacuation Decision Consistency and Sharing Capacity." *Transportation Research Interdisciplinary Perspectives* 7: 100180. https://doi.org/10.1016/j.trip.2020.100180.

American Society of Civil Engineers. 2017. *Minimum Design Loads and Associated Criteria for Buildings and Other Structures*. 7th ed. Reston, VA: American Society of Civil Engineers. https://doi.org/10.1061/9780784414248.

Asfaw, Henok Workeye, Tara McGee, and Amy Cardinal Christianson. 2019b. "The Role of Social Support and Place Attachment During Hazard Evacuation: The Case of Sandy Lake First

Nation, Canada." *Environmental Hazards* 18 (4): 361–381. https://doi.org/10.1080/17477891.2019.1608147.

Asfaw, Henok Workeye, Tara K. McGee, and Amy Cardinal Christianson. 2020. "Indigenous Elders' Experiences, Vulnerabilities and Coping During Hazard Evacuation: The Case of the 2011 Sandy Lake First Nation Wildfire Evacuation." *Society & Natural Resources* 33 (10): 1273–1291. https://doi.org/10.1080/08941920.2020.1745976.

Asfaw, Henok Workeye, Sandy Lake First Nation, Tara K. McGee, and Amy Cardinal Christianson. 2019a. "A Qualitative Study Exploring Barriers and Facilitators of Effective Service Delivery for Indigenous Wildfire Hazard Evacuees During Their Stay in Host Communities." *International Journal of Disaster Risk Reduction* 41: 101300. https://doi.org/10.1016/j.ijdrr.2019.101300.

Baou, Evangelia, Vasilis P. Koutras, Vasileios Zeimpekis, and Ioannis Minis. 2018. "Emergency Evacuation Planning in Natural Disasters Under Diverse Population and Fleet Characteristics." *Journal of Humanitarian Logistics and Supply Chain Management* 8 (4): 447–476. https://doi.org/10.1108/JHLSCM-11-2017-0066.

BBC. 2017. "Italy Wildfires: Tourists Rescued by Boat from Calampiso." *BBC News*, July 13, 2017, sec. Europe. https://www.bbc.com/news/world-europe-40590090.

Beloglazov, Anton, Mahathir Almashor, Ermyas Abebe, Jan Richter, and Kent Charles Barton Steer. 2016. "Simulation of Wildfire Evacuation with Dynamic Factors and Model Composition." *Simulation Modelling Practice and Theory* 60: 144–159. https://doi.org/10.1016/j.simpat.2015.10.002.

Bevilacqua, Matt. 2017. "Bikes Helped These Women Escape the California Wildfires." *Bicycling* (Blog). October 13, 2017. https://www.bicycling.com/news/a20027686/two-women-flee-california-wildfires-on-bikes/.

Bian, Ruijie, and Chester G. Wilmot. 2018. "An Analysis on Transit Pick-up Points for Vulnerable People During Hurricane Evacuation: A Case Study of New Orleans." *International Journal of Disaster Risk Reduction* 31 (October): 1143–1151. https://doi.org/10.1016/j.ijdrr.2017.07.005.

Bodaghi, Behrooz, Ekambaram Palaneeswaran, Shahrooz Shahparvari, and Mahsa Mohammadi. 2020. "Probabilistic Allocation and Scheduling of Multiple Resources for Emergency Operations; a Victorian Bushfire Case Study." *Computers, Environment and Urban Systems* 81: 101479. https://doi.org/10.1016/j.compenvurbsys.2020.101479.

Boone, Alastair. 2018. "After Mudslides Bury the Highway, Commuters Must Take to the Sea." *Bloomberg.Com*, January 11, 2018. https://www.bloomberg.com/news/articles/2018-01-11/santa-barbara-mudslide-victims-commute-on-tourist-boats.

Borowski, Elisa, Jason Soria, Joseph Schofer, and Amanda Stathopoulos. 2022. Does Ridesourcing Respond to Unplanned Rail Disruptions? A Natural Experiment Analysis of Mobility Resilience and Disparity.".

Borowski, Elisa, and Amanda Stathopoulos. 2020. "On-Demand Ridesourcing for Urban Emergency Evacuation Events: An Exploration of Message Content, Emotionality, and Intersectionality." *International Journal of Disaster Risk Reduction* 44: 101406. https://doi.org/10.1016/j.ijdrr.2019.101406.

Brachman, Micah L., Richard Church, Benjamin Adams, and Danielle Bassett. 2020. "Wayfinding During a Wildfire Evacuation." *Disaster Prevention and Management: An International Journal* 29 (3): 249–265. https://doi.org/10.1108/DPM-07-2019-0216.

CalTrans. 2021. "State Route 67 Highway Improvements Project." CalTrans. 2021. https://dot.ca.gov/caltrans-near-me/district-11/current-projects/sr67-corridor/improvements.

Cambero, Fabian, and Natalia A. Ramos Miranda. 2023. "At Least 23 Dead as Dozens of Wildfires Torch Forests in Chile." *Reuters*, February 5, 2023, sec. Americas. https://www.reuters.com/world/americas/firefighters-battle-dozens-wildfires-chile-emergency-extended-2023-02-04/.

Campbell, Michael J., Wesley G. Page, Philip E. Dennison, and Bret W. Butler. 2019. "Escape Route Index: A Spatially-Explicit Measure of Wildland Firefighter Egress Capacity." *Fire* 2 (3): 40. https://doi.org/10.3390/fire2030040.

Carabella, Cristiano, Enrico Miccadei, Giorgio Paglia, and Nicola Sciarra. 2019. "Post-Wildfire Landslide Hazard Assessment: The Case of The 2017 Montagna Del Morrone Fire (Central Apennines, Italy)." *Geosciences* 9 (4): 175. https://doi.org/10.3390/geosciences9040175.

CBS News. 2023. "Maui Fires Death Toll Rises to 80, Marking Deadliest Natural Disaster in Hawaii History." August 12, 2023. https://www.cbsnews.com/news/hawaii-wildfires-maui-lahaina-death-toll-warning-sirens/.

Cecco, Leyland, and Cole Burston. 2021. "'There's Nothing Left in Lytton': The Canadian Village Destroyed by Wildfire – Picture Essay." *The Guardian*, July 25, 2021, sec. World news. https://www.theguardian.com/world/2021/jul/25/lytton-canada-heat-wildfire-record-temperatures.

Chen, Yu, S. Yusef Shafi, and Yi-fan Chen. 2020. "Simulation Pipeline for Traffic Evacuation in Urban Areas and Emergency Traffic Management Policy Improvements Through Case Studies." *Transportation Research Interdisciplinary Perspectives* 7: 100210. https://doi.org/10.1016/j.trip.2020.100210.

Christianson, Amy Cardinal, Tara K. McGee, and Whitefish Lake First Nation 459. 2019. "Wildfire Evacuation Experiences of Band Members of Whitefish Lake First Nation 459, Alberta, Canada." *Natural Hazards* 98 (1): 9–29. https://doi.org/10.1007/s11069-018-3556-9.

Christianson, Amy, Tara K. McGee, and Lorne L'Hirondelle. 2012. "Community Support for Wildfire Mitigation at Peavine Métis Settlement, Alberta, Canada." *Environmental Hazards* 11 (3): 177–193. https://doi.org/10.1080/17477891.2011.649710.

Christianson, Amy Cardinal, Colin Robert Sutherland, Faisal Moola, Noémie Gonzalez Bautista, David Young, and Heather MacDonald. 2022. "Centering Indigenous Voices: The Role of Fire in the Boreal Forest of North America." *Current Forestry Reports* 8 (3): 257–276. https://doi.org/10.1007/s40725-022-00168-9.

Ciriaco, Thayanne G. M., and Stephen D. Wong. 2022. "Review of Resilience Hubs and Associated Transportation Needs." *Transportation Research Interdisciplinary Perspectives* 16: 100697. https://doi.org/10.1016/j.trip.2022.100697.

Connett, David. 2021. "Tourists Rescued from Burning Med Resorts by Flotilla of Boats." *The Observer*, July 31, 2021, sec. World news. https://www.theguardian.com/world/2021/jul/31/tourists-rescued-mediterranean-beach-turkey-wildfires-heatwave.

Cote, Doug W., and Tara K. McGee. 2014. "An Exploration of Residents' Intended Wildfire Evacuation Responses in Mt. Lorne, Yukon, Canada." *The Forestry Chronicle* 90 (04): 498–502. https://doi.org/10.5558/tfc2014-100.

Country Fire Authority. 2023. "Community Fireguard." 2023. http://www.cfa.vic.gov.au/plan-prepare/your-local-area-info-and-advice/community-fireguard/community-fireguard.

Cova, Thomas J., Philip E. Dennison, and Frank A. Drews. 2011. "Modeling Evacuate versus Shelter-in-Place Decisions in Wildfires." *Sustainability*. https://doi.org/10.3390/su3101662.

Cova, Thomas J., Frank A. Drews, Laura K. Siebeneck, and Adrian Musters. 2009. "Protective Actions in Wildfires: Evacuate or Shelter-in-Place?" *Natural Hazards Review* 10 (4): 151–162. https://doi.org/10.1061/(ASCE)1527-6988(2009)10:4(151).

Cova, Thomas J., and Justin P. Johnson. 2002. "Microsimulation of Neighborhood Evacuations in the Urban–Wildland Interface." *Environment and Planning A: Economy and Space* 34 (12): 2211–2229. https://doi.org/10.1068/a34251.

Dastin, Jeffrey. 2017. "California Wildfire: Helicopter Saves 42 People, 5 Dogs and Cat from Brink - National | Globalnews.Ca." Global News. 2017. https://globalnews.ca/news/3798552/california-wildfire-helicopter-saves-42-people/.

De Graff, V. Jerome, and Alan J. Gallegos. 2012. "The Challenge of Improving Identification of Rockfall Hazard After Wildfires." *Environmental & Engineering Geoscience* 18 (4): 389–397. https://doi.org/10.2113/gseegeosci.18.4.389.

Donaldson, Daniel L., Manuel S. Alvarez-Alvarado, and Dilan Jayaweera. 2022. "Integration of Electric Vehicle Evacuation in Power System Resilience Assessment." *IEEE Transactions on Power Systems*, 1–12. https://doi.org/10.1109/TPWRS.2022.3206900.

Drinkwater, Rob. 2022. "Planes, Helicopters and Trains Help Close to 2,000 Flee Fire in Northern Manitoba." Winnipeg. July 18, 2022. https://winnipeg.ctvnews.ca/planes-helicopters-and-trains-help-close-to-2-000-flee-fire-in-northern-manitoba-1.5991955.

Dye, Alex W., John B. Kim, Andrew McEvoy, Fang Fang, and Karin L. Riley. 2021. "Evaluating Rural Pacific Northwest Towns for Wildfire Evacuation Vulnerability." *Natural Hazards* 107 (1): 911–935. https://doi.org/10.1007/s11069-021-04615-x.

Eavis, Peter, and Ivan Penn. 2019. "California Says PG&E Power Lines Caused Camp Fire That Killed 85." *The New York Times*, May 15, 2019, sec. Business. https://www.nytimes.com/2019/05/15/business/pge-fire.html.

Ellis, S., P. Kanowski, and R. J. Whelan. 2004. "National Inquiry on Bushfire Mitigation and Management."

Ergibi, Mohamed, and Hayley Hesseln. 2020. "Awareness and Adoption of FireSmart Canada: Barriers and Incentives." *Forest Policy and Economics* 119: 102271. https://doi.org/10.1016/j.forpol.2020.102271.

Erskine, Michael A., Scott J. Seipel, and Cayson R. Seipel. 2022. "Development of a Geospatial Agent- Based Simulation of Disaster Evacuations for Battery Electric Vehicle (BEV) Policy."

Faulkner, Hilary, Bonital McFarlane, L. Bonita, and Tara K. McGee. 2009. "Comparison of Homeowner Response to Wildfire Risk among Towns with and Without Wildfire Management." *Environmental Hazards* 8 (1): 38–51. https://doi.org/10.3763/ehaz.2009.0006.

Fawcett, William, Ignacio Robles Urquijo, Hannes Krieg, Martin Hughes, Lars Mikalsen, and Óscar Ramon Ramos Gutiérrez. 2015. "Cost and Environmental Evaluation of Flexible Strategies for a Highway Construction Project under Traffic Growth Uncertainty." https://ascelibrary-org.login.ezproxy.library.ualberta.ca/doi/epdf/10.1061%28ASCE%29IS.1943-555X.0000230.

FHWA. 2009. *Manual on Uniform Traffic Control Devices*.

Firehouse. 2015. "Australian Firefighters on Dirt Bikes Use Guns to Fight Wildfires." Firehouse. November 12, 2015. https://www.firehouse.com/tech-comm/video/12137802/firefighters-down-under-in-australia-use-guns-to-fight-wildfires.

Fitch-Polse, Dillon T., Chen Chen, and Stephen D. Wong. 2023. "Bicycles and Micromobility for Disaster Response and Recovery," May. https://escholarship.org/uc/item/3ks9k4pr.

Fragkos, Michael E., Vasileios Zeimpekis, Vasilis Koutras, and Ioannis Minis. 2022. "Supply Planning for Shelters and Emergency Management Crews." *Operational Research* 22 (1): 741–777. https://doi.org/10.1007/s12351-020-00557-7.

Fraser, Andrew M., Mikhail V. Chester, and B. Shane Underwood. 2022. "Wildfire Risk, Post-Fire Debris Flows, and Transportation Infrastructure Vulnerability." *Sustainable and Resilient Infrastructure* 7 (3): 188–200. https://doi.org/10.1080/23789689.2020.1737785.

French, Janet. 2016. "When Evacuation Was Ordered, Fort McMurray Principal Fled with Busload of Students." Edmontonjournal. May 2016. https://edmontonjournal.com/news/local-news/when-evacuation-was-ordered-mcmurray-principal-fled-with-busload-of-students.

French, Richard H., Julianne J. Miller, and Charles R. Dettling. 2005. "Estimating Playa Lake Flooding: Edwards Air Force Base, California, USA." *Journal of Hydrology* 306 (1): 146–160. https://doi.org/10.1016/j.jhydrol.2004.09.006.

Fuller, Thomas, and Richard Pérez-Peña. 2017. "In California, Fires So Fast Hesitation Proved Lethal." *The New York Times*, October 13, 2017, sec. U.S. https://www.nytimes.com/2017/10/13/us/california-wildfires-victims.html.

Gan, Heng-Soon, Kai-Florian Richter, Mingzheng Shi, and Stephan Winter. 2016. "Integration of Simulation and Optimization for Evacuation Planning." *Simulation Modelling Practice and Theory* 67: 59–73. https://doi.org/10.1016/j.simpat.2016.07.001.

Garnham, Jolie McCullough, and Juan Pablo. 2020. "As Hurricane Laura Heads for Southeast Texas, Officials Scramble to Evacuate and Shelter People During a Pandemic." The Texas Tribune. August 26, 2020. https://www.texastribune.org/2020/08/26/hurricane-laura-texas-coronavirus/.

Gold, Russell, Katherine Blunt, and Rebecca Smith. 2019. "PG&E Sparked at Least 1,500 California Fires. Now the Utility Faces Collapse." *Wall Street Journal*, January 13, 2019, sec. Business. https://www.wsj.com/articles/pg-e-sparked-at-least-1-500-california-fires-now-the-utility-faces-collapse-11547410768.

Golembo, Max, and Morgan Winsor. 2018. "Southern California Wildfires Paved the Way for Deadly Mudslides." ABC News. 2018. https://abcnews.go.com/US/southern-california-wildfires-paved-deadly-mudslides/story?id=52257400.

Grajdura, Sarah, Sachraa Borjigin, and Deb Niemeier. 2022. "Fast-Moving Dire Wildfire Evacuation Simulation." *Transportation Research Part D: Transport and Environment* 104: 103190. https://doi.org/10.1016/j.trd.2022.103190.

Grajdura, Sarah, Xiaodong Qian, and Deb Niemeier. 2021. "Awareness, Departure, and Preparation Time in No-Notice Wildfire Evacuations." *Safety Science* 139: 105258. https://doi.org/10.1016/j.ssci.2021.105258.

Gralow, Jill, and Sonali Paul. 2020. "Thousands Flee Fires in Australia, Navy Helps Evacuate the Stranded." *Reuters*, January 2, 2020, sec. Environment. https://www.reuters.com/article/us-australia-bushfires-idUSKBN1Z100O.

Greenwood Sustainability LLC. 2011. "Community Wildfire Protection Plan."

Guth, Johanna, Sven Wursthorn, Andreas Ch. Braun, and Sina Keller. 2019. "Development of a Generic Concept to Analyze the Accessibility of Emergency Facilities in Critical Road Infrastructure for Disaster Scenarios: Exemplary Application for the 2017 Wildfires in Chile and Portugal." *Natural Hazards* 97 (3): 979–999. https://doi.org/10.1007/s11069-019-03672-7.

Hankins, Don L. 2013. "The Effects of Indigenous Prescribed Fire on Riparian Vegetation in Central California." *Ecological Processes* 2 (1): 24. https://doi.org/10.1186/2192-1709-2-24.

Hooper, Craig. 2019. "Pushing Australians Into The Sea, Bushfires Showcase Australia's Gritty, Do-Anything Navy." Forbes. 2019. https://www.forbes.com/sites/craighooper/2020/01/05/pushing-australians-into-the-sea-bushfires-showcase-australias-gritty-do-anything-navy/.

Hou, Zenghao, Justin Darr, and Michael Zhang. 2022. "Predicting Traffic Performance During a Wildfire Using Machine Learning." *Transportation Research Record: Journal of the Transportation Research Board* 2677: 1625–1636. https://doi.org/10.1177/03611981221126509.

IFRC. 2022. "Sea-like Flood Waters Ravage Pakistan; Affecting Millions of People | IFRC." 2022. https://www.ifrc.org/press-release/sea-flood-waters-ravage-pakistan-affecting-millions-people.

Imbach, Romain, Manon Romain, and Pierre Breteau. 2022. "France's Unprecedented Summer of Wildfires, in Maps and Graphs." *Le Monde.Fr*, August 25, 2022. https://www.lemonde.fr/en/les-decodeurs/article/2022/08/25/fires-in-france-maps-and-graphs-to-visualize-an-unprecedented-summer_5994672_8.html.

Intini, Paolo, Enrico Ronchi, Steven Gwynne, and Adam Pel. 2019. "Traffic Modeling for Wildland–Urban Interface Fire Evacuation." *Journal of Transportation Engineering, Part A: Systems* 145 (3): 04019002. https://doi.org/10.1061/JTEPBS.0000221.

ISO. 2018. "ISO 23932-1:2018 Fire Safety Engineering — General Principles — Part 1: General." ISO. https://www.iso.org/standard/63933.html.

Jahn, Wolfram, James L. Urban, and Guillermo Rein. 2022. "Powerlines and Wildfires: Overview, Perspectives, and Climate Change: Could There Be More Electricity Blackouts in the Future?" *IEEE Power and Energy Magazine* 20 (1): 16–27. https://doi.org/10.1109/MPE.2021.3122755.

Jakes, Pamela J., and E. R. (Lisa) Langer. 2012. "The Adaptive Capacity of New Zealand Communities to Wildfire." *International Journal of Wildland Fire* 21 (6): 764. https://doi.org/10.1071/WF11086.

Jent, Breeanna. 2023. "Colorado Springs Planning Commission Recommends Approval of Master Transportation Plan." Colorado Springs Gazette. February 8, 2023. https://gazette.com/news/colorado-springs-planning-commission-recommends-approval-of-master-transportation-plan/article_6fd7fbbc-a7e6-11ed-b8a1-97fc1a01ac7b.html.

Jin, Yufang, Michael L. Goulden, Nicolas Faivre, Sander Veraverbeke, Fengpeng Sun, Alex Hall, Michael S. Hand, Simon Hook, and James T. Randerson. 2015. "Identification of Two Distinct Fire Regimes in Southern California: Implications for Economic Impact and Future Change." *Environmental Research Letters* 10 (9): 094005. https://doi.org/10.1088/1748-9326/10/9/094005.

Jordan, Peter. 2015. "Post-Wildfire Debris Flows in Southern British Columbia, Canada." *International Journal of Wildland Fire* 25 (3): 322–336. https://doi.org/10.1071/WF14070.

Kearns, Christopher James. 2017. "The Fort McMurray Wildfire 2016: Risk Perceptions and Behaviours Among Evacuees." Sc.D., Alabama, US: Jacksonville State University. https://www.proquest.com/docview/2516915392/abstract/A4144755413345B1PQ/1.

Kirsch, Katie R., Bonnie A. Feldt, David F. Zane, Tracy Haywood, Russell W. Jones, and Jennifer A. Horney. 2016. "Longitudinal Community Assessment for Public Health Emergency Response to Wildfire, Bastrop County, Texas." *Health Security* 14 (2): 93–104. https://doi.org/10.1089/hs.2015.0060.

Kourmpa, Efthymia, and Stefanos Tsigdinos. 2020. "Detection Of Fire-Prone Areas In Attica Region Integrating Urban And Transport Aspect." *Geography, Environment, Sustainability* 13 (3): 84–89. https://doi.org/10.24057/2071-9388-2019-148.

KPMG. 2017. "May 2016 Wood Buffalo Wildfire - Post Indicident Assement Report." Alberta Emergency Management Agency. https://open.alberta.ca/dataset/accfd27e-5e08-4f6c-8cd9-188be0e1e1b2/resource/541f276f-2fb4-4789-a41f-ef5ce7c0eec5/download/2016-wildfire-kpmg-report.pdf.

Krutein, Klaas Fiete, Jennifer McGowan, and Anne Goodchild. 2022. "Evacuating Isolated Islands with Marine Resources: A Bowen Island Case Study." *International Journal of Disaster Risk Reduction* 72: 102865. https://doi.org/10.1016/j.ijdrr.2022.102865.

Kuligowski, Erica. 2021. "Evacuation Decision-Making and Behavior in Wildfires: Past Research, Current Challenges and a Future Research Agenda." *Fire Safety Journal* 120: 103129. https://doi.org/10.1016/j.firesaf.2020.103129.

Kuligowski, Erica D., Xilei Zhao, Ruggiero Lovreglio, Ningzhe Xu, Kaitai Yang, Aaron Westbury, Daniel Nilsson, and Nancy Brown. 2022. "Modeling Evacuation Decisions in the 2019 Kincade Fire in California." Safety Science 146: 105541. https://doi.org/10.1016/j.ssci.2021.105541.

Kurjata, Andrew. 2017. "'3 Days of Chaos': Backcountry Campers Escape Wildfire by Boat and Foot on B.C.'s Bowron Lakes | CBC News." CBC. July 18, 2017. https://www.cbc.ca/news/canada/british-columbia/3-days-of-chaos-backcountry-campers-escape-wildfire-by-boat-and-foot-on-b-c-s-bowron-lakes-1.4210882.

Kurowski, Matt, and Allan Bradley. 2022. "Wildfire Risk to Resource Roads in British Columbia." TR2022N38.

Kwon, Tae J., and Liping Fu. 2013. "Evaluation of Alternative Criteria for Determining the Optimal Location of RWIS Stations." *Journal of Modern Transportation* 21 (1): 17–27. https://doi.org/10.1007/s40534-013-0008-9.

Lainas, Spyridon, Nikolaos Depountis, and Nikolaos Sabatakakis. 2021. "Preliminary Forecasting of Rainfall-Induced Shallow Landslides in the Wildfire Burned Areas of Western Greece." *Land* 10 (8): 877. https://doi.org/10.3390/land10080877.

Lancaster, Jeremy T., Brian J. Swanson, Stefani G. Lukashov, Nina S. Oakley, Jacob B. Lee, Eleanor R. Spangler, Janis L. Hernandez, et al., 2021. "Observations and Analyses of the 9 January 2018 Debris-Flow Disaster, Santa Barbara County, California." *Environmental and Engineering Geoscience* 27 (1): 3–27. https://doi.org/10.2113/EEG-D-20-00015.

Lessan, Javad, and Amy M. Kim. 2022. "Planning Evacuation Orders Under Evacuee Compliance Uncertainty." *Safety Science* 156 (December): 105894. https://doi.org/10.1016/j.ssci.2022.105894.

Lewis, Sukey. 2018. "Inside the CHP Helicopter That Rescued 26 People from the Atlas Peak Fire." KQED. March 6, 2018. https://www.kqed.org/news/11653959/inside-the-chp-helicopter-that-rescued-dozens-from-the-atlas-peak-fire.

Li, Rui, and Mikhail V. Chester. 2023. "Vulnerability of California Roadways to Post-Wildfire Debris Flows." *Environmental Research: Infrastructure and Sustainability* 3 (1): 015003. https://doi.org/10.1088/2634-4505/acb3f5.

Li, Dapeng, Thomas J. Cova, and Philip E. Dennison. 2019. "Setting Wildfire Evacuation Triggers by Coupling Fire and Traffic Simulation Models: A Spatiotemporal GIS Approach." *Fire Technology* 55 (2): 617–642. https://doi.org/10.1007/s10694-018-0771-6.

Lindell, Michael K., Jung Eun Kang, and Carla S. Prater. 2011. "The Logistics of Household Hurricane Evacuation." *Natural Hazards* 58 (3): 1093–1109. https://doi.org/10.1007/s11069-011-9715-x.

Lovreglio, Ruggiero, Erica Kuligowski, Steve Gwynne, and Ken Strahan. 2019. "A Modelling Framework for Householder Decision-Making for Wildfire Emergencies." *International Journal of Disaster Risk Reduction* 41 (December): 101274. https://doi.org/10.1016/j.ijdrr.2019.101274.

MacDonald, Craig David, Lina Kattan, and David Layzell. 2021. "Modelling Electric Vehicle Charging Network Capacity and Performance During Short-Notice Evacuations." *International Journal of Disaster Risk Reduction* 56: 102093. https://doi.org/10.1016/j.ijdrr.2021.102093.

Mahajan, Kasturi, and Amy M. Kim. 2020. "Vulnerability Assessment of Alberta's Provincial Highway Network." *Transportation Research Interdisciplinary Perspectives* 6: 100171. https://doi.org/10.1016/j.trip.2020.100171.

Maranghides, Alexander, William Mell, Karen Ridenour, and Derek McNamara. 2014. "Initial Reconnaissance of the 2011 Wildland-Urban Interface Fires in Amarillo, Texas." *Fire Technology* 50 (1): 93–104. https://doi.org/10.1007/s10694-012-0287-4.

Matear, David. 2017. "The Fort McMurray, Alberta Wildfires: Emergency and Recovery Management of Healthcare Services." *Journal of Business Continuity & Emergency Planning* 11 (2): 128–150.

Matherly, Deborah, Neeli Langdon, Brian Wolshon, Pamela Murray-Tuite, John Renne, Roberta Thomas, Jane Mobley, et al., 2014. "*A Guide to Regional Transportation Planning for Disasters, Emergencies, and Significant Events*." Washington, D.C.: Transportation Research Board. https://doi.org/10.17226/22338.

McCaffrey, Sarah M., and Alan Rhodes. 2009. "Public Response to Wildfire: Is the Australian "Stay and Defend or Leave Early" Approach an Option for Wildfire Management in the United States?" *Journal of Forestry* 107 (1): 9–15. https://doi.org/10.1093/jof/107.1.9

McCaffrey, Sarah, Robyn Wilson, and Avishek Konar. 2018. "Should I Stay or Should I Go Now? Or Should I Wait and See? Influences on Wildfire Evacuation Decisions." *Risk Analysis* 38 (7): 1390–1404. https://doi.org/10.1111/risa.12944.

McGee, Tara K. 2021. "Evacuating First Nations During Wildfires in Canada." *Fire Safety Journal*, 120: 103120. https://doi.org/10.1016/j.firesaf.2020.103120.

McGee, Tara K., Amy Cardinal Christianson, and First Nations Wildfire Evacuation Partnership. 2021. *First Nations Wildfire Evacuations: A Guide for Communities and External Agencies*. Purich Books. Vancouver: UBC Press.

McGee, Tara K., Mishkeegogamang Ojibway Nation, and Amy Cardinal Christianson. 2019. "Residents' Wildfire Evacuation Actions in Mishkeegogamang Ojibway Nation, Ontario, Canada." *International Journal of Disaster Risk Reduction* 33: 266–274. https://doi.org/10.1016/j.ijdrr.2018.10.012.

McLennan, Jim, Barbara Ryan, Chris Bearman, and Keith Toh. 2019. "Should We Leave Now? Behavioral Factors in Evacuation Under Wildfire Threat." *Fire Technology* 55 (2): 487–516. https://doi.org/10.1007/s10694-018-0753-8.

Melendez, Benjamin, Sahar Ghanipoor Machiani, and Atsushi Nara. 2021. "Modelling Traffic During Lilac Wildfire Evacuation Using Cellular Data." *Transportation Research Interdisciplinary Perspectives* 9: 100335. https://doi.org/10.1016/j.trip.2021.100335.

Menon, Nikhil, Brian Staes, Robert L. Bertini, Equity Center for Transportation Decisions & Dollars (CTEDD). University of Texas, and University of Texas at Arlington. 2020. "Measuring Transportation Network Performance During Emergency Evacuations: A Case Study of Hurricane Irma and Woolsey Fire." https://rosap.ntl.bts.gov/view/dot/54690.

Metcalfe, Bill. 2021. "BC Transit and SD8 Could Provide Buses for Possible Nelson Wildfire Evacuation - Today In BC." August 12, 2021. https://www.todayinbc.com/news/bc-transit-and-sd8-could-provide-buses-for-possible-nelson-wildfire-evacuation/.

Meyer, Michael D. 2016. *Transportation Planning Handbook*. Wiley.

Mojtahedi, Mohammad, Sidney Newton, and Jason Von Meding. 2017. "Predicting the Resilience of Transport Infrastructure to a Natural Disaster Using Cox's Proportional Hazards Regression Model." *Natural Hazards* 85 (2): 1119–1133. https://doi.org/10.1007/s11069-016-2624-2.

Moody, John A., and Brian A. Ebel. 2012. "Hyper-Dry Conditions Provide New Insights Into the Cause of Extreme Floods After Wildfire." *CATENA* 93: 58–63. https://doi.org/10.1016/j.catena.2012.01.006.

Mottershead, Kyla D., Tara K. McGee, and Amy Christianson. 2020. "Evacuating a First Nation Due to Wildfire Smoke: The Case of Dene Tha' First Nation." *International Journal of Disaster Risk Science* 11 (3): 274–286. https://doi.org/10.1007/s13753-020-00281-y.

Nader, G., and M. De Lasaux. 2015. "UC Cooperative Extension Works with Fire Safe Councils to Reduce Wildfires." *California Agriculture* 69 (1): 57–63. https://doi.org/10.3733/ca.v069n01p57

NFPA. 2022. "NFPA - Firewise USA®." 2022. https://www.nfpa.org/Public-Education/Fire-causes-and-risks/Wildfire/Firewise-USA.

Nihad, Ghalib. 2022. "Iranian Firefighting Aircraft to Join Operation as Balochistan Forest Inferno Rages On." DAWN.COM. 2022. https://www.dawn.com/news/1691111.

Niu, Chence, Divya Jayakumar Nair, Tingting Zhang, Vinayak Dixit, and Pamela Murray-Tuite. 2022. "Are Wildfire Fatalities Related to Road Network Characteristics? A Preliminary Analysis of Global Wildfire Cases." *International Journal of Disaster Risk Reduction* 80: 103217. https://doi.org/10.1016/j.ijdrr.2022.103217.

Ohi, Sabrena Jahan, and Amy M. Kim. 2021. "Identifying Critical Corridors During an Area-Wide Disruption by Evaluating Network Bottleneck Capacity." *International Journal of Disaster Risk Reduction* 64: 102487. https://doi.org/10.1016/j.ijdrr.2021.102487.

Oloriz, Margaret, Shreyas Vangala, and Audrey Sadowicz. 2022. "Electric Vehicle Adoption and Grid Emergency Preparedness." *Climate and Energy* 38 (8): 1–11. https://doi.org/10.1002/gas.22275.

Ortega-Becerril, José A., Julio Garrote, Álvaro Vicente, and María José Marqués. 2022. "Wildfire-Induced Changes in Flood Risk in Recreational Canyoning Areas: Lessons from the 2017 Jerte Canyons Disaster." *Water* 14 (15): 2345. https://doi.org/10.3390/w14152345.

Pande, Anurag, and Brian Wolshon, eds. 2016. *Traffic Engineering Handbook*. 7th ed. Hoboken, New Jersey: Wiley.

Parr, Scott A., Lorraine M. Acevedo, Pamela Murray-Tuite, and Brian Wolshon. 2022. "Methodology to Quantify Statewide Evacuations." *Transportation Research Record: Journal of the Transportation Research Board* 2676 (2): 775–787. https://doi.org/10.1177/03611981211046922.

Parr, Scott A., Brian Wolshon, and Pamela Murray-Tuite. 2016. "Unconventional Intersection Control Strategies for Urban Evacuation." *Transportation Research Record: Journal of the Transportation Research Board* 2599 (1): 52–62. https://doi.org/10.3141/2599-07.

Partners in Protection. 2003. "FireSmart - Protecting Your Community from Wildfire."

Paveglio, Travis B., Amanda D. Boyd, and Matthew S. Carroll. 2012. "Wildfire Evacuation and Its Alternatives in a Post-Black Saturday Landscape: Catchy Slogans and Cautionary Tales." *Environmental Hazards* 11 (1): 52–70. https://doi.org/10.1080/17477891.2011.635185.

Paveglio, Travis B., Matthew S. Carroll, and Pamela J. Jakes. 2010. "Alternatives to Evacuation During Wildland Fire: Exploring Adaptive Capacity in One Idaho Community." *Environmental Hazards* 9 (4): 379–394. https://doi.org/10.3763/ehaz.2010.0060.

Paveglio, Travis, Tony Prato, Douglas Dalenberg, Tyron Venn, and Tyron Venn. 2014. "Understanding Evacuation Preferences and Wildfire Mitigations among Northwest Montana Residents." *International Journal of Wildland Fire* 23 (3): 435–444. https://doi.org/10.1071/WF13057.

Pel, Adam J., Michiel C. J. Bliemer, and Serge P. Hoogendoorn. 2012. "A Review on Travel Behaviour Modelling in Dynamic Traffic Simulation Models for Evacuations." *Transportation* 39 (1): 97–123. https://doi.org/10.1007/s11116-011-9320-6.

Pérez, Juan, Sebastián Maldonado, and Héctor López-Ospina. 2016. "A Fleet Management Model for the Santiago Fire Department." *Fire Safety Journal* 82: 1–11. https://doi.org/10.1016/j.firesaf.2016.02.008.

Porter, Ryan, Taylor Joyal, Rebecca Beers, Joseph Loverich, Aubrey LaPlante, John Spruell, Ann Youberg, Edward Schenk, Peter R. Robichaud, and Abraham E. Springer. 2021. "Seismic Monitoring of Post-Wildfire Debris Flows Following the 2019 Museum Fire, Arizona." *Frontiers in Earth Science* 9. https://doi.org/10.3389/feart.2021.649938.

Press, The Associated. 2022. "California's Biggest Wildfire This Year Forces Forcing Thousands of Residents to Flee | CBC News." CBC. July 25, 2022. https://www.cbc.ca/news/world/oak-fire-california-yosemite-national-park-1.6530814.

Purba, Denissa Sari Darmawi, Eleftheria Kontou, and Chrysafis Vogiatzis. 2022. "Evacuation Route Planning for Alternative Fuel Vehicles." *Transportation Research Part C: Emerging Technologies* 143: 103837. https://doi.org/10.1016/j.trc.2022.103837.

Quarles, Stephen L., Yana Valachovic, Gary M. Nakamura, Glenn A. Nader, and Michael J. de Lasaux. 2010. "Home Survival in Wildfire-Prone Areas: Building Materials and Design Considerations," May. https://doi.org/10.3733/ucanr.8393.

Rengers, Francis K., Luke A. McGuire, Nina S. Oakley, Jason W. Kean, Dennis M. Staley, and Hui Tang. 2020. "Landslides After Wildfire: Initiation, Magnitude, and Mobility." *Landslides* 17 (11): 2631–2641. https://doi.org/10.1007/s10346-020-01506-3.

Renne, John L., and Estefania Mayorga. 2022. "What Has America Learned Since Hurricane Katrina? Evaluating Evacuation Plans for Carless and Vulnerable Populations in 50 Large Cities Across the United States." *International Journal of Disaster Risk Reduction* 80: 103226. https://doi.org/10.1016/j.ijdrr.2022.103226.

Resort Municipality of Whistler and and District of Squamish. 2019. Sea to Sky Multimodal Evacuation Plan."

Richter, Edward G., Erica C. Fischer, Amy Metz, and Brad P. Wham. 2022. "Simulation of Heat Transfer Through Soil for the Investigation of Wildfire Impacts on Buried Pipelines." *Fire Technology* 58 (4): 1889–1915. https://doi.org/10.1007/s10694-022-01232-3.

Rodrigues, Andreia, Aldina Santiago, Rural Fires—Causes of Human Losses in the 2017 Fires in Portugal. 2022. "Rural Fires—Causes of Human Losses in the 2017 Fires in Portugal." *Applied Sciences* 12 (24): 12561. https://doi.org/10.3390/app122412561.

Romo, Vanessa. 2019. "With Blackouts, California's Electric Car Owners Are Finding New Ways To Charge Up." *NPR*, November 8, 2019, sec. Business. https://www.npr.org/2019/11/08/777752175/with-blackouts-californias-electric-car-owners-are-finding-new-ways-to-charge-up.

Ronchi, Enrico, Wong, Stephen, Suzuki, Sayaka, Theodori, Maria, Wadhwani, Rahul, Vaiciulyte, Sandra, Gwynne, Steve, et al., 2021. "Case Studies of Large Outdoor Fires Involving Evacuations." Zenodo. https://doi.org/10.5281/ZENODO.4504853.

Rosato, Joe. 2018. "Mother of Children Lost in North Bay Wildfire Begins Long Recovery." *NBC Bay Area* (blog). October 9, 2018. https://www.nbcbayarea.com/news/local/mother-of-children-lost-in-north-bay-wildfire-begins-long-recovery/206695/.

Roy, Eleanor Ainge, and Eleanor de Jong. 2020. "New Zealand Bushfires Flare amid Fears Country Becoming More 'Flammable.'" *The Guardian*, January 7, 2020, sec. World news. https://www.theguardian.com/world/2020/jan/07/new-zealand-bushfires-flare-amid-fears-country-becoming-more-flammable.

Sallinger, Marc. 2022. "School Bus Drivers Braved the Flames for Marshall Fire Evacuations." KUSA.Com. February 9, 2022. https://www.9news.com/article/news/local/marshall-fire-school-bus-drivers-help-evacuate/73-6650981d-e100-40fd-9eac-e62b0eeb6f99.

Sampson, Hannah. 2023. "How Airlines Are Helping People Flee Maui Wildfires." *Washington Post*, August 11, 2023. https://www.washingtonpost.com/travel/2023/08/10/airlines-maui-wildfires-flights/.

Sfetsos, Athanasios, Frederique Giroud, Alice Clemencau, Vassiliki Varela, Catherine Freissinet, Jean LeCroart, Diamando Vlachogiannis, et al. 2021. "Assessing the Effects of Forest Fires on Interconnected Critical Infrastructures Under Climate Change. Evidence from South France." *Infrastructures* 6 (2): 16. https://doi.org/10.3390/infrastructures6020016.

Sgqolana, Tembile. 2021. "OUR BURNING PLANET: The Burning Season: Wildfires Sweeping Across South Africa and Namibia Have Left Devastation in Their Wake." Daily Maverick. October 4, 2021. https://www.dailymaverick.co.za/article/2021-10-04-the-burning-season-wildfires-sweeping-across-south-africa-and-namibia-have-left-devastation-in-their-wake/.

Shahabi, Kaveh, and John P. Wilson. 2018. "Scalable Evacuation Routing in a Dynamic Environment." *Computers, Environment and Urban Systems* 67: 29–40. https://doi.org/10.1016/j.compenvurbsys.2017.08.011.

Shahparvari, Shahrooz, and Babak Abbasi. 2017. "Robust Stochastic Vehicle Routing and Scheduling for Bushfire Emergency Evacuation: An Australian Case Study." *Transportation Research Part A: Policy and Practice* 104: 32–49. https://doi.org/10.1016/j.tra.2017.04.036.

Shahparvari, Shahrooz, Babak Abbasi, and Prem Chhetri. 2017. "Possibilistic Scheduling Routing for Short-Notice Bushfire Emergency Evacuation Under Uncertainties: An Australian Case Study." *Omega* 72: 96–117. https://doi.org/10.1016/j.omega.2016.11.007.

Shahparvari, Shahrooz, Babak Abbasi, Prem Chhetri, and Ahmad Abareshi. 2019. "Fleet Routing and Scheduling in Bushfire Emergency Evacuation: A Regional Case Study of the Black Saturday Bushfires in Australia." *Transportation Research Part D: Transport and Environment* 67: 703–722. https://doi.org/10.1016/j.trd.2016.11.015.

Shahparvari, Shahrooz, Behrooz Bodaghi, Iman Roozbeh, Mahsa Mohammadi, Hamed Soleimani, and Prem Chhetri. 2021. "A Cooperative (or Coordinated) Multi-Agency Response to Enhance the Effectiveness of Aerial Bushfire Suppression Operations." *International Journal of Disaster Risk Reduction* 61: 102352. https://doi.org/10.1016/j.ijdrr.2021.102352.

Shahparvari, Shahrooz, Prem Chhetri, Babak Abbasi, and Ahmad Abareshi. 2016. "Enhancing Emergency Evacuation Response of Late Evacuees: Revisiting the Case of Australian Black Saturday Bushfire." *Transportation Research Part E: Logistics and Transportation Review* 93: 148–176. https://doi.org/10.1016/j.tre.2016.05.010.

Siam, M. R. K., Haizhong Wang, Michael K. Lindell, Chen Chen, Eleni I. Vlahogianni, and Kay Axhausen. 2022. "An Interdisciplinary Agent-Based Multimodal Wildfire Evacuation Model: Critical Decisions and Life Safety." *Transportation Research Part D: Transport and Environment: Transport and Environment* 103: 103147. https://doi.org/10.1016/j.trd.2021.103147.

Slowikowski, Susan, and Judy Motion. 2021. "Unlocking Meaning of Embodied Memories from Bushfire Survivors." *The Oral History Review* 48 (1): 83–99. https://doi.org/10.1080/00940798.2020.1866954.

Smith, Helena. 2019. "'In My Nightmares I'm Always in the Sea': A Year on from the Greek Fires." *The Guardian*, July 20, 2019, sec. World news. https://www.theguardian.com/world/2019/jul/20/greek-fires-one-year-on-103-dead-survivors-and-rescuers-look-back.

Soga, Kenichi, Louise Comfort, Bingyu Zhao, Paola Lorusso, and Sena Soysal. 2021. "Integrating Traffic Network Analysis and Communication Network Analysis at a Regional Scale to Support More Efficient Evacuation in Response to a Wildfire Event," May. https://doi.org/10.7922/G21G0JJ7.

South Florida Times. 2017. "Broward Transit Took Residents to Safety During Hurricane Irma." *South Florida Times* (Blog). 2017. https://www.sfltimes.com/news/local/broward-transit-took-residents-to-safety-during-hurricane-irma.

Spayne, Rebecca Morpeth. 2021. "Wildfire Communication Challenges." *Fire Buyer International* (blog). October 13, 2021. https://firebuyer.com/wildfire-communication-challenges/.

Steer, Kent, Ermyas Abebe, Mahathir Almashor, Anton Beloglazov, and Xu Zhong. 2017. "On the Utility of Shelters in Wildfire Evacuations." *Fire Safety Journal* 94: 22–32. https://doi.org/10.1016/j.firesaf.2017.09.001.

Strickland, Patrick. 2018. "Greece Wildfires: 'These Are Images I'Ll Never Forget.'" July 25, 2018. https://www.aljazeera.com/news/2018/7/25/greece-wildfires-survivors-of-deadly-blazes-dig-through-wreckage.

Sullivan, Patrick R., Michael J. Campbell, Philip E. Dennison, Simon C. Brewer, and Bret W. Butler. 2020. "Modeling Wildland Firefighter Travel Rates by Terrain Slope: Results from GPS-Tracking of Type 1 Crew Movement." *Fire* 3 (3): 52. https://doi.org/10.3390/fire3030052.

Thériault, Laura, Geneviève Belleville, Marie-Christine Ouellet, and Charles M. Morin. 2021. "The Experience and Perceived Consequences of the 2016 Fort McMurray Fires and Evacuation." *Frontiers in Public Health* 9. https://doi.org/10.3389/fpubh.2021.641151.

Thompson, Laurel. 2016. "Canadian Wildland Fire Strategy: A 10-Year Review and Renewed Call to Action," no. Canadian Council of Forest Ministers.

Thorne, James H., Ryan M. Boynton, Allan D. Hollander, Jason P. Whitney, and Kristen D. Shapiro. 2021. "2020 Critical Update to Caltrans Wildfire Vulnerability Analysis," July. https://doi.org/10.7922/G2N29V7S.

Tiwari, Binod, Beena Ajmera, Anthony Gonzalez, and Hashem Sonbol. 2020. "Impact of Wildfire on Triggering Mudslides—A Case Study of 2018 Montecito Debris Flows." In Geo-Congress 2020: Engineering, Monitoring, and Management of Geotechnical Infrastructure (GSP 316), 40–49. https://doi.org/10.1061/9780784482797.00.

Urbina, Elba, and Brian Wolshon. 2003. "National Review of Hurricane Evacuation Plans and Policies: A Comparison and Contrast of State Practices." *Transportation Research Part A: Policy and Practice* 37 (3): 257–275. https://doi.org/10.1016/S0965-8564(02)00015-0.

Vaiciulyte, Sandra, Edwin R. Galea, Anand Veeraswamy, and Lynn M. Hulse. 2019. "Island Vulnerability and Resilience to Wildfires: A Case Study of Corsica." *International Journal of Disaster Risk Reduction* 40: 101272. https://doi.org/10.1016/j.ijdrr.2019.101272.

Vaiciulyte, Sandra, Lynn M. Hulse, Edwin R. Galea, and Anand Veeraswamy. 2022. "Exploring 'Wait and See' Responses in French and Australian WUI Wildfire Emergencies." *Safety Science* 155: 105866. https://doi.org/10.1016/j.ssci.2022.105866.

Valentin, Vanessa, John Stormont, and University of New Mexico. Department of Civil Engineering. Hydraulics Laboratory. 2019. "Evaluating Post-Wildfire Flood Impacts on Transportation Infrastructure for Mitigation Planning." SPTC15.1-50-F. https://rosap.ntl.bts.gov/view/dot/55580.

Vera, Amir, Eric Levenson, Jason Hanna, and Nouran Salahieh. 2022. "Hurricane Ian Continues to Batter Florida as a Category 1 Storm While Officials Warn the Worst Is yet to Come." CNN. September 28, 2022. https://www.cnn.com/2022/09/28/weather/hurricane-ian-florida-path-wednesday/index.html.

Vespaziani, Leni.. 2019. "Best Practices in Wildfire Mass Evacuation Planning." G. Graduate Research [Non-Thesis]. https://doi.org/10.14288/1.0387296.

Vitali, Javiera Loyola, María-Cristina Riff, and Elizabeth Montero. 2017. "Bus Routing for Emergency Evacuations: The Case of the Great Fire of Valparaiso." In 2017 IEEE Congress on Evolutionary Computation (CEC), 2346–2353. https://doi.org/10.1109/CEC.2017.7969589.

Vonberg, Judith, Melissa Bell, Saskya Vandoorne, 2018. "Cars Turn to Molten Metal as Greek Wildfires Wipe Villages off the Map." CNN. July 25, 2018. https://www.cnn.com/2018/07/25/europe/greece-wildfires-missing-intl/index.html.

Wahlqvist, Jonathan, Enrico Ronchi, Steven M. V. Gwynne, Max Kinateder, Guillermo Rein, Harry Mitchell, Noureddine Bénichou, Chunyun Ma, Amanda Kimball, and Erica Kuligowski. 2021. "The Simulation of Wildland-Urban Interface Fire Evacuation: The WUI-NITY Platform." *Safety Science* 136: 105145. https://doi.org/10.1016/j.ssci.2020.105145.

Wang, Ding, Kaan Ozbay, and Zilin Bian. 2021. "Modeling and Analysis of Optimal Strategies for Leveraging Ride-Sourcing Services in Hurricane Evacuation." *Sustainability* 13 (8): 4444. https://doi.org/10.3390/su13084444.

West, Vincent. 2022. "Unseasonal Heat Sparks Dozens of Wildfires in Spain." *Reuters*, October 28, 2022, sec. Europe. https://www.reuters.com/world/europe/unseasonal-heat-sparks-dozens-wildfires-spain-2022-10-28/.

Whittaker, Joshua, Katharine Haynes, John Handmer, and Jim McLennan. 2013. "Community Safety During the 2009 Australian 'Black Saturday' Bushfires: An Analysis of Household Preparedness and Response." *International Journal of Wildland Fire* 22 (6): 841–849. https://doi.org/10.1071/WF12010.

Whitworth, Alex. 2022. "Off-Road Bikers Help Chinese Authorities Contain Wildfires in Chongqing." Visordown. 2022. https://www.visordown.com/news/moto/road-bikers-help-chinese-authorities-contain-wildfires-chongqing.

Williamson, Lorraine. 2022. "Damage to Roads, Lightning and Flooding in Southern Spain." *InSpain.News* (blog). December 10, 2022. https://inspain.news/damage-to-roads-lightning-and-flooding-in-southern-spain/.

Wilmot, Chester G., Ravindra Gudishala, Louisiana Transportation Research Center, and Louisiana State University. Dept. of Civil and Environmental Engineering. 2013. "Development of a Time-Dependent Hurricane Evacuation Model for the New Orleans Area." FHWA/LA.12/494. https://rosap.ntl.bts.gov/view/dot/25769.

Wolshon, Brian, and Emile Marchive. 2007. "Emergency Planning in the Urban-Wildland Interface: Subdivision-Level Analysis of Wildfire Evacuations." *Journal of Urban Planning and Development* 133 (1): 73–81. https://doi.org/10.1061/(ASCE)0733-9488(2007)133:1(73).

Wong, Stephen D. 2020. "Compliance, Congestion, and Social Equity: Tackling Critical Evacuation Challenges through the Sharing Economy, Joint Choice Modeling, and Regret Minimization."

Wong, Stephen D., Jacquelyn C. Broader, and Susan A. Shaheen. 2020a. "Review of California Wildfire Evacuations from 2017 to 2019," March. https://doi.org/10.7922/G29G5K2R.

Wong, Stephen D., Jacquelyn C. Broader, and Susan A. Shaheen. 2020b. "Can Sharing Economy Platforms Increase Social Equity for Vulnerable Populations in Disaster Response and Relief? A Case Study of the 2017 and 2018 California Wildfires." *Transportation Research Interdisciplinary Perspectives* 5: 100131. https://doi.org/10.1016/j.trip.2020.100131.

Wong, Stephen D., Jacquelyn C. Broader, and Susan A. Shaheen. 2022. "Power Trips: Early Understanding of Preparedness and Travel Behavior During California Public Safety Power Shutoff Events." *Transportation Research Record: Journal of the Transportation Research Board* 2676 (7): 395–410. https://doi.org/10.1177/03611981221078569.

Wong, Stephen D., Jacquelyn C. Broader, Joan L. Walker, and Susan A. Shaheen. 2022. "Understanding California Wildfire Evacuee Behavior and Joint Choice Making." *Transportation*, 50: 1165–1211. https://doi.org/10.1007/s11116-022-10275-y.

Wong, Stephen D., Caspar G. Chorus, Susan A. Shaheen, and Joan L. Walker. 2020. "A Revealed Preference Methodology to Evaluate Regret Minimization with Challenging Choice Sets: A Wildfire Evacuation Case Study." *Travel Behaviour and Society* 20: 331–347. https://doi.org/10.1016/j.tbs.2020.04.003.

Wong, Stephen D., Ian Martin, and Jeremy Halpern. 2020. "Kensington Evacuation Planning Final Report."

Wong, Stephen D., Susan A. Shaheen, and Joan L. Walker. 2018. "Understanding Evacuee Behavior: A Case Study of Hurricane Irma." https://doi.org/10.7922/G2FJ2F00.

Wong, Stephen D., Joan L. Walker, and Susan A. Shaheen. 2021. "Trust and Compassion in Willingness to Share Mobility and Sheltering Resources in Evacuations: A Case Study of the 2017 and 2018 California Wildfires." *International Journal of Disaster Risk Reduction* 52: 101900. https://doi.org/10.1016/j.ijdrr.2020.101900.

Wong, Stephen D., Mengqiao Yu, Anu Kuncheria, Susan A. Shaheen, and Joan L. Walker. 2022. "Willingness of Hurricane Irma Evacuees to Share Resources: A Multi-Modeling Approach." *Transportmetrica A: Transport Science* 19 (0): 1–36. https://doi.org/10.1080/23249935.2021.2017064.

Woo, Matthew, Tin Kathy, Ying Hui, Kexin Ren, Kai Ernn Gan, and Amy Kim. 2017. "Reconstructing an Emergency Evacuation by Ground and Air the Wildfire in Fort McMurray, Alberta, Canada." *Transportation Research Record: Journal of the Transportation Research Board* 2604 (1): 63–70. https://doi.org/10.3141/2604-08.

Wu, Hao-Che, Michael K. Lindell, and Carla S. Prater. 2012. "Logistics of Hurricane Evacuation in Hurricanes Katrina and Rita." *Transportation Research Part F: Traffic Psychology and Behaviour* 15 (4): 445–461. https://doi.org/10.1016/j.trf.2012.03.005.

Wu, Alex, Xiang Yan, Erica Kuligowski, Ruggiero Lovreglio, Daniel Nilsson, Thomas J. Cova, Yiming Xu, and Xilei Zhao. 2022. "Wildfire Evacuation Decision Modeling Using GPS Data." *International Journal of Disaster Risk Reduction* 83: 103373. https://doi.org/10.1016/j.ijdrr.2022.103373.

Yang, Yupeng, Kai Zhang, Houbing Song, and Dahai Liu. 2021. "Machine Learning-Enabled Adaptive Air Traffic Recommendation System for Disaster Evacuation." In *2021 IEEE/AIAA 40th Digital Avionics Systems Conference (DASC)*, 1–8. https://doi.org/10.1109/DASC52595.2021.9594435.

Zhao, Bingyu, and Stephen D. Wong. 2021. "Developing Transportation Response Strategies for Wildfire Evacuations via an Empirically Supported Traffic Simulation of Berkeley, California." *Transportation Research Record: Journal of the Transportation Research Board* 2675 (12): 557–582. https://doi.org/10.1177/03611981211030271.

Zhao, Xilei, Yiming Xu, Ruggiero Lovreglio, Erica Kuligowski, Daniel Nilsson, Thomas J. Cova, Alex Wu, and Xiang Yan. 2022. "Estimating Wildfire Evacuation Decision and Departure Timing Using Large-Scale GPS Data." *Transportation Research Part D: Transport and Environment* 107: 103277. https://doi.org/10.1016/j.trd.2022.103277.

International Journal of
Environmental Research and Public Health

MDPI

Review

Wildfires and Older Adults: A Scoping Review of Impacts, Risks, and Interventions

Colleen Cummings Melton, Carson M. De Fries, Rebecca M. Smith and Lisa Reyes Mason *

Graduate School of Social Work, University of Denver, Denver, CO 80210, USA;
colleen.cummings@du.edu (C.C.M.); carson.defries@du.edu (C.M.D.F.); rebecca.m.smith@du.edu (R.M.S.)
* Correspondence: lisareyes.mason@du.edu

Abstract: Climate change is leading to worsening disasters that disproportionately impact older adults. While research has begun to measure disparities, there is a gap in examining wildfire-specific disasters. To address this gap, this scoping review analyzed literature to explore the nexus of wildfires and older adults. We searched peer-reviewed literature using the following inclusion criteria: (1) published in a peer-reviewed journal; (2) available in English; (3) examines at least one topic related to wildfires; and (4) examines how criterion three relates to older adults in at least one way. Authors screened 261 titles and abstracts and 138 were reviewed in full, with 75 articles meeting inclusion criteria. Findings heavily focused on health impacts of wildfires on older adults, particularly of smoke exposure and air quality. While many articles mentioned a need for community-engaged responses that incorporate the needs of older adults, few addressed firsthand experiences of older adults. Other common topics included problems with evacuation, general health impacts, and Indigenous elders' fire knowledge. Further research is needed at the nexus of wildfires and older adults to highlight both vulnerabilities and needs as well as the unique experience and knowledge of older adults to inform wildfire response strategies and tactics.

Keywords: wildfires; climate change; disaster recovery; evacuation; adaptation; mitigation; older adults; elders

check for updates

Citation: Melton, C.C.; De Fries, C.M.; Smith, R.M.; Mason, L.R. Wildfires and Older Adults: A Scoping Review of Impacts, Risks, and Interventions. *Int. J. Environ. Res. Public Health* **2023**, *20*, 6252. https://doi.org/10.3390/ijerph20136252

Academic Editors: Juan Ramón Molina Martínez, Francisco Rodríguez y Silva and Jorge Antonio De las Heras Ibáñez

Received: 20 April 2023
Revised: 15 June 2023
Accepted: 21 June 2023
Published: 29 June 2023

Copyright: © 2023 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

1. Introduction

The growing threat of climate change has been well-documented in recent years. Since 2011, concentrations of greenhouse gases in the atmosphere have soared, pushing global surface temperatures to an estimated 1.3 degrees Celsius above pre-industrial levels [1]. Human-induced climate change has accelerated impacts of ecological degradation, biodiversity loss, and extreme weather events. These include, but are not limited to, increases in areas burned in wildfires, cyclone intensity attributed to sea-level rise, severe and prolonged droughts, heavier precipitation, and substantial—and in some cases irreversible—damages to biodiversity and ecosystems [1]. These impacts are not felt evenly, with already vulnerable populations suffering the brunt of the crisis. Those living in poverty, women, children, older adults, outdoor workers, people with disabilities, Indigenous populations, and people of color are facing adverse health events. These include increased morbidity and mortality from disease connected to heat stress, exposure to air pollution and smoke, and vector-borne illnesses, in addition to ongoing human rights violations during this era of climate crisis [2].

The social and ecological consequences of wildfires are areas of growing concern, with recent wildfire seasons breaking precedents for frequency and intensity [3]. In the U.S. alone, wildfire events are increasing, with an average of 6.9 million acres burned annually, more than double the annual acreage burned in the 1990s, with the top five worst wildfire seasons in the U.S. all occurring since 2006 [3]. Record-breaking wildfire seasons from Australia to the Arctic and in North and South America are an ominous sign of the

ever-growing duration, frequency, and intensity of wildfire seasons to come [4]. Even in the best-case scenarios for curbing emissions, the risk of global wildfire occurrence will still increase by 31–57% by the end of the century [4]. Environmental change related to wildfires is also unique in that wildfires are exacerbated by climate change and are also a contributing factor in the worsening of climate change through the release of greenhouse gasses (GHG) and destruction of carbon stored in trees.

Beyond the environmental impacts, increasing wildfires are also a grave threat to human health. Smoke from wildfires worsens air quality and increases exposure to and inhalation of smoke and small particulates from ash, referred to as particulate matter smaller than 2.5 microns ($PM_{2.5}$) [5,6]. Wildfires lead to increased $PM_{2.5}$ and decreased air quality—increasing the odds of respiratory and health concerns such as burning eyes, runny nose, scratchy throat, headaches, respiratory illness, and exacerbation of pre-existing conditions such as asthma and COPD [6,7]. Breathing wildfire smoke is associated with increased outpatient visits, emergency visits, hospitalization, and death from a myriad of respiratory issues, which is only complicated by the current COVID-19 pandemic, as breathing $PM_{2.5}$ (the primary health concern related to wildfire smoke) is associated with increased morbidity and mortality of the novel coronavirus [7,8].

When a wildfire encroaches upon or destroys communities, emergency preparedness and response and mitigation strategies have also been investigated in conjunction with human health vulnerabilities during times of wildfire disaster. Studies concerning evacuation and emergency service systems in protecting human life and health have been carried out around the world [9]. Many studies indicate significant numbers of people delay evacuation during a wildfire event, often leading to increased evacuation danger [9]. In the immediate aftermath of a wildfire disaster, access to prescription medication, healthcare providers, and mental health services can be lacking [10]. Once these aftershocks have subsided, psychological distress following landscape and ecosystem loss—as well as personal loss or trauma—can be prevalent among the general populations [11].

The very same populations experiencing the most adverse health consequences from climate change are also vulnerable to impacts from other natural disasters, including wildfires, with older adults principal among them. Research has demonstrated that in addition to the usual concerns associated with natural disasters such as injuries and infectious disease outbreaks, older adults face added challenges due to functional or mobility limitations, decreased social supports, difficulty maintaining necessary health regimens, and limited access to information about disaster preparedness and recovery practices [12]. Due to the higher prevalence of chronic conditions among older adults, they often require specialized diets, medicine, and other medical treatments which can be more difficult to maintain or access following the trauma and disruptions caused by natural disasters [13]. Additionally, as people age, their social networks may shrink for a number of reasons, including spouses and close friends passing away or having their children move away, making it more difficult to reach out to others for help [14].

As a result of these age-related risks, older adults are disproportionately negatively impacted by natural disasters when compared to other age groups [15]. For example, while older adults made up only 15% of the New Orleans population, 71% of the people who died from Hurricane Katrina were over the age of 65 [15]. Studies have shown that older adults are often more likely to encounter life-threatening challenges while trying to evacuate during a natural disaster, are less likely to receive disaster warnings, and often experience greater financial losses following the destruction of natural disasters [16]. These disparate outcomes faced by older adults occur with all types of natural disasters, indicating that the needs of this population during these times of crisis need to be addressed [17].

While the disparate impact of natural disasters on older adults is well-documented in scholarly literature, most of this research has focused on hurricanes and flooding [18]. There is a gap in the literature examining the impact of wildfires on older adults [18]. While some findings from other natural disasters (e.g., evacuation, emergency communication, etc.) are relevant across disasters, wildfires have unique health impacts related to smoke and

heat exposure that may pose multiple burdens and harms for older adults. This study seeks to examine this gap in the literature through a systematic scoping review of scholarly literature to understand the existing knowledge base on the impact of wildfires on older adults, as well as identify other gaps in data and priorities and directions for interventions and future research.

2. Materials and Methods

Due to the lack of literature on wildfires and older adults, the scoping review methodology was chosen due to its usefulness to "determine the scope or coverage of a body of literature on a given topic and give clear indication of the volume of literature and studies available as well as an overview (broad or detailed) of its focus" [19] (p. 2). The scoping review methodological framework followed guidelines from Arksey and O'Malley [20], as well as recommendations by Levac et al. [21] and Cloquhoun et al. [22]. The PRISMA-ScR checklist was followed for documenting and reporting findings [23].

2.1. Inclusion Criteria

To answer the research question "What is the extent and scope of literature on wildfires and older adults?" the following inclusion criteria were used:

1. Published in a peer-reviewed journal;
2. Available in English language;
3. Examines at least one topic related to wildfires;
4. Examines how criterion (3) relates to older adults in at least one way.

For criterion (1), peer-reviewed journal publications were chosen to explore academic literature relating to older adults and wildfires to gain an understanding of relevant evidence, themes, needs, and gaps in the literature. For criterion (2), references were limited to the English language due to the research team's inability to translate articles from other languages. For criterion (3), wildfires were specifically chosen as the disaster of focus due to gaps in the literature exploring the impacts of wildfires (versus other types of disasters such as hurricanes, flooding, etc.) on vulnerable populations, especially older adults. For criterion (4), we defined older adults as those who are 60 years and older, or who were referred to in the references as "older adults", "elderly", "elders", etc. (see search terms below). This age was chosen based on literature indicating that 60 is a common parameter for identifying this age group [24]. Further, criterion (4) means that included articles must specifically connect wildfires to older adults in some way, excluding those that discussed older adults and wildfires separately.

2.2. Literature Search and Screening

Search terms and protocols were established in consultation with a university librarian. Based on these discussions, the following databases were searched: PubMed, Web of Science, ProQuest (Agriculture and Environmental Sciences Collection, Sociological Abstracts, and Social Service Abstracts), and EBSCO Host (Academic Search Complete, Environment Complete, GreenFILE, PsycInfo, and SocINDEX).

In consultation with the librarian, the following search strings were created and run in each database:

1. "older adult*" OR senior* OR elder* OR "older person*" OR "older people" OR geriatric* OR gerontolog* OR "old age" OR "long term care" OR "nursing home*" OR "assisted living" OR "independent living" OR "skilled nursing facilit*" OR "memory care" OR "residential care" OR "retirement communit*";

   AND

2. wildfire* OR "wild fire*" OR bushfire* OR "bush fire*" OR bushfire* OR "forest fire*" OR "brush fire*" OR brushfire* OR "wildland fire*" OR "uncontrolled fire*" OR "fire season*".

Both search strings were searched "anywhere but full text (NOFT)" within the ProQuest database, and with the default search settings for other databases, which was the recommendation and guidance of the university librarian. The search, conducted in March of 2021, yielded 585 articles. After removing duplicate records, 261 remained.

The research team used Covidence systematic review software [25] to complete the screening process. Two authors independently reviewed the titles and abstracts of the 261 non-duplicate records. After title and abstract screening, 138 remained. Two authors then independently read the full text of these 138 remaining articles. Of these, 75 met the inclusion criteria (Figure 1) [18,26–99]. Throughout the screening and review process, any disagreements on inclusion/exclusion were discussed and reconciled as a team before making a final decision.

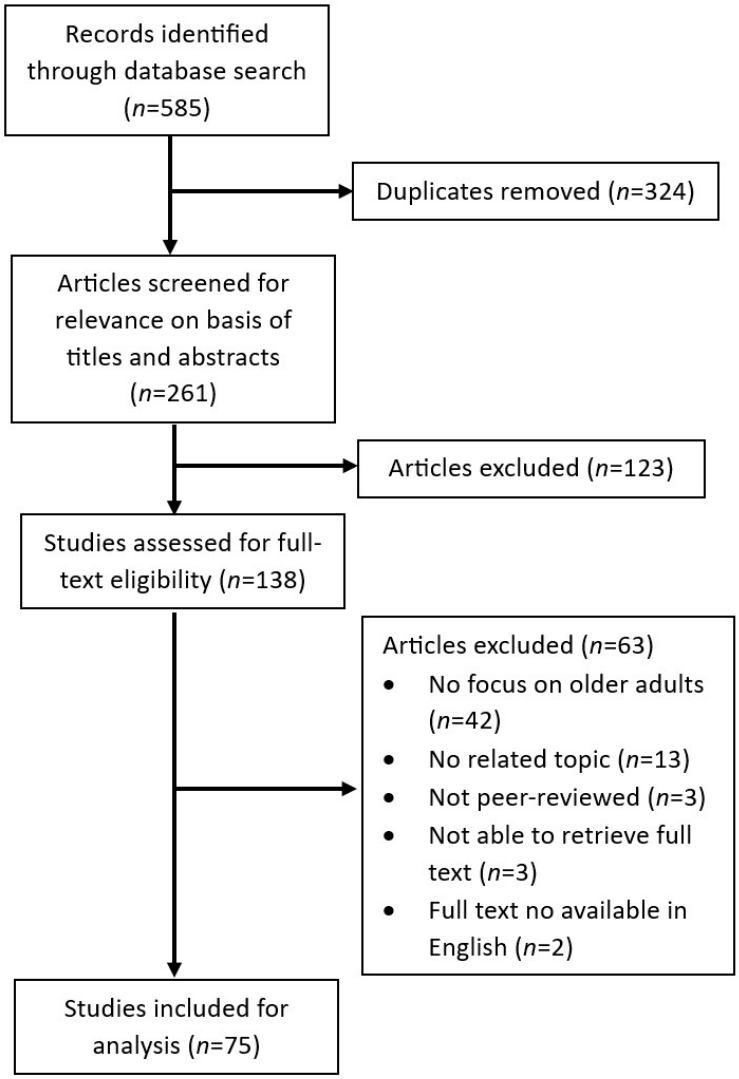


Figure 1. Flowchart of search, screen, and review process.

2.3. Data Extraction and Analysis

Data collected on each article included: (1) article characteristics and type; (2) information related to environmental issues including the disaster recovery cycle, specific hazards, etc.; (3) information on how older adults were included and relevant findings; and (4) whether articles addressed problems, used responses or interventions, or suggested solutions, recommendations, or areas of future research. We created, pilot tested, and refined our data collection tool using Google Forms. Once the final form was created, two members of the research team independently recorded data from each article. Any

questions or disagreements were discussed and resolved as a team. During analysis, we also identified thematic topics arising from the literature.

First, basic characteristics included the year of publication, article title, author(s), journal title, country or geographic focus, study type, sample, and methods used. Second, information related to environmental issues included the hazards addressed (wildfires, air quality, heat, haze, or other types of hazards); specific disasters addressed; explicitly mentioning climate change or recommendations for climate adaptation and/or mitigation; focus on any part of the disaster recovery cycle (response, recovery, mitigation, preparedness); explicitly mentioning environmental justice or alluding to it; and the inclusion of Indigenous or Aboriginal traditional ecological knowledge (TEK). Third, questions related to older adults included whether the primary focus of the article was older adults and/or how older adults were included; focus on older adults in the community or in residential facilities; and relevant findings or recommendations related to older adults. Fourth, questions related to study focus included focus on problem description, measuring exacerbation of specific health problems, inclusion of responses or interventions, inclusion of Indigenous or Aboriginal knowledge of fire management, solutions or recommendations, areas of future research, and thematic topics arising in the literature. All criterion, except for thematic topics, were established during the creation and pilot testing of the data collection tool. Thematic topics arose during data collection as patterns emerged in the literature.

3. Results

3.1. Basic Characteristics of the Literature

A total of 75 peer-reviewed journal articles met study inclusion criteria. There was no limit on year of publication in our initial search; the earliest article was published in 2001, with the frequency of publications increasing over time (Figure 2). Only 3 of the 75 articles (4%) were published between 2001 and 2006, 10 (13.3%) were published between 2007 and 2011, 23 (30.7%) were published between 2012 and 2016, and 39 (52%) were published between 2017 and 2021 (Figure 2).

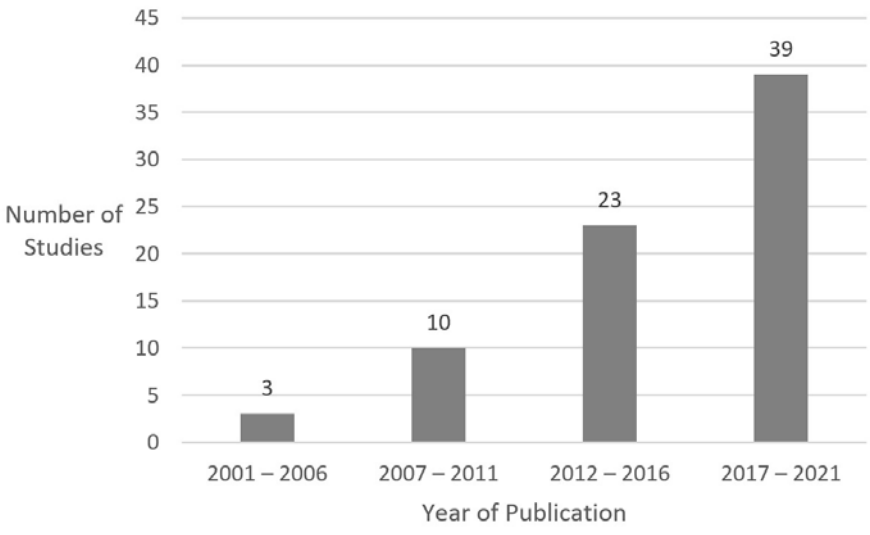


Figure 2. Year of publication.

Geographic regions discussed were diverse, but the majority were based in North America (44%) and Oceania and Australia (26.7%), and many were about wildfires or fire management on First Nations or Tribal land (18.7%) (Figure 3). The United States (U.S.) was the most represented country, representing 26 of the 33 total mentions of North America. Most of these focused on the western U.S. (n = 12), specifically California (n = 8). Of the eight articles focused on Canada, six were about wildfires on First Nations land. The 20 articles focusing on Oceania and Australia were almost exclusively focused on Australia,

with 1 mentioning New Zealand and 6 of the 20 focusing on Aboriginal land. Seven articles focused on Northern and Western Europe (Spain, Portugal, Greece, and two from Finland), and five articles focused on South America, all of which were in Brazil's Amazon region. Five articles were based in Southeastern Asia (two in Malaysia, two in Indonesia, and one covering Singapore, Malaysia, Indonesia, Brunei, and Thailand). Finally, those that covered more than three countries were labeled as "global", though these predominantly focused on countries above including the U.S., Australia, Malaysia, and Indonesia. Notably, no articles covered geographic regions of Africa, Central America, or North and Central Asia, though one global article mentioned "Asia, Latin America, and Africa" [42] (p. 99).



Figure 3. Geographic focus of articles. Note: Percentage exceeds 100% as some articles covered multiple regions. * Articles focusing on First Nations and/or Tribal lands were based in North America (Canada, $n = 7$; United States, $n = 3$) and Oceania and Australia (Australia, $n = 6$).

Of the 75 articles, 63 (84%) were empirical research articles or evaluations (Table 1). Most of these were quantitative (44%) or qualitative (26.7%), with a few being mixed methods (4%) or systematic reviews (9.3%). The 12 non-empirical articles (16%) were conceptual, descriptive, or commentaries. Methods used in empirical articles varied, with secondary data (37.3%) being the most prevalent. A large majority of articles focused on measuring morbidity and mortality related to wildfire smoke, with 22 articles (29.3%) using emergency room and hospital admissions or mortality rates as secondary data. The second most common method was remote-sensed environmental measures (29.3%), measuring air quality and pollution, particularly of $PM_{2.5}$ levels and other particulate matter. Interviewing was the third most prevalent method (21.3%). Other methods included systematic reviews (9.3%), surveys (9.3%), focus groups (8%), case studies (6.7%), field research (5.3%), biological data (5.3%), and other methods (8%; e.g., participatory action research, future modeling, ethnography, and Q methodology) (Table 1).

Table 1. Basic characteristics of the literature (n = 75).

Characteristic	*n* (%)
Paper Type	
Quantitative	33 (44)
Qualitative	20 (26.7)
Mixed Methods	3 (4)
Systematic/Scoping Review	7 (9.3)
Conceptual Papers	9 (12)
Other (e.g., commentary, interview transcript)	3 (4)
Method	
Secondary Data	28 (37.3)
Remote-Sensed Environmental Measures (Air Quality)	22 (29.3)
Interviews	16 (21.3)
Systematic Review	7 (9.3)
Survey	7 (9.3)
Focus Group	6 (8)
Case Study	5 (6.7)
Field Research	4 (5.3)
Biological Data	4 (5.3)
Other Methods	6 (8)
Not Applicable (e.g., conceptual papers or other paper type)	12 (16)

Note: Methods percentage exceeds 100% as some articles used multiple methods and/or data collection strategies.

3.2. Environmental: Hazards, Climate Change, and Disaster Recovery Cycle

We reviewed articles for specific information related to environmental issues including specific wildfires, other hazards, and language or information about climate change, environmental justice, or the disaster recovery cycle (Table 2). All articles discussed wildfires, bushfires, or forest fires in some way. Some articles also discussed other types of disasters such as flooding and hurricanes, but due to the proliferation of literature on these topics, we only collected data on hazards related to wildfires. Of these related hazards, 41 articles discussed air quality (54.7%), 12 covered heat (16%), and five discussed haze (6.7%). Almost half of articles were either about a specific wildfire (17.3%) or a specified wildfire season or time period where wildfires occurred (25.3%). Wildfire events or seasons that were covered in more than one article included: wildfires and associated "haze disaster" in Indonesia in 1997 [49,53]; wildfires in San Diego, California in 2007 [31,33]; a 2011 wildfire impacting Sandy Lake First Nation in Canada [27,28]; California's 2017–2018 wildfire season [43,47,97]; and the catastrophic 2019–2020 wildfire season in southeastern Australia [40,50,89].

Table 2. Environmental hazards, climate change, and disaster recovery cycle (N = 75).

Environmental Categories	*n* (%)	Examples
Hazards		
Fire	75 (100)	• See articles with asterisks in reference list [18,26–99]
Air Quality	41 (54.7)	• Impacts of air quality and/or particulate matter [26,29,32,34,37,41,42,44–49,51,54,56–62,65,66,71,72,74,78,88–90]
Heat	12 (16)	• Impacts of heat [18,29,36,39,40,43,57,66,72,80,87,88]
Haze	5 (6.7)	• Haze disasters and/or impacts of haze [48,53,54,82,85]
Specific Wildfire(s)		
Specific Wildfire	13 (17.3)	• 1997 wildfire and "haze disaster" in Indonesia [49,53] • 2007 wildfire in San Diego, CA [31,33] • 2011 wildfire in Canada impacting Sandy Lake First Nation [27,28]
Wildfire Season/ Time Period	19 (25.3)	• California's 2017–2018 wildfire season [43,47,97] • Australia's 2019–2020 wildfire season [40,50,89]

Table 2. *Cont.*

Environmental Categories	*n* (%)	Examples
Climate Change (CC)		
Mentions	41 (54.7)	• Individual-focused adaptations (e.g., adapting to heat, addressing disease burden, air filtration systems, individual survival plans) [18,29,34,39,41,42,61,66,80,84,85,88,91,96] • Facility or community-level emergency protocols (planning, preparation, evacuation, communication, etc.) [18,26,27,29,33,47,52,63,79,81,87,97] • Land-use management (including traditional ecological knowledge and burning practices) [29,36,38,50,55,67–70,75,83,94,98]
Adaptation	41 (54.7)	
Mitigation	18 (24)	• Traditional ecological knowledge and burning practices [38,55,64,67–70,73,74,83,94,98] • Mentions or addresses need to reduce greenhouse gas emissions [29,58,71,80,88,93]
Article Focuses on CC	7 (9.3)	• Health impacts of climate change [29,72,80,88] • Disproportionate impact on older adults [18,66,71]
Disaster Recovery Cycle		
Mentions	42 (56)	• Needs of older adults in recovery period following wildfires (e.g., disruption in continuity of care, physical recovery, economic recovery, and trauma/mental health) [29,32,79,81,97] • Community recovery [50] • Debriefing sessions with facility staff following wildfire [31,86]
Recovery	9 (12)	
Response	24 (32)	• Needs of older adults during acute wildfire disaster (e.g., life-support equipment such as oxygen during power outages, immediate interventions for air quality, etc.) [9,17,18,34,79] • Evacuation (individuals, facilities, communities) [27,28,30,31,40,47,52,76,86,87,91,96] • Early warning systems, communication, and local response protocols [18,29,33,34,63,96] • Social support needs (families, caregivers, etc.) [18,27–29,79,81] • Response of health care providers and/or facilities [32,42,52,66,86,92,97]
Mitigation	25 (33.3)	• Building codes and updates, and facility emergency protocols [18,29,71] • Mitigating smoke exposure [34,41,88] • Public outreach, local contingency planning, community risk-reduction etc. [47,63,77,81,87] • Reintroducing "ecologically beneficial fire" [35] (p. 677) and Indigenous burning practices [35,38,55,64,67–70,73,83,94,98]
Preparation	22 (29.3)	• Barriers or facilitators to preparedness for older adults (e.g., socioeconomic factors, mobility and health issues, etc.) [39,77,79] • Incorporating needs of older adults into planning measures (recommendations, community-engagement, etc.) [29,32,63,66,79,87] • Recommendations for evacuation preparedness and/or facility emergency protocols [27,28,33,52,86,98] • Individual preparation (survival plans, preparing personal property, evacuating, etc.) [40,76,91,97]

Table 2. *Cont.*

Environmental Categories	*n* (%)	Examples
Environmental Justice (EJ)		
Explicit mention of EJ	2 (3)	• Intersectional analysis of subgroups of older adults most impacted by wildfire smoke using an environmental justice lens (e.g., race, gender, education) [40] • Mention of environmental justice as factor of vulnerability for respiratory disease [26]
Alludes to EJ	40 (53)	• Intersectional view of impacted older adults (more impacted based on race, socioeconomic status, gender, housing status, chronic disease, urban vs. rural, and/or) [18,29,32,34,36,39,64–66,77] • Calls for more focus on vulnerable populations in future research [18,34,57,65,71,82] • Connection of Indigenous sovereignty and knowledge, colonization, historical oppression, and resistance [38,55,64,69,70,75,83,94]
No Mention of EJ	33 (44)	
Indigenous or Aboriginal Peoples		
Traditional Fire Knowledge	12 (16)	• Co-management strategies and tensions between Indigenous elders and peoples and state, national, or other fire management groups [38,64,67–70,83] • Western science's need for Indigenous knowledge and tension between the two [38,64,75,94] • Description of Indigenous fire knowledge, experiences, and/or history [28,38,55,73,75,94,98]
Focus on Indigenous or Aboriginal Lands	14 (18.7)	• In addition to the above 12 articles, 2 focused on community experiences and needs during evacuation for Sand Lake First Nation [27,28]

Data have consistently shown that climate change is increasing the intensity and impact of wildfires [1,18,60]. However, not all disaster research makes the connection between climate change-related causes and impacts. We found that 41 articles (54.7%) mentioned climate change or global warming explicitly, but only 7 (9.3%) focused on climate change as a main topic. We also collected data on interventions, recommendations, or responses that may be climate mitigation or adaptation strategies, even if they were not named as such. We found that 41 articles (54.7%) addressed some form of adaptation strategies and 18 (24%) addressed mitigation strategies (Table 2).

In addition to climate change, data were collected on mentions of the disaster recovery cycle and specific phases including recovery, response, mitigation, and preparation (Table 2). A majority of articles mentioned the disaster recovery cycle or at least one phase (56%). Mitigation measures were the most prevalent phase discussed (33.3%), closely followed by response (32%) and preparation (29.3%). Recovery was the least discussed phase, addressed by eight articles (10.7%).

Because of the particular vulnerability of older adults to disasters, including wildfires, we noted whether articles specifically mentioned environmental justice. However, during analysis, we found that many articles alluded to environmental justice by discussing "disadvantaged and vulnerable populations" [65] or "vulnerable populations, including the elderly, socioeconomically disadvantaged groups, and those with underlying chronic disease … [who are] most affected [29]. While only two (3%) articles explicitly named environmental justice [46,60,64], more than half (53%) alluded to environmental justice by discussing disproportionate impacts or particularly vulnerable populations in some way (Table 2).

3.3. Older Adult Findings

When reviewing how articles discussed older adults (Table 3), 39 articles defined older adults based on either an age cutoff (e.g., 65 or older) or by naming this population (e.g., elders, older adults, seniors, etc.). A large portion of articles (41.3%) included older adults as a population they were specifically interested in looking at in addition to others, while 29.3% focused solely on older adults, and the remaining 29.3% made mention of this age group but did not have them as their primary focus. The majority of articles (69.3%) based their findings on older adults using information that was collected about them, rather than from them firsthand (24%), with some (6.7%) doing both. Most articles did not explicitly state the living conditions of the older adults that were included; however, out of the 24 articles that did make this specification, 20 focused on older adults living in the community while only 4 focused on older adults living in long-term care communities.

Table 3. Older adult findings (N = 75).

Categories Related to Older Adults	*n* (%)	Examples
Focus Demographic		
Older Adults Sole Focus	22 (29.3)	• Focus on Indigenous elders [28,68–70] • Focus on health impacts of older adults in disasters [18,32,54,60]
Focus on Older Adults in Addition to Others	31 (41.3)	• Focus on Indigenous elders in addition to others (other Indigenous people, non-Indigenous land management decision makers, etc.) [27,29,38] • Participants were stratified by age or age groups and included both older adults and younger participants [34,65,71,88,90,99]
Mentioned Older Adults, but not Focus	22 (29.3)	• Mentioned older adults as another group that could be affected but was not specifically studied in the article [35,47,63,76]
Data Sources		
From Older Adults	18 (24)	• Older adults participated in the study (e.g., completed survey, participated in interview, etc.) [70,75,83,91,94]
About Older Adults	52 (69.3)	• Medical records about older adults were obtained and analyzed [26,32,48,72,74] • Other individuals contributed information about older adults (e.g., caregivers, health professionals, first responders, etc.) [52,63]
Both	5 (6.7)	• A combination of information shared by older adults and obtained about older adults was used concurrently in the study [27,28,35,40,78]
Living Environment		
Community	20 (26.7)	• Articles focus on older adults living in community, not in long-term care [27,40,41,55,97]
Long-Term Care	4 (5.3)	• Articles focus on older adults living in long-term care communities [31,33,66,86]
Not Specified	51 (68)	• Articles do not specify the living setting of the older adult[s] in the study [26,44,56,62,78,95]

With respect to the findings and recommendations made for older adults in the context of wildfires, articles discussed the various ways that older adults are impacted by and respond to wildfires. A majority of articles (60%) discussed the health impacts that wildfires had on older adults, describing increased hospitalization and death rates for cardiovascular and respiratory issues during or following wildfires for this population [26,53,66,82,90]. These negative outcomes were increasingly worse for older women and older adults of color [60]. While a meta-analysis of these impact estimates was beyond the scope of this study, some examples of specific findings include a 7.2% increase in respiratory hospital

admissions among Medicare enrollees in the Western U.S. during intense smoke days [59] and impairments to lung function, especially among the elderly, of 33.9% of participants at two-years post-exposure to smoke from a Montana wildfire in the U.S. [78].

Additionally, when it came to responding to a wildfire, most notably with evacuations, older adults faced a disproportionate amount of barriers and challenges including difficulty maintaining the level of care they needed, accessing medications, and staying connected with caregivers, demonstrating how the needs of older adults may not be fully considered and addressed during wildfire disasters [27,28]. Finally, findings illustrated the role that older adults play during wildfires in supporting their local community, family members, and friends. During evacuations, older adults offered additional support to one another by making meals for one another, helping with laundry, and providing emotional support [27,28].

3.4. Thematic Topics, Problem-Focus, Interventions, Recommendations, and Future Research

While reviewing included articles, authors made note of recurring themes of interest that provided additional insight on the impacts and experiences felt by older adults due to wildfires (Table 4). With respect to the experiences of older adults, 17.3% (n = 13) of articles discussed animals/pets, 12% (n = 9) included caregivers, 34.7% (n = 26) touched on evacuation efforts and experiences, 14.7% (n = 11), focused on intergenerational relationships during wildfires, and 37.3% (n = 28) mentioned the effect of social support/social capital for this population during these disasters. Additionally, some articles discussed more specific impacts on older adults during wildfires, including 25.3% (n = 19) that looked at mental health associations, and 48% (n = 36) focused on morbidity and/or mortality of wildfires and associated hazards (air pollution, particulate matter, heat, etc.) from an epidemiological focus on population health. Finally, it should be noted that the onset of the COVID-19 pandemic brought about additional issues, especially as they relate to an older adult's health and well-being, and 2.7% (n = 2) of articles discussed the added complexity to the impact of wildfires.

Table 4. Specific topics and themes (N = 75).

Thematic Topic	*n* (%)	Examples
Animals/Pets	13 (17.3)	• Traditional ecological knowledge including importance of animals in landscape, ecosystem, or relationality between humans and the more-than-human world [55,67–70,75,83,94,98] • "Animal guardians" or "animal ownership" and its impact on evacuation, preparedness, and/or emergency response [76,91,96]
Caregivers	9 (12)	• Importance of having caregivers of older adults involved in and/or educated on preparedness protocol for disasters [18,27,81] • How the presence of a caregiver can impact how well older adults do during wildfires [28,76]
COVID-19	2 (2.7)	• Wildfires and older adults within the context of COVID-19 [40,47]
Evacuation	26 (34.7)	• Individual/community evacuation preparedness and/or experiences (e.g., survival plans, etc.) [27,28,30,40,76,87,96] • Medical facilities' evacuation preparedness and/or experiences [31,33,52,86,97] • Needs of/impacts on older adults during evacuations (care disruption, communication, social support, etc.) [18,43,60,79,81,88] • Not focused on evacuation, but mention implications, needs, or considerations for evacuation [66,81,84,88]

Table 4. *Cont.*

Thematic Topic	*n* (%)	Examples
Health Issues	45 (60)	• Wildfire impacts on respiratory and/or cardiovascular health [26,34,54,62,84] • Heat-related hospitalizations, illnesses and/or deaths [36,66,80] • Effects of wildfires on cancer [81,82] • Complications for older adults with dementia [39,43]
Intergenerational	11 (14.7)	• How relationships between generations were impacted by wildfires or how these intergenerational relationships could be used as a protective factor against the negative impacts of these natural disasters [30,40] • Intergenerational transmission of Indigenous knowledge [55,64,67–69,83,94]
Mental Health	19 (25.3)	• General discussion of traumatic impact of disasters/wildfires, evacuation, etc. [27,30,40,86,96] • Disproportionate impact of disasters/wildfires on older adults' mental health [18,32,79,81] • Vulnerability of individuals with mental health issues during disasters and/or heat [29,32,36,39] • Gap in research on mental health impact of disasters/wildfires [81,82]
Morbidity/Mortality	36 (48)	• Secondary data of mortality rates related to wildfire smoke-related exposures ($PM_{2.5,}$ $PM_{10,}$ heat, etc.) [26,36,43,51,56,74,85] • Secondary data of hospital records measuring morbidity of diseases (respiratory, pulmonary, cardiovascular, cancer, etc.) [37,44,46,48,54,59–62,81,84,89,90,93,95] • Systematic reviews of morbidity and/or mortality from wildfire smoke and related exposures [32,34,57,82,99] • Primary data of health impacts related to wildfire smoke and related exposures [45,49,53,78] • Future projections of hospital admissions under climate forecasting scenarios [58] • General review of climate change impacts on morbidity and mortality [66,72,88]
Social Support or Social Capital	28 (37.3)	• Importance of shared social support networks on older adults' well-being, especially in disasters [19,28,43] • Social isolation as a risk factor for older adults during wildfires [18,39,79] • Use of social networks on a community level to prepare for and respond to wildfires [47,77,81]

Of the 75 articles, 56 (74.4%) were problem-focused, describing negative impacts of wildfires in some way (e.g., need for evacuation, impacts of air quality, needs of communities, etc.) (Table 5). Of the 56 that focused on problem description, 36 (48%) described problems of morbidity or mortality related to wildfires and/or wildfire smoke. Most of these used secondary, epidemiologic data such as hospital admissions and death rates to describe the health impacts of wildfire smoke and/or $PM_{2.5}$ (particulate matter smaller than 2.5 microns). Aside from morbidity and mortality, other articles described problems with evacuation, displacement, and/or issues with disaster response [27,28,40,47,86,87,91,96,97]; inequalities and vulnerabilities of certain populations to wildfires [29,77,79]; and general descriptions of health impacts without epidemiologic data [35,42,80].

Table 5. Responses or interventions, solutions and recommendations, and future research (N = 75).

Categories	*n* (%)	Examples
Problem Description	56 (74.7)	• Health impacts of wildfires and related exposures (smoke, heat, etc.) [26,32,41–46,51,53,54,56–62,72,74,78,80–82,84,85,88–90,93,95,99] • Problems/lessons from evacuation and/or disaster response (individuals, communities, and/or facilities) [27,28,40,47,86,87,91,96,97] • Disproportionate impact of wildfires and disasters on older adults [18,29,32,39,60,65,66,71,79]
Responses or Interventions	31 (41.3)	• Evacuation at individual, organizational, facility, or community levels [27,28,30,31,33,52,86,87] • Community-level disaster response (communication, first responders, coordination of services, increasing community-engagement and relationships, etc.) [31,33,47,63,87] • Individual level response/interventions (e.g., air filters, masking, survival plans, etc.) [34,41,53,76,84,91,96] • Indigenous response/interventions including traditional burning, integrating TEK into conservation/land "management", employing Indigenous peoples in land "management", etc. [38,55,64,67–70,73,75,94,98] • Community care, social capital, caring for one another during disasters [27,28,40,50] • Interventions by healthcare providers and/or facilities [42,52,86,92,97]
Solutions and Recommendations	61 (81.3)	• Need for community-level disaster response workers and coordinators to increase community engagement towards better response and preparedness (community-inclusiveness, responsiveness, education, trust building, outreach, etc. [36,39,43,47,63,77,79,81] • Needs for elders leading up to, during, and following evacuation [27,28,43,63,79] • Recommendations for healthcare providers and/or facilities regarding clinical or organizational response to wildfires [31,33,66,88,90] • Recommendations for public policy [34,60–62,71,78,81] • Recommendations for utilizing TEK into wildfire management agencies and tactics (in culturally sensitive, ethical ways) [38,67–70,75,83] • Greater need for community care, increased social support, etc. [18,27,28,40,43,47,50,79] • Recommendations for climate mitigation and/or drawdown strategies [29,64,71,88,93]
Future Research Directions	61 (81.3)	• Future research should work to better understand the impacts of wildfires on the health of older adults [26,31,48,57,65,81] • More research is needed on how to develop and evaluate community preparedness and response strategies and the effects of these strategies [27,28,47,84,87,97] • Additional research should look at and evaluate effective mitigation strategies [55,63,88] • More research should work to find ways to address specific needs of older adults and reduce risks faced by this population before, during, and following wildfires [18,66,77]

Many articles moved beyond problem description with 32 of the 75 (41.3%) articles describing responses or interventions during, after, or in preparation for wildfires. Interventions and responses included individual, organizational, and community-level efforts. Individual efforts included masking to avoid smoke exposure [53,84], installing in-home air filters [34,41,84], and creating survival plans [76,91,96]. Organizational interventions predominantly focused on organizations (e.g., long-term care facilities, rehabs, and hospitals) evacuation and/or disaster management plans [27,28,30,31,33,52,86,97], but also included treatment recommendations for providers [42,92]. Community-level responses included descriptions of families and neighbors caring for one another during acute disaster phases [27,28,30,40,50], and disaster management and coordinating systems at the community level [28,30,63,87]. Finally, many articles described traditional ecological knowledge (TEK) or Indigenous and Aboriginal elders as an important intervention for "hazard abatement" [55], as well as the opportunity for fire management institutions to listen to, learn from, and rematriate (e.g., return power to Indigenous peoples to reclaim ancestral traditions) [100] fire "management" as well as the ethics of fire management agencies "using" this knowledge [26,38,64,67–70,73,75,94,98].

In addition to interventions and solutions, 61 (81.3%) articles provided recommendations targeted at multiple levels and points of intervention including individuals, organizations, communities, policy, scholarly literature, and disaster and fire management agencies. Many recommendations intersected with other findings, such as recommended adaptation strategies [29,58,61,66,71,88] and the importance of individual survival plans, community evacuation plans, and organizational disaster management protocols and plans, especially in relation to communicating with older adults [28,39,52,54,76,77,79,81,97]. Community-centered disaster management planning and strategies were prolific across recommendations, with 26 of the 31 (83%) discussing community needs, community engagement, or community inclusion in disaster management planning in some way (Table 5).

Finally, most articles (81.3%) outlined areas for future research, describing the importance of utilizing more rigorous and longitudinal research methods to examine the long-term health effects on older adults due to wildfires, especially those from more minoritized communities (Table 5). Additionally, findings suggest community and local government officials need to consider the needs of older adults during wildfires and research should serve as a tool to evaluate the short- and long-term impacts of responses and interventions through all phases of the disaster recovery cycle [2,7].

3.5. Study Strengths and Limitations

One strength of this review is its systematic and rigorous approach to identifying relevant peer-reviewed literature, by using expansive search terms and searching more than 10 databases. This allowed a breadth of literature to be explored across geographic regions, fields of study, and disciplines. However, one limitation is the exclusion of gray literature (e.g., books, non-peer-reviewed articles, etc.) that may have had additional information related to the impact of wildfires on older adults and relevant recommendations or interventions. Further, our search was limited to publications available in English, which excluded two potential studies from full review, as well as other non-English publications that may have been excluded from our initial database search.

4. Discussion

4.1. Wildfires and Older Adults: Increased Engagement and Trends

While there is prolific literature on the impact of extreme heat and hurricanes on older adults, there is a gap in the literature "on the vulnerability of older adults to other health-related climate impacts, such as . . . wildfire [and] changes in air quality" [18] (p. 21). This review systematically synthesized scholarly literature focusing on older adults and wildfires to help identify priorities and directions for addressing gaps in the literature on the impact of wildfires on older adults, and recommendations for interventions and future research. In a global search with no restriction on publication date, only 75 articles were found and most (52%) were published within the past 5 years (2017–2021). This may indicate the impact of wildfires on older adults is a newer area of research that requires additional exploration and evaluation.

Wildfires may have unique health impacts that spread beyond a specific boundary where the disaster occurred, as smoke and air quality transcend boundaries, with smoke from large fires sometimes traveling thousands of miles, across countries and even continents [54,101,102]. This was seen in multiple articles, with some specifically addressing "long-range transboundary air pollution" [54,85] and others examining health-related impacts of air quality even when the source of the fire was in a different geographic location [53,82,85].

Findings from this review show the particular vulnerabilities of older adults to wildfires, particularly due to poor air quality and exposure to smoke and particulate matter (i.e., $PM_{2.5}$). Many articles within the review explained that older adults are more susceptible to adverse health impacts of $PM_{2.5}$ [29,34,37,42], as are those with pre-existing respiratory or cardiovascular diseases and those with lower socioeconomic status (SES) [29,34,72]. While older adults are named as specifically susceptible, they also often have pre-existing

conditions or may have lower incomes, exhibiting a double—or triple—burden related to poor air quality. While there is substantial research on health impacts related to particulate matter, some studies have found that $PM_{2.5}$ exposure from wildfires may be more toxic than equal doses of ambient $PM_{2.5}$ [59,103], highlighting the importance of examining wildfire-related air quality and health impacts, especially for older adults.

Impacts of air quality are compounded by heat exposure—another hazard related to wildfires. Many articles spoke to the health impacts of heat on older adults particularly, highlighting "the double burden that heat and socioeconomics play for low-income older adults who are unable to afford air conditioning or caregiver support during extreme heat" [66] (p. 7). Heat-related deaths are the most deadly "natural disaster", and accompany wildfires—along with poor air quality—illustrating the impact of wildfires on older adults even if they are not directly exposed to the epicenter of a wildfire event [36].

Aside from indirect—albeit very real—impacts of wildfires through air quality and smoke, many articles discussed acute phases of the disaster recovery cycle when a wildfire occurs, namely the response phase (32%) and evacuation (34.7%). The findings showed that older adults are particularly vulnerable during evacuation phases, noting the importance of considering elders when planning for community-level communications for evacuation [47,79,81] and physical difficulties elders may have with evacuation, especially without social support [18,27,28,79]. Even if older adults are not evacuated, being in the geographic region of a wildfire event with power outages may affect life-sustaining equipment such as oxygen, ventilators, CPAP machines, refrigeration for medications, power wheelchairs, elevators, and heating and cooling systems for body regulation [18,79]. Wildfires may also pose a threat to the continuity of care for older adults who need ongoing medical treatment such as dialysis, cancer treatment, obtaining medications, or other medical needs [18,79,97].

4.2. Dominant Narratives: Secondary Data and Epidemiological Studies

The most prolific finding in this review was the use of secondary data to measure morbidity and mortality from wildfires or associated hazards (e.g., heat, air quality, etc.). This aligns with findings from an included article stating, "in relation to extreme weather conditions, literature has highlighted the vulnerability of older adults as a cohort, though there is limited attention on how to prevent the cohort from experiencing increased risk" [39] (p. 974). The majority of articles (74.7%) focused on problem description, with 48% of all articles describing the problem of morbidity and mortality impacts—either focusing on older adults or whose findings skewed towards older adults. This illustrates the dominant narrative of wildfires and older adults, telling a story of risk and vulnerability. While many articles also discussed responses or interventions, these were still predominantly focused on describing problems within the intervention or response itself, such as lessons learned from evacuation or community responses or preparation. Epidemiologic findings are imperative to provide statistics to build a base of scientific knowledge about this issue, but they only tell a fraction of the story about older adults, leaving out vital information from older adults on their lived experiences and needs before, during, and after wildfires.

4.3. Older Adults: Lived Experiences and Primary Data Sources

The results demonstrate how most of the information on the intersection of wildfires and older adults is primarily data collected about older adults from other sources rather than from this population firsthand. Medical and hospital records were one of the main sources of information that articles drew from, focusing on the negative physical health effects of wildfires on this population, but articles rarely focused on learning from what older adults went through or how they felt about wildfires and their role in relation to these disasters. To adequately address the disproportionately negative issues faced by older adults in the face of wildfires, it is essential to better understand their perspectives and what they find to be their greatest challenges and needs during these disasters. Articles also demonstrated how older adults can be a vital source of knowledge in knowing how to reduce or respond to wildfires, as evidenced by

the numerous articles on the role Indigenous elders have previously had in mitigation efforts (see also Section 4.4) [38,55,64,67–70,73,74,83,94,98]. It is important to understand that older adults are not simply victims of wildfires but can, in fact, play a major role in addressing these growing disasters.

4.4. Social Support and Community Focus

Articles demonstrated the importance of social support for older adults at both a community and individual level. Older adults who lacked social support were more likely to die during a wildfire as they did not receive adequate warning of the danger or were unable to evacuate on their own [43,79]. Caregivers were noted as a vital source of support for older adults but were still in need of the appropriate resources and financial assistance to prepare for and respond to wildfires [97]. Caregivers should be considered a valuable point of contact for older adults in providing needed public health and disaster response messaging to this population [81]. When formal institutional responses were not adequate in meeting the needs of older adults, articles stressed the importance and power of informal neighborhood and community responses to make up for this lack of support [43,50]. In fact, one study found the number of fatalities due to wildfires was reduced when communities supported their older adults [43]. A good social support network was also found to provide critical psychological and emotional support for older adults during wildfire evacuations, which older adults cited as the most prevalent and valuable support they received during this crisis [27,28].

Building on the importance of social support and community care, many articles discussed the need for community-engaged tactics within disaster management systems including first responders and emergency management agencies. Articles discussed the need for community-responsive practices, with one article asserting "community engagement to determine most appropriate strategies from the local level should become a focus of adaptation. For example, bushfire preparedness and management should incorporate knowledge of community, government, and industry groups to identify impacts on community safety" [29] (p. 754). Other articles reiterated this, highlighting the need to build partnerships between local, state, and federal emergency management and public health systems, and that these should be in conversation and relationship with community members and responsive to their needs [32,35]. Other findings highlighted the need for communication strategies to be developed in conjunction with communities [34,35] and a need for more education and "community activism . . . to promote outreach that assists vulnerable persons [e.g., older adults] during emerging hazardous weather situations" [43] (p. 383).

4.5. Elders and Traditional Ecological Knowledge (TEK)

An important finding of this review was the inclusion of Indigenous, First Nations, and/or Aboriginal elders' experiences and knowledge of fire. Almost 20% (n = 14) of articles focused explicitly on Indigenous, First Nations, or Aboriginal elders, with 12 focusing on fire knowledge and TEK and 2 focusing on the impacts of evacuation during a fire event [27,28]. While it is beyond the scope of this paper to fully explore the relevance of TEK to wildfires, this emergent finding became salient during data collection and analysis due to the volume of related articles. These articles highlighted the importance of community in a different way, illustrating the deeply held community and cultural ties of Indigenous peoples to each other and the land. In contrast with other articles focusing on evacuation, those focused on the evacuation of Indigenous peoples highlighted a deeper sense of social cohesion and therefore social disruption when evacuations occurred. A participant from one article discussed the way evacuation broke up "communityness" stating, "the evacuation breaks up families, it breaks up that 'communityness', how you feel home. It breaks that up and you're being sent to a strange land" [27] (p. 372). These findings illustrate not only recommendations for Indigenous elders during evacuations,

but also aspects of building "communityness" and social cohesion that other communities may learn from as a form of disaster preparation and response.

The majority of articles focused on Indigenous elders' fire knowledge and how this contrasts with dominant "fire management" agencies, policies, and protocols. Fire knowledge included cultural and traditional burning practices that have been utilized by Indigenous peoples for generations, and how fire knowledge is a part of sacred and cultural practices of being in relationship with the land. Almost all of these articles discussed implications of fire knowledge for fire management agencies, and many included cross-cultural dialogues or comparisons between Indigenous elders and other fire management agencies [38,55,64,67–69,75,83]. Many of these articles discussed the difference between Indigenous peoples' ontological views of fire and those of fire management institutions, most of which are run by White settler nations (e.g., Australia, Canada, and the United States). One article explained the difference between TEK and scientific ecological knowledge (SEK) [64], explaining that TEK takes a relational view of nature whereas SEK views nature through lenses of control, domination, and subjugation. Other articles affirmed this, explaining the incongruity of "fire management" or "fire-fighting" with TEK's view of fire and land as something to be in balance and relationship with rather than managed or fought [38,64,68,75].

Findings provided examples for collaborative co-management between Indigenous elders and fire management agencies, highlighting the importance and potential of TEK in fire "management" practices, while also naming the tension and ethics of non-Indigenous peoples "using" TEK for fire mitigation and/or adaptation measures [64,70]. One article explained that Indigenous elders have difficulty trusting fire management agencies run by the government due to generational trauma of genocide, relocation, and colonialism, with an Indigenous elder stating "science means not us" [83] (p. 26). Other articles provided recommendations for adaptive co-management strategies to build relationships between fire management agencies and Indigenous peoples to create "cross-cultural partnerships directed towards fostering resilience" [68–70]. These findings illustrate a nuanced and complex picture of the role of TEK in fire "management". Indigenous people have been caretakers of the land for generations and TEK must be incorporated into any understanding of ecological care, including wildfire management. While ethics and use of TEK are beyond the scope of this paper, there is a breadth of literature that looks at the intersection of TEK and fire "management", building on the articles related to TEK in this review. For the purpose of this paper, these findings illustrate not only the impact that wildfires have on older adults, but also the positive impact older adults can have on adaptation, mitigation, or responses to wildfires.

4.6. Increased Focus on (Un)Natural Disasters: Climate Change and Environmental Justice

While a primary focus of this paper was the impact of wildfires on older adults, this impact cannot be understood without analyzing the causes of wildfires. While wildfires are not new, the frequency and intensity of wildfires have dramatically increased due to climate change, creating (un)natural disasters [1]. While only 7 (9.3%) articles had a primary focus on climate change, 41 (51.7%) mentioned climate change as a reason for increasing disasters, reaffirming the relationship between worsening wildfires and climate change. Of the seven articles focused on climate change, three highlighted the disproportionate impact of climate change on older adults [18,66,71] while others had findings that skewed towards older adults [29,72,80,88]. However, the low number of articles focusing on the intersection of climate change and older adults illustrates a need for further research in this area, particularly the relationship between climate change, wildfires, and older adults. This intersection will only become more pertinent, as 8 of the 10 worst global wildfire seasons have happened in the past decade. Coupling the increased intensity and frequency of wildfires with the ongoing COVID-19 pandemic, further research is needed to examine these intersectional crises and their impacts on older adults.

The findings from this review continually reiterated that the impact of disasters is not distributed equally. The disproportionate impact of environmental hazards on some groups of people more than others is known as environmental injustice. While only 2 (3%) articles named environmental justice specifically, 40 (53%) of articles alluded to environmental justice in some way. Most of these references were related to older adults as being particularly "vulnerable" to wildfires and associated hazards (e.g., heat, air quality), while others provided a more nuanced understanding of environmental justice with other intersecting identities such as race, class, ethnicity, gender, geographic location (i.e., urban versus rural), and socioeconomic status [18,29,64–66,77]. While environmental justice is well-documented within scholarly literature, these findings point to the importance of incorporating an environmental justice perspective into research on wildfires and older adults. Some articles that used the "dominant narrative" named above (i.e., epidemiological studies of morbidity and mortality) used variables to understand the impacts of intersectional identities, providing a framework to incorporate environmental justice, though others named the gap in understanding environmental justice through public health-related data [65]. Some articles explicitly named this as a limitation or need for future research [34,47,49,57,65]. Future studies of all kinds should incorporate environmental justice into their data collection, methods, or analysis to understand the nuanced and disproportionate burden or wildfires on vulnerable populations and ways to address these harms and uneven impacts. Studies may also build upon this literature base by incorporating climate justice into environmental justice, especially in the case of increasing and worsening wildfires [104].

5. Conclusions

Findings from this scoping review demonstrate how older adults can be an important source of knowledge for wildfire mitigation, response, recovery, and adaptation strategies and should be included in local community planning efforts. Additional efforts should be made to incorporate environmental justice and intersectionality to better understand the root causes in health disparities among older adults during and following wildfires. Overall, the literature on the different ways older adults respond to or are impacted by wildfires is still relatively new and needs further development and exploration to better learn from and support this population in the face of worsening wildfire disasters.

Author Contributions: Conceptualization, methodology, C.C.M., C.M.D.F. and L.R.M.; data collection, C.C.M. and C.M.D.F.; data analysis, C.C.M., C.M.D.F. and R.M.S.; writing—original draft preparation, C.C.M., C.M.D.F. and R.M.S.; writing—review and editing, C.C.M., C.M.D.F., R.M.S. and L.R.M. All authors have read and agreed to the published version of the manuscript.

Funding: Open access publishing of this manuscript was supported by the University of Denver's Open Access Publication Equity Fund.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable. The included literature in references.

Acknowledgments: We thank Jenny Bowers for database and search consultation.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Intergovernmental Panel on Climate Change (IPCC). *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment of the Intergovernmental Panel on Climate Change*; Masson Delmotte, V., Zhai, P., Pirani, A., Connors, S.L., Péan, C., Berger, S., Caud, N., Chen, Y., Goldfarb, L., Gomis, M.I., et al., Eds.; Cambridge University Press: Cambridge, UK, 2021.
2. Levy, B.S.; Patz, J.A. Climate Change, Human Rights, and Social Justice. *Ann. Glob. Health* **2015**, *81*, 310–322. [CrossRef]
3. Hoover, K.; Hanson, L.A. Wildfire Statistics. Congressional Research Service. Available online: https://fas.org/sgp/crs/misc/IF10244.pdf (accessed on 8 December 2022).

4. United Nations Environment Programme. Spreading Like Wildfire: The Rising Threat of Extraordinary Landscape Fires. 2022. Available online: http://www.unep.org/resources/report/spreading-wildfire-rising-threat-extraordinary-landscape-fires (accessed on 8 December 2022).
5. Reid, C.E.; Brauer, M.; Johnston, F.H.; Jerrett, M.; Balmes, J.R.; Elliott, C.T. Critical Review of Health Impacts of Wildfire Smoke Exposure. *Environ. Health Perspect.* **2016**, *124*, 1334–1343. [CrossRef] [PubMed]
6. Stone, S.L.; Anderko, L.A.; Butler, C.R.; Cascio, W.E.; Clune, A.; Damon, S.; Garbe, P.; Hauptman, M.; Haskell, W.E.; Hoshiko, S.; et al. Wildfire Smoke: A Guide for Public Health Officials | AirNow.Gov. 2019. Available online: https://www.airnow.gov/publications/wildfire-smoke-guide/wildfire-smoke-a-guide-for-public-health-officials/ (accessed on 8 December 2022).
7. Henderson, S.B.; Brauer, M.; MacNab, Y.C.; Kennedy, S.M. Three Measures of Forest Fire Smoke Exposure and Their Associations with Respiratory and Cardiovascular Health Outcomes in a Population-Based Cohort. *Environ. Health Perspect.* **2011**, *119*, 1266–1271. [CrossRef] [PubMed]
8. Mehmood, K.; Iqbal, M.; Abrar, M.M. Can Exposure to PM2.5 Particles Increase the Incidence of Coronavirus Disease 2019 (COVID-19)? *Sci. Total Environ.* **2020**, *741*, 140441. [CrossRef]
9. McCaffrey, S. Community Wildfire Preparedness: A Global State-of-the-Knowledge Summary of Social Science Research. *Curr. For. Rep.* **2015**, *1*, 81–90. [CrossRef]
10. Jenkins, J.L.; Hsu, E.B.; Sauer, L.M.; Hsieh, Y.-H.; Kirsch, T.D. Prevalence of Unmet Health Care Needs and Description of Health Care–seeking Behavior Among Displaced People After the 2007 California Wildfires. *Disaster Med. Public Health Prep.* **2009**, *3*, S24–S28. [CrossRef] [PubMed]
11. Eisenman, D.; McCaffrey, S.; Donatello, I.; Marshal, G. An Ecosystems and Vulnerable Populations Perspective on Solastalgia and Psychological Distress After a Wildfire. *EcoHealth* **2015**, *12*, 602–610. [CrossRef] [PubMed]
12. Ashida, S.; Robinson, E.L.; Gay, J.; Slagel, L.E.; Ramirez, M.R. Personal Disaster and Emergency Support Networks of Older Adults in a Rural Community: Changes After Participation in a Preparedness Program. *Disaster Med. Public Health Prep.* **2017**, *11*, 110–119. [CrossRef] [PubMed]
13. Durant, T.J. The Utility of Vulnerability and Social Capital Theories in Studying the Impact of Hurricane Katrina on the Elderly. *J. Fam. Issues* **2011**, *32*, 1285–1302. [CrossRef]
14. Somes, J. The Loneliness of Aging. *J. Emerg. Nurs.* **2021**, *47*, 469–475. [CrossRef]
15. Aldrich, N.; Benson, W.F. Disaster Preparedness and the Chronic Disease Needs of Vulnerable Older Adults. *Prev. Chronic Dis.* **2008**, *5*, A27. [PubMed]
16. Acierno, R.; Ruggiero, K.J.; Kilpatrick, D.G.; Resnick, H.S.; Galea, S. Risk and Protective Factors for Psychopathology Among Older versus Younger Adults After the 2004 Florida Hurricanes. *Am. J. Geriatr. Psychiatry* **2006**, *14*, 1051–1059. [CrossRef]
17. Gibson, A.; Kusmaul, N.; Leedahl, S.; Rizzo, V.M. Create Social Responses to a Changing Environment. In *Gerontological Social Work and the Grand Challenges*; Sanders, S., Kolomer, S.R., Spellman, C.W., Rizzo, V.M., Eds.; Springer: Berlin/Heidelberg, Germany, 2019; pp. 93–110.
18. Gamble, J.L.; Hurley, B.J.; Schultz, P.A.; Jaglom, W.S.; Krishnan, N.; Harris, M. Climate Change and Older Americans: State of the Science. *Environ. Health Perspect.* **2013**, *121*, 15–22. [CrossRef] [PubMed]
19. Munn, Z.; Peters, M.D.J.; Stern, C.; Tufanaru, C.; McArthur, A.; Aromataris, E. Systematic Review or Scoping Review? Guidance for Authors When Choosing between a Systematic or Scoping Review Approach. *BMC Med. Res. Methodol.* **2018**, *18*, 143. [CrossRef]
20. Arksey, H.; O'Malley, L. Scoping Studies: Advancing the Methodology. *Int. J. Soc. Res. Methodol.* **2005**, *8*, 19–32. [CrossRef]
21. Levac, D.; Colquhoun, H.; O'Brien, K.K. Scoping Studies: Advancing the Methodology. *Implement. Sci.* **2010**, *5*, 69. [CrossRef]
22. Colquhoun, H.L.; Levac, D.; O'Brien, K.K.; Straus, S.; Tricco, A.C.; Perrier, L.; Kastner, M.; Moher, D. Scoping Reviews: Time for Clarity in Definition, Methods, and Reporting. *J. Clin. Epidemiol.* **2014**, *67*, 1291–1294. [CrossRef] [PubMed]
23. Tricco, A.C.; Lillie, E.; Zarin, W.; O'Brien, K.K.; Colquhoun, H.; Levac, D.; Moher, D.; Peters, M.D.J.; Horsley, T.; Weeks, L.; et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. *Ann. Int. Med.* **2018**, *169*, 467–473. [CrossRef]
24. World Health Organization: Ageing and Health. Available online: https://www.who.int/news-room/fact-sheets/detail/ageing-and-health (accessed on 1 February 2023).
25. Covidence. *Covidence Systematic Review Software*; Veritas Health Information: Melbourne, Australia, 2022.
26. Analitis, A.; Georgiadis, I.; Katsouyanni, K. Forest Fires Are Associated with Elevated Mortality in a Dense Urban Setting. *Occup. Environ. Med.* **2012**, *69*, 158–162. [CrossRef] [PubMed]
27. Asfaw, H.W.; McGee, T.; Christianson, A.C. The Role of Social Support and Place Attachment during Hazard Evacuation: The case of Sandy Lake First Nation, Canada. *Environ. Hazards* **2019**, *18*, 361–381. [CrossRef]
28. Asfaw, H.W.; McGee, T.K.; Christianson, A.C. Indigenous Elders' Experiences, Vulnerabilities and Coping during Hazard Evacuation: The Case of the 2011 Sandy Lake First Nation Wildfire Evacuation. *Soc. Nat. Resour.* **2020**, *33*, 1273–1291. [CrossRef]
29. Bambrick, H.J.; Capon, A.G.; Barnett, G.B.; Beaty, R.M.; Burton, A.J. Climate change and health in the urban environment: Adaptation opportunities in Australian cities. *Asia Pac. J. Public Health* **2011**, *23*, 67S–79S. [CrossRef] [PubMed]
30. Barber, C.E. Full Article: Forest Fire As a Shared Intergenerational Experience: Perceived Short-term Impacts on the Grandparent-Grandchild Relationship. *J. Intergener. Relatsh.* **2014**, *12*, 128–140. [CrossRef]
31. Barnett, J.; Dennis-Rouse, M.; Martinez, V. Wildfire Disaster Leads to Facilities Evacuation. *Orthop. Nurs.* **2009**, *28*, 17–20. [CrossRef]

32. Bell, S.A.; Horowitz, J.; Iwashyna, T.J. Health Outcomes After Disaster for Older Adults with Chronic Disease: A Systematic Review. *Gerontologist* **2020**, *60*, e535–e547. [CrossRef]
33. Blake, S.C.; Howard, D.H.; Eiring, H.; Tarde, S. San Diego's Area Coordinator System: A Disaster Preparedness Model for US Nursing Homes | Disaster Medicine and Public Health Preparedness | Cambridge Core. *Disaster Med. Public Health Prep.* **2012**, *6*, 424–427. [CrossRef]
34. Cascio, W.E. Wildland Fire Smoke and Human Health—ScienceDirect. *Sci. Total. Environ.* **2018**, *624*, 586–595. [CrossRef]
35. Cisneros, R.; Alcala, E.; Schweizer, D.; Burke, N. Smoke Complaints Caused by Wildland Fire in the Southern Sierra Nevada Region, California. *Int. J. Wildland Fire* **2018**, *27*, 677. [CrossRef]
36. Coates, L.; Haynes, K.; O'brien, J.; McAneney, J.; de Oliveira, F.D. Exploring 167 Years of Vulnerability: An Examination of Extreme Heat Events in Australia 1844–2010. *Environ. Sci. Policy* **2014**, *42*, 33–44. [CrossRef]
37. DeFlorio-Barker, S.; Crooks, J.; Reyes, J.; Rappold, A.G. Cardiopulmonary Effects of Fine Particulate Matter Exposure among Older Adults, during Wildfire and Non-Wildfire Periods, in the United States 2008–2010. *Environ. Health Perspect.* **2019**, *127*, 37006. [CrossRef]
38. Eriksen, C.; Hankins, D.L. The Retention, Revival, and Subjugation of Indigenous Fire Knowledge through Agency Fire Fighting in Eastern Australia and California. *Soc. Nat. Resour.* **2014**, *27*, 1288–1303. [CrossRef]
39. Farugia, T.L.; Cuni-Lopez, C.; White, A.R. Potential Impacts of Extreme Heat and Bushfires on Dementia. *J. Alzheimer's Dis.* **2021**, *79*, 969–978. [CrossRef]
40. Fergie, D.; Lucas, R.; Harrington, M. Take My Breath Away: Transformations in the Practices of Relatedness and Intimacy through Australia's 2019–2020 Convergent Crises. *Anthr. Action* **2020**, *27*, 49–62. [CrossRef]
41. Fisk, W.J.; Chan, W.R. Health Benefits and Costs of Filtration Interventions That Reduce Indoor Exposure to PM2.5 during Wildfires. *Indoor Air* **2017**, *27*, 191–204. [CrossRef] [PubMed]
42. Forsberg, N.T.; Longo, B.M.; Baxter, K.; Boutté, M. Wildfire Smoke Exposure: A Guide for the Nurse Practitioner. *J. Nurse Pract.* **2012**, *8*, 98–106. [CrossRef]
43. Garner, J.M.; Iwasko, W.C.; Jewel, T.D.; Charboneau, B.R.; Dodd, A.A.; Zontos, K.M. A Multihazard Assessment of Age-Related Weather Vulnerabilities. *Weather Clim. Soc.* **2020**, *12*, 367–386. [CrossRef]
44. Haikerwal, A.; Akram, M.; Del Monaco, A.; Smith, K.; Sim, M.R.; Meyer, M.; Tonkin, A.M.; Abramson, M.J.; Dennekamp, M. Impact of Fine Particulate Matter (PM2.5) Exposure During Wildfires on Cardiovascular Health Outcomes. *J. Am. Heart Assoc.* **2015**, *4*, e001653. [CrossRef]
45. Huttunen, K.; Siponen, T.; Salonen, I.; Yli-Tuomi, T.; Aurela, M.; Dufva, H.; Hillamo, R.; Linkola, E.; Pekkanen, J.; Pennanen, A.; et al. Low-Level Exposure to Ambient Particulate Matter Is Associated with Systemic Inflammation in Ischemic Heart Disease Patients—ScienceDirect. *Environ. Res.* **2012**, *116*, 44–51. [CrossRef]
46. Ignotti, E.; Valente, J.G.; Longo, K.M.; Freitas, S.R.; Hacon, S.D.S.; Netto, P.A. Impact on Human Health of Particulate Matter Emitted from Burnings in the Brazilian Amazon Region. *Rev. Saude Publica* **2010**, *44*, 121–130. [CrossRef]
47. Jia, S.; Kim, S.H.; Nghiem, S.V.; Doherty, P.; Kafatos, M.C. Patterns of Population Displacement during Mega-Fires in California Detected Using Facebook Disaster Maps. *Environ. Res. Lett.* **2020**, *15*, 074029. [CrossRef]
48. Johnston, F.H.; Purdie, S.; Jalaludin, B.; Henderson, S.B.; Morgan, G.G. Air Pollution Events from Forest Fires and Emergency Department Attendances in Sydney, Australia 1996–2007: A case-crossover analysis. *Environ. Health* **2014**, *13*, 105. [CrossRef] [PubMed]
49. Kim, Y.; Knowles, S.; Manley, J.; Radoias, V. Long-Run Health Consequences of Air Pollution: Evidence from Indonesia's Forest Fires of 1997. *Econ. Hum. Biol.* **2017**, *26*, 186–198. [CrossRef] [PubMed]
50. Kitson, A. Rising from the Ashes: Affirming the Spirit of Courage, Community Resilience, Compassion and Caring. *J. Clin. Nurs.* **2020**, *29*, 2765–2766. [CrossRef] [PubMed]
51. Kollanus, V.; Tiittanen, P.; Niemi, J.V.; Lanki, T. Effects of Long-Range Transported Air Pollution from Vegetation Fires on Daily Mortality and Hospital Admissions in the Helsinki Metropolitan Area, Finland. *Environ. Res.* **2016**, *151*, 351–358. [CrossRef] [PubMed]
52. Kreinin, A.; Lyansberg, A.; Yusupov, M.; Moran, D.S. Fire Disaster Readiness: Preparation for the Evacuation of Medical Facilities During Fires in Haifa, Israel. *Disaster Med. Public Health Prep.* **2019**, *13*, 375–379. [CrossRef]
53. Kunii, O.; Kanagawa, S.; Yajima, I.; Hisamatsu, Y.; Yamamura, S.; Amagai, T.; Ismail, I.T.S. The 1997 Haze Disaster in Indonesia: Its Air Quality and Health Effects. *Arch. Environ. Health Int. J.* **2002**, *57*, 16–22. [CrossRef]
54. Le, G.E.; Breysse, P.N.; McDermott, A.; Eftim, S.E.; Geyh, A.; Berman, J.D.; Curriero, F.C. Canadian Forest Fires and the Effects of Long-Range Transboundary Air Pollution on Hospitalizations among the Elderly. *ISPRS Int. J. Geo. Inf.* **2014**, *3*, 713–731. [CrossRef]
55. Lewis, M.; Christianson, A.; Spinks, M. Return to Flame: Reasons for Burning in Lytton First Nation, British Columbia. *J. For.* **2018**, *116*, 143–150. [CrossRef]
56. Linares, C.; Carmona, R.; Tobias, A.; Mirón, I.J.; Diaz, J. Influence of Advections of Particulate Matter from Biomass Combustion on Specific-Cause Mortality in Madrid in the Period 2004–2009. *Environ. Sci. Pollut. Res.* **2015**, *22*, 7012–7019. [CrossRef]
57. Liu, J.C.; Pereira, G.; Uhl, S.A.; Bravo, M.A.; Bell, M.L. A systematic Review of the Physical Health Impacts from Non-Occupational Exposure to Wildfire Smoke. *Environ. Res.* **2015**, *136*, 120–132. [CrossRef]

58. Liu, J.C.; Mickley, L.J.; Sulprizio, M.P.; Yue, X.; Peng, R.D.; Dominici, F.; Bell, M.L. Future Respiratory Hospital Admissions from Wildfire Smoke under Climate Change in the Western US. *Environ. Res. Lett.* **2016**, *11*, 124018. [CrossRef]
59. Liu, J.C.; Wilson, A.; Mickley, L.J.; Dominici, F.; Ebisu, K.; Wang, Y.; Sulprizio, M.P.; Peng, R.D.; Yue, X.; Son, J.-Y.; et al. Wildfire-specific Fine Particulate Matter and Risk of Hospital Admissions in Urban and Rural Counties. *Epidemiology* **2017**, *28*, 77–85. [CrossRef] [PubMed]
60. Liu, J.C.; Wilson, A.; Mickley, L.J.; Ebisu, K.; Sulprizio, M.P.; Wang, Y.; Peng, R.D.; Yue, X.; Dominici, F.; Bell, M.L. Who Among the Elderly Is Most Vulnerable to Exposure to and Health Risks of Fine Particulate Matter From Wildfire Smoke? *Am. J. Epidemiol.* **2017**, *186*, 730–735. [CrossRef] [PubMed]
61. Machado-Silva, F.; Libonati, R.; de Lima, T.F.M.; Peixoto, R.B.; França, J.R.D.A.; Magalhães, M.D.A.F.M.; Santos, F.L.M.; Rodrigues, J.A.; DaCamara, C.C. Drought and Fires Influence the Respiratory Diseases Hospitalizations in the Amazon. *Ecol. Indic.* **2020**, *109*, 105817. [CrossRef]
62. Machin, A.B.; Nascimento, L.F.; Mantovani, K.; Machin, E.B. Effects of Exposure to Fine Particulate Matter in Elderly Hospitalizations Due to Respiratory Diseases in the South of the Brazilian Amazon. *Braz. J. Med. Biol. Res.* **2019**, *52*, e8130. [CrossRef] [PubMed]
63. Madsen, R.S.; Haynes, H.J.G.; McCaffrey, S.M. Wildfire Risk Reduction in the United States: Leadership Staff Perceptions of Local Fire Department Roles and Responsibilities. *Int. J. Disaster Risk Reduct.* **2018**, *27*, 451–458. [CrossRef]
64. Mason, L.; White, G.; Morishima, G.; Alvarado, E.; Andrew, L.; Clark, F.; Durglo, M.; Durglo, J.; Eneas, J.; Erickson, J.; et al. Listening and Learning from Traditional Knowledge and Western Science: A Dialogue on Contemporary Challenges of Forest Health and Wildfire. *J. For.* **2012**, *110*, 187–193. [CrossRef]
65. Mazdiyasni, O.; AghaKouchak, A. Natural Disasters Are Prejudiced Against Disadvantaged and Vulnerable Populations: The Lack of Publicly Available Health-Related Data Hinders Research at the Cusp of the Global Climate Crisis. *Geohealth* **2020**, *4*, e2019GH000219. [CrossRef]
66. McDermott-Levy, R.; Fick, D.M. Advancing Gerontological Nursing Science in Climate Change. *Res. Gerontol. Nurs.* **2020**, *13*, 6–12. [CrossRef]
67. McKemey, M.; Ens, E.; Rangers, Y.M.; Costello, O.; Reid, N. Indigenous Knowledge and Seasonal Calendar Inform Adaptive Savanna Burning in Northern Australia. *Sustainability* **2020**, *12*, 995. [CrossRef]
68. Miller, A.M.; Davidson-Hunt, I. Agency and Resilience: Teachings of Pikangikum First Nation Elders, Northwestern Ontario. *Ecol. Soc.* **2013**, *18*, e2019GH000219. [CrossRef]
69. Miller, A.M.; Davidson-Hunt, I.J.; Peters, P. Talking about Fire: Pikangikum First Nation Elders Guiding Fire Management. *Can. J. For. Res.* **2010**, *40*, 2290–2301. [CrossRef]
70. Miller, A.M.; Davidson-Hunt, I. Fire, Agency and Scale in the Creation of Aboriginal Cultural Landscapes. *Hum. Ecol.* **2010**, *38*, 401–414. [CrossRef]
71. Mills, D.; Jones, R.; Wobus, C.; Ekstrom, J.; Jantarasami, L.; Juliana, A.S.; Crimmins, A. Projecting Age-Stratified Risk of Exposure to Inland Flooding and Wildfire Smoke in the United States under Two Climate Scenarios. *Environ. Health Perspect.* **2018**, *126*, 47007. [CrossRef]
72. Mirsaeidi, M.; Motahari, H.; Khamesi, M.T.; Sharifi, A.; Campos, M.; Schraufnagel, D.E. Climate Change and Respiratory Infections. *Ann. Am. Thorac. Soc.* **2016**, *13*, 1223–1230. [CrossRef]
73. Morgan, G.W.; Tolhurst, K.G.; Poynter, M.W.; Cooper, N.; McGuffog, T.; Ryan, R.; Wouters, M.A.; Stephens, N.; Black, P.; Sheehan, D.; et al. Prescribed burning in south-eastern Australia: History and future directions. *Aust. For.* **2020**, *83*, 4–28. [CrossRef]
74. Nunes, K.V.R.; Ignotti, E.; de Souza Hacon, S. Circulatory Disease Mortality Rates in the Elderly and Exposure to PM2.5 Generated by Biomass Burning in the Brazilian Amazon in 2005. *Cad. Saúde Pública* **2013**, *29*, 589. [CrossRef] [PubMed]
75. O'Brien, L.; Watson, I. In Conversation with Uncle Lewis: Bushfires, Weather-Makers, Collective Management. *Altern. Int. J. Indig. Peoples* **2014**, *10*, 450–461. [CrossRef]
76. O'Dwyer, L.; Thompson, K. Attachment, Bushfire Preparedness, Planning, and Response among Animal Guardians: A South Australian Case Study. *PLoS Curr.* **2018**, *10*. Available online: https://pubmed.ncbi.nlm.nih.gov/30191080/ (accessed on 20 June 2023).
77. Oliveira, S.; Zêzere, J.L.; Queirós, M.; Pereira, J.M. Assessing the Social Context of Wildfire-Affected Areas. The Case of Mainland Portugal. *Appl. Geogr.* **2017**, *88*, 104–117.
78. Orr, A.; Migliaccio, C.A.L.; Buford, M.; Ballou, S.; Migliaccio, C.T. Sustained Effects on Lung Function in Community Members Following Exposure to Hazardous $PM_{2.5}$ Levels from Wildfire Smoke. *Toxics* **2020**, *8*, 53. [CrossRef]
79. Pekovic, V.; Seff, L.; Rothman, M. Planning for and Responding to Special Needs of Elders in Natural Disasters. *Generations* **2007**, *31*, 37–41.
80. Pennisi, E. Living with heat. *Science* **2020**, *370*, 778–781. [CrossRef]
81. Prohaska, T.R.; Peters, K.E. Impact of Natural Disasters on Health Outcomes and Cancer Among Older Adults. *Gerontologist* **2019**, *59* (Suppl. 1), S50–S56. [CrossRef] [PubMed]
82. Ramakreshnan, L.; Aghamohammadi, N.; Fong, C.S.; Bulgiba, A.; Zaki, R.A.; Wong, L.P.; Sulaiman, N.M. Haze and Health Impacts in ASEAN Countries: A Systematic Review. *Environ. Sci. Pollut. Res.* **2018**, *25*, 2096–2111. [CrossRef]
83. Ray, L. Using Q-Methodology to Identify Local Perspectives on Wildfires in Two Koyukon Athabascan Communities in Rural Alaska. *Sustain. Sci. Pract. Policy* **2011**, *7*, 18–29. [CrossRef]

84. Reisen, F.; Brown, S.K.; Reisen, F.; Brown, S.K. Implications for Community Health from Exposure to Bushfire Air Toxics. *Environ. Chem.* **2006**, *3*, 235–243. [CrossRef]
85. Sahani, M.; Zainon, N.A.; Mahiyuddin, W.R.W.; Latif, M.T.; Hod, R.; Khan, M.F.; Tahir, N.M.; Chan, C.-C. A Case-Crossover Analysis of Forest Fire Haze Events and Mortality in Malaysia. *Atmos. Environ.* **2014**, *96*, 257–265. [CrossRef]
86. Scrymgeour, G.C.; Smith, L.; Maxwell, H.; Paton, D. Nurses Working in Healthcare Facilities during Natural Disasters: A Qualitative Enquiry. *Int. Nurs. Rev.* **2020**, *67*, 427–435. [CrossRef] [PubMed]
87. Shahparvari, S.; Chhetri, P.; Abareshi, A.; Abbasi, B. Multi-Objective Decision Analytics for Short-Notice Bushfire Evacuation: An Australian Case Study. *Australas. J. Inf. Syst.* **2015**, *19*, 133–151. [CrossRef]
88. Shankar, H.M.; Rice, M.B. Update on Climate Change: Its Impact on Respiratory Health at Work, Home, and at Play. *Clin. Chest Med.* **2020**, *41*, 753–761. [CrossRef]
89. Sherwen, A.; Paratz, E.; La Gerche, A.; Prior, D.; MacIsaac, A. Smoke but No Fire: Increased Myocardial Infarction with Normal Coronary Arteries in the Australian Bushfires? *Int. Med. J.* **2020**, *50*, 1439–1440. [CrossRef] [PubMed]
90. Stowell, J.D.; Geng, G.; Saikawa, E.; Chang, H.H.; Fu, J.; Yang, C.-E.; Zhu, Q.; Liu, Y.; Strickland, M.J. Associations of Wildfire Smoke $PM_{2.5}$ Exposure with Cardiorespiratory Events in Colorado 2011–2014. *Environ. Int.* **2019**, *133*, 105151. [CrossRef] [PubMed]
91. Thompson, K.; Trigg, J.; Smith, B. Animal Ownership Among Vulnerable Populations in Regional South Australia: Implications for Natural Disaster Preparedness and Resilience. *J. Public Health Manag. Pract.* **2017**, *23*, 59–63. [CrossRef] [PubMed]
92. Tilney, P. Extensive Burns in an Elderly Man Found in a Brush Fire. *Air Med. J.* **2010**, *29*, 98–103. [CrossRef] [PubMed]
93. Uriarte, M.; Yackulic, C.B.; Cooper, T.; Flynn, D.; Cortes, M.; Crk, T.; Cullman, G.; McGinty, M.; Sircely, J. Expansion of Sugarcane Production in São Paulo, Brazil: Implications for Fire Occurrence and Respiratory Health. *Agric. Ecosyst. Environ.* **2009**, *132*, 48–56. [CrossRef]
94. Vaarzon-Morel, P.; Gabrys, K. Fire on the Horizon: Contemporary Aboriginal burning Issues in the Tanami Desert, Central Australia. *GeoJournal* **2008**, *74*, 465. [CrossRef]
95. Weichenthal, S.; Kulka, R.; Lavigne, E.; van Rijswijk, D.; Brauer, M.; Villeneuve, P.J.; Stieb, D.; Joseph, L.; Burnett, R.T. Biomass Burning as a Source of Ambient Fine Particulate Air Pollution and Acute Myocardial Infarction. *Epidemiology* **2017**, *28*, 329–337. [CrossRef]
96. Westcott, R.A.N.; Ronan, K.; Bambrick, H.; Taylor, M. "Don't Just Do Something . . . Stand There!" Emergency Responders' Peri-Incident Perceptions of Animal Owners in Bushfire. *Front. Vet. Sci.* **2017**, *4*, 34. [CrossRef]
97. Wyte-Lake, T.; Claver, M.; Johnson-Koenke, R.; Dobalian, A. Home-Based Primary Care's Role in Supporting the Older Old During Wildfires. *J. Prim. Care Community Health* **2019**, *10*, 2150132719846773. [CrossRef] [PubMed]
98. Yibarbuk, D.; Whitehead, P.J.; Russell-Smith, J.; Jackson, D.; Godjuwa, C.; Fisher, A.; Cooke, P.; Choquenot, D.; Bowman, D.M.J.S. Fire Ecology and Aboriginal Land Management in Central Arnhem Land, Northern Australia: A Tradition of Ecosystem Management. *J. Biogeogr.* **2001**, *28*, 325–343. [CrossRef]
99. Youssouf, H.; Liousse, C.; Roblou, L.; Assamoi, E.-M.; Salonen, R.O.; Maesano, C.; Banerjee, S.; Annesi-Maesano, I. Non-Accidental Health Impacts of Wildfire Smoke. *Int. J. Environ. Res. Public Health* **2014**, *11*, 11772–11804. [CrossRef] [PubMed]
100. Urbanski, C. Rematriate the Land: How the Indigenous Women of the Sogorea Te' Land Trust Help Solve Climate Change. Available online: https://sogoreate-landtrust.org/2020/05/01/rematriate-the-land/ (accessed on 20 June 2023).
101. Hung, W.-T.; Lu, C.-H.; Shrestha, B.; Lin, H.-C.; Lin, C.-A.; Grogan, D.; Hong, J.; Ahmadov, R.; James, E.; Joseph, E. The Impacts of Transported Wildfire Smoke Aerosols on Surface air Quality in New York State: A Case Study in Summer 2018. *Atmos. Environ.* **2020**, *227*, 117415. [CrossRef]
102. Langford, A.O.; Senff, C.J.; Alvarez, R.J.; Brioude, J.; Cooper, O.R.; Holloway, J.S.; Lin, M.Y.; Marchbanks, R.D.; Pierce, R.B.; Sandberg, S.P.; et al. An Overview of the 2013 Las Vegas Ozone Study (LVOS): Impact of Stratospheric Intrusions and Long-Range Transport on Surface air Quality. *Atmos. Environ.* **2015**, *109*, 305–322. [CrossRef]
103. Aguilera, R.; Corringham, T.; Gershunov, A.; Benmarhnia, T. Wildfire Smoke Impacts Respiratory Health More than Fine Particles from Other Sources: Observational evidence from Southern California. *Nat. Commun.* **2021**, *12*, 1493. [CrossRef]
104. Boyd, E.; Chaffin, B.C.; Dorkenoo, K.; Jackson, G.; Harrington, L.; N'Guetta, A.; Johansson, E.L.; Nordlander, L.; De Rosa, S.P.; Raju, E.; et al. Loss and damage from climate change: A new climate justice agenda. *One Earth* **2021**, *4*, 1365–1370. [CrossRef]

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.

APRIL 2023

40 ACRES

COMMUNITY WILDFIRE PROTECTION PLAN

Working together to build fire adapted communities, resilient to wildfire



WILDLAND FIRE ASSOCIATES

SWCA® ENVIRONMENTAL CONSULTANTS

Funding for this project was provided by the California Department of Forestry and Fire Protection as part of the California Climate Investments Program.

We would like to formally thank the Core Team and all stakeholders, notably 40 Acres Fire Safe Council and CAL FIRE (Bishop Station), for contributing their time and expertise throughout the planning process. Your participation has contributed to creating resilient landscapes, implementing public education, reducing structural ignitability, and ensuring safe and effective wildfire response.

Funding for this project was provided by the California Department of Forestry and Fire Protection (CAL FIRE) through the California Climate Investments Fire Prevention Grants.

For additional information, questions, or concerns regarding this project, please contact Project Manager Victoria Amato at vamato@swca.com.

For all your planning and implementation needs, please visit www.swca.com.

SWCA®
ENVIRONMENTAL CONSULTANTS

The entities listed below participated in the development of and/or reviewed and are in support of the 40 Acres Community Wildfire Protection Plan:

Signature	**Signature**
Name (printed)	**Name (printed)**
Date	**Date**
Agency /Position (printed)	**Agency /Position (printed)**

Signature	**Signature**
Name (printed)	**Name (printed)**
Date	**Date**
Agency /Position (printed)	**Agency /Position (printed)**

Signature	**Signature**
Name (printed)	**Name (printed)**
Date	**Date**
Agency /Position (printed)	**Agency /Position (printed)**
Signature	**Signature**
Name (printed)	**Name (printed)**
Date	**Date**
Agency /Position (printed)	**Agency /Position (printed)**



CONTENTS

Executive Summary ..... **iv**

Chapter 1 – Introduction **1**

Goal of a Community Wildfire Protection Plan 2

Alignment With the National Cohesive Strategy 2

Alignment with Plans and Agreements 3

Core Team 4

Planning Area 4

Land Ownership 4

Public Involvement 6

Chapter 2 – Fire Environment **7**

Wildland Urban Interface 7

WUI Land Use 9

Fuels and Topography Within the WUI 11

Fire Regimes 11

Shrubland and Grasses 11

Riaparian Vegetation 12

Climate and Weather Patterns 12

Fire History 13

Past Fire Management Policies and Land Management Actions 14

Recent Fire Occurrence 14

Future Challenges 19

Fire Response Capabilities 20

Chapter 3 – Risk-Hazard Assessment **21**

Purpose 21

Field-based Community Hazard Assessments 22

Composite Risk-Hazard Assessment Inputs 24

DRAFT

Fire Behavior Modeling 24
Fire Behavior Models 25
Fire Behavior Model Inputs 25
Fire Behavior Model Outputs 22
Composite Risk-Hazard Assessment Results 26
Values at Risk 29
Natural Values at Risk 30
Socioeconomic Values at Risk 31
Cultural Values at Risk 33
Chapter 4 – Mitigation Strategies 34
Cohesive Strategy Goal 1: Restore and Maintain Landscapes 34
Recommendations for Hazardous Fuel Reduction 37
Cohesive Strategy Goal 2: Fire-Adapted Communities 41
Recommendations for Public Education and Outreach 41
Recommendations for Reducing Structural Ignitability 42
Cohesive Strategy Goal 3: Wildfire Response 45
Recommendations for Improving Fire Response Capabilities 45
Chapter 5 – Monitoring and Evaluation 47
Fuels Treatment Monitoring 48
Implementation 50
CWPP Evaluation 50
Timeline for Updating the CWPP 52

APPENDICES

Appendix A: CWPP Planning Process and Background
Appendix B: Community Background Information
Appendix C: Additional Mapping
Appendix D: Community and Parcel Descriptions and Hazard Ratings
Appendix E: Forms
Appendix F: Funding Sources
Appendix G: Homeowner Resources
Appendix H: Project Outreach
Appendix I: Project Recommendations
Appendix J: Fuel Treatment Types and Methods
Appendix K: Post-fire Response and Restoration

DRAFT

FIGURES

Figure 1.1. The CWPP incorporates the three primary goals of the Cohesive Strategy and post-fire recovery and serves as a holistic plan for fire prevention and resilience. 3
Figure 1.2. 40 Acres land ownership. 5
Figure 2.1. 40 Acres WUI delineation. 8
Figure 2.2. Example of the WUI in 40 Acres (1 of 2). 10
Figure 2.3. Example of the WUI in 40 Acres (2 of 2). 10
Figure 2.4. Monthly climate normal for the Bishop Airport weather station for 1991 through 2020. 13
Figure 2.5. Historic fire perimeters for 40 Acres from 1923 through 2021. 16
Figure 2.6. Decadal wildfire frequency in 40 Acres (and 20-mile buffer) based on fire history data from 1923 through 2021. 17
Figure 2.7. Fire size statistics per decade for 40 Acres (and 20-mile buffer) based on fire history data from 1923 through 2021. 17
Figure 2.8. Acres burned per decade for 40 Acres (and 20-mile buffer) based on fire history data from 1934 through 2021. 18
Figure 2.9. Monthly fire frequency in 40 Acres (and 20-mile buffer) based on data from 1934 through 2021. 18
Figure 2.10. Fire causes for 40 Acres (and 20-mile buffer) from 1934 through 2021. 19
Figure 3.1. Effect of topography on fire behavior. 23
Figure 3.2. Composite Risk-Hazard Assessment breakdown. 25
Figure 3.3. Composite Risk-Hazard Assessment overlay process. 27
Figure 3.4. Composite Risk-Hazard Assessment. 28
Figure 3.5. Example of a natural VAR, public trails. 30
Figure 3.6. Example of a socioeconomic VAR, Pine Creek flume, which could be impacted by post-fire erosion and sedimentation. 32
Figure 4.1. Ongoing, planned, and proposed fuels treatments around 40 Acres. Note: the “CRL #” text refers to the Project ID in Table 4.1. 36
Figure 4.2. CEQA process for CalVTP implementation. 38
Figure 4.3. The 7.2-acre fuel break on the west side of 40 Acres. 39

TABLES

Table 2.1. Climate Summaries for Weather Stations near 40 Acres 13
Table 3.1. Communities at Risk Ratings with Community Hazard Assessment Summary 23
Table 3.2. Fuel Model Classification for the Planning Area 21
Table 3.3. Risk Assessment Inputs, Sources, and Weights 26
Table 4.1. Recommendations to Create Resilient Landscapes (Fuel Treatments) 40
Table 4.2. Recommendations for Creating Fire-Adapted Communities (Public Education and Reducing Structural Ignitability) 43
Table 4.3. Recommendations for Safe and Effective Wildfire Response 46
Table 5.1. Recommended Monitoring Strategies 48

DRAFT

EXECUTIVE SUMMARY

WHAT IS THE PURPOSE OF THIS COMMUNITY WILDFIRE PROTECTION PLAN?

The purpose of the 2023 40 Acres Community Wildfire Protection Plan (CWPP) is to:

1. Provide a community-wide scale of wildfire risk and protection needs.
2. Protect human life from wildfire and reduce property loss due to wildfire throughout the community.
3. Bring together all the responsible wildfire management and suppression entities in the Planning Area to address the identified needs.
4. Provide a framework for future planning and implementation of necessary mitigation measures.

This CWPP aims to assist in protecting human life and reducing property loss due to wildfire throughout the community. This 2023 plan was compiled from reports, documents, and data developed by a wide array of contributors, including input from the Core Team and the public. This plan was compiled in 2022 and 2023 as 40 Acres' first CWPP and has been developed in response to the federal Healthy Forests Restoration Act of 2003 (HFRA).

The CWPP meets the requirements of the HFRA by addressing the following:

1. Having been developed collaboratively by multiple agencies at the state and local levels in consultation with federal agencies and other interested parties.
2. Prioritizing and identifying fuel reduction treatments and recommending the types and methods of treatments to protect at-risk communities and pertinent infrastructure.
3. Suggesting multi-party mitigation, monitoring, and outreach.
4. Recommending measures and action items that residents and communities can take to reduce the ignitability of structures.
5. Soliciting input from the public on the draft 40 Acres CWPP.

WHERE IS THE PLANNING AREA?

The Planning Area includes the entire community of 40 Acres and the surrounding area (Figure ES.1).

DRAFT

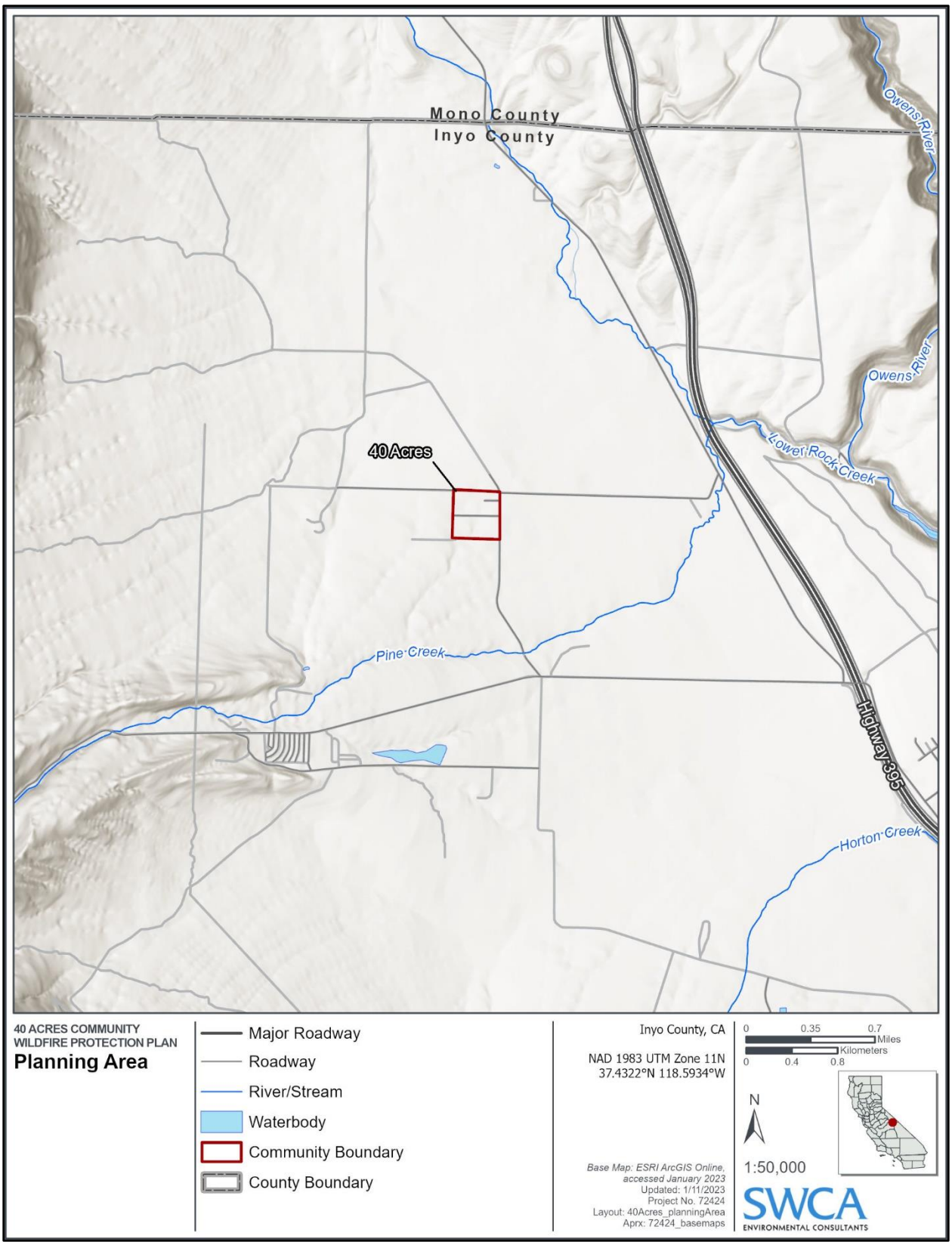


Figure ES 1. 40 Acres CWPP Planning Area.

WHAT ARE THE KEY ISSUES ADDRESSED?

Issues addressed in this CWPP include:

- Fuel treatment recommendations for land management agencies and homeowners to mitigate hazard and risk
- Prioritizing hazardous fuels reduction in the perimeter of the community and surrounding high-risk areas
- Ingress and egress issues, including evacuation routes and fire response access
- Increasing community capacity and participation to accomplish community wildfire protection and prevention objectives
- Public education and outreach to homeowners, including second-home owners and absentee homeowners, to enable individuals to reduce the risk of fire to their properties, particularly regarding defensible space implementation, structural hardening measures, and community pre-fire planning
- Constant and consistent messaging for residents and visitors concerning wildfire risks and mitigation strategies
- Investing and supporting fire response at all levels, including resources for local fire departments to increase capacity to serve the community
- Increasing public understanding of the fire response process
- Continuing to address wildfire issues across multiple jurisdictions
- Managing fire to protect values and accomplish resource management goals, including protection and enhancement of wildlife habitat, water supply and quality, and forest health
- Recent climate patterns and associated changes to the wildland fire environment
- Raising awareness about the natural role that fire plays in the ecosystem and maintaining resilient landscapes
- Disease and insect outbreaks associated with tree mortality

HOW IS THE PLAN ORGANIZED?

The CWPP provides a Risk-Hazard Assessment, action items, project recommendations, and background information about the community's wildland fire environment as well as land management plans and agencies. Most of the background information is housed in several appendices.

Chapter 1 provides a general overview of CWPPs, the Core Team, Planning Area, land ownership, and public involvement.

Chapter 2 presents an overview of the wildland urban interface (WUI) and fire environment and specific information about vegetation and fire history as well as fire management and response.

Chapter 3 describes the Risk-Hazard Assessment, results of the assessment, and community values at risk.

DRAFT

Chapter 4 provides mitigation strategies in accordance with the National Cohesive Wildfire Strategy as well as post-fire protocols and rehabilitation strategies.

Chapter 5 presents monitoring strategies to assist in tracking project progress and in evaluating work accomplished.

Appendix A contains background information on the planning process steps; state, municipal, and federal wildfire policy and direction; past planning efforts; and an overview of current land management strategies.

Appendix B contains background information on the community including demographic and social information, land ownership, natural resources, climate and environmental information, and education and outreach programs.

Appendix C presents additional mapping.

Appendix D provides summary information on the community and parcel risk-hazard assessments for WUI communities.

Appendix E presents a sample form of the National Fire Protection Association (NFPA) Wildfire Fire Risk and Hazard Severity Form 1144.

Appendix F details funding opportunities.

Appendix G contains additional resources for community members, including a homeowner wildfire mitigation guide and a list of outside resources covering a variety of topics.

Appendix H presents information on public outreach and engagement with regard to this CWPP.

Appendix I houses project recommendations.

Appendix J outlines fuels treatment types and methods.

Appendix K contains information on post-fire response and recovery including response agencies, safety information, and post-fire treatment methods.

WHAT IS THE GOAL OF A CWPP?

The goal of a CWPP is to enable local communities to improve their wildfire-mitigation capacity, while working with government agencies to identify high fire risk areas and prioritize areas for mitigation, fire suppression, and emergency preparedness. Another goal of the CWPP is to enhance public awareness by helping residents better understand the natural- and human-caused risks of wildland fires that threaten lives, safety, and the local economy. The minimum requirements for a CWPP, as stated in the HFRA, are the following (Society of American Foresters [SAF] 2004):

- **Collaboration:** Local and state government representatives, in consultation with federal agencies or other interested groups, must collaboratively develop a CWPP.
- **Prioritized Fuel Reduction:** A CWPP must identify and prioritize areas for hazardous fuels reduction and treatments and recommend the types and methods of treatment that will protect one or more communities at risk (CARs) and their essential infrastructures.

DRAFT

- **Treatments of Structural Ignitability:** A CWPP must recommend measures that homeowners and communities can take to reduce the ignitability of structures throughout the area addressed by the plan.

HOW WAS THE 40 ACRES CWPP DEVELOPED?

A group of multijurisdictional agencies (federal, state, and local), organizations, and residents joined together as a Core Team to develop this CWPP. Several Core Team members have had many years of experience working in fire management in the community and surrounding areas and have contributed their expertise to this CWPP.

The CWPP planning process served multiple purposes. One purpose was to model and map wildfire risk. Another was to identify and map the many physical hazards throughout the Planning Area that could increase the threat of wildfire to communities. This mapping process allowed the Core Team to prioritize treatments tailored specifically for the community to reduce fire risk. The development of the 2023 CWPP also provided for public involvement where community members were highly engaged in providing input. Public meetings were convened to increase awareness and collect local input, and social media and online forums have allowed for further engagement. The CWPP planning process also brings together wildfire responders and land managers into a Core Team, providing opportunities to build lasting working relationships and encourage collaboration. By incorporating public and Core Team input into the recommendations, treatments are tailored specifically for the Planning Area. Overall, the 40 Acres CWPP emphasizes the importance of collaboration among multijurisdictional agencies and the public in developing fuels mitigation treatment programs to address wildfire hazards.

In addition, the 2017 Inyo County-City of Bishop Multi-Jurisdictional Hazard Mitigation Plan was consulted to develop this CWPP. Therefore, projects identified in this CWPP are in alignment with the wildfire-specific hazard mitigation actions identified in pages 110-111 of the Hazard Mitigation Plan (Inyo County and City of Bishop 2017).

WHO PARTICIPATED IN DEVELOPING THE PLAN?

The development of the 40 Acres CWPP was overseen by the 40 Acres Fire Safe Council. Representatives from various government agencies, including California Department of Forestry and Fire Protection (CAL FIRE), Bureau of Land Management (BLM), U.S. Forest Service (USFS), Los Angeles Department of Water and Power (LADWP), Southern California Edison, and Inyo County Office of Emergency Services, along with other community or organization representatives, served as the Core Team for this CWPP and drove the decision-making process. Several Core Team members have many years of experience working together in fire management for 40 Acres and have contributed their expertise to this CWPP.

WHAT WAS THE PUBLIC INVOLVEMENT?

The Core Team engaged in public outreach using community surveys, community visits, community live demonstrations and walkthroughs, and information distributed through emails. The Core Team met virtually on July 26, 2022, in person in Bishop on October 27, 2022, and with community members in 40 Acres on October 29, 2022. Feedback, comments, and suggestions received from community members during community events (e.g., meetings and walkthroughs), the community survey, and project recommendations review were synthesized and utilized to craft project recommendations for the 40 Acres

DRAFT

CWPP. Therefore, the project recommendations are specifically tailored to address the concerns and priorities of the community.

WHAT IS THE CURRENT WILDFIRE SITUATION?

The 40 Acres community is located in northwestern Inyo County in Round Valley. The community is on the lower extent of an alluvial fan to the northeast of Pine Creek canyon at an elevation of 4,600 feet. This geographic location is significant because of downslope winds off the Sierra Nevada immediately to the west and very strong winds out of Pine Creek canyon. In a typical year, four to 10 windstorms occur with gusts exceeding 50 mph. As a result of this topography and regional weather patterns, the community is particularly at risk of wind-driven wildfires approaching from the west, as well as ignitions within the community during windy weather.

40 Acres is surrounded by a sagebrush scrub plant community largely composed of big sagebrush (*Artemisia tridentata*), antelope bitterbrush (*Purshia tridentata*), rubber rabbitbrush (*Ericameria nauseous*), and a wide variety of understory forbs and grasses (Howald 2000). More recent terminology would describe the native vegetation as *Artemisia tridentata* Shrubland Alliance (California Native Plant Society n.d.). Vegetation density (and therefore fuel continuity) is relatively sparse because of the arid climate (an average of approximately 5–10 inches of annual precipitation). However, wind-driven embers can readily propagate fire through the scrubland.

An artificial channel that delivers water from Pine Creek to the community supports dense riparian vegetation. Live and dead fuel loads along this channel are quite high and could readily carry a fire from upstream into 40 Acres (Switzer and Umek 2022). This canal supplies water to nearly 1 mile of small irrigation channels serving all parcels within 40 Acres and supports relatively luxuriant vegetation throughout the community. 40 Acres is known as the “big green square of dense vegetation” observed in Round Valley when driving down the Sherwin Grade on Highway 395. The number of trees has been estimated at nearly 1,000, some of which are up to 60 feet tall. The abundant vegetation contributes to 40 Acres often being described as an oasis, with portions called a jungle.

WHAT RECENT FIRES OCCURRED HERE?

The 40 Acres community and surrounding environment consist of diverse landscapes that produce a complex wildfire setting due to variable topography, dead and downed vegetation, and an assortment of vegetation types. Recent large, severe wildfires include the 2015 Round Fire, which burned about 7,000 acres and destroyed 40 homes in Paradise and Swall Meadows a few miles north of 40 Acres; the 1983 Rovana Fire; and the 2018 Pleasant Fire.

WHAT IS THE PURPOSE OF THE RISK-HAZARD ASSESSMENT?

The purpose of the risk assessment is to evaluate and provide information pertaining to the risk of wildland fires within the WUI of the 40 Acres community. The Risk-Hazard Assessment is twofold and combines a geographic information system (GIS) model of hazard based on fire behavior and fuels modeling technology (Composite Risk-Hazard Assessment) and a Core Team–generated assessment of on-the-ground community hazards and values at risk (VARs).

The risk assessment considers:

- Fire behavior modeling, which includes:
  - Fire history
  - Probability of fire occurring
  - Intensity of a fire if one occurs
- Exposure and susceptibility of the WUI and VARs to wildfire based on their locations

Due to its size, uniformity, and WUI location, the entirety of 40 Acres is rated as high risk.

HOW IS MY COMMUNITY RATED?

A community-level assessment and a parcel-level risk assessment, summarizing information on hazard and risk for 40 Acres, are provided in this plan. A team from SWCA Environmental Consultants conducted on-the-ground community-level and parcel-level risk assessment surveys throughout the Planning Area between October 26 and 30, 2022, using the NFPA 1144 standard for assessing structure ignitability in the WUI. Using this standard provided a consistent process for assessing wildland fire hazards around existing structures to determine the potential for structure ignition from wildland fire ignitions.

The community-level and parcel-level assessments provide a total score of risk and hazard based on various parameters observed during the surveys, and corresponding descriptive ratings of low, moderate, high, or extreme are available in Appendix D.

WHAT ARE THE STRATEGIES TO ADDRESS WILDFIRE HAZARDS?

Goal 1 of the Cohesive Strategy and the Western Regional Action Plan is to **Restore and Maintain Landscapes**: Landscapes across all jurisdictions are resilient to fire and other disturbances in accordance with management objectives.

Recommendations for hazardous fuels treatments include:

- Fuel reductions along the perimeter of the community, including the continuance of proposed projects
- Vegetation treatments along ditches and creeks
- Fuel reduction efforts on private lands, including green waste disposal
- Interagency collaboration to facilitate project implantation
- Increasing community capacity to implement projects
- Increasing workforce (firefighting personnel) to carry out projects

Goal 2 of the Cohesive Strategy/Western Regional Action Plan is **Fire-Adapted Communities:** Human populations and infrastructure can withstand wildfire without loss of life and property.

Recommendations for public outreach/education and structural ignitability include:

- Developing and promoting wildfire education, including evacuation procedures
- Offering financial assistance for defensible space work to seniors and low-income individuals

DRAFT

- Improving defensible space and structural hardening
- Hosting community awareness events
- Involving second-home owners and absentee homeowners in wildfire education (defensible space and structure hardening measures)
- Conducting community walkthroughs with fire response organizations
- Addressing combustible debris and rubbish on private property
- Developing a community pre-fire plan

Goal 3 of the Cohesive Strategy/Western Regional Action Plan is **Wildfire Response:** All jurisdictions participate in making and implementing safe, effective, efficient risk-based wildfire management decisions:

Recommendations for improving fire response capabilities include:

- Creating additional ingress and egress points
- Emergency notification improvements
- Identification of evacuation routes and shelter-in place locations
- Maintenance of dirt roads and trails around the community
- Expanding coverage of Alert California live cameras

WHAT DOES POST-FIRE RESPONSE AND RECOVERY INVOLVE?

There are many aspects to post-fire response recovery, including but not limited to the following:

- Returning home and checking for hazards
- Coordinating and mobilizing a group of teams in the community to respond to emergencies
- Rebuilding communities and assessing economic needs—securing the financial resources necessary for communities to rebuild homes, business, and infrastructure
- Restoring the damaged landscape—restoration of watersheds, soil stabilization, and vegetation planting
- Prioritizing the needs of vulnerable and disadvantaged communities during response and disaster recovery efforts
- Evaluating and updating disaster recovery plans every 5 years to respond to changing needs and characteristics of the community
- Coordinating with planning, housing, health, and human services, and other local, regional, or state agencies to develop contingency plans for meeting short-term, temporary housing needs of those displaced during a catastrophic wildfire event

HOW WILL THE PLAN BE IMPLEMENTED?

DRAFT

The CWPP does not mandate implementation of any of the recommendations, but the message throughout this document is that the greatest fire mitigation could be achieved through the joint actions of individual homeowners and local, state, and federal governments.

The recommendations for fuels reduction projects are general in nature; site-specific planning that addresses location, access, land ownership, topography, soils, and fuels would need to be employed upon implementation. Also, it is important to note that the recommendations are specific to WUI areas and are expected to reduce the loss of life and property.

In addition, implementation of fuels reduction projects must be tailored to the specific project and will be unique to the location depending on available resources and regulations. In an effort to streamline project implementation, this CWPP has identified the pertinent land management/ownership agencies associated with each recommendation. On-the-ground implementation of the recommendations identified in this CWPP will require the use of the action plan (recommendation matrices in Chapter 4) as well as an assessment strategy for completing each project.

WHO WILL LEAD THE IMPLEMENTATION OF THIS CWPP?

Implementation of most projects identified in this CWPP will require the collaboration and cooperation of multiple individuals and entities such as community residents, private organizations (such as LADWP), fire safe councils, and local, state, and federal agencies. However, to ensure that projects move forward, the plan will be governed by the 40 Acres Fire Safe Council with support from Inyo County's Wildfire Coordinator.

WHEN DOES THE CWPP NEED TO BE UPDATED?

The CWPP should be treated as a living document to be updated annually or immediately following a significant fire event. The plan should continue to be revised to reflect changes, modification, or new information. These elements are essential to the success of mitigating wildfire risk throughout the community and will be critical in maintaining the ideas and priorities of the plan in the future. Chapter 5 provides an evaluation framework that can help guide the CWPP update process.

CORE TEAM LIST

Name	Organization
Kay Ogden	40 Acres Fire Safe Council
Kristina Justice	Bishop Volunteer Fire Department
Lance Rosen	BLM
Heather Stone	BLM
David Haas	CAL FIRE
Carol Snow	CAL FIRE
Matt Edmiston	CAL FIRE
Steven Hynes	CAL FIRE
Kristen Pfeiler	Inyo County
Mikaela Torres	Inyo County Office of Emergency Services

Name	Organization
Carma Roper	Inyo County PIO
Cathreen Richards	Inyo County Planner
Matt Kingsley	Inyo County Supervisor, District 5
Jenn Roeser	Inyo County Supervisor, District 4
Chance Traub	USFS Inyo National Forest
Tim Bachman	Inyo County Sheriff's Office
Elsa Jimenez	LADWP
Frosty Matheiu	LADWP
Matthew Paruolo	Southern California Edison
Rich McCrea	Wildland Fire Associates
Tom Nichols	Wildland Fire Associates
Jeff Manley	Wildland Fire Associates
Holly Alpert	Whitebark Institute
Rick Kattelmann	Whitebark Institute
Victoria Amato	SWCA Environmental Consultants
Montiel Ayala	SWCA Environmental Consultants
Elizabeth Hitzfelder	SWCA Environmental Consultants
Tim Clute	SWCA Environmental Consultants

1

DRAFT



CHAPTER 1 – INTRODUCTION

The United States is facing urgent forest and watershed health concerns. Indeed, the number of annual wildfires throughout the United States has been slightly increasing (58,100 in 2018 and 50,000 in 2019 vs. 59,000 each in 2020 and 2021). Similarly, the number of acres burned has been on the rise (Congressional Research Service [CRS] 2022). An average of 7 million acres is burned every year due to wildfire, more than doubling the annual average of acres burned in the 1990s (CRS 2022). Communities are seeing the most destructive wildfire seasons in history. In the last 5 years, the 2020 fire season had the most acreage impacted in a single year at 10.1 million acres, and 2017 was the second highest with 10 million acres (CRS 2022). These statistics demonstrate that wildfires are becoming larger and increasingly impactful.

The California's Forests and Rangelands 2017 Assessment states that California, like other western states, faces urgent issues concerning frequent and severe pest and wildfire events that are unprecedented. These events threaten the sustainability of ecosystems, the economic and environmental services they provide, and the built environment. These issues require reexamination of land and fire management policies and practices as human populations demand more from natural systems and climate change continues (California Department of Forestry and Fire Protection [CAL FIRE] 2018a).

The 2015 Round Fire illustrates the increasing risk of wildfire in the 40 Acres community. The Round Fire burned about 7,000 acres and destroyed 40 homes in Paradise and Swall Meadows a few miles north of 40 Acres. This fire occurred in mid-winter during a severe wind event.

As wildfire severity increases, communities need a plan to help prepare for, reduce the risk of, and adapt to wildland fire events. Community wildfire protection plans (CWPPs) help accomplish these goals. A CWPP provides recommendations that are intended to reduce, but not eliminate, the extreme severity or risk of wildland fire.

The development of the 40 Acres CWPP has included meaningful collaboration among many local stakeholders including local, state, and federal officials, as well as other interested parties such as non-governmental stakeholders and private citizens. The planning process involves looking at past fires and treatments using the knowledge and expertise of the professional fire managers who work for the various agencies and governing entities in the Planning Area. Using this information, the CWPP identifies

DRAFT

the current local wildfire risks and needs that occur in the Planning Area, which is further supported with relevant science and literature from the western region of the United States.

GOAL OF A COMMUNITY WILDFIRE PROTECTION PLAN

The goal of a CWPP is to enable local communities to improve their wildfire-mitigation capacity, while working with government agencies to identify high fire risk areas and prioritize areas for mitigation, fire suppression, and emergency preparedness. Another goal of the CWPP is to enhance public awareness by helping residents better understand the natural and human-caused risk of wildland fires that threaten lives, safety, and the local economy. The minimum requirements for a CWPP, as stated in the Healthy Forests Restoration Act of 2003 (HFRA), are the following (Society of American Foresters [SAF] 2004):

- **Collaboration:** State and local government representatives, in consultation with federal agencies or other interested groups, must collaboratively develop a CWPP.
- **Prioritized Fuel Reduction:** A CWPP must identify and prioritize areas for hazardous fuels reduction and treatments and recommend the types and methods of treatment that will protect one or more communities at risk (CARs) and their essential infrastructures.
- **Treatments of Structural Ignitability:** A CWPP must recommend measures that homeowners and communities can take to reduce the ignitability of structures throughout the area addressed by the plan.

It is the intent of this 2023 40 Acres CWPP to provide a community-wide scale of wildfire risk and protection needs, as well as bring together the responsible wildfire management and suppression entities in the area to support planning and implementation of the necessary mitigation measures. Additional information regarding the planning process is available in Appendix A.

ALIGNMENT WITH THE NATIONAL COHESIVE STRATEGY

The 2023 CWPP has been aligned with the National Cohesive Wildland Fire Management Strategy (Cohesive Strategy) and its Phase III Western Regional Action Plan by adhering to the nationwide goal "to safely and effectively extinguish fire, when needed; use fire where allowable; manage our natural resources; and as a Nation, live with wildland fire" (Forests and Rangelands 2014:3).

The primary, national goals identified as necessary to achieving the vision are:

- **Restore and maintain landscapes:** Landscapes across all jurisdictions are resilient to fire-related disturbances in accordance with management objectives.
- **Fire-adapted communities:** Human populations and infrastructure can withstand wildfire without loss of life and property.
- **Wildfire response:** All jurisdictions participate in making and implementing safe, effective, efficient risk-based wildfire management decisions.

For more information on the Cohesive Strategy, please visit: https://www.forestsandrangelands.gov/documents/strategy/strategy/CSPhaseIIINationalStrategyApr2014.pdf

Alignment with these Cohesive Strategy goals is described in more detail in Chapter 4, Mitigation Strategies.

In addition to aligning with the Cohesive Strategy, the CWPP also incorporates information on post-fire recovery, the significant hazards of a post-fire environment, and the risk that post-fire effects pose to communities (Figure 1.1).



Figure 1.1. The CWPP incorporates the three primary goals of the Cohesive Strategy and post-fire recovery and serves as a holistic plan for fire prevention and resilience.

ALIGNMENT WITH PLANS AND AGREEMENTS

This CWPP is aligned with multiple local, state, and federal planning documents. These documents or agreements are summarized in Appendix A. In addition, fire policy and legislative direction are also summarized in Appendix A.

CORE TEAM

The development of the 40 Acres CWPP was overseen by the 40 Acres Fire Safe Council. Representatives from various government agencies—along with members of fire departments and local communities—formed a Core Team and participated in decision-making activities that led to the development of the 40 Acres CWPP. Stakeholder involvement is critical in producing a meaningful document that includes all collaborators' diverse perspectives. The Core Team drives the planning process in its decision making, data sharing, experience, and communication with community members who are not on the Core Team. The project was kicked off on June 28, 2022; the Core Team met for the first time on July 26, 2022, and convened again on October 27, 2022, and lastly on February 15, 2023.

The Core Team list is provided in the Executive Summary.

PLANNING AREA

The Planning Area includes the entire community of 40 Acres and the surrounding area (Refer to Figure ES.1 in the Executive Summary).

LAND OWNERSHIP

40 Acres itself is composed of privately owned land. Surrounding the community is land owned by the City of Los Angeles and federal land administered by the Bureau of Land Management (BLM) (Figure 1.2).

Additional details regarding the Planning Area, such as topography, weather, and vegetation are summarized in Appendix B.

DRAFT

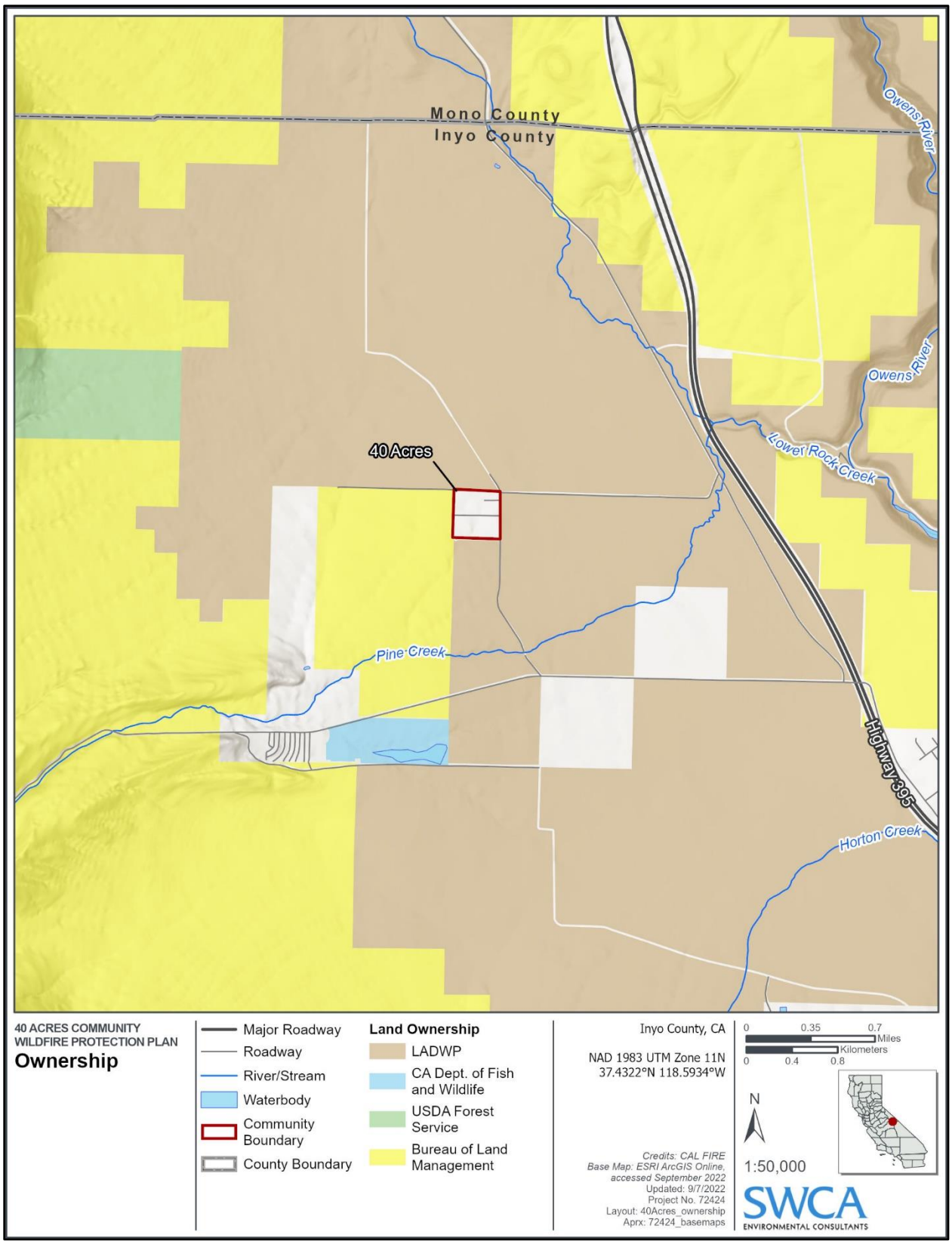


Figure 1.2. 40 Acres land ownership.

PUBLIC INVOLVEMENT

A key element in the CWPP process is the meaningful discussions it generates among community members regarding their priorities for local fire protection and forest management (SAF 2004). The draft CWPP was made available for public review from February 27, 2023, through March 10, 2023. In addition to the CWPP report, public meetings and events were held to gather community input. These efforts are described in detail in Appendix H.

Every effort was made to include a broad cross section of the community in the outreach process, and different communication channels were used to engage as many members of the public as possible (e.g., social media postings, email distributions, and in-person activities). All community members were welcomed and encouraged to participate in in-person activities such as the community event, community walkthrough, and home assessment demonstrations (home assessments were offered to all members). Moreover, all community members were provided multiple opportunities to provide input, such as the community survey, project recommendations review, and CWPP document review.

Recommendations for future community engagement and outreach are provided in Chapter 4, Table 4.4.

Public education and outreach programs are a common factor in virtually every agency and organization involved with the wildfire issue. Detailed information on these programs is provided in Appendix B.

DRAFT



CHAPTER 2 – FIRE ENVIRONMENT

WILDLAND URBAN INTERFACE

The wildland urban interface (WUI) is composed of both interface and intermix communities and is defined as areas where human habitation and development meet or intermix with wildland fuels (U.S. Department of the Interior and U.S. Department of Agriculture [USDA] 2001:752–753). Interface areas include housing developments that meet or are in the vicinity of continuous vegetation. Intermix areas are those areas where structures are scattered throughout a wildland area where the cover of continuous vegetation and fuels is often greater than cover by human habitation.

In addition, the WUI has an area of influence, or influence zone. This area is described with respect to wildland and urban fire; it is an area with a set of conditions that facilitate the opportunity for fire to burn from wildland fuels to the home and or structure ignition zone (National Wildfire Coordinating Group [NWCG] 2021a).

A CWPP offers the opportunity for collaboration of land managers to establish a definition and a boundary for the local WUI; better understand the unique resources, fuels, topography, and climatic and structural characteristics of the area; and prioritize and plan fuels treatments to mitigate for fire risks. At least 50% of all funds appropriated for projects under the HFRA must be used within the WUI.

According to the HFRA, the WUI can be defined by a CWPP, and the standard HFRA definition is as follows:

- An area extending 1.5 miles from the boundary of an at-risk community.
    - In the event a strategic fuel project enhances community protection, the WUI boundary may extend beyond the traditional 1.5-mile buffer to include said areas where the strategic project would be completed. For example, sustained slopes and ridgelines may continue beyond the 1.5-mile buffer. However, it is still important that project work is completed in those high-risk areas. Therefore, the entire strategic Planning Area would be considered as WUI, not just the sections within the 1.5-mile buffer.

Given the fuels, topography, and wind patterns in the region, the Core Team collectively determined that the WUI encompass a 5-mile buffer around the 40 Acres community (Figure 2.1).

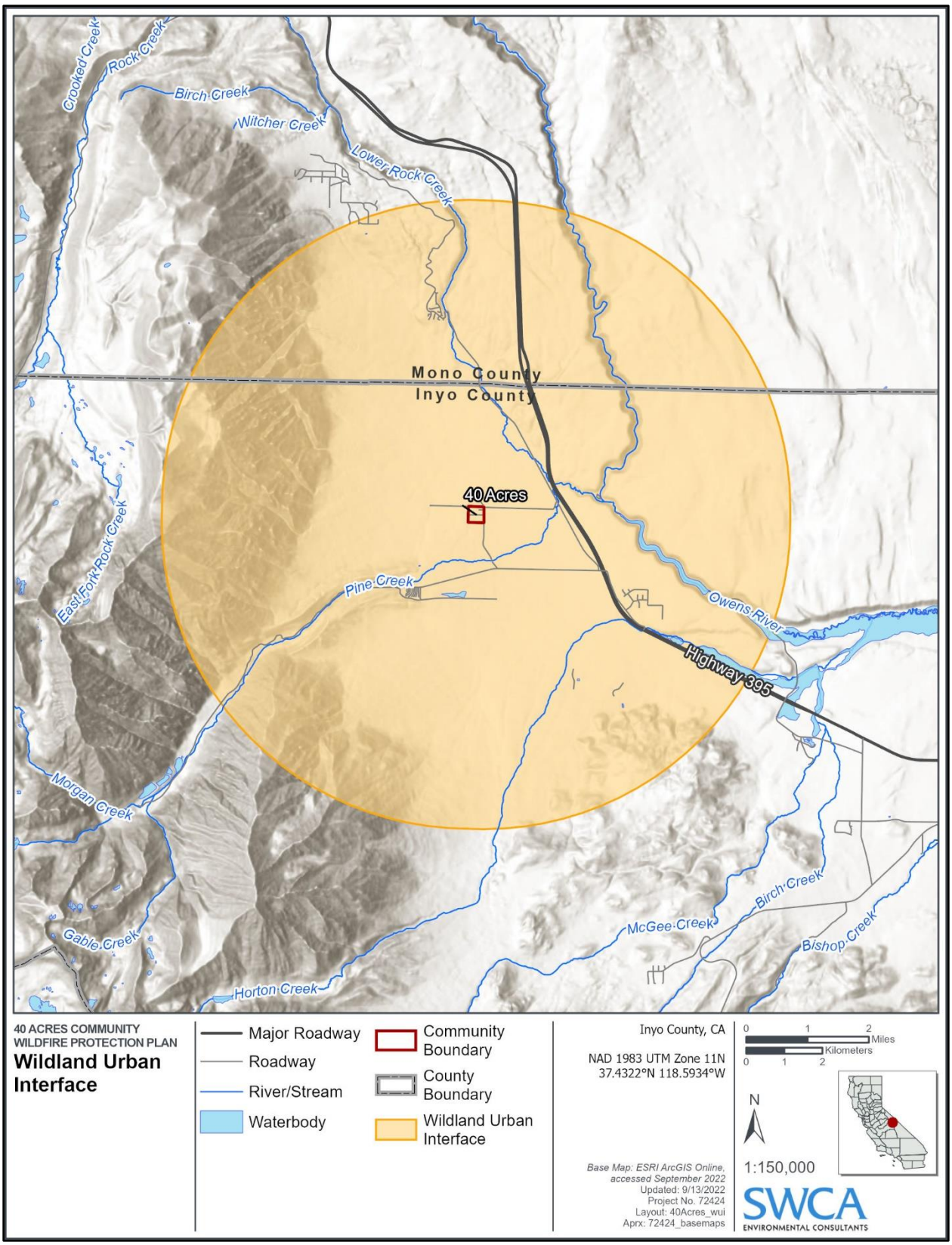


Figure 2.1. 40 Acres WUI delineation.

The WUI creates an environment in which fire can move readily between structural and vegetative fuels, increasing the potential for wildland fire ignitions and the corresponding potential loss of life and property. Human encroachment upon wildland ecosystems within recent decades is increasing the extent of the WUI throughout the country (Figures 2.2 and 2.3), which is having a significant influence on wildland fire management practices. Combined with the collective effects of aggressive suppression policies, resource management practices, land use patterns, climate change, and insect and disease infestations, the expansion of the WUI into areas with high fire risk has created an urgent need to modify fire management practices and policies and to understand and manage fire risk effectively in the WUI (Pyne 2001; Stephens et al. 2005). Mitigation techniques for fuels and fire management can be strategically planned and implemented in WUI areas, for example, with the development of defensible space around homes and structures.

WUI LAND USE

Cities and counties are continuously challenged to accommodate both current and future residents in need of safe and affordable housing. In California, approximately 180,000 homes need to be constructed annually to meet demand (California Department of Housing and Community Development 2018). Over the past few decades, jurisdictions across the state have approved many new housing units. These are often placed within or near wildland areas, creating WUI conditions. Today, more than 46 million residences in 70,000 communities are at risk for WUI fires (U.S. Fire Administration [USFA] 2021a). When it comes to wildfire, this trend is of special concern since WUI conditions are linked with an increased risk of loss of human life, property, natural resources, and economic assets. According to the 2018 Strategic Fire Plan for California, “since the turn of the century there has been a steep increase in structures lost compared to the 1990s” (CAL FIRE 2018b).

Development in high or very high fire hazard areas is required to be constructed in a way that reduces the risk from fire hazards and meets all appropriate county and state fire standards. The requirement includes the use of fire-resistant materials produced to minimize fire susceptibility within high or very high fire hazard areas according to the 2001 California Fire Code, Fire Safe Regulations, and other standards. New development schemes must contain certain fire protection plans, codes, and actions for fire engineering components for buildings and structures in very high fire hazard zones.

The entirety of 40 Acres is designated as a WUI. Under the Inyo County Building Code, all new construction must comply with chapters of California Building Code applicable to Wildland-Urban Interface Fire Areas. All properties shall be maintained in accordance with defensible space requirements of the state (Inyo County Code: https://library.qcode.us/lib/inyo_county_ca/pub/county_code/item/title_14-chapter_14_08-14_08_140). In 40 Acres, only two undeveloped parcels remain. However, some existing structures may be torn down and replaced with new construction in the future.

The following sections describe important wildfire attributes within and around the WUI in the Planning Area.

Additional Fire Code information is described in Appendix A.

DRAFT



Figure 2.2. Example of the WUI in 40 Acres (1 of 2).



Figure 2.3. Example of the WUI in 40 Acres (2 of 2).

Appendix D houses a description and a hazard rating accompanied by a WUI delineation map for the community of 40 Acres. The WUI maps depict the entire WUI boundary for the community. The WUI buffer is an area where fuel treatments should be prioritized to provide additional protection to the community from potential wildfire spread. During Core Team meetings, stakeholders agreed that the WUI buffer should be a 5-mile buffer on all sides of the community to account for the vegetation, topography, and wind patterns.

In addition, Appendix D contains summaries, hazard ratings, and recommended mitigation actions for the community-level and parcel-level assessments that were conducted in 40 Acres.

FUELS AND TOPOGRAPHY WITHIN THE WUI

Most of the fuels around 40 Acres are primarily composed of shrubland and grass-shrub fuels; however, the community is bordered by riparian vegetation on its east, north, and west sides. In addition, a corridor of riparian fuels travels into the community from the southwest, along the Pine Creek diversion. Shrubland communities are primarily characterized by rabbitbrush and blackbrush vegetation and occur at low to mid-elevations. Shrubland vegetation around 40 Acres is intermixed with sparse grasses and does not typically occur as a homogeneous stand.

Forested communities exist primarily in the higher elevations of the Sierra Nevada to the west of 40 Acres. Typically, forested communities are dominated by pinyon-juniper woodlands at the lower elevations; transition to red fir forests, Jeffrey pine forests, and mixed-conifer forests at mid- to higher elevations; and to white pine (whitebark pine, foxtail pine, limber pine) forests in the subalpine zone (USFS 2018a).

Map C.1 in Appendix C shows fuels within and around 40 Acres.

FIRE REGIMES

Fires are characterized by their intensity, the frequency with which they occur, the season in which they occur, their spatial pattern or extent, and their type. Combined, these attributes describe the fire regime.

In order to classify, prioritize, and plan for fuels treatments across a fire management region, methods have been developed to stratify the landscape based on physiographic and ecological characteristics.

The region is home to the Sierra Nevada biological province and converges with the Great Basin and the Mojave Desert biological provinces. The convergence of these biological provinces creates an environment conducive to a wide variety of vegetation ecosystems such as sagebrush shrubland, pinyon-juniper woodland, montane mixed conifer, and dry mixed conifer (USFS 2018a). However, the most widespread and common plant communities in and around 40 Acres is sagebrush shrubland mixed with grasses and riparian vegetation. The fire regimes of these communities are summarized below.

SHRUBLAND AND GRASSES

Shrubland communities are widely distributed throughout the Great Basin and exist across the Eastern Sierra in arid environments. Recent terminology would describe the native vegetation as *Artemisia tridentata* Shrubland Alliance (California Native Plant Society n.d.). These communities are dominated by drought-resistant shrubs, particularly sagebrush vegetation. Sagebrush in the Eastern Sierra comprises all subspecies of big sagebrush, low sagebrush, bitterbrush, and black sagebrush (USFS 2018a). The

community is also distinguished by an understory of perennial grasses and forbs within the open spaces between shrubs. The composition of sagebrush shrubland communities is highly varied at both local and regional scales and is oftentimes intermixed with pinyon-juniper vegetation. Sagebrush shrubland is a disconnected fuel bed that interrupts the occurrence of many large wildfires. Natural fire frequency in these communities range from 32 to 70 years (Kitchen et al. 2013). Historic fires were usually small, high-intensity surface fires that maintained the composition of the community. However, anthropogenic disturbances have altered this regime—the modern fire regime is a short fire-return interval of large, intense fires. Disturbances such as livestock grazing prevent the propagation of native bunchgrasses and allow for invasive species (e.g., cheatgrass) to invade and proliferate. Cheatgrass, a highly combustible fuel, has further contributed to changing the fire regime. Cheatgrass produces an abundance of light, flashy, and continuous fuel, which creates the perfect conditions for frequent fires (USFS 2014). Cheatgrass exists throughout California and is the primary annual grass on sagebrush rangelands in the Owens Valley (University of California, Agriculture and Natural Resources [UCANR] 2019). The adjacent Inyo National Forest has also recorded invasions by cheatgrass (USFS 2018a).

RIPARIAN VEGETATION

Lowland riparian environments in many regions of California have been altered extensively by human caused disturbances. As a result of these modifications, species composition and spatial dimensions of riparian plant communities have changed. In most cases, native riparian vegetation has been eliminated completely. Studies suggest that fire frequency and severity are increasing in many riparian environments where nonnative plants constitute a significant part of the plant community (Webb et al. 2019). Native riparian trees such as willows and cottonwoods typically do not recover well from high-intensity crown fires; contrarily, invasives such as salt cedar, giant reed, and Russian olive recover quickly from even the highest-intensity fires (UCANR 2009). Nonnative vegetation alters fuel properties such as flammability and continuity, and fuel loading, which leads to increased fire risk. Fires in these riparian areas are typically extensive and severe, and fire spreads easily from the surface into the canopies of the tallest native trees (UCANR 2009). In the Owens Valley, salt cedar has been expanding its range since the mid twentieth century (Inyo County Water Department 2023).

CLIMATE AND WEATHER PATTERNS

40 Acres has an arid climate typical of Owens Valley (Powell and Klieforth 2000). The geographic location immediately east of the Sierra Nevada results in minimal precipitation because of the strongly declining precipitation gradient in the lee of the mountains (“rain shadow effect”), occasional strong downslope winds, and warm to hot temperatures except during winter. Relative humidity is rarely above 20% and often less than 10%, during the fire season.

July is typically the hottest month of the year in the area, with average maximum July temperatures of approximately 98ºF at the Bishop Airport weather station (Figure 2.4). December and January are usually the coldest months, with average minimum temperatures of approximately 22ºF at the Bishop Airport weather station (Western Regional Climate Center 2022).

40 Acres receives relatively little precipitation because of its location in the rain shadow of the Sierra Nevada (Table 2.1). Annual precipitation totals have ranged from 1.3 inches in 2013 to 17 inches in 1969, with an average of 5.3 inches at the Bishop Airport weather station. The months of December, January, February, and March receive approximately 65% of the annual precipitation. The summer months of July,

August, and September are hot and dry with infrequent precipitation from thunderstorms and receive only approximately 7% of the annual precipitation.

Table 2.1. Climate Summaries for Weather Stations near 40 Acres

			Mean Annual Temperature (°F)		
Station	Period of Record	Total Mean Annual Precipitation (Inches)	Max	Min	Mean Annual
Bishop WSO	1895–2016	5.3	74.5	37.6	65
Union Carbide	1957–1969	10.4	54.1	33.0	---

Source: Western Regional Climate Center (2022)

The geographic location of 40 Acres is significant because of downslope winds off the Sierra Nevada immediately to the west and very strong winds out of Pine Creek canyon. In a typical year, four to 10 windstorms occur with gusts exceeding 50 mph. A private weather station within the community measured a wind gust of 125 mph in April 2007 when 22 utility poles were brought down by the strong winds. As a result of the topography and regional weather patterns, the community is particularly at risk of wind-driven wildfires approaching from the west, as well as ignitions within the community during windy weather.

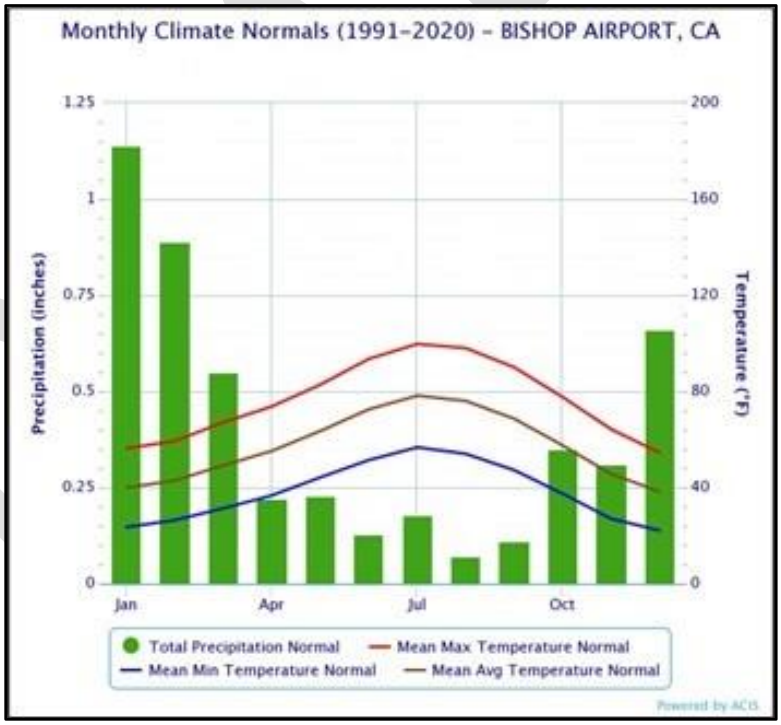


Figure 2.4. Monthly climate normal for the Bishop Airport weather station for 1991 through 2020.

FIRE HISTORY

Fire is a natural part of California's diverse landscapes and is essential to many ecosystems across the state. Almost all of California's diverse ecosystems are fire-dependent or fire-adapted. For centuries,

many California Native American tribes recognized this interdependence between fire and the ecosystem and used prescribed burning to maintain and restore ecosystem health. However, in the 1800s, a shift in management actions—settlers began enforcing strict fire suppression regimes—led to issues such as dense stand conditions and increased vulnerability to fire. Wildland fire suppression regimes, in conjunction with other management actions such as human expansion into wildlands and climate change, have resulted in an imbalance between wildfire and ecosystem interactions (California Department of Fish and Wildlife [CDFW] 2021).

PAST FIRE MANAGEMENT POLICIES AND LAND MANAGEMENT ACTIONS

Beginning in the early 1900s, the policy for handling wildland fire leaned heavily toward suppression. Over the years, other agencies, such as the BLM, the Bureau of Indian Affairs, and the National Park Service, have followed the lead of the USFS and adopted fire suppression as the proper means for protecting the nation from wildfire. As a result, many areas now have excessive fuel buildups, dense and continuous vegetative cover, and tree and shrub encroachment into open grasslands.

RECENT FIRE OCCURRENCE

This section was developed using fire history data from CAL FIRE's Fire and Resource Assessment Program (FRAP) (2022a). Although the fire history data from CAL FIRE is the most comprehensive digital record of fire perimeters in California, it has its limitations. CAL FIRE states that the earlier data (i.e., prior to 1950) is subject to significant uncertainty due to poor and inconsistent record keeping. In addition, data for some fires may be missing or have incorrect information. This is due to the loss or damage of historical records as well as inadequate documentation (CAL FIRE 2022a). Given the limitations of the data, our fire history analysis may contain discrepancies.

The fire history dates differ between the charts and the map because the charts contain fire history for 40 Acres and a surrounding 20-mile buffer. The map shows fire history only for the area that is displayed (i.e., less than the 20-mile buffer). It should be noted that the 20-mile buffer captures some of the fires in the western Sierra, including large fires such as the 2020 Creek Fire. These fires strongly influence the analysis below.

An analysis of 40 Acre's wildland fire history (1923–2021) shows historic fires occurring to the north and south of the community, within and around the valley floor and foothills (Figure 2.5). Historically, fire events have been relatively constant, with most decades (1963–2003) experiencing six events (Figure 2.6). However, there has been a steady increase of fire events, human ignitions, and total acreage burned per decade over the last 20 years (Figures 2.6, 2.7, 2.8, and 2.10). In fact, 94.5% (393,440 acres) of all acres burned since 1934 have burned in the last two decades (2003–2021) (see Figure 2.8). Many of the fires in the region have unknown causes (which are probably human caused), and human ignitions have increased substantially in the last two decades.

Most fires occurred within the period of July to September, which is when high temperatures and hot, dry winds are most frequent (see Figure 2.9) and when live fuel moistures are low and grasses cured out. This trend coincides with California's fire season, which usually occurs between July and November. The region also experiences a fire season in the winter and spring, with a considerable number of fires occurring within the period of February to April (see Figure 2.9). In addition, fire seasons are increasing in

DRAFT

length. Climate change acts as a key driver of increased fire season duration due to warmer spring and summer temperatures, decreased snowpack, and earlier spring snow melt (CAL FIRE 2021a).

DRAFT

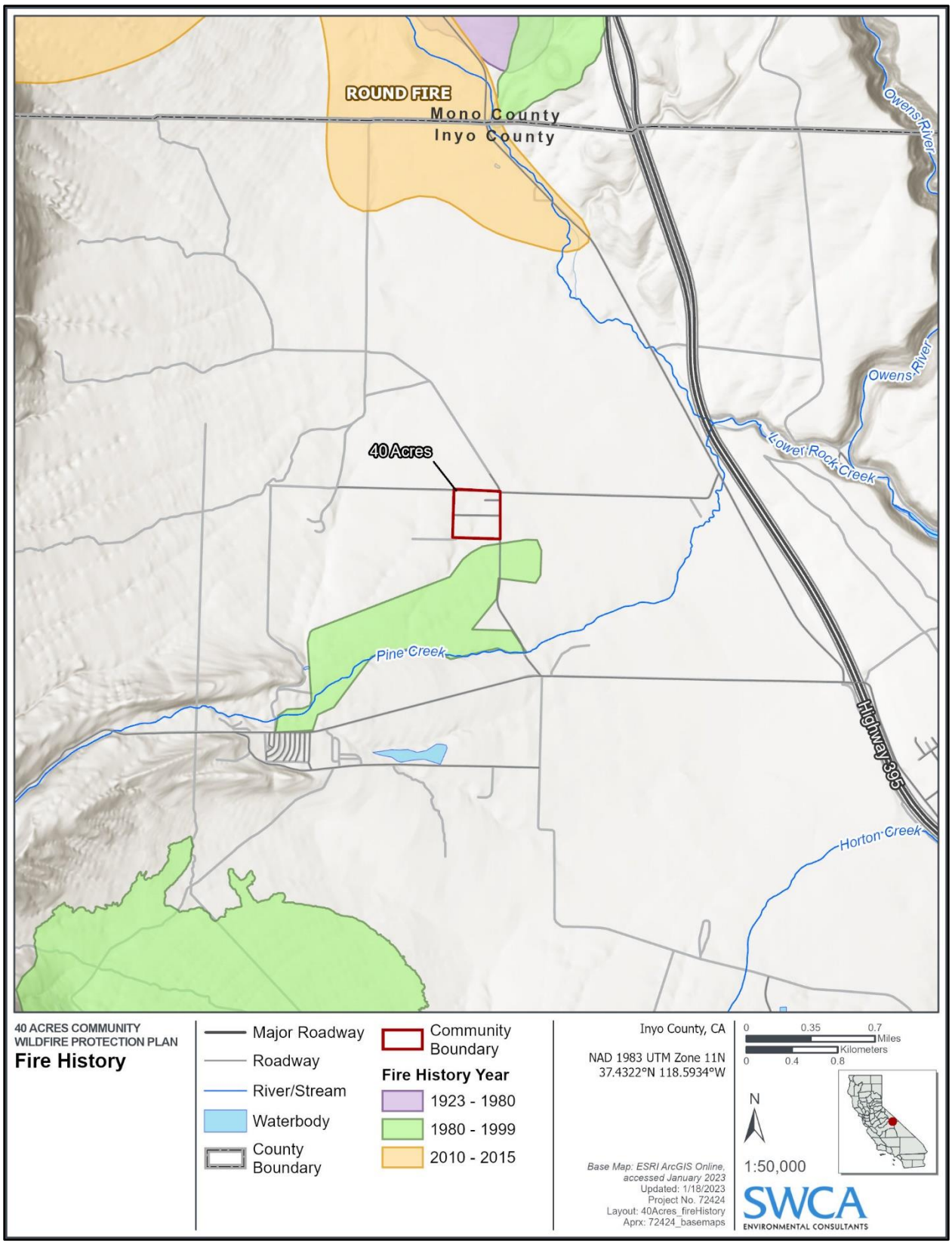


Figure 2.5. Historic fire perimeters for 40 Acres from 1923 through 2021.

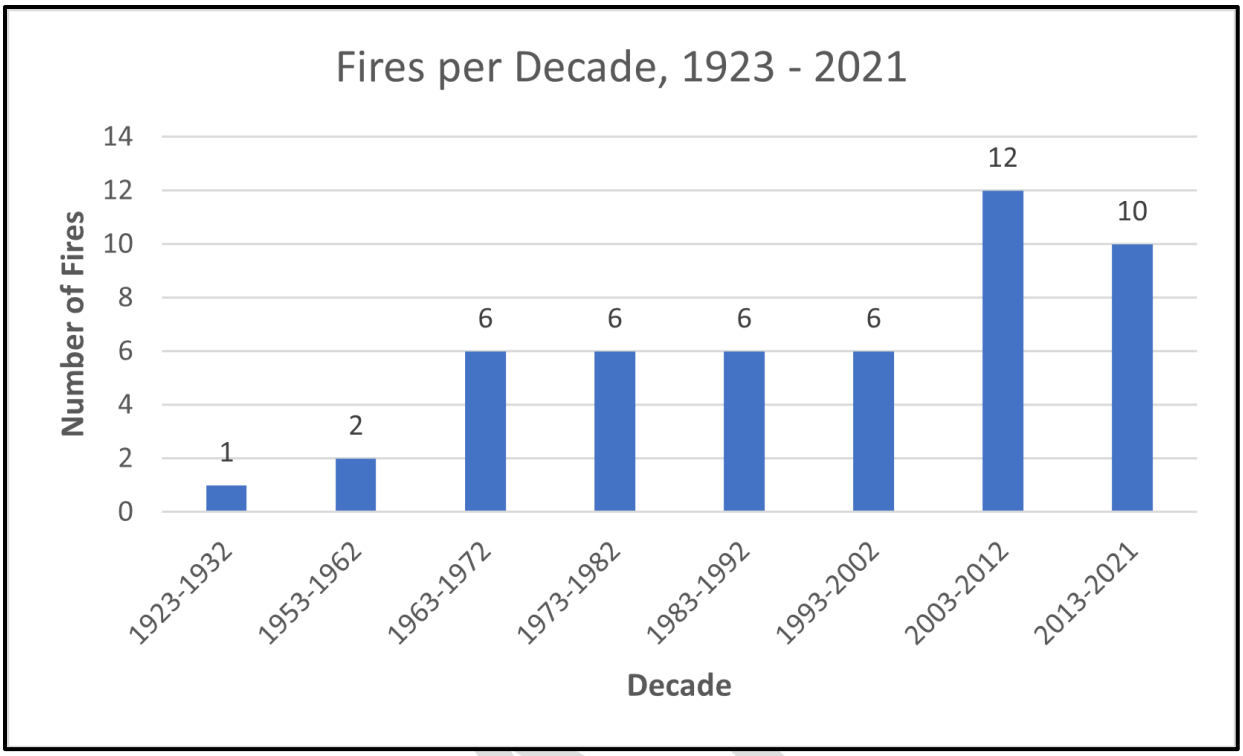


Figure 2.6. Decadal wildfire frequency in 40 Acres (and 20-mile buffer) based on fire history data from 1923 through 2021.

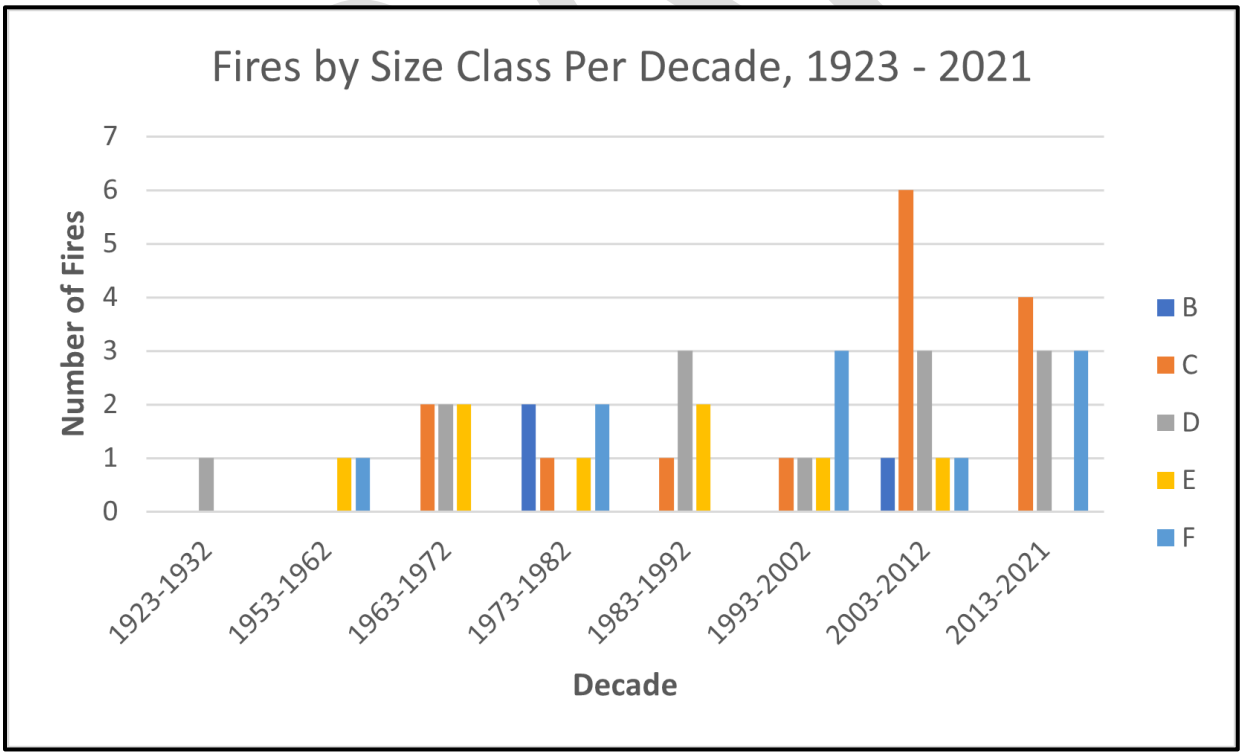


Figure 2.7. Fire size statistics per decade for 40 Acres (and 20-mile buffer) based on fire history data from 1923 through 2021.

Size Class: A = 0.25 acre or less; B = greater than 0.25 to 10 acres; C = 10 to 100 acres; D = 100 to 300 acres; E = 300 to 1,000 acres; F = 1,000+ acres.

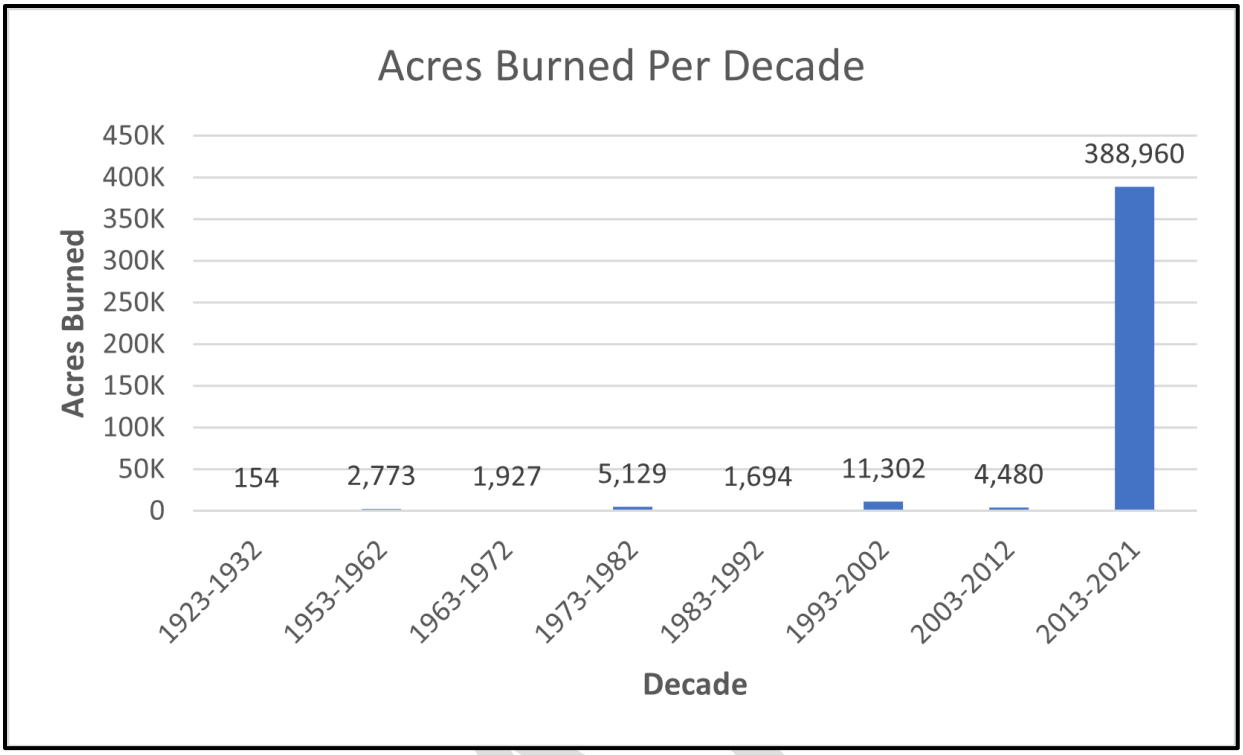


Figure 2.8. Acres burned per decade for 40 Acres (and 20-mile buffer) based on fire history data from 1934 through 2021.

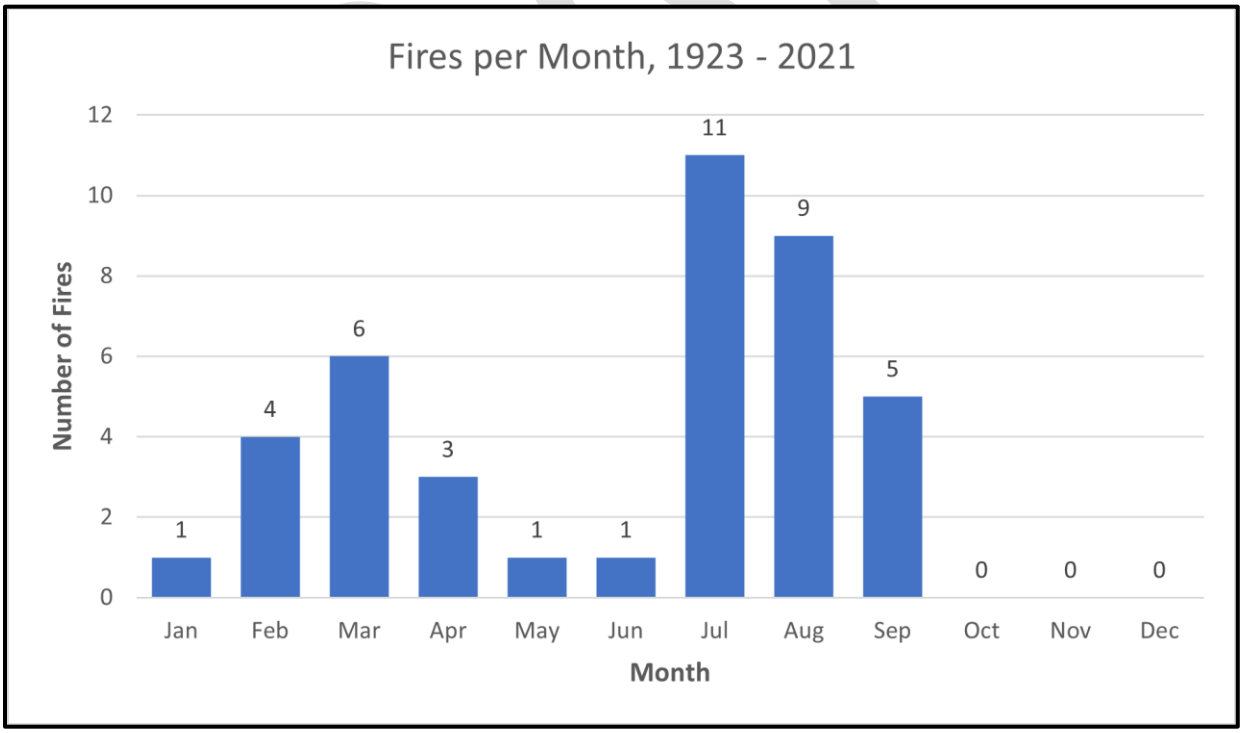


Figure 2.9. Monthly fire frequency in 40 Acres (and 20-mile buffer) based on data from 1934 through 2021.

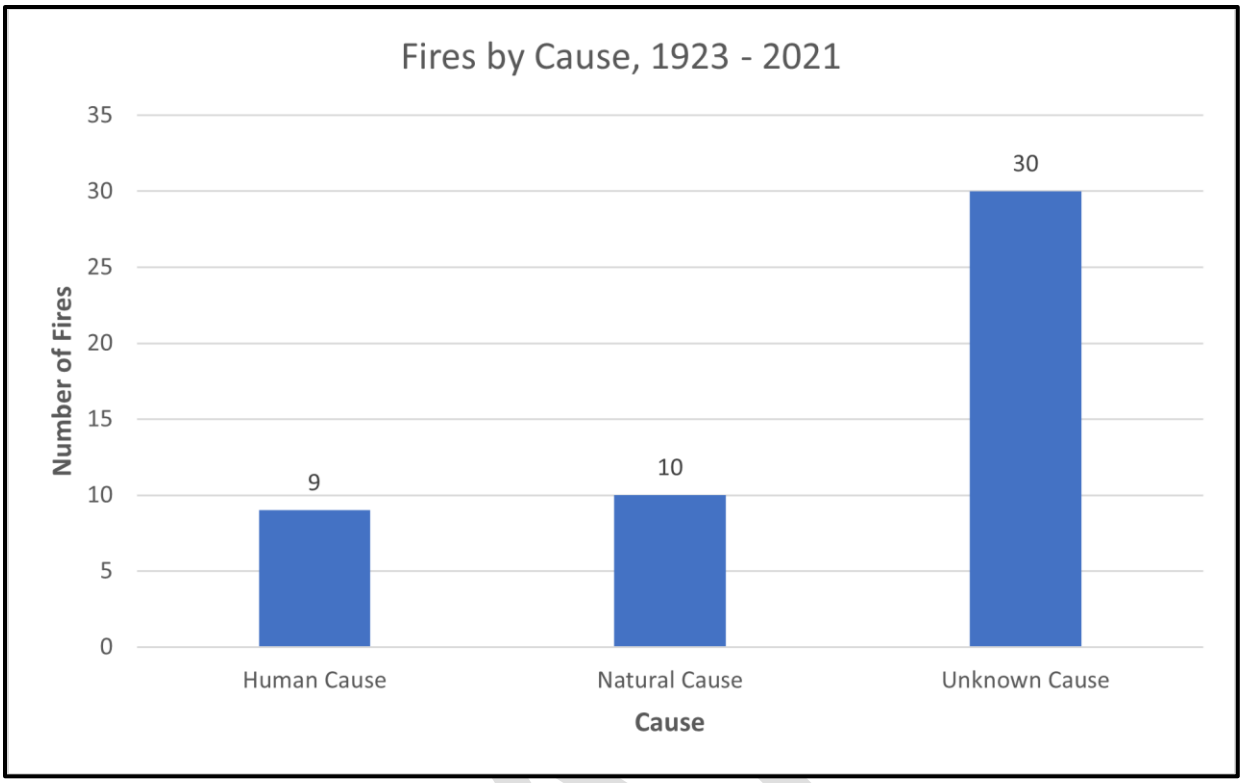


Figure 2.10. Fire causes for 40 Acres (and 20-mile buffer) from 1934 through 2021.

The Round Fire that caused great damage in Swall Meadows and Paradise is the fire that most residents of 40 Acres vividly remember. Besides destroying 40 homes within the neighboring communities to the north, this 7,000-acre fire was starkly visible from 40 Acres. The Round Fire apparently ignited from sparks from wind-tossed electrical lines less than 2 miles from 40 Acres on February 6, 2015. Strong winds from the south moved the fire away from 40 Acres. Little imagination is required to think about a different outcome if the wind direction had been the opposite. In addition, the vegetation density and fuel loads within the area burned by the Round Fire were minimal compared with those of 40 Acres. Other recent fires in the general vicinity of 40 Acres include the Rock Creek Fire of August 2016, which burned 120 acres along Rock Creek, just northeast of the Round Fire area; and the Pleasant Fire of February 2018, which burned more than 2,000 acres a few miles east of 40 Acres. Older (i.e., before 2010) fires include the Rovana Fire of June 1983, which started less than 2 miles to the southwest and burned 317 acres as the fire approached 40 Acres driven by 30-mph winds. Two homes within 40 Acres burned during the Rovana Fire, perhaps ignited by windblown embers.

FUTURE CHALLENGES

Frequent drought, suppression-based forest management practices, and climate change have interacted to increase forest vulnerability. Removing natural fire from a fire-dependent ecosystem, drought, insects, and diseases have resulted in increased fuel build-up and alterations to vegetation composition. These forest changes can increase the risk of uncharacteristically large high-severity fires (CDFW 2021). In the past few years, fires have grown to record sizes and are burning earlier, longer, hotter, and more intensely than they have in the past (Westerling et al. 2006; Westerling 2016).

According to Westerling et al. (2006), a study of large (>1,000 acres) wildfires throughout the western United States for the period of 1970 to 2003 saw a pronounced increase in fire frequency since the

mid-1980s (1987–2003 fires were four times more frequent than the 1970–1986 average). An update to Westerling et al.'s 2006 work found that the frequency of large wildfires has continued to increase with each decade since 1970 (Westerling 2016). Indeed, recent studies suggest that this trend will continue. Iglesias et al. (2022) found that average fire occurrences in regions of the United States are up to four times larger in size, more extensive, and triple the frequency during the last two decades.

Within the last 10 years, a record number of acres have burned, and numbers have surged since the turn of the century (National Interagency Fire Center [NIFC] 2021a). In 2021, 58,985 fires were reported nationwide, burning well over 7 million acres (NIFC 2021a). Of these, over 2.5 million acres were burned in California, which represents more than a third of all acreage burned nationwide (CAL FIRE 2022b). With increased fires comes increased suppression costs; 2021 beat all previous records, with federal firefighting costs hitting over $4 billion (NIFC 2021b). Indeed, the 2015 Round Fire burned more than 7,000 acres and 40 homes about 2 miles north of 40 Acres.

Impacts of climate change and tree mortality are discussed in Appendix A.

FIRE RESPONSE CAPABILITIES

Planning Decision and Support

Wildfires have continued to grow in size and severity over the last decade, requiring fire managers to institute more robust pre-fire planning as well as adapt and improve decision-making tools in order to reduce risk to fire responders and the public and assess impacts on ecological processes.

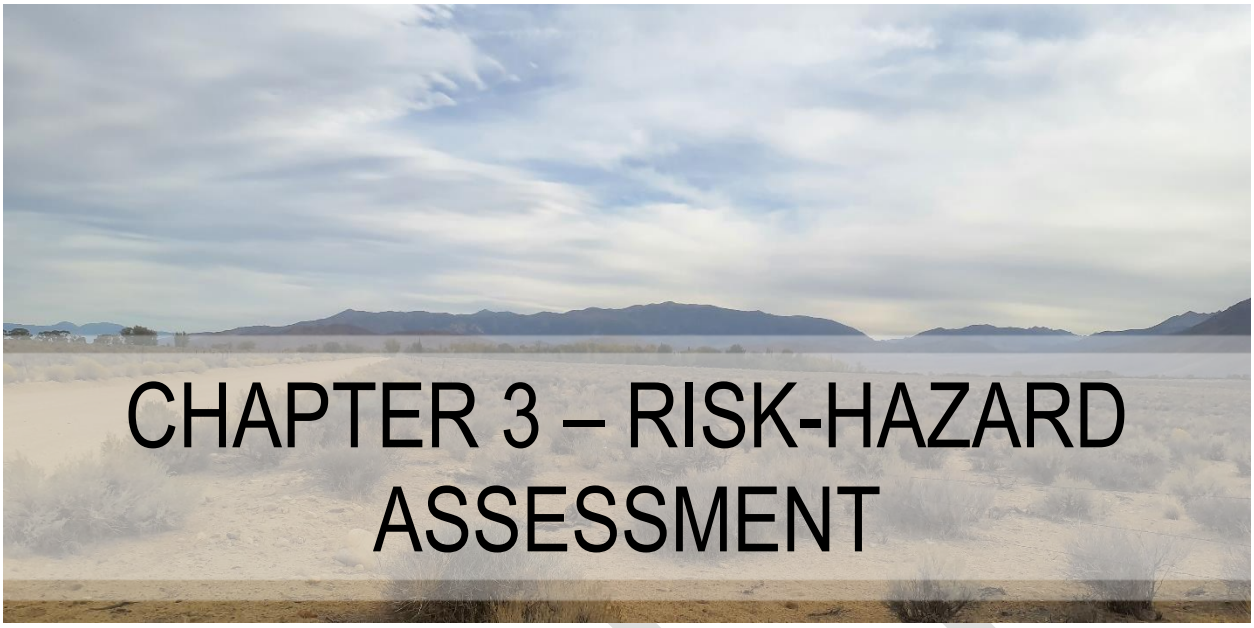
A primary decision tool utilized by fire managers across all agencies is the Wildland Fire Decision Support System (WFDSS), a system that assists fire managers and analysts in making strategic and tactical decisions for fire incidents (WFDSS 2021). WFDSS combines desktop applications for fire modeling into one web-based system. It provides a risk-informed decision process and documentation system for all wildland fires, and it also introduces economic principles into the fire decision process to improve efficiency while also ensuring safe and effective wildfire response.

Fire Resources

California contains many federal, state, and local fire protection organizations that are well integrated through a variety of mutual aid and fire protection agreements and coordinated by organizations such as the California Wildfire Coordinating Group, the Northern and Southern California Geographic Area Coordination Centers, and FIRESCOPE (an interagency resource coordination system for fire and other emergencies in the southern California). Agencies such as California Emergency Management, USFS, and CAL FIRE contribute to the substantial wildfire response capacity, which can be deployed to incidents throughout the state. California contains one of the strongest wildfire suppression capabilities in the nation.

Within California, fire response is broken down into three areas: Local, State, and Federal Responsibility Areas (Appendix C, Map C.10). Local Responsibility Area (LRA) is a legal term defining the area where the local government has financial responsibility for the prevention and suppression of wildfire. State Responsibility Area (SRA) defines where the state government is responsible for wildfire response, and Federal Responsibility Area (FRA) defines where the federal government is responsible.

Additional information regarding local, state, and federal fire response capabilities for 40 Acres can be found in Appendix B.



CHAPTER 3 – RISK-HAZARD ASSESSMENT

PURPOSE

The purpose of developing the Composite Risk-Hazard Assessment model described here is to create a unique tool for evaluating the risk of wildland fires to 40 Acres. Although many definitions exist for hazard and risk, for the purpose of this document these definitions follow those used by the firefighting community:

Risk is defined as the chance of a fire starting as determined by the presence and activity of causative agents (NWCG 1998).

Hazard is a fuel complex defined by kind, arrangement, volume, condition, and location that forms a special threat of ignition and resistance to control.

The Composite Risk-Hazard Assessment combines the findings from a Desktop Risk-Hazard Assessment (a geographic information system [GIS] model of hazard based on fire behavior and fuels modeling technology) and a Community Hazard Assessment (a Core Team–generated assessment of on-the-ground community hazards and VARs).

From these assessments, land use managers, fire officials, planners, and others can begin to prepare strategies and methods for reducing the threat of wildfire, as well as work with community members to educate them about methods for reducing the damaging consequences of fire. The fuels reduction treatments can be implemented on both private and public land, so community members can actively apply the treatments on their properties, as well as recommend treatments on public land that they use or care about.

The Inyo County and City of Bishop Multi-Jurisdictional Hazard Mitigation Plan (Inyo County and City of Bishop 2017) lists wildfire as a top priority hazard.

Disclaimer

The purpose of this risk assessment is to provide a community- and landscape-level overview of wildfire risk and is not recommended for use at smaller scales (such as for a property level analysis). It is also not recommended for use in determining insurance rates or policies. This risk assessment is a model, and as

DRAFT

such has inherent biases, missing data, and other shortcomings, though every effort has been made to include the best available data and use the most robust scientific processes. Also note that just because an area is shown as high or low risk does not mean that that area will be burned or not burned in a wildfire—a low risk area can still be affected by wildfire if the conditions are right. This risk assessment is also not intended for use during active wildfire events, but rather only as a tool for pre-fire planning. It is not recommended that this risk assessment be used for any other purpose than what is stated here.

FIELD-BASED COMMUNITY HAZARD ASSESSMENTS

Community Hazard Assessments were conducted using the NFPA Wildland Fire Risk and Hazard Severity Form 1144 (see Appendix E). This form is based on the NFPA Standard for Reducing Structure Ignition Hazards from Wildland Fire 2013 Edition. The NFPA standard focuses on individual structure hazards and requires a spatial approach to assessing and mitigating wildfire hazards around existing structures. It also includes ignition-resistant requirements for new construction and is used by planners and developers in areas that are threatened by wildfire and is commonly applied in the development of Firewise Communities (for more information, see www.firewise.org).

The purpose of the Community Hazard Assessment and subsequent ratings is to identify fire hazards and risks and prioritize areas requiring mitigation and more detailed planning. These assessments should not be seen as tactical pre-suppression or triage plans. The Community Hazard Assessment helps to drive the recommendations for mitigation of structural ignitability, community preparedness, and public education. The assessment also helps to prioritize areas for fuels treatment based on the hazard rating. Each area was rated based on conditions within the community and immediately surrounding structures, including access, adjacent vegetation (fuels), defensible space, adjacent topography, roof and building characteristics, available fire protection, and placement of utilities. Where a range of conditions was less easily parsed out, a range of values was assigned on a single assessment form. Each score was given a corresponding adjective rating of low, moderate, high, or extreme.

A Community Hazard Assessment for 40 Acres was conducted in October 2022. The community at risk (CAR) hazard rating from the Community Hazard Assessment is provided in Table 3.1. This table also includes a summary of the positive and negative attributes of the community as they relate to wildfire risk. The full CAR description is provided in Appendix D.

In addition, a parcel-level hazard assessment was conducted for 40 Acres. In general, parcels exhibited limited defensible space, combustible construction materials (siding, decks, fences, and roofs), exposure to adjacent fuels, and improper placement of woodpiles and propane tanks. Appendix D contains the parcel-level summaries for the properties that SWCA was given permission to assess.

DRAFT

Table 3.1. Communities at Risk Ratings with Community Hazard Assessment Summary

Community	Risk Rating	Fire Station	Positives	Negatives
40 Acres	87 (High)	• CAL FIRE Bishop Forestry Fire Station	• Two or more roads in and out of community (Birchim Ln and Round Valley Rd) • Surfaced roads with < 5% grade • Street signs present and reflective • Relatively flat terrain around community • Good water source (3 water tanks and ditches within community)	• Narrow roads < 20 feet in width • Limited defensible space for most structures • Limited turnarounds • Little separation of adjacent structures • Combustible house siding • Predominantly combustible roofing material • Predominantly combustible deck and fence material • Some properties with combustible debris or rubbish • Community is between 10 to 15 minutes from fire station (Round Valley Rd currently closed) • Gas and electric utilities are aboveground • Community is exposed to grass-shrub fuels on all sides • Significant dead and dying fuels within community and adjacent areas/ditches • Southwest corner of the community has a ditch lined with heavy fuels that is aligned with wind and topography • Roads with no outlet (Ocean View, Walford)

DRAFT

COMPOSITE RISK-HAZARD ASSESSMENT INPUTS

A desktop analysis of risks and hazards uses fuels properties, topography, and weather to generate fire behavior modeling outputs: flame length (Map C.2 in Appendix C), fireline intensity (Map C.3 in Appendix C), rate of spread (Map C.4 in Appendix C), crown fire potential (Map C.5 in Appendix C), and fire occurrence density (Map C.6 in Appendix C). These outputs were subsequently used as inputs along with drive time distance from the fire station (Map C.7 in Appendix C), the WUI (Figure 2.1 in Chapter 2), and highly valued resources and assets (HVRA) (Map C.8 in Appendix C) in the Composite Risk-Hazard Assessment.

Detailed information regarding topography, weather, fire regimes, fire history, and fire response can be found in Chapter 2.

FIRE BEHAVIOR MODELING

Overview

The wildland fire environment consists of three factors that influence the spread of wildfire: fuels, topography, and weather. Understanding how these factors interact to produce a range of fire behavior is fundamental to determining treatment strategies and priorities in the WUI. In the wildland environment, vegetation is synonymous with fuels. When sufficient dry fuels for continued combustion are present, the level of risk for those residing in the WUI is heightened. Fire spreads in three ways: 1) surface fire spread, in which the flaming front remains on the ground surface (in grasses, shrubs, small trees, etc.) and resistance to control is comparatively low; 2) crown fire, in which the surface fire “ladders” up into the upper levels of the forest canopy and spreads through the tree crowns independent of or along with the surface fire and, when sustained, is often beyond the capabilities of suppression resources; and 3) spotting, in which embers are lifted and carried with the wind ahead of the main fire and ignite in receptive fuels; if embers are plentiful and/or long range (>0.5 mile), spotting can be prolific and resistance to control can be very high. Crown fire and spotting activity have been a concern for fire managers, particularly under extreme weather conditions. In areas where homes are situated close to timber fuels and/or denser shrubs and trees, potential spotting from woody fuels to adjacent fuels is usually a factor and should always be acknowledged.

Treating fuels in the WUI can lessen the risk of intense or extreme fire behavior (Martinson and Omi 2013; Safford et al. 2009). Studies and observations of fires burning in areas where fuel treatments have occurred have shown that the fire either remains on or drops to the surface, thus avoiding destructive crown fire, as long as activity fuels are treated or removed (Graham et al 2004; Pollet and Omi 2002; Prichard et al. 2010; Safford et al. 2012; Waltz et al. 2014). Fuel mitigation efforts should therefore be focused specifically on where these critical conditions could develop in or near CARs.

For this plan, an assessment of fire behavior has been carried out using well-established fire behavior models: FARSITE, FlamMap, BehavePlus, and FireFamily Plus housed within the Interagency Fuel Treatment Decision Support System (IFTDSS), as well as ArcGIS Desktop Spatial Analyst tools. Data used in the Composite Risk-Hazard Assessment is largely obtained from LANDFIRE 2020.

DRAFT

FIRE BEHAVIOR MODELS

LANDFIRE

LANDFIRE is a national remote sensing analysis project that provides managers a data source for inputs needed for FARSITE, FlamMap, and other fire behavior models. The database is managed by the USFS and the U.S. Department of the Interior and is widely used throughout the United States for land management planning. More information can be obtained from http://www.landfire.gov.

FARSITE

FARSITE is a computer model based on Rothermel's spread equations (Rothermel 1983) and Huygen's principle of wave propagation (Anderson et al. 1981); the model also incorporates crown fire models. FARSITE uses spatial data on fuels, canopy cover, crown bulk density, canopy base height, canopy height, aspect, slope, elevation, wind, and weather to model fire behavior across a landscape. FARSITE is a spatial and temporal fire behavior model. FARSITE is used to generate fuel moisture and landscape files as inputs for FlamMap. Information on fire behavior models can be obtained from http://www.fire.org.

FlamMap

Like FARSITE, FlamMap uses a spatial component for its inputs but only provides fire behavior predictions for a single set of weather inputs. In essence, FlamMap gives fire behavior predictions across a landscape for a snapshot of time; however, FlamMap does not predict fire spread across the landscape. FlamMap has been used for the CWPP to predict fire behavior across the landscape under extreme (97% worst case) weather scenarios. For this CWPP assessment, the model was run within the IFTDSS modeling platform (IFTDSS 2022).

FIRE BEHAVIOR MODEL INPUTS

Fuels

The fuels in the Planning Area are classified using Scott and Burgan's (2005) Standard Fire Behavior Fuel Model classification system. This classification system is based on the Rothermel surface fire spread equations, and each vegetation and litter type is broken down into 40 fuel models.

The general classification of fuels is by fire-carrying fuel type (Scott and Burgan 2005):

- (NB) Non-burnable
- (GR) Grass
- (GS) Grass-Shrub
- (SH) Shrub
- (TU) Timber-Understory
- (TL) Timber Litter
- (SB) Slash-Blowdown

Table 3.2 provides a description of each fuel type.

Map C.1 in Appendix C illustrates the fuels classification throughout the Planning Area.

DRAFT

Field surveys revealed that some fuels were incorrectly classified in the fuel model. Following on-the-ground verification of fuels around 40 Acres and Core Team input, the fuel model was calibrated to reflect the type of fuels observed in the vicinity. In detail, fuel models were calibrated to align with expected fire behavior in the region; for instance, if fire was expected to travel at 50 chains per hour and have a flame length of 8+ feet, we assigned a fuel model with those characteristics that was also in accordance with our field observations.

Table 3.2. Fuel Model Classification for the Planning Area

1.	**Mixture of grass and shrub, up to about 50% shrub cover (Grass-Shrub)**
i.	**GS1:** Shrubs are about 1 foot high, low grass load. Spread rate moderate (5–20 chains/hour); flame length low (1–4 feet); fine fuel load (1.35 tons/acre).
ii.	**GS2:** Shrubs are 1–3 feet high, moderate grass load. Spread rate high (20–50 chains/hour); flame length moderate (4–8 feet); fine fuel load (2.1 tons/acre).
iii.	**GS3:** Moderate grass and shrub load, average depth less than 2 feet. Spread rate high (20–50 chains/hour); flame length moderate (4–8 feet).
2.	**Shrubs cover at least 50% of the site; grass sparse to non-existent (Shrub)**
i.	**SH1:** Low fuel load, depth about 1 foot, some grass fuels present. Spread rate very low (0–2 chains/hour); flame length very low (0–1 feet).
ii.	**SH2:** Moderate fuel load (higher than SH1), depth about 1 foot, no grass fuels present. Spread rate low (2–5 chains/hour); flame length low (1–4 feet); fine fuel load (5.2 tons/acre).
iii.	**SH4:** Low to moderate shrub and litter load, possibly with pine overstory. Fuel bed depth about 3 feet. Spread rate high (20–50 chains/hour); flame length moderate (4–8 feet).
iv.	**SH5:** Heavy shrub load. Fuel bed depth 4–6 feet. Spread rate very high (50–150 chains/hour), flame length very high (12–25 feet).
v.	**SH7:** Very heavy shrub load, possibly with pine overstory. Fuel bed depth 4–6 feet. Spread rate high (20–50 chains/hour); flame length very high (12–25 feet).
3.	**Grass or shrubs mixed with litter from forest canopy (Timber-Understory)**
i.	**TU1:** Fuel bed is low load of grass and/or shrub with litter. Spread rate low (2–5 chains/hour); flame length low (1–4 feet); fine fuel load (1.3 tons/acre).
ii.	**TU5:** High load conifer litter with shrub understory. Spread rate moderate (5–20 chains/hour); flame length moderate (4–8 feet).
4.	**Dead and downed woody fuel (litter) beneath a forest canopy (Timber Litter)**
i.	**TL2:** Low load, compact. Spread rate very low (0–2 chains/hour); flame length very low (0–1 foot).
ii.	**TL3:** Moderate load. Spread rate very slow (0–2 chains/hour); flame length low (1–4 feet); fine fuel load (0.5 ton/acre).
iii.	**TL5:** High load conifer litter. Spread rate slow (2–5 chains/hour); flame length low (1–4 feet).
iv.	**TL6:** Moderate load. Spread rate moderate (5–20 chains/hour); flame length low (1–4 feet).
5.	**Insufficient wildland fuel to carry wildland fire under any condition (Non-burnable)**
i.	**NB1:** Urban or suburban development; insufficient wildland fuel to carry wildland fire.
ii.	**NB8:** Open water.
iii.	**NB9:** Bare ground.

Notes: Based on Scott and Burgan's (2005) 40 Fuel Model System.

DRAFT

Topography

Topography is important in determining fire behavior. Steepness of slope, aspect (direction the slope faces), elevation, and landscape features can all affect fuels, local weather (by channeling winds and affecting local temperatures), and rate of spread of wildfire.

Weather

Of the three fire behavior components, weather is the most likely to fluctuate, especially on a daily basis. Accurately predicting fire weather remains a challenge for forecasters. As downslope winds from the Sierra Nevada and rising temperatures dry fuels in the spring and summer, conditions can deteriorate rapidly, creating an environment that is susceptible to wildland fire. It should be noted that the region also experiences a fire season in the winter. Fine fuels (grass and leaf litter) can cure rapidly, making them highly flammable in as little as 1 hour following changes in relative humidity. Low live fuel moisture of shrubs and trees can significantly contribute to fire behavior in the form of crowning and torching. With high wind, grass and shrub fires can spread rapidly, engulfing communities, often with limited warning for evacuation. The creation of defensible space is of vital importance in protecting communities from this type of fire. For instance, a carefully constructed fuel break placed in an appropriate location could protect homes or possibly an entire community from fire. This type of defensible space can also provide safer conditions for firefighters, improving their ability to suppress fires and protect life and property.

One of the critical inputs for FlamMap is the fuel moisture files. The initial run of the Risk-Hazard Assessment utilized the IFTDSS Auto 97th modeling parameters, which integrate historic fire weather data from nearby RAW stations. SWCA noted that some of the fire behavior outputs did not reflect the intensity and severity of fire behavior that has been observed during recent fires. Therefore, the Risk-Hazard Assessment was revised using more extreme live and dead fuel moistures to better align with extreme fire behavior conditions.

FIRE BEHAVIOR MODEL OUTPUTS

The following is a discussion of the fire behavior outputs from IFTDSS.

Flame Length

Map C.2 in Appendix C illustrates the flame length classifications for the Planning Area. Flame lengths are determined by modeling in the FlamMap system using the following inputs: fuels, weather, and topography. Flame length is a particularly important component of the Risk-Hazard Assessment because it relates to potential crown fire (particularly important in timber areas) and suppression tactics. Direct attack by hand lines is usually limited to flame lengths less than 4 feet. In excess of 4 feet, indirect suppression is the dominant tactic. Suppression using engines and heavy equipment will move from direct to indirect with flame lengths in excess of 8 feet.

Flame lengths across the Planning Area range from 0 to more than 25 feet. The highest flame lengths are associated with the timber fuels and heavy riparian vegetation found along ditches and creeks.

Following the fuel model calibration, flame length increased slightly as areas previously classified as grass were calibrated to a grass-shrub fuel.

DRAFT

Fireline Intensity

Map C.3 in Appendix C illustrates the predicted fireline intensity throughout the Planning Area. Fireline intensity describes the rate of energy released by the flaming front and is measured in British thermal units per foot per second (Btu/ft/sec). This is a good measure of intensity and is used for planning suppression activities. The expected fireline intensity throughout the Planning Area is similar in pattern to predicted flame length, as fireline intensity is a function of flame length.

Fireline intensity across the Planning Area ranges from 0 to more than 6,175 Btu/ft/sec.

The pattern for fireline intensity is similar to flame length in that intensities range from very low (0 Btu/ft/sec) through moderate (100–500 Btu/ft/sec) to high and extreme intensity (greater than 1,000 Btu/ft/sec), which tend to be associated with areas dominated by tall shrub and timber fuel loads. Fireline intensity impacts the strategies that fire responders can use to suppress the fire, with intensities over 1,000 Btu/ft/sec too severe for direct attack by hand or engine crews.

Following the fuel model calibration, fireline intensity increased as areas previously classified as grass were calibrated to a grass-shrub fuel.

Rate of Spread

Map C.4 in Appendix C illustrates the rate of spread classifications for the Planning Area.

The rate of spread, or the speed with which fire is moving away from the point of origin, is influenced by the slope. Fire moves at a faster rate uphill than downhill, thus the steeper the slope the faster the rate of spread. Additionally, steep slopes bring the fuels above the fire closer to a growing fire, making them more susceptible to ignition. Another issue with steep slopes is the possibility of burning debris rolling down the hill and igniting fuel below the main fire. This is illustrated in Figure 3.1.

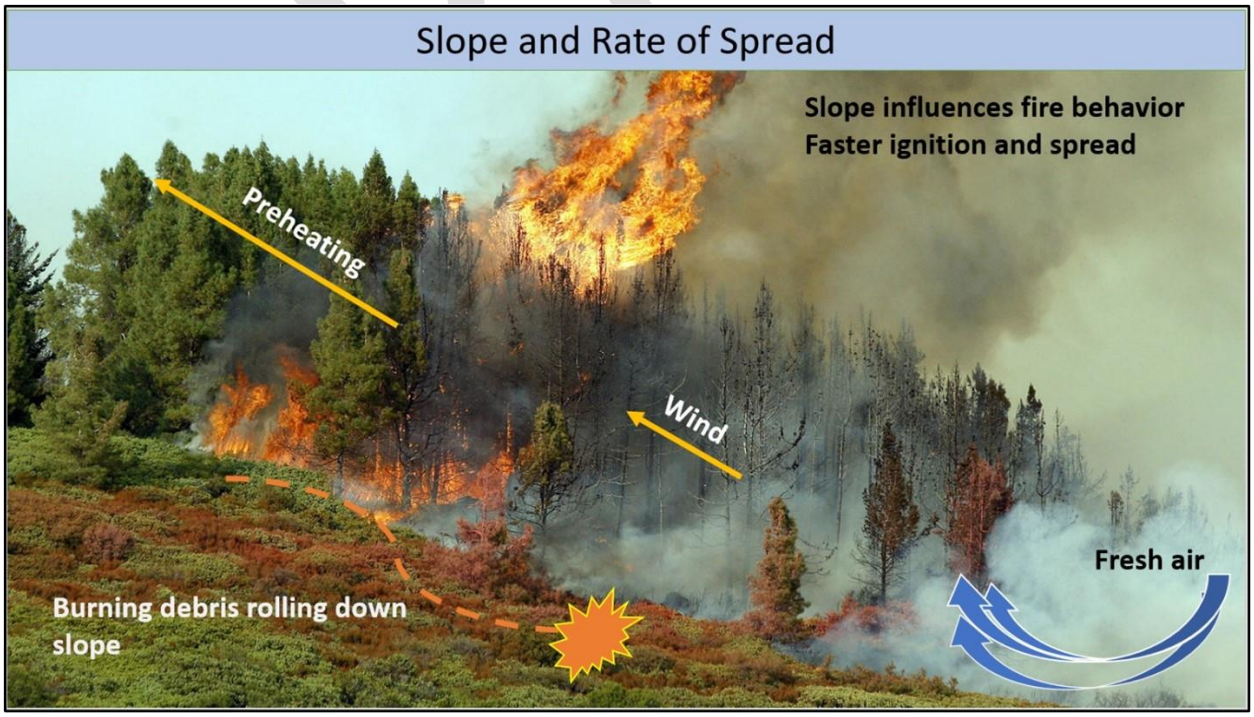


Figure 3.1. Effect of topography on fire behavior.

The rates of spread in the area range from 0 chains/hour up to 150 chains/hour (one chain is approximately 66 feet and is a common measure in wildland firefighting). Low rates of spread are associated with timber-dominated areas, while moderate and high rates of spread are associated with grass and shrub fuels and riparian vegetation.

Following the fuel model calibration, the rate of spread increased slightly as areas previously classified as grass were calibrated to a grass-shrub fuel.

Crown Fire Potential

Map C.5 in Appendix C illustrates the range of crown fire activity from surface fire (in grass-dominated areas) to passive and active crown fire (in riparian fuel beds). Since the fuel calibration focused on changing grass to grass-shrub fuels, crown fire activity stayed the same.

Fire Occurrence/Density of Starts

Figure 2.5 in Chapter 2 illustrates the fire history for the Planning Area. These perimeters have been provided by the USFS and CAL FIRE, and show the location of fires within the Planning Area from 1923 to 2021. Fire history data were used to determine the location where fires tend to occur more often. Map C.6 (Appendix C) shows the density of fire events within the Planning Area and reveals a higher incidence of fire events to the north and south of 40 Acres. The fire history map (see Figure 2.5 in Chapter 2) and fire occurrence density map (see Map C.6 in Appendix C) are used to provide information on areas where fires are prevalent and hence could be more prone to fire in the future.

Composite Risk-Hazard Assessment Model

All data used in the Risk-Hazard Assessment have been processed using ESRI ArcGIS Desktop and the ESRI Spatial Analyst Extension. Information on these programs can be found at http://www.esri.com. Data have been gathered from all relevant agencies, and the most current data have been used.

All fire parameter data sets have been converted to a raster format (a common GIS data format comprising a grid of cells or pixels, with each pixel containing a single value). The cell size for the data is 30 × 30 meters (98 × 98 feet). Each of the original cell values have been reclassified with a new value between 1 and 4, based on the significance of the data (1 = lowest, 4 = highest). Prior to running the models on the reclassified data sets, each of the input parameters have been weighted; that is, they are assigned a percentage value reflecting that parameter's importance in the model. We used the weighted sum raster overlay geoprocessing tool to stack each geographically aligned data set and evaluate an output value derived from each cell value of the overlaid data set in combination with the weighted assessment. In a Weighted Sum Model, the weighted values of each cell from each parameter data set are added together so that the resulting data set contains cells with summed values of all the parameters. This method ensures that the model resolution is maintained in the results and thus provides finer detail and range of values for denoting fire risk.

Composite Risk-Hazard Assessment Modeling Process

Our Composite Risk-Hazard Assessments comprise multiple inputs, which can be grouped into three categories: hazard, threat, and values. The result is a raster data layer that weighs and sums those inputs to determine risk. Data sets in the hazard category include historical weather data, topography, vegetation, and fuel regimes. Data sets in the threat category include fire history points and perimeters.

DRAFT

The values category includes the WUI, distance from fire station, and natural, cultural, and socioeconomic assets data sets.

As shown in Figure 3.2 with the elements in the black shaded box, we began by using the IFTDSS application to prepare a landscape file for the Planning Area. This landscape file compiles multiple LANDFIRE data sets, including fuels (calibrated to recent fires), slope, elevation, and aspect, into one layer that can then be used to develop fire behavior outputs. We then edited the fuels model to match the more precise local data sets and used the edited fuels and landscape file to create custom fire behavior outputs.

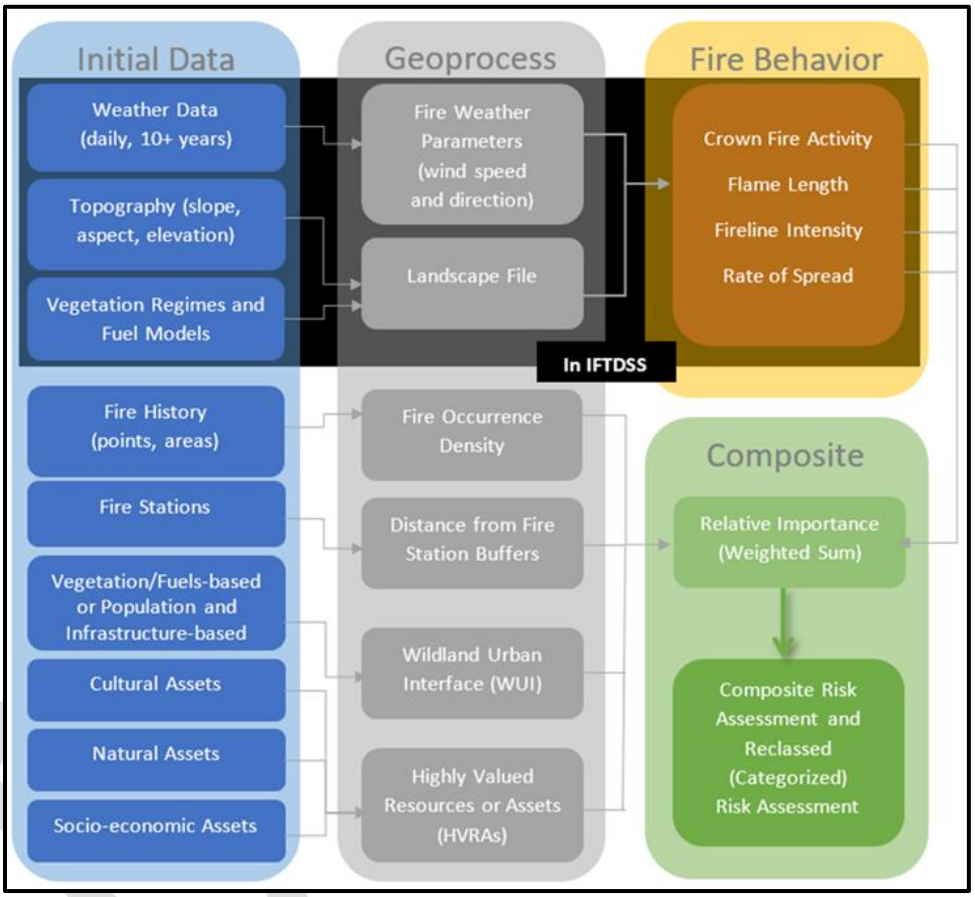


Figure 3.2. Composite Risk-Hazard Assessment breakdown.

Next, in Esri ArcGIS Pro, we processed the fire history, fire station, WUI, and HVRA data sets to merge and create buffers where appropriate and converted the layers to rasters with the same spatial extent and resolution as the IFTDSS fire behavior outputs (30-meter cell size).

Finally, we used ArcGIS Pro to run a weighted sum raster process to add all the inputs together. Risk assessment inputs were assigned weights according to their significance and Core Team input, and all eight inputs were weighted equally due to their potential influence on wildfire risk (Table 3.3).
The distance from the nearest fire station(s) to the community typically determines fire response times. The WUI and HVRA designate areas that constitute life, property, and critical infrastructure. Lastly, fire occurrence and fire behavior characteristics (crown fire activity, fireline intensity, flame length, and rate of spread) determine where a fire is likely to occur and the type, intensity, and speed at which the fire spreads.

Table 3.3. Risk Assessment Inputs, Sources, and Weights

Risk Assessment		
Inputs	**Source**	**Weight**
Flame length	IFTDSS, LANDFIRE	12.5%
Rate of spread	IFTDSS, LANDFIRE	12.5%
Fireline intensity	IFTDSS, LANDFIRE	12.5%
Crown fire activity	IFTDSS, LANDFIRE	12.5%
Fire occurrence density	CAL FIRE	12.5%
HVRA	Inyo County GIS and IFTDSS	12.5%
WUI*	Delineated according to fuels and topography	12.5%
Distance from fire stations†	Fire stations from IFTDSS	12.5%

*We used a 5-mile buffer based on Core Team guidance regarding wind, fuels, and topography in the region.

†Distance from fire stations was partitioned in 5-, 10-, and 15-minute drive time intervals: 5-minute rated 0, 10-minute rated 1, 15-minute rated 2, and >15-minute rated 3. We used the ESRI tool—generate service areas—and configured the analysis for access for emergency vehicles.

COMPOSITE RISK-HAZARD ASSESSMENT RESULTS

The Composite Risk-Hazard Assessment modeling approach uses a weighted sum model, which "stacks" geographically aligned data sets and evaluates an output value derived from each cell value of the overlaid data set in combination with the weighted assessment. In a weighted sum model, the weighted values of each pixel from each parameter data set are added together so that the resulting data set contains pixels with summed values of all the parameters. This method ensures that the model resolution is maintained in the results and thus provides finer detail and range of values for denoting fire risk. While weighted sum composite rasters can be better for describing more detailed variations in risk, they can be overwhelming and difficult to understand, so we also created a reclassified raster from the weighted sum composite, using the natural breaks (Jenks) method, with four categories of low, medium, high, and extreme risk. Figure 3.3 illustrates the individual data sets and the relative weights assigned within the modeling framework. Table 3.3 shows the same data sets and weights but includes the data source. These include fire behavior parameters, fire occurrence density, HVRA, WUI, and distance from fire stations. Figure 3.4 is the Composite Risk-Hazard Assessment for the Planning Area and classifies the Planning Area into low, moderate, high, and extreme risk categories.

Overall, the Composite Risk-Hazard Assessment (see Figure 3.4) shows high and extreme risk areas around the perimeter of 40 Acres, with extreme risk areas concentrated to the east, south, and southwest.

Moreover, discussions with local experts revealed that fires in the region are driven by strong west and southwest winds (and occasionally, north) and that the region has a history of fires along riparian corridors. Indeed, the riparian fuel bed leading into 40 Acres from the southwest (Pine Creek diversion) is classified as extreme risk.

DRAFT

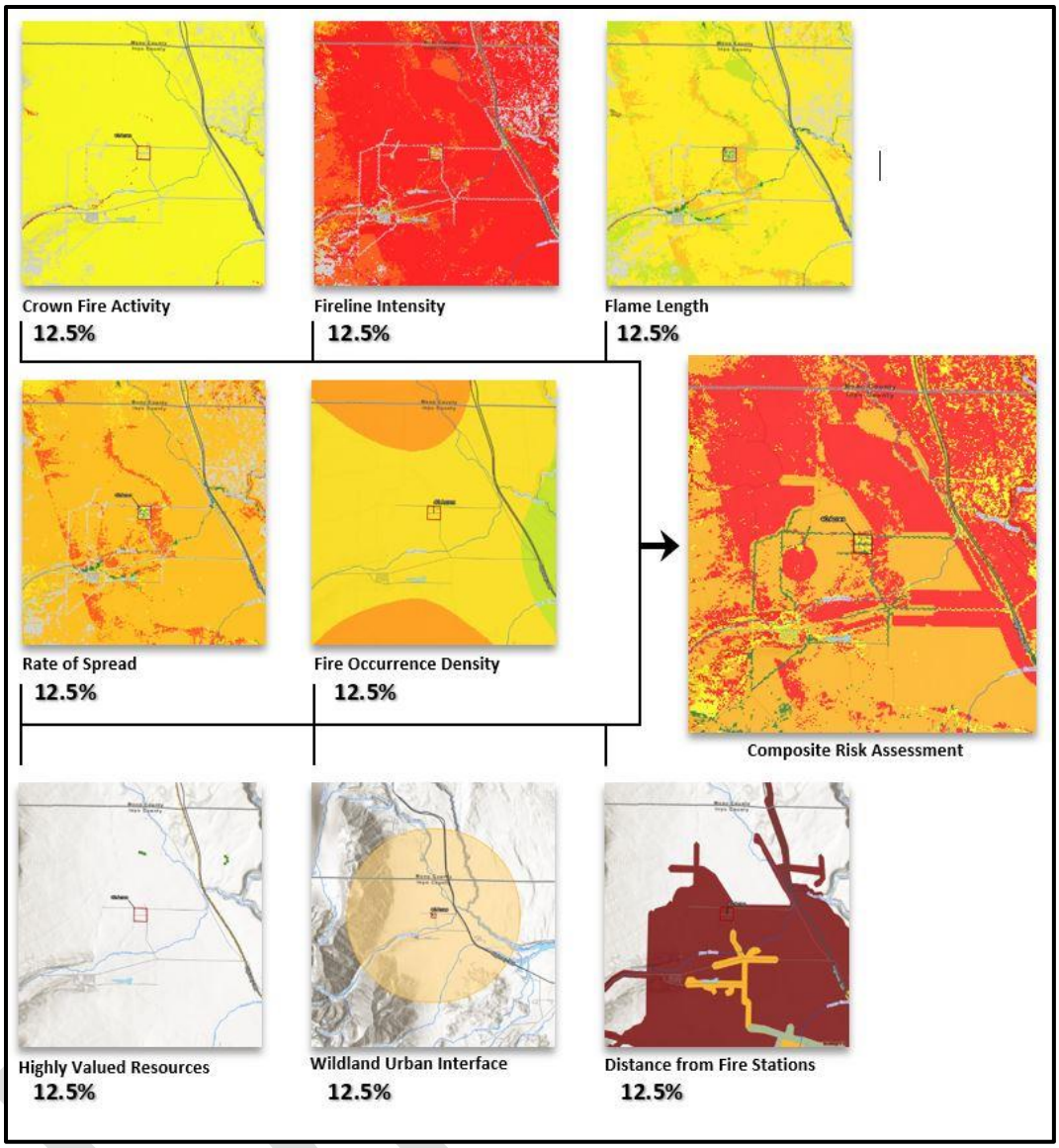


Figure 3.3. Composite Risk-Hazard Assessment overlay process.

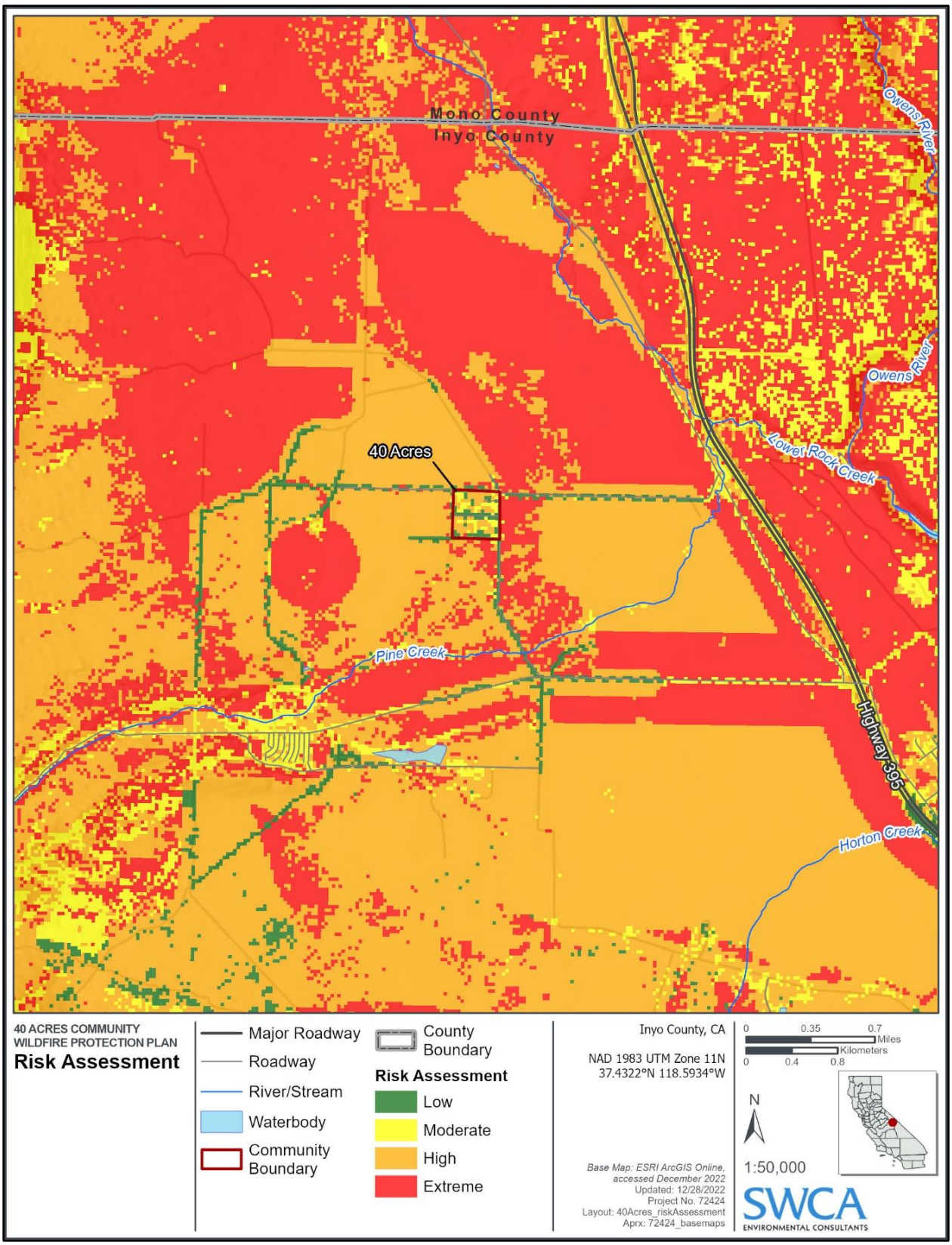


Figure 3.4. Composite Risk-Hazard Assessment.

VALUES AT RISK

Earlier compilation of the critical infrastructure in the Planning Area, coupled with the community assessments, public outreach, and Core Team input, has helped in the development of a list of VARs from wildland fire. These data are also supplemented with HVRA data, which is a data set that is being gathered nationwide and available through the Interagency Fuel Treatment Decision Support System (IFTDSS). The public was encouraged to provide additional VARs during the public outreach period, via the story map survey link. Based on feedback provided, this section and the associated mapping was revised.

In addition to critical infrastructure, VARs can also include natural, social, and cultural resources. It is important to note that although an identification of VARs can inform treatment recommendations, a number of factors must be considered in order to fully prioritize areas for treatment; these factors include appropriateness of treatment, land ownership constraints, locations of ongoing projects, available resources, and other physical, social, or ecological barriers to treatment.

The scope of this CWPP does not allow determination of the absolute natural, socioeconomic, and cultural values that could be impacted by wildfire in the Planning Area. In terms of socioeconomic values, the impact due to wildfire would cross many scales and sectors of the economy and call upon resources locally, regionally, and nationally.

DRAFT

NATURAL VALUES AT RISK

The CWPP Planning Area and the adjacent federal land have a variety of natural resources of particular concern to land managers, such as rare habitats and listed plant and wildlife species. Public outreach throughout the community has emphasized the importance of protecting natural/ecological values to the general public (Figure 3.5). Examples of natural values identified by the public and the Core Team include the following:

- Public land (e.g., Inyo National Forest, BLM lands)
- Trail systems (e.g., BLM trails)
- Agricultural land
- Scenic viewsheds
- Wildlife habitat and sensitive species
- Archeological sites
- Watersheds and preservation of water quality for 40 Acres



Figure 3.5. Example of a natural VAR, public trails.

SOCIOECONOMIC VALUES AT RISK

Social values include population, recreation, infrastructure, and the built environment (Figure 3.6). The entire community of 40 Acres falls within the WUI. Examples include the following:

- Communications infrastructure, powerlines, (e.g., cell phone, weather stations, and radio towers)
- Water infrastructure and storage
- Recreation sites (e.g., campgrounds)
- Schools
- Public safety infrastructure
- Highways

DRAFT



Figure 3.6. Example of a socioeconomic VAR, Pine Creek flume, which could be impacted by post-fire erosion and sedimentation.

CULTURAL VALUES AT RISK

Several historical landmarks are scattered throughout the region. Cultural VARs that have been identified by the Core Team and the public in the CWPP Planning Area are the following:

- Barns
- Agricultural infrastructure
- Historic houses

DRAFT



CHAPTER 4 – MITIGATION STRATEGIES

This chapter provides project recommendations and implementation guidance. However, mitigation does not stop there. In addition to the recommendations, recognizing wildfire mitigation, preparedness, and resilience means being prepared both pre- and post-fire. Post-fire response and rehabilitation information can be found in Appendix K.

This plan has been aligned with the Cohesive Strategy and its Phase III Western Regional Action Plan by adhering to the nationwide goal:

> *"To safely and effectively extinguish fire, when needed; use fire where allowable; manage our natural resources; and as a Nation, live with wildland fire." (Forests and Rangelands 2014:3).*

Thus, CWPP recommendations have been structured around the three main goals of the Cohesive Strategy: restoring and maintaining landscapes, fire-adapted communities, and wildfire response. Many of the recommendations listed can be implemented at the homeowner or community level. Projects requiring large-scale support can be prioritized based on the Composite Risk-Hazard Assessment.

Recommendation matrixes are used throughout this chapter to serve as an action plan for implementation. Recommendations have been aligned with the strategies in the 2021 California's Wildfire and Forest Resilience Action Plan (California Forest Management Task Force 2021) wherever possible.

COHESIVE STRATEGY GOAL 1: RESTORE AND MAINTAIN LANDSCAPES

Goal 1 of the Cohesive Strategy and the Western Regional Action Plan is Restore and Maintain Landscapes: Landscapes across all jurisdictions are resilient to fire and other disturbances in accordance with management objectives.

> *"Sustaining landscape resiliency and the role of wildland fire as a critical ecological process requires a mix of actions that are consistent with management objectives. The West will use all*

> *available methods and tools for active management of the landscape to consider and conserve a diversity of ecological, social, and economic values. The West will coordinate with all partners and seek continued stakeholder engagement in developing market-based, flexible and proactive solutions that can take advantage of economies of scale. All aspects of wildland fire will be used to restore and maintain resilient landscapes. Emphasis will be placed on protecting the middle lands near communities."* (Western Regional Strategy Committee [WRSC] 2013:14).

In this CWPP, recommendations to restore and maintain landscapes focus on vegetation management and hazardous fuel reduction.

The federal lands surrounding 40 Acres have been home to an active fuel treatment program by land managers for many years. Figure 4.1 shows existing fuel treatments that have been completed or planned in and around the Planning Area. This information is derived from the BLM and the 40 Acres Fire Safe Council (FSC). The reader is referred to agency websites and the Federal Register for the latest information on planned or ongoing actions on adjacent public land. The treatment already observed surrounding the Planning Area should be built upon to increase fuel treatment effectiveness across the landscape.

DRAFT

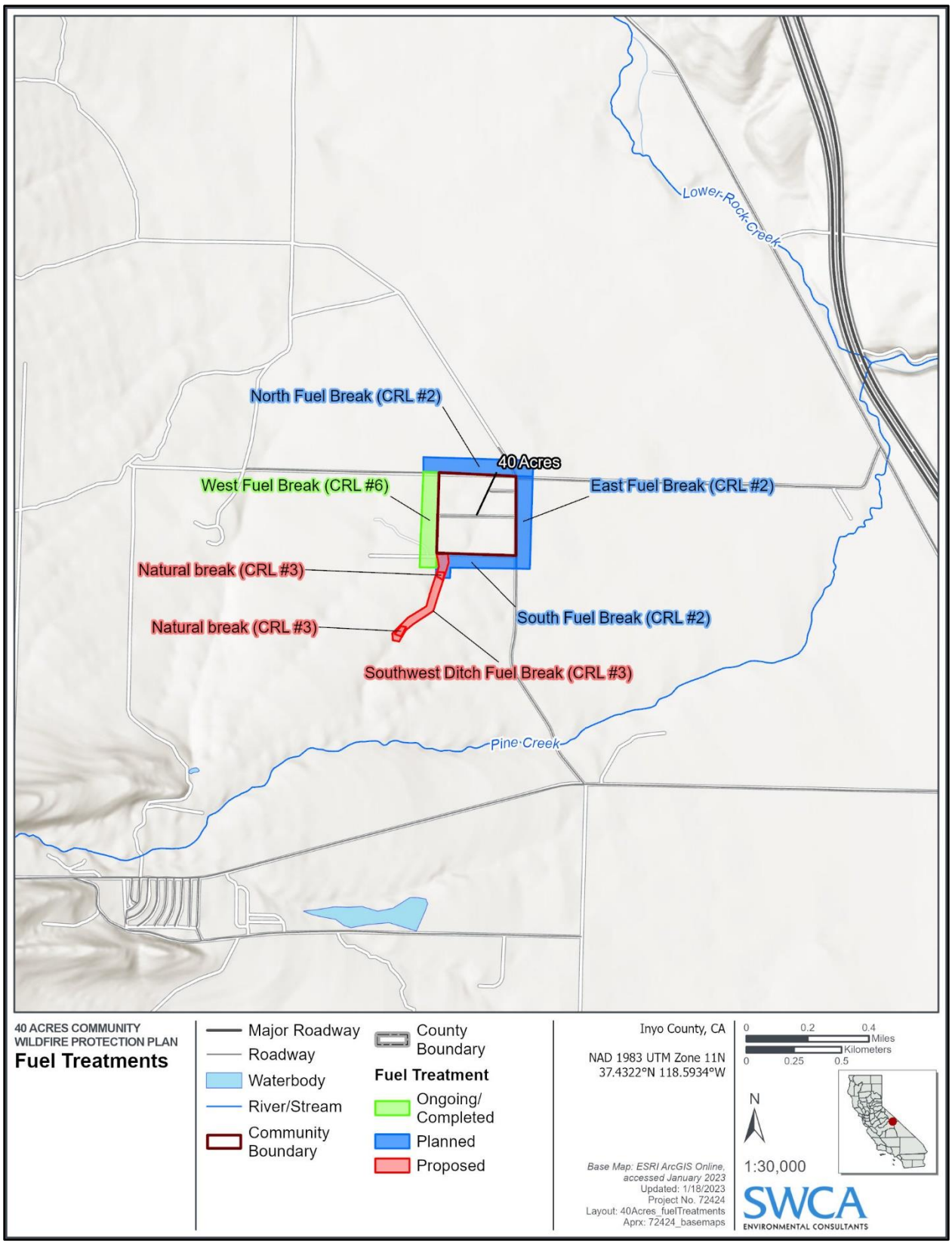


Figure 4.1. Ongoing, planned, and proposed fuels treatments around 40 Acres. Note: the "CRL #" text refers to the Project ID in Table 4.1.

RECOMMENDATIONS FOR HAZARDOUS FUEL REDUCTION

Fuels management of public and private land in the WUI is key to the survival of homes during a wildfire event, as well as the means to meet the criteria of Goal 1. Research has shown how fuel treatments in the WUI can change fire behavior to support suppression activities and protect homes (Evans et al. 2015). The importance of fuels management is reflected in policy at the federal level, with the HFRA requiring that federal land management agencies spend at least 50% of their fuels reduction funds on projects in the WUI.

Fuels should be modified with a strategic approach to reduce the threat that high-intensity wildfires pose to lives, property, and other values. This section provides information on fuel treatment methodologies that can be applied to protect structures (defensible space) as a top priority, then near community boundaries (fuel breaks, cleanup of adjacent open spaces), and finally in the wildlands beyond community boundaries (larger-scale forest health and restoration treatments). The emphasis of each of these treatment types is unique. Proximate to structures, the recommendations focus on reducing fire intensity and fire spread rates consistent with Firewise and International Fire Code standards. Further into open space areas, treatments tend to emphasize forest health and increasing resiliency to catastrophic wildfire and other disturbances.

Table 4.1 summarizes the types of treatments recommended throughout the Planning Area. The majority of the treatments are focused on higher risk areas, as defined by the Composite Risk-Hazard Assessment and Core Team input. Tables 4.1, 4.2, and 4.3 also address the requirement for an action plan and assessment strategy by providing monitoring guidelines and a timeline for implementation. This timeline is obviously dependent on available funding and resources, as well as the National Environmental Policy Act (NEPA) and CEQA protocols for any treatments pursued on public land. See Figure 4.2 to view the CEQA process for California Vegetation Treatment Program (CalVTP) implementation. It should be noted that CalVTP is not the only option available to comply with CEQA requirements; project-specific negative declarations or mitigated negative declarations may also be employed.

When applying fuel treatments, every effort should be made to align treatments with the State Forest Action Plan Assessment and Strategy (CAL FIRE 2018a, 2018b) with consideration of all appropriate best management practices and sound science. In addition, treatments should be strategically located in areas to maximize effectiveness of other existing and ongoing projects (Figure 4.1). A list and detailed descriptions of fuels treatment types and methods, including defensible space practices and larger-scale projects, is housed in Appendix J.

When possible, simultaneously planning for the management of multiple resources while reducing fuels will ensure that the land remains viable for multiple uses in the long term. The effectiveness of any fuel reduction treatment depends on the degree of maintenance and monitoring that is employed. Monitoring will also ensure that objectives are being met in a cost-effective manner.

The treatment list is by no means exhaustive and serves to provide a baseline of required projects for the future management of the Planning Area. Many projects may be eligible for grant funds available from federal and/or state sources. For a list of funding sources, please refer to Appendix F.

DRAFT

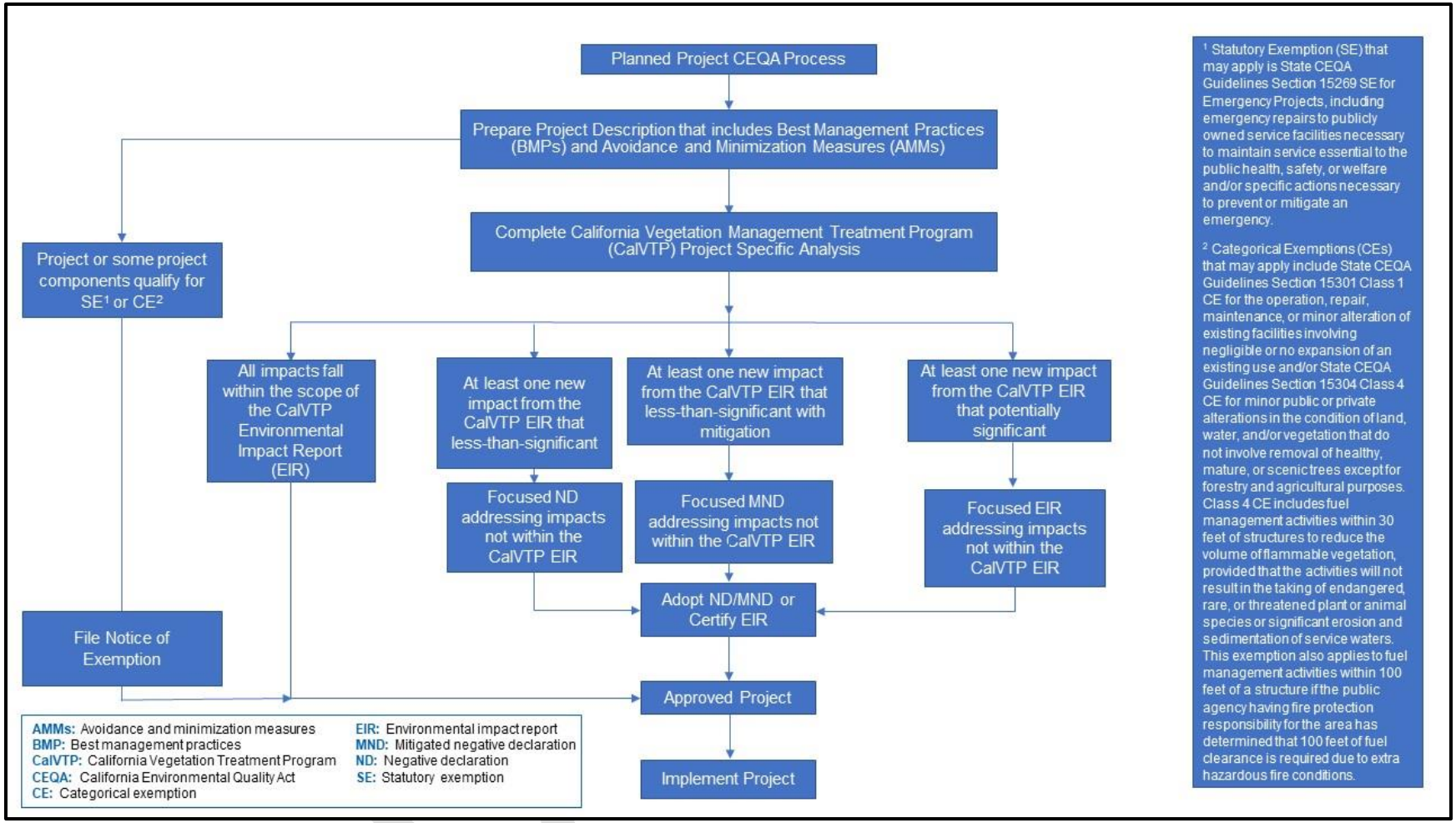


Figure 4.2. CEQA process for CalVTP implementation.

Table of Contents

Ongoing, Planned, and Proposed Fuels Treatments in 40 Acres

As previously stated, fuel treatments are an effective means of reducing fire risk to communities in the WUI. Fuel treatments such as mastication, thinning, prescribed burning, and dead tree and shrub removal serve to reduce fuel loading, and will diminish potential fire behavior. For example, reducing ladder fuels minimizes transmission of fire from the surface into the crowns, and tree thinning increases the distance between tree crowns, which will help to reduce the potential for crown fires and extreme fire behavior. In addition, fuels treatments enhance firefighter safety and increase the efficiency of fire suppression actions.

The 40 Acres FSC has been proactive in planning and implementing fuel breaks around the perimeter of 40 Acres. Figure 4.1 above shows the ongoing, planned, and proposed fuels reductions projects in 40 Acres. The west fuel break was recently completed and included treatment on 7.2 Acres of BLM land (Figure 4.3). Fuel breaks to the north (8 acres along Birchim Lane), east (7.2 acres along North Round Valley Road), and south (6.8 acres along Hardy Road) are currently in the works (see Figure 4.1). In addition, the Core Team and the Risk-Hazard Assessment identified the southwest ditch as a priority area for fuel reduction due to the dense and continuous fuel bed as well as topography and wind patterns. Therefore, fuel reductions along this ditch are identified as a high-priority project for 40 Acres (see Table 4.1 and Figure 4.1).



Figure 4.3. The 7.2-acre fuel break on the west side of 40 Acres.

Table 4.1. Recommendations to Create Resilient Landscapes (Fuel Treatments)*

Project ID	Status	Priority (H,M,L)	Timeline for Action	Project Description	Location	Partners and/or Collaborating Agencies	Methodology/Approach	Serves To:	Monitoring/Maintenance Requirements	Funding Sources
CRL #1		H	Spring 2024	Selective thinning and removal of dead and downed vegetation, particularly light fuels (small branches, twigs, dead brush) along ditches and creeks. Consider selective and strategic removal of larger dead logs to enhance firefighter access.	Along ditches and creeks, focusing on the southwest ditch	40 Acres FSC, LADWP (to provide access and coordination), CDFW, BLM	• Work with CDFW to determine feasible projects • Treatment methods could include hand thinning and prescribed fire when appropriate • Consider creating breaks for fire apparatus access	• Limit the spread of wildland fire and increase access to water resources with strategic placement of fuel breaks • Provide for safe and effective wildfire response capabilities	• Frequent maintenance since riparian vegetation grows quickly	• CAL FIRE Forest Health Grants • California EPA Loans and Grants • U.S. Forest Service Community Wildfire Defense Grant (USFS CWDG) • California Climate Investments Fire Prevention Grant Program (CAL FIRE) • LADWP can provide letters of support for grant applications
CRL #2	Ongoing	H	According to project schedule	Follow through with the planned fuel breaks on the north, east, and south sides of the community Refer to Figure 4.1	Eastern, northern, and southern boundaries	LADWP (to provide access and coordination), CAL FIRE, 40 Acres FSC	• Work with LADWP and CDFW to install fuel breaks on the north, east, and south sides of the community	• Create resilient landscapes and address potential for extreme wildfire behavior in and around the WUI • Protect life and property by mitigating fuels • Provide defensible space for firefighters protecting structures	• Regular maintenance is needed to ensure the fuel break remains clear of dense and flammable vegetation • Monitor for invasive species	• CAL FIRE Grant Programs • USFS CWDG
CRL #3		H	Fall 2024	Work with CDFW and BLM to install fuel breaks along the ditch to the southwest Refer to Figure 4.1	Southwest ditch	40 Acres FSC, CAL FIRE, BLM	• Search for natural breaks in vegetation to create fuel breaks up to a quarter mile upstream from 40 Acres • Align treatment with CDFW land management and habitat objectives	• Balance the reduction of hazardous fuels with the protection of wildlife habitat • Protect life and property by mitigating fuels	• Regular maintenance is needed to ensure the fuel break remains clear of vegetation. • Monitor for invasive species	• FEMA Building Resilient Infrastructure and Communities Grant (BRIC) • USFS CWDG Grants • CAL FIRE Grant Programs
CRL #4		H	Fall 2024	Increase workforce and firefighting personnel capacity	40 Acres and surrounding area	CAL FIRE	• Develop workforce to implement and maintain needed hazardous fuels projects and to perform defensible space inspections • Seek recruitment opportunities with non-profits such as the California Conservation Corps	• Reduce wildfire risk through greater capacity for wildfire projects • Create resilient landscapes and address potential for extreme wildfire behavior in and around the WUI.	• Assess capacity on an annual basis	• FEMA Staffing for Adequate Fire and Emergency Response • FEMA Assistance to Firefighters Grants • California Fire Foundation Grant Program • USFS CWDG
CRL #5		H	Spring 2024	Support fuel reduction efforts on private property by addressing green waste management	40 Acres	Inyo County, 40 Acres FSC, CAL FIRE, BLM	• County to investigate how to acquire, rent, or borrow a chipper from BLM or CAL FIRE • 40 Acres FSC to coordinate/ establish chipper days for the communities • Consider liability concerns if trained personnel are not on-site to operate equipment	• Support community defensible space efforts • Reduce fuel loading within the community	• Springtime, yearly	• CAL FIRE Forest Health Grants • Firewise Communities Grants • California Fire Safe Council Grants • USFS CWDG
CLR #6	Ongoing	H	According to project schedule	Maintain the fuel break on the west side of 40 Acres Refer to Figure 4.1	40 Acres	BLM, CAL FIRE, 40 Acres FSC	• Continue to apply the current approach	• Create resilient landscapes and address potential for extreme wildfire behavior in and around the WUI	• As scheduled	• CAL FIRE Grant Programs • USFS CWDG Grants • FEMA Building Resilient Infrastructure and Communities Grant (BRIC)

*See Appendix A to consult relevant regulations and past planning efforts

Table of Contents

COHESIVE STRATEGY GOAL 2: FIRE-ADAPTED COMMUNITIES

Goal 2 of the Cohesive Strategy/Western Regional Action Plan is: Fire-Adapted Communities: Human populations and infrastructure can withstand wildfire without loss of life and property. The basic premise of this goal is:

> *"Preventing or minimizing the loss of life and property due to wildfire requires a combination of thorough pre-fire planning and action, followed by prudent and immediate response during a wildfire event. Post-fire activities can also speed community recovery efforts and help limit the long-term effects and costs of wildfire. CWPPs should identify high-risk areas and actions residents can take to reduce their risk. Fuels treatments in and near communities can provide buffer zones to protect structures, important community values and evacuation routes. Collaboration, self-sufficiency, acceptance of the risks and consequences of actions (or non-action), assisting those who need assistance (such as the elderly), and encouraging cultural and behavioral changes regarding fire and fire protection are important concepts. Attention will be paid to values to be protected in the middle ground (lands between the community and the forest) including watersheds, viewsheds, utility and transportation corridors, cultural and historic values, etc."* (WRSC 2013:15).

In this CWPP, recommendations for fire-adapted communities include public education and outreach actions and actions to reduce structural ignitability.

RECOMMENDATIONS FOR PUBLIC EDUCATION AND OUTREACH

Just as environmental hazards need to be mitigated to reduce the risk of fire loss, so do human hazards. Lack of knowledge, lack of positive actions (e.g., failing to create adequate defensible space), and negative actions (e.g., keeping leaf litter and exposed propane tanks close to structures) all contribute to increased risk of loss in the WUI.

Most residents in the WUI understand the risk that wildfire poses to their communities. However, it is important to continually engage the community as a partner to expand wildfire mitigation options across land ownership (McCaffrey 2004, 2020; McCaffrey and Olsen 2012; Winter and Fried 2000).

Methods to improve public education could include increasing awareness about fire department response and resource needs; providing workshops at demonstration sites showing Firewise landscaping techniques or fuels treatment projects; organizing community cleanups to remove green waste; publicizing availability of government funds for treatments on private land; and, most importantly, improving communication between homeowners and local land management agencies to improve and build trust, particularly since the implementation of fuel treatments and better maintenance of existing treatments needs to occur in the interface between public and private land.

Please see Appendix B for a list of educational resources.

Table 4.2 lists public education recommendations to be implemented in 40 Acres.

DRAFT

RECOMMENDATIONS FOR REDUCING STRUCTURAL IGNITABILITY

Table 4.2 provides a list of community-based recommendations to reduce structural ignitability that should be implemented throughout the 40 Acres CWPP Planning Area. Reduction of structural ignitability depends largely on public education, which provides homeowners the information they need to take responsibility for protecting their own properties. A list of action items that individual homeowners can follow can be found below. Carrying out fuels reduction treatments on public land may only be effective in reducing fire risk to some communities; if homeowners have failed to provide mitigation efforts on their own land, the risk of home ignition remains high, and firefighter lives are put at risk when they carry out structural defense.

Preparing for wildland fire by creating defensible space around the home is an effective strategy for reducing structural ignitability as discussed under Cohesive Strategy Goal 1: Resilient Landscapes. Studies have shown that burning vegetation beyond 120 feet of a structure is unlikely to ignite that property through radiant heat (Butler and Cohen 1996), but fire bands that travel independently of the flaming front have been known to destroy or damage houses that had not been impacted by direct flame impingement. Hardening the home to ignition from embers, including maintaining vent coverings and other openings, is also strongly advised to protect a home from structural ignitability. Managing the landscape around a structure by removing weeds, leaves, pine needles, woody material, and combustible debris within a 30-foot radius and keeping the roof and gutters of a home clean are two maintenance measures proven to limit combustible materials that could provide an ember bed and ignite the structure. In essence, reducing structural ignitability and creating defensible space are key for protecting from the potential loss and damage due to intense wildfires, such as the 2015 Round Fire, in and around the Planning Area. Detailed information regarding defensible space practices, as well as a list of actions for reducing structural ignitability, can be found in Appendix J.

Pertinent information regarding recent legislation related to Goal 2 of the Cohesive Strategy is provided below.

Assembly Bill 38: Assembly Bill 38 (2019) amended sections of the Civil, Government, and Public Resources Codes to set forth a comprehensive wildfire mitigation financial support program, which facilitates cost-effective home/structure hardening and retrofitting to create fire-resistant homes, businesses, and public structures. The amendments require the State Fire Marshal, in consultation with the Director of Forestry and Fire Protection and the Director of Housing and Community Development to identify building retrofits and hardening measures eligible for financial assistance under the program. Additionally, the amendments require that CAL FIRE identify defensible space, vegetation management, and fuel treatment procedures eligible for financial assistance. Wildfire hazard areas eligible for financial assistance under the program include LRAs situated within very high fire hazard severity zones and SRAs within any fire hazard severity zone (California Governor's Office of Planning and Research [CA GOPR] 2020a).

DRAFT

Table 4.2. Recommendations for Creating Fire-Adapted Communities (Public Education and Reducing Structural Ignitability)*

Project ID	Status	Priority (H,M,L)	Timeline for Action	Project Description	Location	Partners and/or Collaborating Agencies	Methodology/Approach	Serves To:	Monitoring/Maintenance Requirements	Funding Sources
FAC #1		H	Winter 2023	Inform the public on how to mitigate risk and damage from wildfire	40 Acres	40 Acres FSC, CAL FIRE, and Inyo County OES	• Create wildfire information and education documents to distribute • Increase awareness and knowledge through community workshops and training classes on defensible space, fire safe landscaping, and structural hardening concepts • Provide a printed list of mitigation measures to homeowners. Utilize Ready, Set, GO! Literature. Utilize list of actions broken down by cost • Provide community-specific homeowner education media, including videos (demonstration projects on private property) • 40 Acres FSC to engage new homeowners/renters to promote fire education for property residents, even if temporary • Work with fire departments to create a checklist of what responders look for during triage so the public can see what responders look for. • Ensure that all interactions result in follow up engagement by collecting contact information for residents interested in action. • Seek opportunities to work with the Whitebark Institute for defensible space and home hardening workshops and/or community demonstrations	• Reduce wildfire risk through community collaboration • Protect communities and valued resources by raising awareness of community residents and those staying in the area about actions that can prevent fires	• Review and revise strategy on an annual basis	• FEMA Building Resilient Infrastructure and Communities (BRIC) Grants • EPA Environmental Education Grants • CAL FIRE Grant Programs • California Fire Safe Council Grants • USFS CWDG
FAC #2		H	Fall 2023	Seek Firewise Community Certification for 40 Acres	40 Acres	40 Acres FSC	• Work with Firewise USA, the California FSC, and the Inyo County Wildfire Coordinator to begin the process of Firewise certification if community supports involvement • Evaluate community interests in Firewise Certification • Conduct a cost-benefit analysis of forming a Firewise certified community • Engage local, county, and state stakeholders	• Reduce wildfire risk through community collaboration • Facilitate access to funding and assistance • Develop a framework for action	• Maintain “good standing” by reporting work completed and accomplishments on an annual basis	• Firewise Grants • California Fire Safe Council Grants • USFS CWDG
FAC #3		H	Spring 2024	Implement community events focused on vulnerable populations	40 Acres	40 Acres FSC and Inyo County OES	• Identify volunteers • Host a community-led day of yard cleanup with fire mitigation in mind to encourage large numbers within the community to carry out mitigation measures and implement defensible space • Residents to assist elderly, disabled, or vulnerable neighbors	• Reduce wildfire risk through greater adoption of Firewise and structure hardening measures	• Yearly, in preparation for the fire season • Conduct annual review to determine what works and what doesn’t	• FEMA BRIC Grants • CAL FIRE Grants • California Fire Safe Council Grants • USFS CWDG

Table of Contents

Project ID	Status	Priority (H,M,L)	Timeline for Action	Project Description	Location	Partners and/or Collaborating Agencies	Methodology/Approach	Serves To:	Monitoring/Maintenance Requirements	Funding Sources
FAC #4		H	Fall 2024	Investigate 1) opportunities to offer financial assistance for defensible space work to seniors and low-income individuals and 2) how to use community-wide benefits to motivate individuals to create defensible space	40 Acres	Inyo County OES, 40 Acres FSC	• 40 Acres FSC to work with the County to identify funding opportunities • 40 Acres FSC to identify methods to incentivize homeowners to create defensible space • Identify grants for the FSC to hire contractors to perform defensible space work • Seek opportunities to partner with Team Rubicon (https://teamrubiconusa.org/) for free wildfire mitigation support	• Assist vulnerable populations with wildfire risk reduction • Support community defensible space efforts • Reduce fuel loading within the community	• Establish a program to determine frequency of activities	• Firewise Grants • CAL FIRE Wildfire Prevention Grants • California Fire Safe Council Grants • USFS CWDG
FAC #5		H	Summer 2023	Involve second-home owners and absentee homeowners in wildfire education and mitigation efforts	40 Acres	Inyo County OES, 40 Acres FSC	• Inyo County Wildfire Coordinator to use the county assessor's mailing list to pull contact information for second homes and absentee homeowners	• Encourage community-wide involvement in wildfire prevention and mitigation efforts	• Biannual	Not applicable
FAC #6		H	Spring 2023	Implement and maintain defensible space and structure hardening measures	40 Acres	Community residents and homeowners	• Implement defensible space standards in the community • Upgrade combustible construction materials to fire-resistive materials • Seek opportunities to partner with Team Rubicon (https://teamrubiconusa.org/) for free wildfire mitigation support	• Reduce wildfire risk through greater adoption of Firewise and structure hardening measures	• Yearly maintenance	• CAL FIRE Wildfire Prevention Grants • Firewise grants • California Fire Safe Council Grants • USFS CWDG
FAC #7		M	Spring 2024	Establish relationships with non-profit and public agencies to increase capacity	40 Acres	40 Acres FSC and Inyo County OES	• Investigate opportunities to form relationships with non-profit agencies such as California Conservation Corps, American Conservation Experience, and Team Rubicon (https://teamrubiconusa.org/)	• Create resilient landscapes and address potential for extreme wildfire behavior in and around the community	N/A	Not applicable
FAC #8		M	Spring 2024	Conduct a community walkthrough	40 Acres	40 Acres FSC, CAL FIRE, BLM	• CAL FIRE and BLM staff to host a community walkthrough day with community residents to determine potential projects and needs for defensible space, fuel breaks, and fire response	• Increase wildfire preparedness and community safety • Engage and involve community members	• Conduct on an annual basis	Not applicable
FAC #9		M	Spring 2025	Address excess rubbish and debris on private properties	40 Acres	Inyo County OES, Inyo County Board of Supervisors	• Investigate the feasibility of establishing a county ordinance to mandate the clearing of hazardous rubbish and debris	• Decrease hazardous combustible materials from the community • Enhance community safety	N/A	Not applicable
FAC #10		H	Summer 2024	Establish a community pre-fire plan	40 Acres	40 Acres FSC, 40 Acres homeowners, CAL FIRE, Inyo County OES	• Collaboratively develop a pre-fire plan to facilitate neighbor to neighbor information sharing and emergency readiness • Make plans for pet and livestock evacuations (e.g., contacts for evacuation assistance and shelter locations) • Create a map with backup energy sources that are independent of the grid • Distribute pre-fire plans to all residents and place in Airbnb properties • Identify elderly residents that may need assistance with evacuation	• Promote community involvement • Improve community preparedness	• Yearly updates	• CAL FIRE Wildfire Prevention Grants • California Fire Safe Council Grants • Firewise Grants • USFS CWDG

1 *See Appendix A to consult relevant regulations and past planning efforts

Table of Contents

COHESIVE STRATEGY GOAL 3: WILDFIRE RESPONSE

Goal 3 of the Cohesive Strategy/Western Regional Action Plan is Wildfire Response: All jurisdictions participate in making and implementing safe, effective, efficient risk-based wildfire management decisions:

> *"A balanced wildfire response requires integrated pre-fire planning with effective, efficient, and coordinated emergency response. Pre-fire planning helps tailor responses to wildfires across jurisdictions and landscape units that have different uses and management objectives. Improved prediction and understanding of weather, burning conditions, and various contingencies during wildfire events can improve firefighting effectiveness, thereby reducing losses and minimizing risks to firefighter and public health and safety. Wildfire response capability will consider the responsibilities identified in the Federal Response Framework. Local fire districts and municipalities with statutory responsibility for wildland fire response are not fully represented throughout the existing wildland fire governance structure, particularly at the NWCG, NMAC, and GACC levels."* (WRSC 2013:15).

This section provides recommended actions that jurisdictions could undertake to improve wildfire response.

RECOMMENDATIONS FOR IMPROVING FIRE RESPONSE CAPABILITIES

Educating the public so they can reduce dependence on fire departments is essential because these resources are often stretched thin due to limited personnel. Education to enhance community preparedness is a key factor in supporting local fire departments in fire response, particularly educating residents about emergency notifications and evacuation protocols so that residents can safely evacuate an area while emergency responders prepare to protect life and property.

Table 4.3 provides recommendations for improving firefighting capabilities.

DRAFT

Table 4.3. Recommendations for Safe and Effective Wildfire Response*

Project ID	Status	Priority (H,M,L)	Timeline for Action	Project Description	Location	Land Ownership/ Lead Agency	Methodology/Approach	Serves To:	Monitoring/Maintenance Requirements	Funding Sources
SEWR #1		H	Fall 2024	Identify roads and shelter-in-place locations and inform residents about evacuation procedures	40 Acres	40 Acres FSC, Inyo County OES	• Identify shelter-in-place locations and distribute maps to all residents • Distribute information regarding County designated community shelters • Distribute evacuation materials using resources from CAL FIRE, Firewise, and Ready, Set, GO! • Increase education through community workshops and mock evacuation drills • Develop a map that clearly shows all roads with potential ingress and egress points into 40 Acres and distribute to all residents	• Improve wildfire response and readiness • Facilitate evacuation procedures	• Update as needed to reflect changes in evacuation routes and shelter-in-place locations	• EPA Environmental Education Grants • FEMA Fire Prevention and Safety Grants • Firewise Communities Grants • CAL FIRE Fire Prevention Grants • USFS CWDG
SEWR #2		M	Spring 2025	Expand coverage of Alert California live cameras	40 Acres	Alert California Core University Partners	• Investigate opportunities to install cameras where there is limited coverage	• Enhance wildfire response and readiness • Support early attack plans • Facilitate emergency notifications such as evacuation orders	• Follow existing maintenance schedule	• FEMA Building Resilient Infrastructure and Communities Grants • CAL FIRE Fire Prevention Grants • USFS CWDG
SEWR #3		H	Fall 2024	Improve wildfire emergency notification systems	40 Acres	Sheriff's Office and Inyo County OES	• Investigate the feasibility of installing a siren system in the community • Establish a reliable source (website or notification system) to relay alerts and messages quickly and consistently • Inyo County to continue the process of upgrading the Inyo OES website	• Provide timely emergency alerts • Facilitate evacuation efforts	• Periodic testing of siren system	• FEMA BRIC Grants • CAL FIRE Community Wildfire Prevention Grants • USFS CWDG
SEWR #4		H	Winter 2023	Create additional means of ingress and egress	40 Acres	40 Acres FSC, BLM	• Connect Ocean View Road to the BLM road to the west • Work with CAL FIRE to determine road width specifications and requirements	• Provide alternative evacuation routes • Provide additional access points for fire responders	• As needed to prevent encroachment of vegetation	• FEMA Fire Prevention and Safety Grants • FEMA BRIC Grants • CAL FIRE Community Wildfire Prevention Grants • USFS CWDG

SEWR #5		M	Summer 2023	Provide sufficient clearance between power lines and trees	40 Acres	40 Acres FSC, Southern California Edison (SCE), LADWP	• Utilize SCE's tree removal/maintenance program to maintain safe clearance between power lines/poles and trees
							  ○ Report hazard trees (trees that are in contact with powerlines or poles) at (800) 655-4555
							• Use LADWPs hotline to report hazard trees that are leaning and/or touching powerlines and poles (760) 873-0251
							  ○ LADWP patrols will evaluate reports and determine if treatment is needed
								• Reduce hazard tree encroachment
								• Enhance firefighter safety
									• As needed	• Not applicable

SEWR #6		M	Spring 2024	Maintain dirt roads and trails	40 Acres	CAL FIRE, BLM, Inyo County OES	• Maintain existing road and trail networks using mechanical treatments	• Provide access to fire personnel • Establish fuel breaks and fire containment lines	• Annually	• USFS Community Wildfire Defense Grant • CAL FIRE Community Wildfire Prevention Grants • FEMA BRIC Grants
SEWR #7		M	Spring 2025	Assess existing water supply for fire suppression and develop a map of backup power sources		CAL FIRE, Inyo County OES	• Conduct an assessment of water resources in 40 Acres to determine if improvements are needed • Identify backup power sources (e.g., solar power and generators) in the community and create a map to distribute to fire agencies and 40 Acres residents	• Protect life and property though improved firefighting response • Improve firefighter safety	• As needed	• FEMA BRIC Grants • USFS CWDG

*See Appendix A to consult relevant regulations and past planning efforts

Table of Contents



CHAPTER 5 – MONITORING AND EVALUATION

Developing an action plan and an assessment strategy that identifies roles and responsibilities, funding needs, and timetables for completing highest-priority projects is an important step in organizing the implementation of the 40 Acres CWPP. The previous chapter identifies tentative timelines and monitoring protocols for project recommendations, the details of which are outlined below.

All stakeholders and signatories to this CWPP desire worthwhile outcomes. It is also known that risk reduction work on the ground, for the most part, is often not attainable in a few months—or even years—and typically requires scheduled maintenance (e.g., annual, semi-annual, etc.). The amount of money and effort invested in implementing a plan such as this requires that there be a means to describe, quantitatively and/or qualitatively, whether the goals and objectives expressed in this plan are being accomplished according to expectations.

Monitoring and reporting contribute to the long-term evaluation of changes in ecosystems, as well as the knowledge base about how natural resource management decisions affect both the environment and the people who live in it. Furthermore, as the CWPP evolves over time, there may be a need to track changes in policy, requirements, stakeholder changes, and levels of preparedness. These can be significant for any future revisions and/or addendums to the CWPP.

It is recommended that project monitoring be a collaborative effort. There are many resources for designing and implementing community based, multi-party monitoring that could support and further inform a basic monitoring program for the CWPP (Egan 2013). Multi-party monitoring involves a diverse group consisting of community members, community-based groups, regional and national interest groups, and public agencies. Using this multi-party approach increases community understanding of the effects of restoration efforts and trust among restoration partners. Multi-party monitoring may be more time consuming due to the collaborative nature of the work; therefore, a clear and concise monitoring plan must be developed.

Table 5.1 Identifies monitoring strategies for various aspects of all categories of CWPP recommendations and the effects of their implementation, both quantifiable and non-quantifiable, for assessing the progress of the CWPP and increase sustainability of projects. It must be emphasized that these strategies are 1) not exhaustive and 2) dependent on available funds and personnel to implement them.

DRAFT

Table 5.1. Recommended Monitoring Strategies

Strategy	Task/Tool	Lead	Remarks
Project tracking system	Online web app to track hazardous fuels projects spatially, integrating wildfire risk layer to show progress toward wildfire hazard and risk reduction. Web app would include attribute tables that outline project details	County	Interactive tool will be easily updated and identify areas that require additional efforts
Photographic record (documents pre- and post-fuels reduction work, evacuation routes, workshops, classes, field trips, changes in open space, treatment type, etc.)	Establish field GPS location; photo points of cardinal directions; keep photos protected in archival location	Core Team member	Relatively low cost; repeatable over time; used for programs and tracking objectives
Number of acres treated (by fuel type, treatment method)	GPS/GIS/fire behavior prediction system	Core Team member	Evaluating costs, potential fire behavior
Number of home ignition zones/defensible space treated to reduce structural ignitability	GPS	Homeowner	Structure protection
Number of residents/citizens participating in any CWPP projects and events	Meetings, media interviews, articles	Core Team member	Evaluate culture change objective
Number of homeowner contacts (brochures, flyers, posters, etc.)	Visits, phone	Agency representative	Evaluate objective
Number of jobs created	Contracts and grants	Core Team member	Evaluate local job growth
Education outreach: number, kinds of involvement	Workshops, classes, field trips, signage	Core Team member	Evaluate objectives
Emergency management: changes in agency response capacity	Collaboration	Agency representative	Evaluate mutual aid
Codes and policy changes affecting CWPP	Qualitative	Core Team	CWPP changes
Number of stakeholders	Added or dropped	Core Team	CWPP changes
Wildfire acres burned, human injuries/fatalities, infrastructure loss, environmental damage, suppression, and rehabilitation costs	Wildfire records	Core Team	Compare with 5- or 10-year average

FUELS TREATMENT MONITORING

It is important to evaluate whether fuel treatments have accomplished their defined objectives and whether any unexpected outcomes have occurred.

The strategies outlined in this section consider several variables:

- Do the priorities identified for treatment reflect the goals stated in the plan? Monitoring protocols can help address this question.

DRAFT

- Can there be ecological consequences associated with fuels work? Items to consider include soil movement and/or invasive species encroachment post-treatment. Relatively cost-effective monitoring may help reduce long term costs and consequences.
- Vegetation will grow back. Thus, fuel break maintenance and fuels modification in both the home ignition zone and at the landscape scale require periodic assessment. Monitoring these changes can help decision-makers identify appropriate treatment intervals.
- Monitoring for all types of fuels treatment is recommended. For example, in addition to monitoring mechanical treatments, it is important to carry out comprehensive monitoring of burned areas to establish the success of pre-fire fuels reduction treatments on fire behavior, as well as monitoring for ecological impacts, repercussions of burning on wildlife, and effects on soil chemistry and physics. Adaptive management is a term that refers to adjusting future management based on the effects of past management. Monitoring is required to gather the information necessary to inform future management decisions. Economic and legal questions may also be addressed through monitoring. In addition, monitoring activities can provide valuable educational opportunities for students.

The monitoring of each fuels reduction project would be site-specific, and decisions regarding the timeline for monitoring and the type of monitoring to be used would be determined by the project. The most important part of choosing a fuels project monitoring program is selecting a method appropriate to the people, place, and type of project. Several levels of monitoring activities meet different objectives, have different levels of time intensity, and are appropriate for different groups of people. They include the following:

Minimum—Level 1: Pre- and Post-project Photographs

Appropriate for many individual homeowners who conduct fuels reduction projects on their properties.

Moderate—Level 2: Multiple Permanent Photo Points

Permanent photo locations are established using rebar or wood posts, GPS-recorded locations, and photographs taken on a regular basis. Ideally, this process would continue over several years. This approach might be appropriate for more enthusiastic homeowners or for agencies conducting small-scale, general treatments.

High—Level 3: Basic Vegetation Plots

A series of plots can allow monitors to evaluate vegetation characteristics such as species composition, percentage of cover, and frequency. Monitors then can record site characteristics such as slope, aspect, and elevation. Parameters would be assessed pre- and post-treatment. The monitoring agency should establish plot protocols based on the types of vegetation present and the level of detail needed to analyze the management objectives. This method is appropriate for foresters or other personnel monitoring fuel treatments on forested lands.

Intense—Level 4: Basic Vegetation Plus Dead and Downed Fuels Inventory

The protocol for this level would include the vegetation plots described above but would add more details regarding fuel loading. Crown height or canopy closure might be included for live fuels. Dead and downed fuels could be assessed using other methods, such as Brown's transects (Brown 1974), an appropriate photo series (Ottmar et al. 2000), or fire monitoring (Fire Effects Monitoring and Inventory System [FIREMON]) plots. This method is ideal for foresters or university researchers tracking vegetation changes in forested land.

DRAFT

IMPLEMENTATION

The 40 Acres CWPP makes recommendations for prioritized fuels reduction projects, measures to reduce structural ignitability, and methods for carrying out public education and outreach. Implementation projects need to be tailored to the specific project and will be unique to the location depending on available resources and regulations. As aforementioned, on-the-ground implementation of the recommendations identified in this CWPP will require the use of the action plan (recommendation matrices in Chapter 4) as well as an assessment strategy for completing each project. This step will identify the roles and responsibilities of the people and agencies involved, as well as funding needs and timetables for completing the highest-priority projects (SAF 2004). Information pertaining to funding is provided in Appendix F.

CWPP EVALUATION

CWPPs are intended to reduce the risk from wildfire for a community and surrounding environment. However, over time, communities change and expand, vegetation grows back, and forests and wildlands evolve. As such, the risk of wildfire to communities is constantly changing. The plans and methods to reduce risk must be dynamic to keep pace with the changing environment. An evaluation of the CWPP will gather information and identify whether the plans and strategies are on course to meet the desired outcomes or if modifications are needed to meet expectations. It is recommended that the CWPP be evaluated on an annual basis, which should be completed by convening the existing Core Team so that all entities contribute to the evaluation. The CWPP document and planning goals and objective should be updated annually, based on findings from the evaluation.

Four general steps can be used to evaluate the CWPP:

1. Identify objectives: What are the goals identified in the plan? How are they reached? Is the plan performing as intended?
    a. Structural ignitability
    b. Fuel treatments
    c. Public education and outreach
    d. Multi-agency collaboration
    e. Emergency response
2. Assess the changing environment: How have population characteristics and the wildfire environment changed?
    a. Population change
        i. Increase or decrease
        ii. Demographics
    b. Population settlement patterns
        i. Distribution
        ii. Expansion into the WUI

DRAFT

c. Vegetation
    i. Fuel quantity and type
    ii. Drought and disease impacts

3. Review action items: Are actions consistent with the plan's objectives?
    a. Check for status, i.e., completed/started/not started
    b. Identify completed work and accomplishments
    c. Identify challenges and limitations
    d. Identify next steps

4. Assess results: What are the outcomes of the action items?
    a. Multi-agency collaboration
        i. Who was involved in the development of the CWPP?
        ii. Have partners involved in the development process remained involved in the implementation?
        iii. How has the planning process promoted implementation of the CWPP?
        iv. Have CWPP partnerships and collaboration had a beneficial impact on the community?
    b. Risk assessment
        i. How is the risk assessment utilized to make decisions about fuel treatment priorities?
        ii. Have there been new wildfire-related regulations?
        iii. Are at-risk communities involved in mitigating wildfire risk?
    c. Hazardous fuels
        i. How many acres have been treated?
        ii. How many projects are cross-boundary?
        iii. How many residents have participated in creating defensible space?
    d. Structural ignitability
        i. Have there been updates to fire codes and ordinances?
        ii. How many structures have been lost to wildfire?
        iii. Has the CWPP increased public awareness of structural ignitability and reduction strategies?
    e. Public education and outreach
        i. Has public awareness of wildfire and mitigation strategies increased?
        ii. Have residents been involved in wildfire mitigation activities?
        iii. Has there been public involvement?
        iv. Have vulnerable populations been involved?

DRAFT

f. Emergency response

i. Has the CWPP been integrated into relevant plans (e.g., hazard mitigation or emergency operations)?

ii. Is the CWPP congruent with other hazard mitigation planning efforts?

iii. Has availability and capacity of local fire departments changed since the CWPP was developed?

TIMELINE FOR UPDATING THE CWPP

The HFRA allows for maximum flexibility in the CWPP planning process, permitting the Core Team to determine the time frame for updating the CWPP. The Core Team members are encouraged to meet on an annual basis to review the project list, discuss project successes, and strategize regarding project implementation funding. It is suggested that the evaluation framework above be used annually to make plan updates, and a more formal revision be made on the fifth anniversary of signing and every 5 years following.

DRAFT

ABBREVIATIONS AND ACRONYMS

°F	degrees Fahrenheit
ATV	all-terrain vehicle
BAER	Burned Area Emergency Rehabilitation
BLM	Bureau of Land Management
Btu/ft/sec	British thermal units per foot per second
CA GOPR	California Governor's Office of Planning and Research
CAL FIRE	California Department of Forestry and Fire Protection
CalVTP	California Vegetation Treatment Program
CAR	community at risk
CDFA	California Department of Food and Agriculture
CDFW	California Department of Fish and Wildlife
CE	categorical exemption
CEQA	California Environmental Quality Act
ch/hr	chains per hour
CIG	Conservation Innovation Grants
Cohesive Strategy	National Cohesive Wildland Fire Management Strategy
CRS	Congressional Research Service
CUSP	Coalition for the Upper South Platte
CWA	Clean Water Act
CWPP	community wildfire protection plan
DEM	digital elevation model
DHS	Department of Homeland Security
EMS	Emergency Management System
EPA	U.S. Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
ESRI	Environmental Systems Research Institute
FEMA	Federal Emergency Management Agency
FIREMON	Fire Effects Monitoring and Inventory System
FLAME	Federal Land Assistance, Management and Enhancement Act
FP&S	Fire Prevention and Safety
FRA	Federal Responsibility Area
FSC	Fire Safe Council
GIS	geographic information system
GPS	global positioning system

DRAFT

HFRA	Healthy Forests Restoration Act of 2003
HIZ	home ignition zone
HMP	hazard mitigation plan
HVRA	highly valued resource or asset
ICC	International Code Council
IFTDSS	Interagency Fuel Treatment Decision Support System
ISO	Insurance Services Office
LADWP	Los Angeles Department of Water and Power
LRA	Local Responsibility Area
MND	mitigated negative declaration
NEPA	National Environmental Policy Act
ND	negative declaration
NFP	National Fire Plan
NFPA	National Fire Protection Association
NIFC	National Interagency Fire Center
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NWCG	National Wildfire Coordinating Group
OES	Office of Emergency Services
OSCC	Southern California Geographic Coordination Center
PERI	Public Entity Risk Institute
PPE	personal protective equipment
RAWS	remote automated weather station
RFA	Rural Fire Assistance
SAF	Society of American Foresters
SAFER	Staffing for Adequate Fire and Emergency Response
SE	statutory exemption
SHPO	State Historic Preservation Office
SRA	State Responsibility Area
SWCA	SWCA Environmental Consultants
Task Force	California Forest Management Task Force
UCANR	University of California, Agriculture and Natural Resources
ULI	Urban Land Institute
USDA	U.S. Department of Agriculture
USDOI	U.S. Department of the Interior

DRAFT

USFA	U.S. Fire Administration
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VAR	value at risk
VCC	Vegetation Condition Class
VDEP	Vegetation Departure
WFDSS	Wildland Fire Decision Support System
WRSC	Western Regional Strategy Committee
WUI	wildland urban interface

1

2

DRAFT

GLOSSARY

Aspect: Cardinal direction toward which a slope faces in relation to the sun (NWCG 2021b~~a~~).

Active Crown Fire: A crown fire in which the entire fuel complex is involved in flame, but the crowning phase remains dependent on heat released from surface fuel for continued spread. An active crown fire presents a solid wall of flame from the surface through the canopy fuel layers. Flames appear to emanate from the canopy as a whole rather than from individual trees within the canopy. Active crown fire is one of several types of crown fire and is contrasted with **passive crown fires**, which are less vigorous types of crown fire that do not emit continuous, solid flames from the canopy (SWCA).

Available Canopy Fuel: The mass of canopy fuel per unit area consumed in a crown fire. There is no post-frontal combustion in canopy fuels, so only fine canopy fuels are consumed. It is assumed that only the foliage and a small fraction of the branchwood is available (Wooten 2021).

Available Fuel: The total mass of ground, surface and canopy fuel per unit area available to be consumed by a fire, including fuels consumed in postfrontal combustion of duff, organic soils, and large woody fuels (Wooten 2021).

Backfiring: Intentionally setting fire to fuels inside a control line to contain a fire (Wooten 2021).

Biomass: Organic material. Also refers to the weight of organic material (e. g. biomass roots, branches, needles, and leaves) within a given ecosystem (Wooten 2021).

Burn Severity: A qualitative assessment of the heat pulse directed toward the ground during a fire. Burn severity relates to soil heating, large fuel and duff consumption, consumption of the litter and organic layer beneath trees and isolated shrubs, and mortality of buried plant parts (SWCA).

Canopy: The more or less continuous cover of branches and foliage formed collectively by adjacent trees and other woody species in a forest stand. Where significant height differences occur between trees within a stand, formation of a multiple canopy (multi-layered) condition can result (SWCA).

Chain: Unit of measure in land survey, equal to 66 feet (20 M) (80 chains equal 1 mile). Commonly used to report fire perimeters and other fireline distances. Popular in fire management because of its convenience in calculating acreage (example: 10 square chains equal one acre) (New Mexico Future Farmers of America [NM FFA] 2021).

Climate adaptation: Adaptation is an adjustment in natural or human systems to a new or changing environment. Adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities (CA GOPR 2020b).

Climate Change: A change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods (CA GOPR 2020b).

Community Assessment: An analysis designed to identify factors that increase the potential and/or severity of undesirable fire outcomes in wildland urban interface communities (SWCA).

Communities at Risk: Defined by the Healthy Forest Restoration Act of 2003 as “Wildland-Urban Interface Communities within the vicinity of federal lands that are at high risk from wildfire.”

- CAL FIRE expanded on this definition for California including all communities (regardless of distance from federal lands) for which a significant threat to human life or property exists as a

result of a wildland fire event. California uses the following three factors to determine at risk communities: 1) high fuel hazard, 2) probability of a fire, and 3) proximity of intermingled wildland fuels and urban environments that are near fire threats (CA GOPR 2020b).

Community Emergency Response Team (CERT): The CERT program educates volunteers about disaster preparedness for the hazards that may impact their area and trains them in basic disaster response skills, such as fire safety, light search and rescue, team organization, and disaster medical operations. CERT offers a consistent, nationwide approach to volunteer training and organization that professional responders can rely on during disaster situations, allowing them to focus on more complex tasks (Ready 2021).

Community Wildfire Protection Plan (CWPP): A planning document that seeks to reduce the threat to life and property from wildfire by identifying and mitigating wildfire hazards to communities and infrastructure located in the wildland urban interface (WUI). Developed from the Healthy Forest Restoration Act of 2003. Addresses issues such as wildfire response, hazard mitigation, community preparedness, or structure protection (SWCA).

Conditional Surface Fire: A potential type of fire in which conditions for sustained active crown fire spread are met but conditions for crown fire initiation are not. If the fire begins as a surface fire, then it is expected to remain so. If it begins as an active crown fire in an adjacent stand, then it may continue to spread as an active crown fire (Wooten 2021).

Contain: A tactical point at which a fire's spread is stopped by and within specific contain features, constructed or natural; also, the result of stopping a fire's spread so that no further spread is expected under foreseeable conditions. For reporting purposes, the time and date of containment. This term no longer has a strategic meaning in Federal wildland fire policy (Wooten 2021).

Control: To construct fireline or use natural features to surround a fire and any control spot fires therefrom and reduce its burning potential to a point that it no longer threatens further spread or resource damage under foreseeable conditions. For reporting purposes, the time and date of control. This term no longer has a strategic meaning in Federal wildland fire policy (Wooten 2021).

Cover type: The type of vegetation (or lack of it) growing on an area, based on cover type minimum and maximum percent cover of the dominant species, species group or non-living land cover (such as water, rock, etc.). The cover type defines both a qualitative aspect (the dominant cover type) as well as a quantitative aspect (the abundance of the predominant features of that cover type) (Wooten 2021).

Creeping Fire: A low intensity fire with a negligible rate of spread (Wooten 2021).

Crown Fire: A fire that advances at great speed from crown to crown in tree canopies, often well in advance of the fire on the ground (National Geographic 2021).

Defensible Space: An area around a structure where fuels and vegetation are modified, cleared, or reduced to slow the spread of wildfire toward or from a structure. The design and distance of the defensible space is based on fuels, topography, and the design/materials used in the construction of the structure (SWCA).

- In California, PRC Section 4291, “defensible space” refers to a 100-foot perimeter around a structure in which vegetation (fuels) must be maintained in order to reduce the likelihood of ignition. This space may extend beyond property lines, or 100 feet as required by State law as well as local ordinances, rules, and regulations (CA GOPR 2020b).

Duff: The layer of decomposing organic materials lying below the litter layer of freshly fallen twigs, needles, and leaves and immediately above the mineral soil (SWCA).

Ecosystem: An interacting natural system including all the component organisms together with the abiotic environment and processes affecting them (SWCA).

Environmental Conditions: That part of the fire environment that undergoes short-term changes: weather, which is most commonly manifest as windspeed, and dead fuel moisture content (Wooten 2021).

Escape Route: A preplanned and understood route firefighters take to move to a safety zone or other low-risk area. When escape routes deviate from a defined physical path, they should be clearly marked (flagged; SWCA).

Evacuation: The temporary movement of people and their possessions from locations threatened by wildfire (SWCA).

Federal Responsibility Area (FRA): A term specific to California, designating areas where the federal government is responsible for fire response efforts. These areas include lands under federal ownership (CA GOPR 2020b).

Fire Adapted Communities: A fire-adapted community collaborates to identify its wildfire risk and works collectively on actionable steps to reduce its risk of loss. This work protects property and increases the safety of firefighters and residents (USFA 2021b).

Fire Behavior: The manner in which fuel ignites, flame develops, and fire spread and exhibits other related phenomena as determined by the interaction of fuels, weather, and topography (Fire Research and Management Exchange System [FRAMES] 2021).

Fire Break: Areas where vegetation and organic matter are removed down to mineral soil (SWCA).

Fire Environment: The characteristics of a site that influence fire behavior. In fire modeling the fire environment is described by surface and canopy fuel characteristics, windspeed and direction, relative humidity, and slope steepness (Wooten 2021).

Fire Frequency: A broad measure of the rate of fire occurrence in a particular area. For historical analyses, fire frequency is often expressed using the fire return interval calculation. For modern-era analyses, where data on timing and size of fires are recorded, fire frequency is often best expressed using fire rotation (SWCA)

Fire Hazard: Fire hazard is the potential fire behavior or fire intensity in an area, given the type(s) of fuel present – including both the natural and built environment – and their combustibility (CA GOPR 2020b).

Fire Hazard Severity Zones: Fire hazard severity zones are defined based on vegetation, topography, and weather (temperature, humidity and wind), and represents the likelihood of an area burning over a 30- to 50-year time period without considering modifications such as fuel reduction efforts. In California, CAL FIRE maintains fire hazard severity zone (FHSZ) data for the entire state. There are three classes of fire hazard severity ratings within FHSZs: Moderate, High, and Very High (CA GOPR 2020b).

Fire History: The chronological record of the occurrence of fire in an ecosystem or at a specific site. The fire history of an area may inform planners and residents about the level of wildfire hazard in that area (SWCA).

Fire Intensity: A general term relating to the heat energy released in a fire (SWCA).

Fireline Intensity: Amount of heat release per unit time per unit length of fire front. Numerically, the product of the heat of combustion, quantity of fuel consumed per unit area in the fire front, and the rate of spread of a fire, expressed in kilowatts per minute (SWCA). This expression is commonly used to

describe the power of wildland fires, but it does not necessarily follow that the severity, defined as the vegetation mortality, will be correspondingly high (Wooten 2021).

Fire Prevention: Activities such as public education, community outreach, planning, building code enforcement, engineering (construction standards), and reduction of fuel hazards that is intended to reduce the incidence of unwanted human-caused wildfires and the risks they pose to life, property or resources (CA GOPR 2020b).

Fire Regime: A measure of the general pattern of fire frequency and severity typical to a particular area or type of landscape: The regime can include other metrics of the fire, including seasonality and typical fire size, as well as a measure of the pattern of variability in characteristics (SWCA).

Fire Regime Condition Class: Condition classes are a function of the degree of fire regime condition class departure from historical fire regimes resulting in alterations of key ecosystem components such as composition structural stage, stand age, and canopy closure (Wooten 2021).

Fire Return Interval: Number of years (interval) between two successive fires in a designated area (SWCA).

Fire Severity: A qualitative measure of the immediate effects of fire on the fire severity ecosystem. It relates to the extent of mortality and survival of plant and animal life both aboveground and belowground and to loss of organic matter. It is determined by heat released aboveground and belowground. Fire Severity is dependent on intensity and residence dependent of the burn. For trees, severity is often measured as percentage of basal area removed. An intense fire may not necessarily be severe (Wooten 2021).

Fire Risk: "Risk" takes into account the intensity and likelihood of a fire event to occur as well as the chance, whether high or low, that a hazard such as a wildfire will cause harm. Fire risk can be determined by identifying the susceptibility of a value or asset to the potential direct or indirect impacts of wildfire hazard events (CA GOPR 2020b).

Flammability: The relative ease with which fuels ignite and burn regardless of the quantity of the fuels (SWCA).

Flame Length: The length of flames in the propagating fire front measured along the slant of the flame from the midpoint of its base to its tip. It is mathematically related to fireline intensity and tree crown scorch height (Wooten 2021).

Foliar Moisture content: Moisture content (dry weight basis) of live foliage, foliar moisture content expressed as a percent. Effective foliar moisture content incorporates the moisture content of other canopy fuels such as lichen, dead foliage, and live and dead branchwood (Wooten 2021).

Forest Fire: uncontrolled burning of a woodland area (National Geographic 2021).

Fuel Break: A natural or manmade change in fuel characteristics which affects fire behavior so that fires burning into them can be more readily controlled (NWCG 2021c).

Fuel Complex: The combination of ground, surface, and canopy fuel strata (Wooten 2021).

Fuel Condition: Relative flammability of fuel as determined by fuel type and environmental conditions (SWCA).

Fuel Continuity: A qualitative description of the distribution of fuel both horizontally and vertically. Continuous fuels readily support fire spread. The larger the fuel discontinuity, the greater the fire intensity required for fire spread (Wooten 2021).

Fuel Loading: The volume of fuel in a given area generally expressed in tons per acre (SWCA). Dead woody fuel loadings are commonly described for small material in diameter classes of 0 to 0.25, 0.25 to 1, and 1 to 3 inches and for large material greater than 3 inches (Wooten 2021).

Fuel Management/Fuel Reduction: Manipulation or removal of fuels to reduce the likelihood of ignition and to reduce potential damage in case of a wildfire. Fuel reduction methods include prescribed fire, mechanical treatments (mowing, chopping), herbicides, biomass removal (thinning or harvesting or trees, harvesting of pine straw), and grazing. Fuel management techniques may sometimes be combined for greater effect (SWCA).

Fuel Model: A set of surface fuel bed characteristics (load and surface-area-to- fuel model volume-ratio by size class, heat content, and depth) organized for input to a fire model (Wooten 2021).

Fuel Modification: The manipulation or removal of fuels (i.e., combustible biomass such as wood, leaves, grass, or other vegetation) to reduce the likelihood of igniting and to reduce fire intensity. Fuel modification activities may include lopping, chipping, crushing, piling and burning, including prescribed burning. These activities may be performed using mechanical treatments or by hand crews. Herbicides and prescribed herbivory (grazing) may also be used in some cases. Fuel modification may also sometimes be referred to as “vegetation treatment” (CA GOPR 2020b).

Fuel Moisture Content: This is expressed as a percent or fraction of fuel moisture content weight (dry) of fuel. It is the most important fuel property controlling flammability. In living plants, it is physiologically bound. Its daily fluctuations vary considerably by species but are usually above 80 to 100 percent. As plants mature, moisture content decreases. When herbaceous plants cure, their moisture content responds as dead fuel moisture content, which fluctuates according to changes in temperature, humidity, and precipitation (Wooten 2021).

Fuel Treatment: The manipulation or removal of fuels to minimize the probability of ignition and/or to reduce potential damage and resistance to fire suppression activities (NWCG 2021d). Synonymous with fuel modification.

Grazing: There are two types of grazing: (1) traditional grazing, and (2) targeted grazing. Traditional grazing refers to cattle that are managed in extensive pastures to produce meat. Targeted grazing involves having livestock graze at a specific density for a given period of time for the purpose of managing vegetation. Even though both kinds of grazing manage fuel loading in range- and forested lands, targeted grazing is different in that its sole purpose is to manage fuels. Targeted grazing is done by a variety of livestock species such as sheep, goats, or cows (UCANR 2019).

Ground Fire: Fire that burns organic matter in the soil, or humus; usually does not appear at the surface (National Geographic 2021).

Ground Fuels: Fuels that lie beneath surface fuels, such as organic soils, duff, decomposing litter, buried logs, roots, and the below-surface portion of stumps (Wooten 2021).

Hazard: A “hazard” can be defined generally as an event that could cause harm or damage to human health, safety, or property (CA GOPR 2020b).

Hazardous Areas: Those wildland areas where the combination of vegetation, topography, weather, and the threat of fire to life and property create difficult and dangerous problems (SWCA).

Hazardous Fuels: A fuel complex defined by type, arrangement, volume, condition, and location that poses a threat of ignition and resistance to fire suppression (NWCG 2021ed).

Hazardous Fuels Reduction: Any strategy that reduces the amount of flammable material in a fire-prone ecosystem. Two common strategies are mechanical thinning and controlled burning (Wooten 2021).

Hazard Reduction: Any treatment that reduces the threat of ignition and spread of fire (SWCA).

Highly Valued Resources and Assets: Landscape features that are influenced positively and/or negatively by fire. Resources are naturally occurring, while Assets are human made (Interagency Fuel Treatment Decision Support System [IFTDSS] 2021).

Ignition: The action of setting something on fire or starting to burn (SWCA).

Incident: An occurrence or event, either natural or person-caused, which requires an emergency response to prevent loss of life or damage to property or natural resources (Wooten 2021).

Influence Zone: An area that, with respect to wildland and urban fire, has a set of conditions that facilitate the opportunity for fire to burn from wildland fuels to the home and or structure ignition zone (NWCG 2021f).

Initial Attack: The actions taken by the first resources to arrive at a wildfire to protect lives and property and prevent further extension of the fire (SWCA).

Invasive Species: An introduced, nonnative organism (disease, parasite, plant, or animal) that begins to spread or expand its range from the site of its original introduction and that has the potential to cause harm to the environment, the economy, or to human health (USGS 2021).

Ladder Fuels: Fuels that provide vertical continuity allowing fire to carry from surface fuels into the crowns of trees or shrubs with relative ease (SWCA).

Litter: Recently fallen plant material that is only partially decomposed and is still discernible (SWCA).

Local Responsibility Area: A term specific to California, designating areas where the local government is responsible for wildfire protection. The Local Responsibility Area (LRA) includes incorporated cities, cultivated agricultural lands, and portions of the desert. Local responsibility area fire protection is typically provided by city fire departments, fire protection districts, counties, and by CAL FIRE under contract to local government (CA GOPR 2020b).

Manual Treatments: Felling and piling of fuels done by hand. The volume of material generated from a manual fuel treatment is typically too small to warrant a biomass sale therefore collected material is disposed of by burning or chipping. The work can be performed by either a single individual or a large, organized crew with powered equipment (UCANR 2021a).

Mechanized Treatments: Mechanical treatments pulverize large continuous patches of fuel to reduce the volume and continuity of material. Mechanical treatments can be applied as either mastication or chipping treatments. Both treatments shred woody material, but mastication leaves residue on-site while chipping collects the particles for transportation off site. Similar to hand treatments, mechanical treatments can target specific areas and vegetation while excluding areas of concern. In addition, mechanical treatment is easily scalable to large areas (>30 acres) with little added cost. (UCANR 2021b).

Mitigation: Action that moderates the severity of a fire hazard or risk (SWCA).

Mutual Aid: Assistance in firefighting or investigation by fire agencies, irrespective of jurisdictional boundaries (NWCG 2021f).

Native Revegetation: The process of replanting and rebuilding the soil of disturbed land (e.g., burned) with native plant species (U.S. Department of Agriculture [USDA] 2005).

Native Species: A species that evolved naturally in the habitat, ecosystem, or region as determined by climate, soil, and biotic factors (USDA 2005).

National Cohesive Strategy: The National Cohesive Wildland Fire Management Strategy is a strategic push to work collaboratively among all stakeholders and across all landscapes, using best science, to make meaningful progress towards the three goals:

- Resilient Landscapes
- Fire Adapted Communities
- Safe and Effective Wildfire Response

Vision: To safely and effectively extinguish fire when needed; use fire where allowable; manage our natural resources; and as a nation, to live with wildland fire (Forests and Rangelands 2021).
Overstory: That portion of the trees in a forest which forms the upper or uppermost layer (SWCA).

Passive Crown Fire: A type of crown fire in which the crowns of individual trees or small groups of trees burn, but solid flaming in the canopy cannot be maintained except for short periods. Passive crown fire encompasses a wide range of crown fire behavior, from occasional torching of isolated trees to nearly active crown fire. Passive crown fire is also called torching or candling. A fire in the crowns of the trees in which trees or groups of trees torch, ignited by the passing front of the fire. The torching trees reinforce the spread rate, but these fires are not significantly different from surface fires (SWCA).

Prescribed Burning: Any fire ignited by management actions under specific, predetermined conditions to meet specific objectives related to hazardous fuels or habitat improvement. Usually, a written, approved prescribed fire plan must exist, and NEPA requirements must be met, prior to ignition (USFS 2021a).

Rate of Spread: The relative activity of a fire in extending its horizontal dimensions. It is expressed as rate of increase of the total perimeter of the fire, as rate of forward spread of the fire front, or as rate of increase in area, depending on the intended use of the information. Usually, it is expressed in chains or acres per hour for a specific period in the fire's history (NWCG 2021h).

Resilience: Resilience is the capacity of any entity – an individual, a community, an organization, or a natural system – to prepare for disruptions, to recover from shocks and stresses, and to adapt and grow from a disruptive experience (CA GOPR 2020b).

Response: Movement of an individual firefighting resource from its assigned standby location to another location or to an incident in reaction to dispatch orders or to a reported alarm (SWCA).

Safety Element: One of the seven mandatory elements of a local general plan (a jurisdictional plan that forms the foundation for future development), the safety element must identify hazards and hazard abatement provisions to guide local decisions related to zoning, subdivisions, and entitlement permits. The element should contain general hazard and risk reduction strategies and policies supporting hazard mitigation measures (CA GOPR 2020b).

Slash: Debris left after logging, pruning, thinning, or brush cutting. Slash includes logs, chips, bark, branches, stumps, and broken trees or brush that may be fuel for a wildfire (SWCA).

Slope Percent: The ratio between the amount of vertical rise of a slope and horizontal distance as expressed in a percent. One hundred feet of rise to 100 feet of horizontal distance equals 100 percent (NWCG 202i).

State Responsibility Area: A term specific to California, designating areas where the state has financial responsibility for wildland fire protection. Incorporated cities and lands under federal ownership are not included in the SRA. Lands under federal ownership are in the federal responsibility area (CA GOPR 2020b).

Suppression: The most aggressive fire protection strategy, it leads to the total extinguishment of a fire (SWCA).

Surface Fire: fire that typically burns only surface litter and undergrowth (National Geographic 2021).

Surface Fuel: Fuels lying on or near the surface of the ground, consisting of leaf and needle litter, dead branch material, downed logs, bark, tree cones, and low stature living plants (SWCA).

Structural Ignitability: The ability of structures (such as homes or fences) to catch fire (SWCA).

Topography: The arrangement of the natural and artificial physical features of an area (SWCA).

Total Fuel Load: The mass of fuel per unit area that could possibly be consumed in a hypothetical fire of the highest intensity in the driest fuels (Wooten 2021).

Tree Crown: The primary and secondary branches growing out from the main stem, together with twigs and foliage (SWCA).

Understory: Low-growing vegetation (herbaceous, brush or reproduction) growing under a stand of trees. Also, that portion of trees in a forest stand below the overstory (SWCA).

Understory Fire: A fire burning in the understory, more intense than a surface fire with flame lengths of 1-3 m (Wooten 2021).

Values and Assets at Risk: The elements of a community or natural area considered valuable by an individual or community that could be negatively impacted by wildfire or wildfire operations. These values can vary by community and can include public and private assets (natural and manmade) -- such as homes, specific structures, water supply, power grids, natural and cultural resources, community infrastructure-- as well as other economic, environmental, and social values (CA GOPR 2020b).

Vulnerable Community: Vulnerable communities experience heightened risk and increased sensitivity to natural hazard and climate change impacts and have less capacity and fewer resources to cope with, adapt to, or recover from the impacts of natural hazards and increasingly severe hazard events because of climate change. These disproportionate effects are caused by physical (built and environmental), social, political, and/ or economic factor(s), which are exacerbated by climate impacts. These factors include, but are not limited to, race, class, sexual orientation and identification, national origin, and income inequality (CA GOPR 2020b).

Wildfire: A “wildfire” can be generally defined as any unplanned fire in a “wildland” area or in the WUI (CA GOPR 2020b).

Wildfire Exposure: During fire suppression activities, an exposure is any area/property that is threatened by the initial fire, but in National Fire Incident Reporting System (NFIRS) a reportable exposure is any fire that is caused by another fire, i.e., a fire resulting from another fire outside that building, structure, or vehicle, or a fire that extends to an outside property from a building, structure, or vehicle (USFA 2020).

Wildfire Influence Zone: A wildland area with susceptible vegetation up to 1.5 miles from the interface or intermix WUI (CA GOPR 2020b).

Wildland: Those unincorporated areas covered wholly or in part by trees, brush, grass, or other flammable vegetation (CA GOPR 2020b).

Wildland Fire: Fire that occurs in the wildland as the result of an unplanned ignition (CA GOPR 2020b).

Wildland Fuels (aka fuels): Fuel is the material that is burning. It can be any kind of combustible material, especially petroleum-based products, and wildland fuels. For wildland fire, it is usually live, or dead plant material, but can also include artificial materials such as houses, sheds, fences, pipelines, and trash piles. In terms of vegetation, there are 6 wildland fuel types (Fuel Type: An identifiable association of fuel elements of distinctive species, form, size, arrangement, or other characteristics that will cause a predictable rate of spread or resistance to control under specified weather conditions.) The 6 wildland fuel types are (NWCG 2021j):

5. Grass
6. Shrub
7. Grass-Shrub
8. Timber Litter
9. Timber-Understory
10. Slash-Blowdown

Wildland-Urban Interface (WUI): The WUI is the zone of transition between unoccupied land and human development. It is the line, area or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuels (USFA 2021a). In the absence of a Community Wildfire Protection Plan, Section 101 (16) of the HFRA defines the wildland urban interface as " (I) an area extending ½ mile from the boundary of an at-risk community; (II) an area within 1 ½ miles of the boundary of an at-risk community, including any land that (1) has a sustained steep slope that creates the potential for wildfire behavior endangering the at-risk community; (2) has a geographic feature that aids in creating an effective fire break, such as a road or ridge top; or (3) is in condition class 3, as documented by the Secretary in the project-specific environmental analysis; (III) an area that is adjacent to an evacuation route for an at-risk community that the Secretary determines, in cooperation with the at-risk community, requires hazardous fuels reduction to provide safer evacuation from the at-risk community." A Community Wildfire Protection Plan offers the opportunity to establish a localized definition and boundary for the wildland urban interface (USFS 2021b)

DRAFT

REFERENCES

Anderson, D. H., E. A. Catchpole, N. J. De Mestre, and T. Parkes. 1981. Modelling the spread of grass fires. J. Austral. Math. 23 (1982), 451-466

Brown, J.K. 1974. *Handbook for Inventorying Downed Woody Material*. Gen. Tech. Rep. No. GTR-INT-16. Ogden, Utah: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station.

Bureau of Land Management (BLM). 2021. Fuels Management. Available at: https://www.blm.gov/programs/public-safety-and-fire/fire/aviation. Accessed January 2023.

Butler, B.W., and Cohen, J.D. 1996. An Analytical Evaluation of Firefighter Safety Zones. 12th Fire and Forest Meteorology Conference, Lorne, Australia, 1996.

California Air Resources Board (CARB). 2001. Title 17 of the California Code of Regulations: Subchapter 2. Smoke Management Guidelines for Agricultural and Prescribed Burning Effective March 14, 2001. Available at: https://www.law.cornell.edu/regulations/california/title-17/division-3/chapter-1/subchapter-2. Accessed January 2023.

———. 2003. Prescribed Burning and Smoke Management. Available at: https://ww2.arb.ca.gov/smoke-management-programs-and-burn-decisions-other-air-districts. Accessed January 2023.

California Department of Conservation. 2019. Post-Fire Debris Flow Facts. Available at: https://www.conservation.ca.gov/index/Pages/Fact-sheets/Post-Fire-Debris-Flow-Facts.aspx. Accessed January 2023.

California Department of Fish and Wildlife (CDFW). 2021. Science: Wildfire Impacts. Available at: https://wildlife.ca.gov/Science-Institute/Wildfire-Impacts. Accessed January 2023.

California Department of Food and Agriculture (CDFA). 2021. Invasive Pest & Diseases. Available at: https://www.cdfa.ca.gov/invasives/. Accessed January 2023.

California Department of Forestry and Fire Protection (CAL FIRE). 2018a. California's Forest and Rangelands 2017 Assessment. Available at: https://frap.fire.ca.gov/media/4babn5pw/assessment2017.pdf. Accessed January 2023.

———. 2018b. Strategic Fire Plan for California. Available at: https://osfm.fire.ca.gov/media/5590/2018-strategic-fire-plan-approved-08_22_18.pdf. Accessed January 2023.

———. 2019a. Community Wildfire Prevention & Mitigation Report. Available at: https://www.fire.ca.gov/media/5584/45-day-report-final.pdf. Accessed January 2023.

———. 2019b. Post-wildfire Recovery. Available at: https://www.readyforwildfire.org/post-wildfire/after-a-wildfire/. Accessed January 2023.

———. 2020a. California Cooperative Forest Management Plan. Available at: https://www.fire.ca.gov/media/pe4fswrg/ca-cooperative-fmp-ada.pdf. Accessed January 2023.

———. 2020b. Returning Home After a Wildfire. Available at: https://www.fire.ca.gov/media/11473/returning-home-after-a-wildfire.pdf. Accessed January 2023.

———.2021a. 2021 Fire Season Outlook. Available at: https://www.fire.ca.gov/incidents. Accessed January 2023.

———. 2021b. Vegetation Management Program. Available at: https://www.fire.ca.gov/programs/resource-management/resource-protection-improvement/vegetation-management-program/. Accessed January 2023.

———. 2022a. Fire Perimeters. Available at: https://frap.fire.ca.gov/frap-projects/fire-perimeters/. Accessed January 2023.

———. 2022b. 2021 Incident Archive. Available at: https://www.fire.ca.gov/incidents/2021/. Accessed January 2023.

———. 2022c. 2022/2023 Strategic Fire Plan for the San Bernardino Unit. Available at: https://osfm.fire.ca.gov/media/ua4bqito/2022-san-bernadino-inyo-mono-unit-fire-plan.pdf. Accessed January 2023.

———. 2022d. Defensible Space. Available at: https://www.fire.ca.gov/programs/communications/defensible-space-prc-4291/. Accessed January 2023.

California Department of Housing and Community Development. 2018. California's Housing Future: Challenges and Opportunities. Available at: https://www.hcd.ca.gov/policy-research/plans-reports/docs/sha_final_combined.pdf. Accessed January 2023.

California Department of Insurance (CDI). 2021. Claims and Loss management. Available at: http://www.insurance.ca.gov/01-consumers/140-catastrophes/WildfireAfter.cfm. Accessed January 2023.

———. 2022a. Interagency Wildfire Mitigation Partnership Summary Document. Available at: https://www.insurance.ca.gov/01-consumers/200-wrr/upload/Wildfire-Mitigation-Partnership-Summary-02142022.pdf. Accessed January 2023.

———. 2022b. Safer from Wildfires. Available at: https://www.insurance.ca.gov/01-consumers/200-wrr/saferfromwildfires.cfm. Accessed January 2023.

California Department of Public Health. 2017. Reduce Exposure to Ash When Returning Home After a Fire. Available at: https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/CDPH%20Document%20Library/ReturnHomeAshGuide.pdf. Accessed January 2023.

California Department of Water Resources. 2021. Flood Preparedness. Available at: https://water.ca.gov/What-We-Do/Flood-Preparedness/Flood-Preparedness-Week. Accessed January 2023.

———. 2022. Drought. Available at: https://water.ca.gov/Water-Basics/Drought. Accessed January 2023.

California Fire Safe Council. 2021. Fire Safe Councils. Available at: https://cafiresafecouncil.org/resources/fire-safe-councils/. Accessed January 2023.

California Forest Management Task Force (CA FMTF). 2021a. California's Wildfire and forest Resilience Action Plan. Available at: https://fmtf.fire.ca.gov/media/cjwfpckz/californiawildfireandforestresilienceactionplan.pdf. Accessed January 2023.

California Forest Pest Council (CFPC). 2020. California Forest Pest Conditions. Available at: https://www.caforestpestcouncil.org/_files/ugd/80da86_5031ef87153f436f90f6e5881baaa715.pdf. Accessed January 2023.

California Governor's Office of Planning and Research (CA GOPR). 2019. Final Report of the Commission on Catastrophic Wildfire Cost and Recovery. Available at: https://opr.ca.gov/

docs/20190618-Commission_on_Catastrophic_Wildfire_Report_FINAL_for_transmittal.pdf. Accessed January 2023.

———. 2020a. Fire Hazard Planning Technical Advisory. Available at: https://www.opr.ca.gov/docs/20201109-Draft_Wildfire_TA.pdf. Accessed January 2023.

———. 2020b. Fire Hazard Planning Technical Advisory, General Plan Technical Advice Series. 2020 Available at: https://www.opr.ca.gov/docs/20201109-Draft_Wildfire_TA.pdf. Accessed January 2023.

———. 2022. Fire Hazard Planning Technical Advisory. Available at: https://opr.ca.gov/docs/20220817-Fire_Hazard_Planning_TA.pdf. Accessed January 2023.

California Native Plant Society. n.d. Big Sagebrush. Available at: https://vegetation.cnps.org/alliance/142. Accessed February 2023.

California Office of Emergency Services (CA OES). 2018. 2018 State of California Hazard Mitigation Plan. Available at: https://www.caloes.ca.gov/wp-content/uploads/002-2018-SHMP_FINAL_ENTIRE-PLAN.pdf. Accessed January 2022.

California Office of Environmental Health Hazard Assessment. 2019. Forest Tree Mortality. Available at: https://oehha.ca.gov/epic/impacts-biological-systems/forest-tree-mortality. Accessed January 2023.

California Office of the Governor. 2020. California, U.S. Forest Service Establish Long-Term Strategy to Manage Forests and Rangelands. Available at: https://www.gov.ca.gov/2020/08/13/california-u-s-forest-service-establish-shared-long-term-strategy-to-manage-forests-and-rangelands/. Accessed January 2023.

California Silver Jackets Team (California SJT). 2019. After Wildfire, A Guide for California Communities. Available at: http://www.readyforwildfire.org/wp-content/uploads/After-Wildfire-Guide-10JUNE2019_draft_final-ADA-compliant.pdf. Accessed January 2023.

California Wildfire & Forest Resilience Task Force. 2022. Governor Newsom Signs State Budget Bill. Available at: https://wildfiretaskforce.org/governor-newsom-signs-state-budget-bill/. Accessed January 2023.

Coalition for the Upper South Platte (CUSP). 2016. The Phoenix Guide. Available at: https://cusp.ws/wp-content/uploads/2016/12/phoenix_guide.pdf. Accessed January 2023.

Congressional Research Service (CRS). 2022. Wildfire Statistics. Available at: https://sgp.fas.org/crs/misc/IF10244.pdf. Accessed January 2023.

Egan, Dave. 2013. Monitoring- Organizing a Landscape-Scale Forest Restoration Multi-Party Monitoring Program. 38pp. Available at: https://openknowledge.nau.edu/id/eprint/2501/1/Dubay_C_etal_2013_HandbookBreakingBarriers3.pdf. Accessed January 2023.

Environmental Protection Agency (EPA). 2019. Wildfire Smoke: A Guide for Public Health Officials. Available at: https://www.airnow.gov/sites/default/files/2021-05/wildfire-smoke-guide-revised-2019.pdf. Accessed January 2023.

Evans, A., S. Auerbach, L.W. Miller, R. Wood, K. Nystrom, J. Loevner, A, Argon, M. Piccarello, E. Krasilovsky. 2015. Evaluating the Effectiveness of Wildfire Mitigation Activities in the Wildland Urban Interface. Forest Guild, October 2015.

Federal Emergency Management Agency (FEMA). 2022. Social Vulnerability. Available at: https://hazards.fema.gov/nri/social-vulnerability. Accessed January 2023.

Fire Research and Management Exchange System (FRAMES). 2021. Applied Wildland Fire Behavior Research and Development. Available at: https://www.frames.gov/applied-fire-behavior/home. Accessed January 2023.

Forests and Rangelands. 2006. *A Collaborative Approach for Reducing Wildland Fire Risks to Communities and the Environment: 10-Year Strategy Implementation Plan*. Available at: https://www.forestsandrangelands.gov/documents/resources/plan/10-yearstrategyfinal_dec2006.pdf. Accessed January 2023.

———. 2014. The National Strategy: The Final Phase in the Development of the National Cohesive Wildland Fire Management Strategy. Available at: https://www.forestsandrangelands.gov/documents/strategy/strategy/CSPhaseIIINationalStrategyApr2014.pdf. Accessed January 2023.

Forests and Rangelands. 2021. The National Strategy. Available at: https://www.forestsandrangelands.gov/strategy/thestrategy.shtml. Accessed January 2023.

Great Basin Unified Air Pollution Control District. n.d. Open Outdoor Burning. Available at: https://gbuapcd.org/PermittingAndRules/Burning/. Accessed January 2023.

Graham, R., S. McCaffrey, and T. Jain. 2004. Science Basis for Changing Forest Structure to Modify Wildfire Behavior and Severity. Gen. Tech Rep. RMRS-GTR-120. Fort Collins, Colorado: U.S. Department of Agriculture Forest Service, Rocky Mountain Research Station.

Howald, A., 2000. Plant communities. in: *Sierra East: Edge of the Great Basin*. Genny Smith (ed.). Berkeley: University of California Press. pp. 94-207.

Interagency Fuel Treatment Decision Support System (IFTDSS). 2021. About Map Values - Highly Valued Resources or Assets (HVRAs). Available at: https://iftdss.firenet.gov/firenetHelp/help/pageHelp/content/30-tasks/qwra/mapvalues/hvraabout.htm. Accessed January 2023.

———. 2022. About Map Values - Highly Valued Resources or Assets (HVRAs). Available at: https://iftdss.firenet.gov/firenetHelp/help/pageHelp/content/30-tasks/qwra/mapvalues/hvraabout.htm. Accessed January 2023.

International Association of Fire Chiefs. 2021. Ready, Set, Go! Available at: http://wildlandfirersg.org/. Accessed January 2023.

Iglesias, V., J. K. Balch, and W. R. Travis. 2022. U.S. fires became larger, more frequent, and more widespread in the 2000s. Science Advances, Vol 8, Issue 11. https://doi.org/10.1126/sciadv.abc0020

Inyo County. 2009. Inyo County Community Wildfire Protection Plan. Prepared by Anchor Point Fire Management, Boulder, CO. 181 pp. Available at: https://www.inyocounty.us/sites/default/files/2019-07/Inyo%20County%20CWPP%20with%20Appendices.pdf. Accessed January 2023.

———. 2016. Inyo County Emergency Operations Plan. Independence, CA. 230 pp. Available at: https://www.inyocounty.us/sites/default/files/2019-07/INYO%20COUNTY%202016%20EOP-FINAL.pdf. Accessed January 2023.

Inyo County and City of Bishop. 2017. Multi-Jurisdictional Hazard Mitigation Plan. Available at: https://www.inyocounty.us/sites/default/files/2019-07/12292017_InyoCountyMJHMP_FEMA_wAppendices.pdf. Accessed January 2023.

Inyo County OES. n.d. Are you prepared? Available at: https://www.inyocounty.us/sites/default/files/2019-11/INYO-PREPAREDNESS.pdf. Accessed January 2023.

Inyo County Water Department. 2023. Inyo County Saltcedar Control Program. Available at: https://www.inyowater.org/projects/saltcedar/. Accessed January 2023.

Inyo National Forest, 2019. Land Management Plan for the Inyo National Forest. Pacific Southwest Region. R5-MB-323a. 196 pp. Available at: https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd664404.pdf. Accessed January 2023.

Kitchen, S. G., P. J. Weisberg, and Z. J. Nelson. 2013. Historic fire frequency in mountain big sagebrush communities of the eastern Great Basin and Colorado Plateau: a comparison of estimates based upon proxy fire scar records and predictions derived from post-fire succession rates. Available at: https://www.firescience.gov/projects/06-3-1-17/project/06-3-1-17_final_report.pdf. Accessed January 2023.

Long, J.W., F.K. Lake, and R.W. Goode. 2021. The importance of Indigenous cultural burning in forested regions of the Pacific West, USA. Forest Ecology and Management 500 (2021):119597, ISSN 0378-1127, https://doi.org/10.1016/j.foreco.2021.119597.

Lovreglio R, Meddour-Sahar O, Leone V. 2014. Goat grazing as a wildfire prevention tool: a basic review. iForest 7: 260-268. doi: 10.3832/ifor1112-007

Martinson, Erik J.; Omi, Philip N. 2013. Fuel treatments and fire severity: A meta-analysis. Res. Pap. RMRS-RP-103WWW. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 38 p.

McCaffrey, S.M. 2004. Fighting fire with education: what is the best way to reach out to homeowners? Journal of Forestry 102:12–19.

———. 2020. What motivates Homeowners to Mitigate Fire Risk? Lessons from Social Science [conference presentation]. Bill Lane Center for the American West, Virtual Wildfire Series: Wildfire management during COVID. Available at: https://www.youtube.com/watch?v=3dmbenV-ZsM. Accessed January 2023.

McCaffrey, S.M. and C.S. Olsen. 2012. Research Perspectives on the Public and Fire Management: A Synthesis of Current Social Science on Eight Essential Questions. Northern Research Station GTR -104. Available at: https://www.firescience.gov/projects/06-4-1-26/project/06-4-1-26_gtr_nrs104.pdf. Accessed January 2023.

National Geographic. 2021. Resource Library, Wildfires. Available at: https://www.nationalgeographic.org/encyclopedia/wildfires/. Accessed January 2023.

National Interagency Fire Center (NIFC). 2021a. Wildland Fire Statistics. Available at: https://www.nifc.gov/fireInfo/fireInfo_stats_totalFires.html. Accessed January 2023.

———. 2021b. Suppression Costs. Available at: https://www.nifc.gov/fire-information/statistics/suppression-costs. Accessed January 2023.

———. 2021c. About Us. Available at: https://www.nifc.gov/about-us. Accessed January 2023.

———. 2021d. Wildfire Education. Available at: https://www.nifc.gov/fire-information/fire-prevention-education-mitigation/wildfire-education. Accessed January 2023.

———. 2021e. Fire Prevention, Education and Mitigation. Available at: https://www.nifc.gov/fire-information/fire-prevention-education-mitigation. Accessed January 2023.

———. 2022. Post Fire Recovery. Available at: https://www.nifc.gov/programs/post-fire-recovery. Accessed January 2023.

National Park Service (NPS). 2021. Sequoia and Kings National Parks, Forest Health. Available at: https://www.nps.gov/seki/learn/nature/forest-health-and-climate-change.htm. Accessed January 2023.

National Wildfire Coordinating Group (NWCG). 1998. Fireline Handbook. NWCG Handbook 3. PMS 410-1. NFES 0065. Boise: National Interagency Fire Center.

———. 2020. Smoke Management Guide for Prescribed Fire. Available at: https://www.nwcg.gov/sites/default/files/publications/pms420-3.pdf. Accessed January 2023.

———. 2021a. NWCG Glossary of Wildland Fire, PMS 205, I-Zone. Available at: https://www.nwcg.gov/term/glossary/i-zone. Accessed January 2023.

———. 2021b. NWCG Glossary of Wildland Fire, PMS 205, Aspect. Available at: https://www.nwcg.gov/term/glossary/aspect. Accessed January 2023.

———. 2021c. NWCG Glossary of Wildland Fire, PMS 205, fuel break. Available at: https://www.nwcg.gov/term/glossary/fuel-break. Accessed January 2023.

———. 2021d. NWCG Glossary of Wildland Fire, PMS 205, fuel treatment. Available at: https://www.nwcg.gov/term/glossary/fuel-treatment. Accessed January 2023.

———. 2021e. NWCG Glossary of Wildland Fire, PMS 205, hazard fuel. Available at: https://www.nwcg.gov/term/glossary/hazard-fuel. Accessed January 2023.

———. 2021f. NWCG Glossary of Wildland Fire, PMS 205, I-Zone. Available at: https://www.nwcg.gov/term/glossary/i-zone. Accessed January 2023.

———. 2021g. NWCG Glossary of Wildland Fire, PMS 205, mutual aid. Available at: https://www.nwcg.gov/term/glossary/mutual-aid. Accessed January 2023.

———. 2021h. NWCG Glossary of Wildland Fire, PMS 205, rate of spread. Available at: https://www.nwcg.gov/term/glossary/rate-of-spread. Accessed January 2023.

———. 2021i. NWCG Glossary of Wildland Fire, PMS 205, slope percent. Available at: https://www.nwcg.gov/term/glossary/slope-percent. Accessed January 2023.

———. 2021j. Instructor Guide, S-190 Unit 2: Fuels. Available at: https://www.nwcg.gov/sites/default/files/training/docs/s-190-ig02.pdf. Accessed January 2023.

New Mexico Future Farmers of America (NM FFA). 2010. Introduction to Wildland Fire Behavior for NM Forestry CDE. Available at: http://www.nmffa.org/uploads/4/1/0/7/41075673/wildland_fire_behavior.pdf#:~:text=Wildland%20fuels%20are%20basically%20live%20and%2For%20dead%20plant,fire%20behavior%20is%20dependent%20on%20certain%20fuel%20characteristics%3A. Accessed January 2023.

Ottmar, R., R. Vihnanek, and J. Regelbrugge. 2000. Wildland Fire in Ecosystems: Effects of Fire on Fauna. Vol. 1. Gen. Tech. Rep. RMRS-GTR-42. Ogden, Utah: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Pollet J., and P.N. Omi. 2002 Effect of thinning and prescribed burning on crown fire severity in ponderosa pine forests. *International Journal of Wildland Fire* 11:1–10.

Powell, D. and H. Klieforth, 2000. Weather and climate. in: *Sierra East: Edge of the Great Basin*. Genny Smith (ed.). Berkeley: University of California Press. pp. 70-93.

Prichard, S. J., D. L. Peterson, and K. Jacobson. 2010. Fuel treatments reduce the severity of wildfire effects in dry mixed conifer forest, Washington, USA. *NRC Research Press* 40:1615–1626

Pyne, S.J. 2001. The fires this time, and next. *Science* 294(2):12–17.

Ready. 2021. Community Emergency Response Team. Available at: https://www.ready.gov/cert. Accessed January 2023.

Rothermel, R.C. 1983. *How to Predict the Spread and Intensity of Forest and Range Fires*. Gen. Tech. Rep. INT-143. Ogden, Utah: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station.

Safford, H.D., Schmidt, D.A., and Carlson, C. H. 2009. Effects of fuel treatments on fire severity in an area of wildland-urban interface, Angora Fire, Lake Tahoe Basin, California. *Forest Ecology and Management* 258:773–787.

Safford, H.D., Stevens, J.T., Merriam, K., Meyer, M.D., and Latimer, A.M. 2012. Fuel treatment effectiveness in California yellow pine and mixed conifer forests. Forest Ecology and Management 274:17–28; https://doi.org/10.1016/j.foreco.2012.02.013.

Scott, J.H., and R.E. Burgan. 2005. *Standard Fire Behavior Fuel Models: A Comprehensive Set for Use with Rothermel's Surface Fire Spread Model*. Gen. Tech. Rep. RMRS-GTR-153. Fort Collins, Colorado: U.S. Department of Agriculture, U.S. Forest Service, Rocky Mountain Research Station.

Sierra Nevada Conservancy. 2021. 2020 megafires create risks for California's water supply. Available at: https://sierranevada.ca.gov/2020-megafires-create-risks-for-californias-water-supply/. Accessed January 2023.

Society of American Foresters (SAF). 2004. Preparing a Community Wildfire Protection Plan: A Handbook for Wildland Urban Interface Communities. Sponsored by Communities Committee, National Association of Counties, National Association of State Foresters, Society of American Foresters, and Western Governors' Association. Available at: https://www.forestsandrangelands.gov/documents/resources/communities/cwpphandbook.pdf. Accessed January 2023.

Southern California Edison. 2022a. 2022 Wildfire Mitigation Plan Update (Fact Sheet). Available at: https://download.newsroom.edison.com/create_memory_file/?f_id=620fe9b4b3aed34b1cc770f3&content_verified=True. Accessed January 2023.

Southern California Edison. 2022b. Wildfire Mitigation Plan. Available at: https://www.sce.com/sites/default/files/custom-files/SCE%202022%20WMP%20Update.pdf https://www.sce.com/sites/default/files/custom-files/SCE 2022 WMP Update.pdf. Accessed January 2023.

State of California. 2022. California Drought Update. Available at: https://drought.ca.gov/media/2022/03/CA-Drought-Update-2-28-22.pdf. Accessed January 2023.

Stephens, S.L., and L.W. Ruth. 2005. Federal forest-fire policy in the United States. *Ecological Applications* 15(2):532–542.

Switzer, R. and J. Umek., 2022. Eastern Sierra Nevada Riparian Areas Assessment for Fuels Reduction. Reno: Great Basin Institute. 163 p.

Team Rubicon. 2022. Capabilities and Services. Available at: https://teamrubiconusa.org/capabilities-services/. Accessed January 2023.

U.S. Department of Agriculture (USDA). 2001. Urban Wildland Interface Communities within Vicinity of Federal Lands that are at High Risk from Wildfire. Federal Register 66(3):751–777.

———. 2005. Terminology and Definitions Associated with Revegetation. Available at: https://www.nrcs.usda.gov/plant-materials/publications/search. Accessed January 2023.

———. 2022. Introduced, Invasive, and Noxious Plants. Available at: https://plantsorig.sc.egov.usda.gov/java/noxiousDriver. Accessed January 2023.

U.S. Fire Administration (USFA). 2020. Exposures. Available at: https://www.usfa.fema.gov/nfirs/coding-help/nfirsgrams/nfirsgram-including-exposures.html. Accessed January 2023.

———. 2021a. What is the WUI? Available at: https://www.usfa.fema.gov/wui/what-is-the-wui.html. Accessed January 2023.

———.2021b. Fire-Adapted Communities. Available at: https://www.usfa.fema.gov/wui/communities/. Accessed January 2023.

U.S. Fish and Wildlife Service. N.d. Information for Planning and Consultation Tool. Available at: https://ipac.ecosphere.fws.gov/location/FBTDFVX7ZNAJBFV7Y4ZMQCMKEM/resources#endangered-species. Accessed January 2023.

U.S. Forest Service (USFS). 2014. Using Resistance and Resilience Concepts to Reduce Impacts of Invasive Annual Grasses and Altered Fire Regimes on the Sagebrush Ecosystem and Greater Sage-Grouse: A Strategic Multi-Scale Approach. Available at: https://agsci.oregonstate.edu/sites/agscid7/files/eoarc/attachments/824_using_resistance_resilience_2014.pdf. Accessed January 2023.

———. 2018a. Land Management Plan for the Inyo National Forest. Available at: https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd589652.pdf. Accessed January 2023.

———. 2018b. Final Environmental Impact Statement for Revision of the Inyo National Forest Land Management Plan. Available at: https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd589660.pdf. Accessed January 2023.

———. 2021a. Fire Terminology. Available at: https://www.nwcg.gov/sites/default/files/data-standards/glossary/pms205.pdf. Accessed January 2023.

———. 2021b. Leadership and National Priorities. Available at: https://www.fs.usda.gov/inside-fs/delivering-mission/excel/leadership-intentions-usda-forest-services-five-national#:~:text=The%20Forest%20Service's%20five%20national%20priorities%20do%20three,work%20with%20citizens%2C%20partners%2C%20volunteers%20and%20each%20other. Accessed January 2023.

———. 2021c. 2021 Aerial Detection Survey Results: California. Available at: https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd999359.pdf. Accessed January 2023.

———. 2021d. Postfire Restoration Framework for National Forests in California. Available at: https://www.fs.usda.gov/psw/publications/documents/psw_gtr270/psw_gtr270.pdf. Accessed January 2023.

———. 2021e. After the Fire. Available at: https://www.fs.usda.gov/science-technology/fire/after-fire. Accessed January 2023.

U.S. Geological Survey (USGS). 2021. What is an invasive species and why are they a problem? Available at: https://www.usgs.gov/faqs/what-invasive-species-and-why-are-they-a-problem?qt-news_science_products=0#qt-news_science_products. Accessed January 2023.

University of California, Agriculture and Natural Resources (UCANR). 2009. Invasive Plants and Wildfires in Southern California. Available at: https://anrcatalog.ucanr.edu/pdf/8397.pdf. Accessed January 2023.

———. 2017. Tree Mortality in the Sierra Nevada. Available at: https://ucanr.edu/sites/CentralSierraForestry/files/331959.pdf. Accessed January 2023.

———. 2019. Grazing for fire fuels management. Available at: https://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=31445. Accessed January 2023.

———. 2020. Mass Tree Mortality, Fuels, and Fire: A Guide for Sierra Nevada Forest Landowners. Available at: https://anrcatalog.ucanr.edu/pdf/8683.pdf. Accessed January 2023.

———. 2021a. Manual. Available at: https://ucanr.edu/sites/fire/Prepare/Treatment/Manual/. Accessed January 2023.

———. 2021b. Mechanical. Available at: https://ucanr.edu/sites/fire/Prepare/Treatment/Mechanical/. Accessed January 2023.

Waltz, A.E.M., M.T. Stoddard, E.L. Kalies, J.D. Springer, D.W. Huffman, and A.S. Meador. 2014. Effectiveness of fuel reduction treatments: Assessing metrics of forest resiliency and wildfire severity after the Wallow Fire, AZ. *Forest Ecology and Management* 334:43-52; https://doi.org/10.1016/j.foreco.2014.08.026.

Wayman, R. B., and H.D. Safford. 2021. Recent bark beetle outbreaks influence wildfire severity in mixed-conifer forests of the Sierra Nevada, California, USA. *Ecological Applications* 31(3): e02287. 10.1002/eap.2287

Webb, A. D., D.A. Falk, M.D. Finch. 2019. Fire Ecology and Management in Lowland Riparian Ecosystems of the Southwestern United States and Northern Mexico. Gen. Tech. Rep. RMRS-GTR-401. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station

Westerling, A.L., H.G. Hidalgo, D.R. Cayan, and T.W. Swetnam. 2006. Warming and earlier spring increase in western U.S. Forest wildfire activity. *Science* 313(5789):940–943.

Westerling. 2016. Increasing western US forest wildfire activity: sensitivity to changes in the timing of spring. Available at: http://ulmo.ucmerced.edu/pdffiles/16RSTB_Westerling.pdf. Accessed January 2023.

Western Regional Climate Center. 2022. Independence, California. Available at: https://wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca4232. Accessed January 2023.

Western Regional Strategy Committee (WRSC). 2013. Western Regional Action Plan. Available at: https://www.forestsandrangelands.gov/documents/strategy/rsc/west/WestRAP_Final20130416.pdf. Accessed January 2023.

Wildland Fire Decision Support System (WFDSS). 2015. WFDSS Spatial Fire Planning Guide. October 2015. Available at: https://wfdss.usgs.gov/wfdss/pdfs/WFDSS_SFP_Guide.pdf. Accessed January 2023.

———. 2021. Wildland Fire Decision Support System. Available at: https://wfdss.usgs.gov/wfdss/wfdss_home.shtml. Accessed January 2023.

Winter, G., and J.S. Fried. 2000. Homeowner perspectives on fire hazard, responsibility, and management strategies at the wildland-urban interface. *Society and Natural Resources* 13:33–49.

Wooten, George. 2021. Fire and fuels management: Fire and fuels management: Definitions, ambiguous terminology and references. Available at: https://www.nps.gov/olym/learn/management/upload/fire-wildfire-definitions-2.pdf. Accessed January 2023.

DRAFT

APPENDIX A:

CWPP Planning Process and Background

This page intentionally left blank.

PLANNING PROCESS

The SAF, in collaboration with the National Association of Counties and the National Association of State Foresters, developed a guide entitled *Preparing a Community Wildfire Protection Plan: A Handbook for Wildland-Urban Interface Communities* (SAF 2004) to provide communities with a clear process in developing a CWPP. The guide outlines eight steps for developing a CWPP and has been followed in preparing the 40 Acres CWPP:

Step One: Convene Decision-makers. Form a Core Team made up of representatives from the appropriate local governments, local fire authorities, and state agencies responsible for forest management.

Step Two: Involve Federal Agencies. Identify and engage local federal representatives and contact and involve other land management agencies as appropriate.

Step Three: Engage Interested Parties. Contact and encourage active involvement in plan development from a broad range of interested organizations and stakeholders.

Step Four: Establish a Community Base Map. Work with partners to establish a base map(s) defining the community's WUI and showing inhabited areas at risk, wildland areas that contain critical human infrastructure, and wildland areas at risk for large-scale fire disturbance.

Step Five: Develop a Community Risk-Hazard Assessment. Work with partners to develop a community Risk-Hazard Assessment that considers fuel hazards; risk of wildfire occurrence; homes, businesses, and essential infrastructure at risk; other values at risk (VARs); and local preparedness capability. Rate the level of risk for each factor and incorporate this information into the base map as appropriate.

Step Six: Establish Community Priorities and Recommendations. Use the base map and community Risk-Hazard Assessment to facilitate a collaborative community discussion that leads to the identification of local priorities for treating fuels, reducing structural ignitability and other issues of interest, such as improving fire response capability. Clearly indicate whether priority projects are directly related to the protection of communities and essential infrastructure or to reducing wildfire risks to other community values.

Step Seven: Develop an Action Plan and Assessment Strategy. Consider developing a detailed implementation strategy to accompany the CWPP as well as a monitoring plan that will ensure its long-term success.

Step Eight: Finalize Community Wildfire Protection Plan. Finalize the CWPP and communicate the results to community and key partners.

FIRE MANAGEMENT POLICY

The primary responsibility for WUI fire prevention and protection lies with property owners and state and local governments. Property owners must comply with existing state statutes and local regulations. These primary responsibilities should be carried out in partnership with the federal government and the private sector where applicable. The current Federal Fire Policy states that protection priorities are 1) life, 2) property, and 3) natural resources. These priorities often limit flexibility in the decision-making process, especially when a wildland fire occurs within the WUI.

DRAFT

LEGISLATIVE DIRECTION

Municipal Direction

Codes & Ordinances

40 Acres falls within Inyo County and therefore operates based on the Inyo County Code. Inyo County has a *Defensible space and fire hazard reduction* section under *Title 14 Building and Safety*, which designates all of the unincorporated areas as WUI and requires that properties in the WUI to be "maintained in accordance with the defensible space requirements set forth in Government Code Section 51182 and Public Resources Code Section 4291." You can find more information about this requirement here: https://library.qcode.us/lib/inyo_county_ca/pub/county_code/item/title_14-chapter_14_08-14_08_140

Additionally, Inyo County has two ordinances regarding "combustible waste materials" and their removal under Title 7: *7.36.040 Fire hazard—Removal—Required* and *7.36.050 Fire hazard—Removal—By city.* These ordinances require the full or partial removal of combustible materials that may pose a fire hazard. In the event of noncompliance, the County may enter the noncompliant premises and remove the combustible material and the owner shall be liable for expenses. You can find more information about these ordinances here: https://library.qcode.us/lib/inyo_county_ca/pub/county_code/item/title_7-chapter_7_36

State Direction

The 2021 California Wildfire and Forest Resilience Action Plan recognizes that California faces continued and urgent threats from catastrophic wildfire. The purpose of this plan is to provide a foundation for supporting healthy, resilient, fire adapted forests. The plan is organized into four overarching goals which break down into sub-goals and their correlated action items. Some of the goals/strategies specific to wildfire include:

11. **Increase Fuel Breaks:** Reduce the risk of wildfire and slow fire spread within the WUI.
12. **Protect Wildfire-Prone homes and Neighborhoods:** Expand and extend defensible space programs.
13. **Improve Utility related wildfire risk:** Ensure electrical corporations are compliant with wildfire regulations.
14. **Create Fire-Safe Roadways:** Ensuring emergency evacuation routes that can function as a fuel break.

Like the 2014 national strategy, California's 2019 Strategic Plan, California's Wildfire and Forest Resilience Action Plan, and Federal Emergency Management Agency (FEMA) Disaster Mitigation Act of 2000, all mandate community-based planning efforts with full stakeholder participation, coordination, project identification, prioritization, funding review, and multiagency cooperation. In compliance with Title 1 of the HFRA, a CWPP must be mutually agreed upon by the local government, local fire departments, and the state agency responsible for forest management. As outlined in HFRA, this CWPP is developed in consultation with interested parties and the federal agencies managing land surrounding the at-risk communities. See Figure A.1 for an overview of California's wildfire regulatory environment.

DRAFT

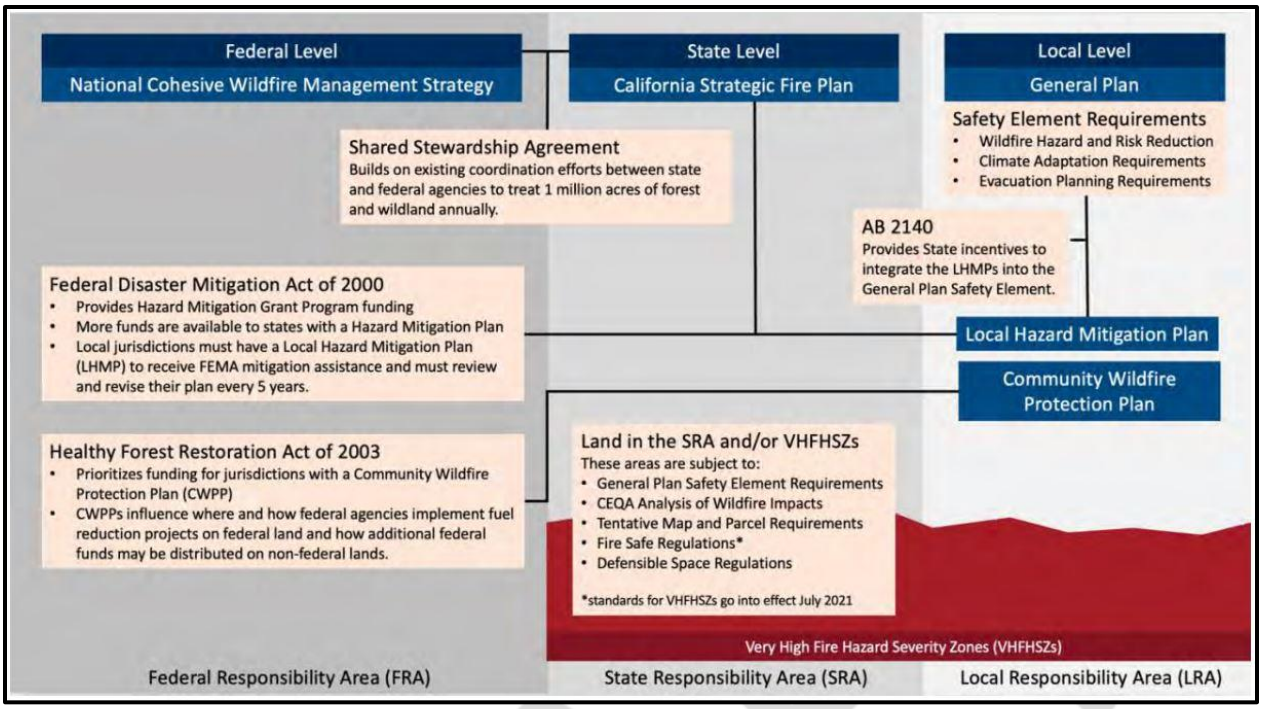


Figure A.1. California's wildfire regulatory framework. Source: California Governor's Office of Planning and Research (CA GOPR 2022).

California Bills and Regulations

Assembly Bill 179: In September of 2022, Governor Newsom signed budget bill AB 179 authorizing $1.3 billion dollars over the next two years to build wildfire resilience and bolster forest health throughout the state. The bill allocates $472 million dollars toward forest health and fire prevention planning, $130 million toward state-owned land stewardship, $50 million for post-fire reforestation, $170 million for state conservancy forest health projects, $70 million for fire crews and prescribed burning activities, $40 million for the Regional Forest and Fire Capacity Program, $30 million for workforce development, and $25 million to assist small landowners (California Wildfire & Forest Resilience Task Force 2022). This plan is part of the governor's Wildfire and Forest Resilience Action plan which aims to increase and expedite forest health projects to sustain and protect communities and meet economic and environmental goals (Department of Water Resources 2021).

Assembly Bill 1823: The Bill requires that on or before July 1, 2022, the State Board of Forestry and Fire Protection develop criteria for and maintain a "Fire Risk Reduction Community" list of local agencies located in a State Responsibility Area (SRA) or a very high hazard severity zone that meet best practices for local fire planning. The existing law requires the State board to consider specific factors when developing the criteria for the list, including recently developed or updated community wildfire protection plans (CWPPs) (CA GOPR 2022). This CWPP is in alignment with the requirement stipulated by Assembly Bill (AB) 1823 (2019).

Senate Bill 1241: Senate Bill 1241 (2012) revised the safety element stipulations in State law to instruct all cities and counties whose planning area is within the SRA or a very high fire hazard severity zone to address and include specific information concerning wildfire hazards and risk, and strategies and policies to address and minimize unreasonable risks associated with wildfire. The specific requirements are codified in chapter 311 of the Bill. As a result, CAL FIRE maintains fire hazard severity zone maps and

data for the entire State. Three classes of fire hazard severity classifications exist: moderate, high, and very high. Fire hazard severity considers the amount of vegetation, temperature, wind, humidity, and topography, and represents the likelihood of an area burning over a 30 to 50-year interval (CA GOPR 2022).

Senate Bill 379: Senate Bill 379 (2015) amended Government Code Section 65302(g)(4) to require that all general plans in California address climate change adaptation and resilience as part of the safety portion of the plan. This amendment requires local jurisdictions to add this change as part of the next revision to their local hazard mitigation plan or, if a local hazard mitigation plan has not been adopted, the safety element must be reviewed and updated to include applicable climate adaptation and resilience strategies (CA GOPR 2022). This CWPP may be integrated into the Safety Element of the City General Plan during the next scheduled revision.

Senate Bill 246: As established by Senate Bill 246 in 2015, the Integrated Climate Adaptation and Resiliency Program (ICARP) is the leading program responsible for coordinating response to climate change impacts on a local, regional, and state scale. ICARP utilizes the Adaptation Clearing House, an online database of climate resources, and coordinates with the Technical Advisory Council to aid in facilitation of resiliency efforts. CA GOPR recommends that climate change–related safety updates be made in alignment with ICARP vision, principals, definitions, and wildfire requirements where applicable (CA GOPR 2022).

Senate Bill 901: Senate Bill 901 (2018) requires the State Board to regularly update regulations for fuel breaks and greenbelts close to communities to enhance fire safety within the State Responsibility Area or areas designated as Very High Fire Hazard Severity Zones. The Bill also requires that the updated regulations include measures to maintain undeveloped ridgelines to minimize fire risk and enhance fire protection (CA GOPR 2022).

PRC 4290: Public Resources Code Section 4290 confers the State Board with the authority to adopt regulations for base level fire safety standards with respect to State Responsibility lands and to lands designated as Very High Fire Hazard Severity Zone. The fire safety standards address multiple issues, including fuel modification standards for fuel breaks and greenbelts; road and driveway standards for emergency response access and public evacuation; minimum private water supply reserves for fire suppression; and standards for street, road, and building signage. However, these standards do not replace local regulations that meet or exceed minimum requirements adopted by the State Board (CA GOPR 2022).

PRC Section 4291: Public Resources Code Section 4291 details mandatory defensible space requirements for any person who owns, leases, controls, operates, or maintains a building in an SRA or very high FHSZ within a Local Responsibility Area (LRA). The requirements include, but are not limited to, 100 feet of defensible space around homes, removal of vegetation debris from the perimeter and the roof of homes/structures, and removal of vegetation from chimneys or stovepipes. This code was updated in January 2021 to require an ember-resistant zone within 5 feet of a home/structure on or before January 1, 2023 (CA GOPR 2022).

Assembly Bill 38: Assembly Bill 38 (2019) amended sections of the Civil, Government, and Public Resources Codes to set forth a comprehensive wildfire mitigation financial support program, which facilitates cost-effective home/structure hardening and retrofitting to create fire-resistant homes, businesses, and public structures. The amendments require the State Fire Marshal, in consultation with the Director of Forestry and Fire Protection and the Director of Housing and Community Development, to identify building retrofits and hardening measures eligible for financial assistance under the program. Additionally, the amendments require that CAL FIRE identify defensible space, vegetation management,

and fuel treatment procedures eligible for financial assistance. Wildfire hazard areas eligible for financial assistance under the program include LRAs situated within very high FHSZs and SRAs within any FHSZ (CA GOPR 2022).

Senate Bill 1035: Senate Bill 1035 (2018) amended Section 65302 of the California Government Code to require local agencies to update the climate adaptation section (safety element) of the general plan at least every eight years. This mandate would require local agencies to identify new information relating to fire hazards, climate adaptation, and resiliency measures that were not available during the last revision of the safety element (CA GOPR 2022).

Evacuation Planning Requirements: Assembly Bill 747 (2019), Assembly Bill 1409 (2020), and Senate Bill 99 (2019) were signed into law to enhance evacuation planning at the local level. Assembly Bills 747 and 1409 require local agencies to assess evacuation routes and locations under a variety of emergency scenarios. Whereas Senate Bill 99 requires municipalities to identify communities with less than two evacuation routes. These planning mandates should be considered when assessing wildfire risk in the safety element of the general plan (CA GOPR 2022).

PRC 4290.5: Assembly Bill 2911 (2018) added Section 4290.5 to the PRC, which requires the State Board, in consultation with the State Fire Marshal and the local jurisdiction, to identify existing subdivisions with more than 30 dwelling units in the State Responsibility Area or areas designated as Very High Fire Hazard Severity Zones without secondary egress routes, that are at high risk for fire. Following identification of subdivisions without secondary egress routes, the State Board must provide recommendations to the local government to enhance public safety in such subdivisions. This process must begin on or before July 1, 2021, and repeat every five years thereafter. If available, recommendations made by the Board should feed directly into the community's general plan update (CA GOPR 2022).

Federal Direction

In response to a landmark fire season in 2000, the National Fire Plan (NFP) was established to develop a collaborative approach among various governmental agencies, including state, federal, and tribal, to actively respond to severe wildland fires and ensure sufficient firefighting capacity for the future. The NFP was followed by a report in 2001 entitled A Collaborative Approach for Reducing Wildland Fire Risks to Communities and the Environment: A 10-year Comprehensive Strategy, which was updated in 2002 to include an implementation plan. This plan was updated once more in 2006, with a similar focus on using a collaborative framework for restoring fire-adapted ecosystems, reducing hazardous fuels, mitigating risks to communities, providing economic benefits, and improving fire prevention and suppression strategies. The 2006 implementation plan also emphasizes information sharing and monitoring of accomplishments and forest conditions, a long-term commitment to maintaining the essential resources for implementation, a landscape-level vision for restoration of fire-adapted ecosystems, the importance of using fire as a management tool, and continued improvements to collaboration efforts (Forests and Rangelands 2006). Progress reports and lessons learned reports for community fire prevention are provided annually.

In 2003, the U.S. Congress recognized widespread declining forest health by passing the Healthy Forests Restoration Act (HFRA), and President Bush signed the act into law (Public Law 108–148, 2003). The HFRA was revised in 2009 to address changes to funding and provide a renewed focus on wildfire mitigation (H.R. 4233 - Healthy Forest Restoration Amendments Act of 2009). The HFRA expedites the development and implementation of hazardous fuels reduction projects on federal land and emphasizes the need for federal agencies to work collaboratively with communities. A key component of the HFRA is

the development of Community Wildfire Protection Plans (CWPPs), which facilitate the collaboration between federal agencies and communities to develop hazardous fuels reduction projects and place priority on treatment areas identified by communities in a CWPP.

A CWPP also allows communities to establish their own definition of the WUI, which is used to delineate priority areas for treatment. In addition, priority is placed upon municipal watersheds, critical wildlife habitat, and areas impacted by wind throw, insects, and disease. Communities with an established CWPP are given priority for funding of hazardous fuels reduction projects carried out in accordance with the HFRA.

In 2014, the final stage of the development of a national cohesive strategy for wildfire was developed: *The National Strategy: The Final Phase in the Development of the National Cohesive Wildland Fire Management Strategy* (Forests and Rangelands 2014). The national strategy takes a holistic approach to the future of wildfire management:

To safely and effectively extinguish fire, when needed; use fire where allowable; manage our natural resources; and as a Nation, live with wildland fire.

In order to achieve this vision, the national strategy goals are:

- **Restore and maintain landscapes:** Landscapes across all jurisdictions are resilient to fire-related disturbances in accordance with management objectives.
- **Fire-adapted communities:** Human populations and infrastructure can withstand wildfire without loss of life and property.
- **Wildfire response:** All jurisdictions participate in making and implementing safe, effective, efficient risk-based wildfire management decisions (Forests and Rangelands 2014:3).

PAST PLANNING EFFORTS

Local

There are several existing documents relating to fire management in the Planning Area. This CWPP is meant to supplement and not replace any other existing plans.

Disaster Preparedness Guide: The Inyo County Office of Emergency Services (Inyo County OES) has a basic Disaster Preparedness Guide available (Inyo County OES nd). The objective of the guide is to prepare residents for human-caused or natural disasters. The guide provides a series of preventive action steps for a range of disasters, including wildfire preparedness. The guide recommends preparing a family emergency plan and assembling an emergency kit and other supplies. It also describes shelter and sheltering-in-place options (Inyo County OES n.d).

Inyo County General Plan: Inyo County last completed a comprehensive update of its General Plan in 2001 in compliance with state law (Government Code 65300). The General Plan is a comprehensive guidance document that directs future physical development throughout the county (Inyo County, 2001). The General Plan addresses seven mandatory topics. Included in these topics is the safety topic, which establishes policies to protect the public from risks associated with natural and human-caused hazards, e.g., wildfire hazards. Inyo County provides annual progress reports about updates and amendments to the plan on the planning department's section of the county website: https://www.inyocounty.us/services/planning-department/inyo-county-general-plan

Inyo County Community Wildfire Protection Plan: A CWPP was prepared for the entire county in 2009 by Anchor Point Group consultants. This plan (Inyo County 2009) assesses the wildfire hazard throughout the county, provides some recommendations for reducing the risks, and outlines a range of fuels modification projects, including a fuelbreak for 40 Acres. The plan's assessment of risk at the community level rated 40 Acres at a "very high" hazard rating, one of only four communities in the county with that high of a hazard rating (Inyo County 2009: B-14 & B-15). The 2023 40 Acres CWPP is much more detailed with respect to its focus on a single community.

Inyo County Multi-Jurisdictional Local Hazard Mitigation Plan: In 2017, Inyo County adopted—and FEMA approved—the Inyo County / City of Bishop Multi-Jurisdictional Hazard Mitigation Plan. The purpose of this plan is to assess human-caused and natural risks to communities throughout Inyo County, and to reduce the potential effects of the hazards by establishing mitigation strategies (Inyo County 2017). Community and hazard profiles; hazard identification, analysis, and assessments; risk assessments; mitigation and adaptation strategies; and monitoring procedures are all outlined within the plan. In addition, the plan also provides hazard analysis and characterization and some generalized mitigation strategies regarding wildfire.

Inyo County has mapped the fire hazard for 40 Acres and surrounding lands as "high." https://gis.inyoco.com/arcgis/apps/webappviewer/index.html?id=381b793851de485f89f2fef2cf9d2f15

Inyo County Emergency Operations Plan: Inyo County adopted its current Emergency Operations Plan in 2016. Regarding wildfire, this plan (Inyo County 2016) describes available resources and direction to form a federal-county Unified Command when necessary to respond to a large wildfire. An emergency operations center will coordinate resources from all jurisdictions within Inyo County.

CAL FIRE San Bernardino Unit Strategic Fire Plan: The CAL FIRE San Bernardino Unit (BDU) is comprised of San Bernardino, Inyo, and Mono counties. Inyo County is served by the Owens Valley Battalion, which operates one fire engine crew out of the Bishop Station at 2781 South Round Valley Road and a second BDU fire engine crew out of its Independence Station at 250 E. Park St. The nearby Owens Valley Conservation Camp has five type 1 hand crews and one dozer. A program for defensible space inspections assists homeowners comply with the requirements of section 4291 of the California Public Resource Code. This recently updated strategic fire plan outlines a variety of fire prevention programs and projects (CAL FIRE 2022c).

Southern California Edison Wildfire Mitigation Plan: Although SCE has limited presence in 40 Acres, they have an active wildfire mitigation program for their utility infrastructure. In 2022, SCE updated their Plan to provide an updated risk assessment, lessons learned in 2021, and to highlight actions taken in 2021 to reduce ignition from SCE infrastructure. The plan has an overarching goal of reducing SCE equipment related ignitions (southern California Edison, 2022a). To achieve this goal, SCE has identified actionable objectives that include increasing system hardening, bolstering situational awareness, and enhancing operational practices. The plan includes a table of 2022 targets to achieve these objectives. Examples of 2022 targets include installing 150 weathers stations, undergrounding 13 miles of power lines in high fire risk areas, and replacing circuits, relays, and fuses in targeted areas (Southern California Edison, 2022a). Additionally, to reduce wildfire risk and improve incident response, SCE is expanding their detection and modeling efforts, investing in suppression resources, and developing fault detection mechanisms. SCE has a vegetation management program to inspect and remove hazardous and dying trees, and clear brush at the base of poles (Southern California Edison 2022b). The WMP provides detailed information on SCE's risk assessment including equipment inventory, weather and wildlife event mapping, and vulnerable communities.

State

Strategic Fire Plan for California: In 2018, CAL FIRE, along with the State Board of Forestry and Fire Protection, developed the Strategic Fire Plan for California (CAL FIRE 2018b). The plan was developed to create a more wildfire resistant environment and community, to increase the understanding of wildfires, and increase cooperation amongst local, state, federal, tribal, and private partnerships. Goals outlined within the plan include identifying natural resources at risk, integrating fire and fuels management tactics with landowners, and implementing post-fire assessments and programs (CAL FIRE 2018b).

California State Hazard Mitigation Plan: In 2018 the California Office of Emergency Services (CA OES) released the latest California State Hazard Mitigation Plan. The intention of the plan was to provide a current update of all past and potential hazards and disasters within California and outline mitigation strategies, risk reduction methods, goals, objectives, strategies, and priorities (CA OES 2018). Mitigation strategies recommended include strengthening interagency coordination, incorporating climate change into future planning efforts, and establishing a mitigation registry (CA OES 2018).

Fire Hazard Planning Technical Advisory: In 2022, the California Office of Planning and Research updated the Fire Hazard Planning Technical Advisory. The goal of the guide is to provide a framework for planners and decision makers in addressing hazards, increasing resilience, and reducing risks associated with fire. This guide provides a brief history of fire in the state, impacts to communities, and implications of climate change as well as describes several local, state, and federal wildfire policies and regulations to inform on required planning elements and available resources. This regulatory overview sets the stage for the fire hazard planning guidance chapter, which has recommendations regarding the integration of fire hazard specific elements into general plans. This guide also contains guidance to align hazard plans with broader plans and connect fire hazard planning to relevant matters such as climate adaptation (CA GOPR 2022).

Wildland Urban Interface Planning Guide: In 2022, in accordance with the requirements of AB 75, the California Governor's Office of Planning and Research, with the Community Wildfire Planning Center and CALFIRE, created the WUI planning guide to provide recommendations and examples to aid communities in planning for living in the WUI (CA GOPR 2022). The guide serves as a supplement to the Fire Hazard Planning Technical Advisory and discusses several plan categories, detailing their respective purpose, and how they relate to WUI planning. Some plan types referenced include, general, hazard, climate, and wildfire plans. The regulation section of the guide provides required and recommended codes for resilient WUI planning and rationale for how these measures promote a fire safe community. Additional tools and programs that enhance community resilience are detailed in the plan (CA GOPR 2022).

California Cooperative Forest Management Plan: In 2020 the California Cooperative Forest Management Plan was developed to be used by CAL FIRE, the USFS, and the Natural Resources Conservation Service. This plan is more of a template for fire management plans. The plan outlines topics that should be discussed while planning for fires, such as road systems, property history and conditions, wildlife, water resources, and others (CAL FIRE 2020a).

California's Forests and Rangelands 2017 Assessment: In 2017, CAL FIRE published California's Forests and Rangelands 2017 Assessment. CAL FIRE's Fire and Resource Assessment Program evaluates the amount and size of California's forests and rangelands and analyzes their conditions to establish management and regulatory guidelines. The assessment is used to delineate priority landscapes that aid in focusing investments and other programs to ameliorate issues. The goal of the assessment is to meet both state and federal mandates for natural resource inventories and planning (CAL FIRE 2018a).

Community Wildfire Prevention & Mitigation Report: In 2019 CAL FIRE published the Community Wildfire Prevention & Mitigation Report in response to Executive Order N-05-19, which directs CAL FIRE and other state agencies to recommend administrative, regulatory, and policy changes to prevent and mitigate wildfires. The order stresses taking necessary actions to protect vulnerable populations and to identify backlogs in fuels treatments projects. CAL FIRE identified 35 priority projects that could be implemented right away to reduce public safety risk for over 200 communities. Potential projects included removal of dead trees, vegetation clearing, creation of ingress and egress paths, and creation of fuel breaks and community defensible spaces (CAL FIRE 2019a).

California's Wildfire and Forest Resilience Action Plan: In 2021 the California Forest Management Task Force (CA FMTF) developed California's Wildfire and Forest Resilience Action Plan (CA FMTF 2021a). The purpose of the plan was to sustain economic strength of the forests, improve forest health and resilience, and increase the level of fire safety within communities. The plan is broken up into four major goals and strategies to achieve said goals (CA FMTF 2021a). The goals include increasing the pace and scale of forest health projects, strengthening the protection of communities, managing the forest to achieve the state's economic and environmental goals, and driving innovation while measuring progress. Strategies for increasing community fire safety include increasing fuel breaks, creating fire-safe roadways, and supporting community risk reduction (CA FMTF 2021a).

Vegetation Management Program: In addition to the Strategic Fire Plan, CAL FIRE operates a Vegetation Management Program that focuses on addressing resource management and wildfire fuel hazards within SRA lands (CAL FIRE 2021b). The program has three management objectives with various sub-goals. The management objectives are the reduction of conflagration of fires, optimization of soil and water productivity, and the protection and improvement of intrinsic floral and faunal species (CAL FIRE 2021b).

California Vegetation Treatment Program: In addition to planning documents, the State of California operates the California Vegetation Treatment Program (CalVTP). This program was developed by the Board of Forestry and Fire Protection to create healthy fire regimes, reduce hazardous vegetation that increases wildfire risk, and reduce risk within communities. Prescribed burning, prescribed herbivory, herbicides, mechanical treatments, and manual treatments are used for vegetation management. In addition, you can visit the CalVTP Implementation Database to find current and approved projects. To learn more about this program, visit the following URL: https://bof.fire.ca.gov/projects-and-programs/calvtp/

Safer from Wildfire Initiative: This partnership program was established to increase home hardening and defensible space efforts on homes that were not built to current CAL FIRE Standards. The program was developed in a partnership with the California Office of Emergency Services, Planning and Research, Department of Insurance, Public Utilities Commission, and CAL FIRE to create pathways for more accessible home insurance by requiring insurers to reward safety and mitigation actions (Colorado Department of Insurance [CDI], 2022a). The program works within the three mitigation topics of Protecting the Structure, Protecting the Surroundings, and Working as a Community to identify actionable steps to improving community resilience in a cost-effective way. Each topic has specific measures, such as upgrading to ember resistant vents, clearing under deck vegetation, or working as a community to achieve a Firewise rating (CDI 2022a). The list of actions creates consistency in home hardening. This program has been used to negotiate insurance discounts for individuals and communities based on mitigation achievements at each level. For example, State Farm offers a discount to communities that achieve a Firewise Community rating (CDI 2022b). More information about the Safer from Wildfires initiative and currently available insurance discounts are available at the following URL: Safer from Wildfires (ca.gov)

Federal

U.S Forest Service

The guiding document is the Land Management Plan for the Inyo National Forest (Inyo National Forest 2019). This Plan satisfies the National Land Management Act of 1976 and directs all fire management activities in the forest, among other things. The “strategic fire management zones” section of chapter 3 and the fire-related actions in appendix B are the most relevant parts of the plan to this CWPP. The Inyo National Forest and BLM Bishop Field Office collaborate through an Interagency Fire Organization.

Bureau of Land Management

The BLM Bishop Field Office has a general fire management plan, prepared in 2004, according to a citation in a LADWP report. However, a public copy of the document is not available. In general, the BLM collaborates with several federal, state, and local organizations to develop and implement wildland fire programs. For instance, the BLM’s fuels management program directs a wide range of active management vegetation treatments using mechanical, biological, and chemical tools, and prescribed fire. The program consists of creating fuel breaks, reducing fuel loads, reducing fire risk near communities, targeted grazing, and herbicide to break fire-grass cycles. Fuels treatments are planned and implemented jointly with other BLM programs, and with federal, state, local, and non-governmental collaborators (BLM 2021). The BLM Bishop Field Office last updated its Resource Management Plan in 1993.

PUBLIC LAND MANAGEMENT

LAND MANAGEMENT STRATEGIES

In 2020, California and the Federal government signed an agreement of the shared stewardship for California forests and rangelands. The agreement sets many goals for the state of California and the Federal government to accomplish together (CA Office of the Governor 2020).These goals include: treating at least 1 million acres of California lands per year to reduce the risk of wildfires, developing a 20-year cooperative forest management plan which will outline projects and priorities, encouraging and increasing the use of sustainable land management practices such as prescribed fire, increase the forest management workforce and in turn increase the pace and scale of forest management, and prioritizing forest health benefits such as carbon sequestration and healthy watersheds. Funding for this agreement will be provided from The Great American Outdoors Act (CA Office of the Governor 2020).

Forest managers in the region are addressing land management objectives through the use of prescribed fire, mechanical, and manual treatments to promote more resilient forest lands. Private, state, and federal lands are interspersed creating a matrix of land ownership, which is often a hurdle to implementation of landscape level treatments. By working with private landowners, forest managers are enhancing landscape-scale efforts to create more resilient forest communities.

State Land

State Responsibility Area (SRA) is a legal term defining the area where the State has financial responsibility for the prevention and suppression of wildfire. 40 Acres is within the SRA and is adjacent to the Federal Responsibility Area on the western side.

DRAFT

In California, CAL FIRE maintains fire hazard severity zone (FHSZ) data for the entire state. There are three classes of fire hazard severity ratings within FHSZs: Moderate, High, and Very High (CA GOPR 2020). Fire hazard severity zones are defined based on vegetation, topography, and weather, and represent the probability of the area burning and potential fire behavior in the area. 40 Acres is currently mapped as a high FHSZ (https://egis.fire.ca.gov/FHSZ/). The mapping is being revised during 2023 (https://osfm.fire.ca.gov/media/0vphbxrc/isor-fhsz-sra-121622-to-020323.pdf), but the high rating for 40 Acres will remain (https://calfire-forestry.maps.arcgis.com/apps/webappviewer/index.html?id=fd937aba2b044c3484a642ae03c35677).

Federal Land

Inyo National Forest

While not within the Planning Area, the Inyo National Forest may impact 40 Acres in the event of a large fire. The Inyo National Forest is less than 2 miles from 40 Acres at its closest point, and only few miles distant as one goes farther north or south. Pine Creek canyon is a well-used recreational area just a few miles to the southwest. The Land Management Plan for the Inyo National Forest (2019) is the guiding document for the Forest. The USFS has created four Strategic Fire Management Zones within the forest (Inyo National Forest 2019: 77-81):

- **Community Wildfire Protection Zone**: This zone is composed of locations where communities and private lands could be at elevated risk of damage from wildfire, particularly where ample fuels exist. Priorities for this zone include identifying and using community buffer areas to implement strategic fuel treatments near structures and access points. In this zone, wildfires are suppressed under most fuel and weather conditions because of the elevated risk to public safety and the potential economic loss presented by a wildfire.
- **General Wildfire Protection Zone**: This zone consists of locations where wildfire threatens natural resources and/or community values. Wildfires in this area may adversely impact natural resources due to the condition of the ecosystem and natural fire regime. Wildfires that commence in this area have the potential to spread to the Community Wildfire Protection Zone. Priorities in this zone include hazardous fuel reduction and targeted ecological restoration.
- **Wildfire Restoration Zone**: This zone contains locations where existing conditions pose a moderate risk of wildfire damage to a particular natural resource. Generally, wildfires that begin in this zone present a low to moderate threat to communities under typical fire season conditions. Priorities in this zone include ecological restoration.
- **Wildfire Maintenance Zone**: This zone is made up of locations where wildfire presents a minor threat to communities under average fire season conditions and where the ecosystem benefits from wildland fires. Priorities in this zone include the implementation of prescribed fire for ecological restoration and to accomplish resource goals.

STEWARDSHIP AGREEMENTS

The Inyo County Emergency Operations Plan (Inyo County 2016) describes how the county participates in local, state, and federal mutual aid systems.

In 2020, the State of California and the U.S. Forest Service (USFS) signed a shared stewardship agreement to commit to collaborative forest management and set landscape scale priorities. The shared stewardship agreement includes a commitment to coordinate and share tools, processes, and innovative approaches in respect to fire management. You can find the stewardship agreement here: https://www.gov.ca.gov/wp-content/uploads/2020/08/8.12.20-CA-Shared-Stewardship-MOU.pdf

DRAFT

APPENDIX B:

Community Background Information

This page intentionally left blank.

CONTENTS

Location and Geography B-1
Roads and Transportation B-2
Topography B-4
Population B-4
Social Vulnerability B-4
Recreation B-5
Fire Response Capabilities B-5
Local Response B-5
State Response B-5
Federal Response B-5
Mutual Aid B-6
Evacuation Resources B-7
Water Availability and Supply B-8
Vegetation B-9
Forest Health Considerations B-11
Wildlife B-13
Public Education and Outreach Programs B-14
Local and State Programs B-14
National Programs B-15

Figures

Figure B.1. Typical landscape in 40 Acres, showing the valley floor with sagebrush shrubland, trees, and riparian vegetation along the ditch in the distance, and the Sierra Nevada range in the background; view facing west into Hardy Road from North Round Valley Road. B-1
Figure B.2. Typical landscape in 40 Acres, showing sagebrush shrubland in the foreground and timber and riparian vegetation along the ditch in the background; view facing south into 40 Acres from the northern extent of North Round Valley Road. B-2
Figure B.3. Birchim Lane; view facing east. B-3
Figure B.4. Local access road at the northwestern corner of 40 Acres, an example of a narrow, unsurfaced road with limited turnaround space. B-4
Figure B.5. Water resources in 40 Acres. B-8
Figure B.6. 40 Acres existing vegetation cover. B-10

DRAFT

LOCATION AND GEOGRAPHY

The 40 Acres (formerly known as Wright's 40 Acres) community is located in northwestern Inyo County in Round Valley and comprises a total of 40 acres. It is about 12 miles west-northwest of Bishop and lies between U.S. Highway 395 (U.S. 395) and the steep escarpment of the Wheeler Crest.

Although smaller than most communities of Owens Valley, 40 Acres shares the common characteristic of eastern Sierra Nevada communities, with isolated patches of private land surrounded by federal land and/or property owned by the City of Los Angeles. The community is square in shape with the outer boundaries oriented west–east and north–south. Bureau of Land Management (BLM)-managed land is on the west side. LADWP land is on the other three sides.

40 Acres is surrounded by a sagebrush scrub plant community largely composed of big sagebrush (*Artemisia tridentata*), antelope bitterbrush (*Purshia tridentata*), rubber rabbitbrush (*Ericameria nauseous*), and a wide variety of understory forbs and grasses (Figures B.1 and B.2) (Howald 2000). Vegetation density (and therefore fuel continuity) is relatively sparse because of the arid climate (about 11–15 inches of precipitation annually on average). However, wind-driven embers would readily propagate fire through the scrubland.



Figure B.1. Typical landscape in 40 Acres, showing the valley floor with sagebrush shrubland, trees, and riparian vegetation along the ditch in the distance, and the Sierra Nevada range in the background; view facing west into Hardy Road from North Round Valley Road.



Figure B.2. Typical landscape in 40 Acres, showing sagebrush shrubland in the foreground and timber and riparian vegetation along the ditch in the background; view facing south into 40 Acres from the northern extent of North Round Valley Road.

An artificial channel that delivers water from Pine Creek to the community supports dense riparian vegetation. Live and dead fuel loads along this channel are quite high and could readily carry a fire from upstream into 40 Acres. This canal supplies water to nearly 1 mile of small irrigation channels serving all parcels within 40 Acres and supports relatively luxuriant vegetation throughout the community. 40 Acres is known as the “big green square of dense vegetation” observed in Round Valley when driving down the Sherwin Grade on U.S. 395. The number of trees has been estimated at nearly 1,000, some of which are up to 60 feet tall. The abundant vegetation contributes to 40 Acres often being described as an oasis, with portions called a jungle.

ROADS AND TRANSPORTATION

40 Acres has two paved roads that have provided access to the community from the east and south. Unfortunately, the southern route has been closed for the past 5 years because of the loss of a critical bridge. Currently (early 2023), the sole paved road access to 40 Acres is Birchim Lane (Figure B.3). From the northeast corner of 40 Acres, Birchim Lane goes east for 1.3 miles to the Old Sherwin Grade/Lower Rock Creek Road, which parallels U.S. 395. From the junction of Birchim Lane and Old Sherwin Grade Road, access to U.S. 395 is available 1.0 mile to the north and 1.5 miles to the south. Before the spring 2017 flood that destroyed the bridge over Pine Creek, and presumably after the bridge reconstruction is completed in 2023, paved-road access to the southeast corner of 40 Acres is provided by North Round Valley Road for a distance of 0.8 mile from the junction with the Pine Creek Road. From that junction, U.S. 395 is 1.8 miles to the east along Pine Creek Road. North Round Valley continues unpaved to the north beyond 40 Acres, connecting with Old Sherwin Road and Boundary Road to connect to the paved Old Sherwin Grade Road after about 3 miles. To access individual parcels within 40 Acres, Birchim Lane

and Hardy Road traverse the north and south sides of the community, respectively. Waiford Circle and Ocean View Road access parcels on the interior of the community, and both are dead-end access roads.

Most roads within 40 Acres are not paved and are narrow without turnarounds (Figure B.4), requiring fire trucks to back in, particularly Birchim Lane and Ocean View Drive. These routes may prove hazardous during emergency evacuation.



Figure B.3. Birchim Lane; view facing east.



Figure B.4. Local access road at the northwestern corner of 40 Acres, an example of a narrow, unsurfaced road with limited turnaround space.

TOPOGRAPHY

The community is on the lower extent of an alluvial fan to the northeast of Pine Creek canyon at an elevation of 4,600 feet. The natural landscape under 40 Acres descends from southeast to northwest at a gentle slope of about 4 percent.

POPULATION

The exact population of the community is unknown but is estimated to be around 100. Sixty-two habitable structures exist in the Planning Area varying in age from 2 to more than 100 years. Lot sizes range from 0.18 to 3.4 acres. Two lots remain undeveloped. Fifty-one homes are of frame and masonry construction. Eleven homes are mobile or manufactured.

SOCIAL VULNERABILITY

The Federal Emergency Management Agency (FEMA) defines social vulnerability as the susceptibility of social groups to the negative impacts of natural hazards (e.g., wildfire), which include disproportionate death, injury, loss, or disruption of livelihood (FEMA 2022). A sole hazard occurrence can bring about considerably different impacts for distinct individuals, even if the magnitude of the hazard was the same for the entire community. Specific groups of individuals may be more susceptible to natural hazards because of socioeconomic status, physical state, or other factors. For instance, elderly individuals may have more difficulty in quickly evacuating during wildfire emergencies, which may make them more susceptible to entrapment. In other cases, low-income individuals may be less able to harden and

improve their homes to reduce structural ignitability, indicating that they can face a higher probability of their home being damaged or destroyed should a wildfire event occur.

According to the 2017 Inyo County and City of Bishop Multi-Jurisdictional Hazard Mitigation Plan (Inyo County and City of Bishop 2017), social vulnerability for wildfire hazards is roughly the same between residents within the high wildfire hazard zones of Inyo County, such as 40 Acres, and residents in all of Inyo County. The similarity in social vulnerability between the communities located in wildfire hazard zones and all Inyo County communities is owed to the similar socioeconomic composition of both populations (Inyo County and City of Bishop 2017).

RECREATION

There is modest recreational use by non-residents of the BLM land to the west and LADWP lands on other sides. Non-resident recreational use of the surrounding lands is primarily walking, running, and mountain biking during the winter months by Mono County residents seeking snow-free dirt roads. Cyclists from Bishop and Mono County use Old Sherwin Grade Road, Pine Creek Road, and North Round Valley Road extensively. The number of recreation visits increases markedly up Pine Creek canyon for hiking, backpacking, fishing, and climbing.

FIRE RESPONSE CAPABILITIES

LOCAL RESPONSE

The nearest volunteer station serving the Planning Area is the Paradise Fire Station, located at 5300 Lower Rock Creek Road, Paradise, and is 6 miles from 40 Acres. The Wheeler Crest Fire Station is an additional 4 miles away to the northwest. There are three fire stations in Bishop: 3206 West Line St., 209 West Line St., and 2190 North Sierra Highway (U.S. 395), which are 11 to 13 miles from 40 Acres. There is also a fire station in Chalfant, which is 25 miles from 40 Acres.

STATE RESPONSE

California Department of Forestry and Fire Protection (CAL FIRE)

CAL FIRE San Bernardino Unit

The nearest CAL FIRE station serving the Planning Area is the CAL FIRE Bishop Station at 2781 South Round Valley Road, Bishop, CA, 93514. When the bridge over Pine Creek is replaced, the distance to 40 Acres is about 5 miles (Map C.10 in Appendix C). The current detour without the bridge is about twice as far.

FEDERAL RESPONSE

The management of wildfire ignitions for multiple resource objectives (managing naturally burning fires in forests as a tool for helping to restore forest health and mitigating the escalating costs of fire suppression) is practiced on federal land but depends on a thorough assessment of risk to values at risk (VARs) in the WUI. Depending on the location and nature of a wildfire, policies developed through interagency

collaboration outline appropriate management responses to guide district personnel in the application of specific suppression techniques. All large wildfire response would be based on assessment using WFDSS (U.S. Geological Survey [USGS] 2021).

Inyo National Forest

Overall, the USFS provides wildfire response and management for over 193 million acres of National Forest System land within the United States (CRS 2021). National Forest lands are considered FRAs, which are regions where the federal government is responsible for fire response. National Forest lands are less than 3 miles west of 40 Acres. On USFS land, the USFS has the responsibility for the management of wildland fire including initial attack (initial response).

The Inyo National Forest and BLM-Bishop Field Office have an Interagency Fire Organization covering an area from the southern Sierra near Ridgecrest to Topaz Lake on the Nevada border, and from the crest of the Sierra Nevada to the White Mountains.

Located in Bishop, the White Mountain Ranger Station has one Type 3 wildland engine, two fire prevention patrol units, one 20-person hotshot crew (the Inyo Hotshots), a District Fire Management Officer and an Assistant District Fire Management Officer, all from the Forest Service. In the summer, a BLM fire prevention unit also works out of this station.

Also located in Bishop are various "Fire Overhead" personnel: fire planners, Forest Fire Management Officers, Interagency Mitigation/Education Specialist, and more. These employees are a mixture of Forest Service and BLM and manage the overall direction of the interagency fire program for the area.

At the Eastern Sierra Regional Airport is the Bishop Air Tanker Base, capable of reloading nearly all air tankers in service today, except for the Very Large Air Tankers (VLATs) such as the DC-10 and 747. The tanker base is operated on an as-needed basis, but also hosts a Single Engine Air Tanker (SEAT) during the summer.

Bureau of Land Management

Public domain lands adjacent to and near 40 Acres are administered by the BLM Bishop Field Office. The BLM is a member of the California Forest Management Task Force (CA FMTF). The CA FMTF is composed of several state, federal, and local wildland firefighting agencies. Additionally, the CA FMTF joins local communities to prevent or minimize fire danger (BLM 2021).

MUTUAL AID

The wildland fire community is well known for its development of mutual aid agreements at the federal, state, and local levels. Such automatic aid agreements allow for the closest forces to respond to an incident as quickly as possible regardless of jurisdiction. Such agreements may also describe how reimbursement will be conducted; state resources responding to wildfires on federal land may have their associated costs reimbursed by the responsible federal agency, and the reverse is true for federal resources suppressing a wildfire on state land.

CAL FIRE BDU participates in the Statewide Mutual Aid system and maintains agreements with local response organizations, including incorporated cities, neighboring counties, and state and federal wildland agencies.

EVACUATION RESOURCES

Evacuation planning is a joint effort among county departments, with law enforcement as the lead agency. 40 Acres operates under the Inyo County evacuation procedures. At a county level, evacuation routes and procedures are detailed in the Emergency Operations Plan and Hazard Mitigation Plan (Inyo County 2016, 2017).

You can sign up for Inyo County emergency notifications, CodeRED, here: https://public.coderedweb.com/CNE/en-US/DAD807D480BF

People

The safe and efficient evacuation of people from wildfire requires several factors, including:

- **Emergency notification methods:** Inyo County has established CodeRED, an Emergency Notification System that utilizes reverse 911. Residents must register their numbers in the system. Social networking sites such as Facebook, Nextdoor, and Twitter, as well as locally maintained blogs and email distribution lists, are other resources that have become highly valued during wildfires in nearby communities.
- **Preplanning by the public about how to evacuate and where to go:** Dead-ends, poor or missing signage, and conflicts with emergency vehicles driving into the community versus the public trying to leave complicate evacuation efforts. Uncertainty about where to find temporary refuge can cause families to become separated and delay reunions. Some individuals without transportation or with limited mobility may be accidentally left behind.
- **Public awareness:** These two items will fail to occur throughout CARs if the residents are unaware of notification methods: 1) the need for preplanning and 2) the elements that should be included in preplanning. Therefore, public education and outreach on these topics should be part of all efforts conducted by agencies such as fire departments in a wide variety of venues.

Animals and Livestock

In the event of a wildfire, it is important that residents and fire responders have a plan for evacuation of pets and livestock. Evacuation planning often neglects to describe how animals will be evacuated and where they will be taken. The loading of horses, for example, during a fire and smoke situation, and transport of stock vehicles down narrow roads under stressful situations, can be very difficult. Public education could emphasize the need for individuals to have a plan for the evacuation of pets in addition to their family, ensuring a lack of planning doesn't slow or prevent evacuation.

There is also a need to pre-identify where animals can be taken, such as county fairgrounds, for large animal shelter. Similarly, locations where small animals such as dogs and cats are picked up in the fire area should also be pre-identified, as well as the lead agencies, such as humane societies, coordinating this work.

Inyo County Animal Services helps with evacuating small and large animals from fire areas; this applies to 40 Acres residents as well. In the past, Millpond Equestrian Center and the Tri-County Fairground have offered emergency housing for evacuated animals.

DRAFT

WATER AVAILABILITY AND SUPPLY

Homeowners within 40 Acres rely on individual wells for domestic water supply. Outside irrigation water originates at a diversion from Pine Creek with a pre-1914 water right. A small unlined canal brings this water to the southwest corner of 40 Acres at the end of Hardy Road, where it flows into two distribution channels. Water in these channels then enters a network of ditches that serve each parcel. There are nine ponds that are filled by the ditches that can serve as water supplies for fire suppression efforts. These nine small reservoirs are near the main roads within the community and can be readily accessed for filling water tender trucks or direct pumping. There are also a few tanks in the community that may offer additional water for fire suppression. Figure B.5 shows all the water resources in 40 Acres.

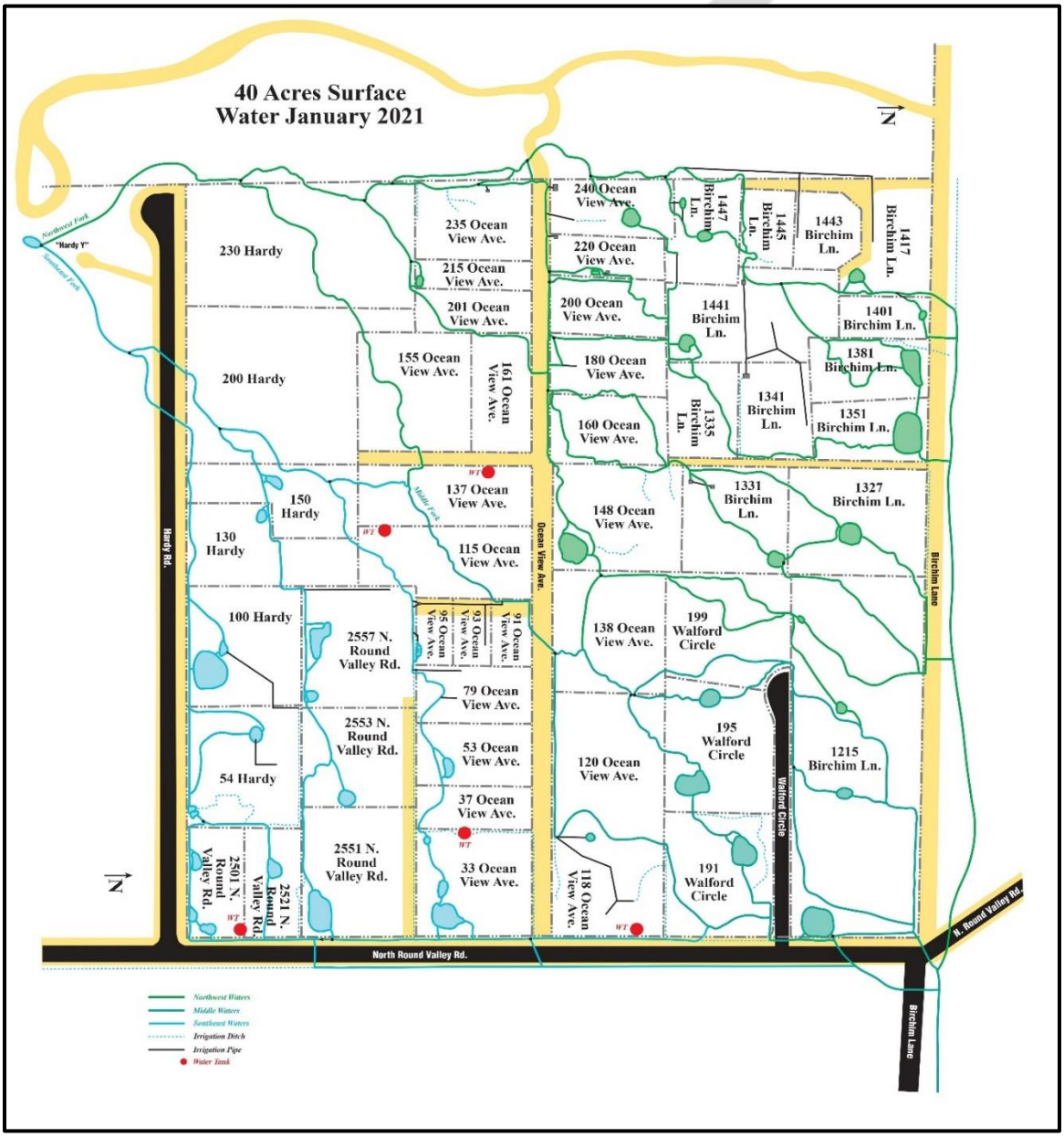


Figure B.5. Water resources in 40 Acres.

Source: 40 Acres FSC

On a broader scale, California experienced the second driest year on record during the period of September 2020 to September 2021, and recent trends suggest that droughts are likely to persist. The months of January and February 2022 were the driest consecutive January and February on record in the Sierra Nevada (State of California 2022). Droughts can have significant adverse impacts on public health and safety. These impacts are mainly associated with severe wildfire risk and drinking water shortages. Small-scale water systems in small towns, rural areas, and private residential wells are particularly vulnerable to the effects of drought (California Department of Water Resources 2022).

VEGETATION

Vegetation zones within the community and surrounding environment are primarily a function of elevation, slope, aspect, substrate (i.e., soils), and associated climatic regimes. Since the Planning Area is relatively homogenous in terms of elevation and topography, there is little change in vegetation characteristics across the area. Most of the Planning Area comprises grass-shrub communities, with pockets of dispersed trees and riparian vegetation along ditches and creeks (Figure B.6).

DRAFT

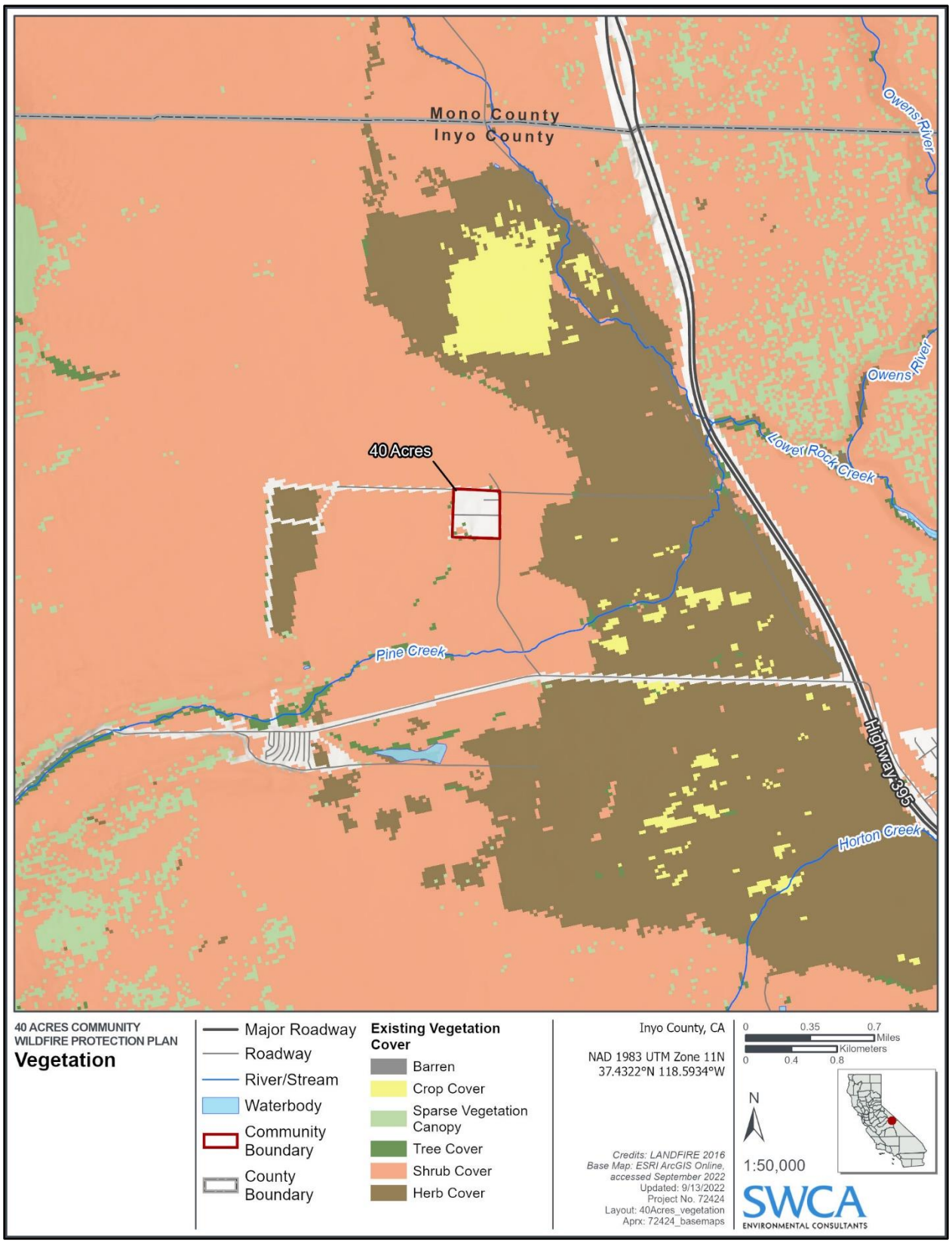


Figure B.6. 40 Acres existing vegetation cover.

FOREST HEALTH CONSIDERATIONS

Insects

Native insect epidemics within plant communities are usually part of a natural disturbance cycle similar to wildfire. They are often cyclic in nature and are usually followed by the natural succession of vegetation over time. Of primary interest are insects that attack tree species because of the implications for fire management.

In addition to native insect epidemics, exotic pests also pose a significant threat to forest ecosystems. Invasive species are organisms that are introduced into an area beyond their natural range and become pests in the new environment. They are also referred to as exotic pests, alien, non-native, or introduced pests. Most introductions have been unintentional and accidental. Having evolved in a different environment, these invasive species may have few natural enemies in their new locations, which can often lead to rapid population increases that can out-compete native species for resources.
The introduction of exotic pests is likely to cause economic, environmental, and agricultural harm as well as harm to human health (California Department of Food and Agriculture [CDFA] 2021). In general, traits of invasive species include fast growth, rapid reproduction, rapid adaptability, tolerating a wide range of environmental conditions, and utilizing a variety of different foods (CDFA 2021).

Insect epidemics in California forests continue to persist. In 2021, USFS's annual aerial survey showed tree mortality in 1.3 million acres out of 38 million acres that were surveyed. Tree mortality is strongly correlated with extreme and prolonged drought and subsequent bark and engraver beetle attacks (USFS 2021c). Stands of trees that have been killed by insects have varying degrees of associated fire danger depending on the time lapse following an insect attack and structure, fuel loading, and continuity of the fuels that remain. However, forests with a large degree of mortality following an insect attack may have the potential to experience extreme fire behavior, especially if a large degree of needle cover remains in the canopy. Moreover, heavy dead fuels increase the fire suppression difficulty and snags are a significant hazard to fire crews.

Insects that have infested or have the potential to infect the forests in the region (e.g., Inyo National Forest) are listed below.

- **Bark Beetles (**Ips Beetles) (*Ips* spp. and *Dendroctonus* spp.) (California Forest Pest Council [CFPC] 2020)
- **Mountain Pine Beetle** (*Dendroctonus ponderosae*) (CFPC 2020)
- **Jeffrey Pine Beetle** (*Dendroctonus jeffreyi*) (CFPC 2020)
- **Pinyon Needle Scale** (*Matsucoccus acalyptus*) (CPFC 2021; USFS 2021c)
- **California flatheaded borer (***Phaenops californica*) (USFS 2018b)
- **Pandora moth** (*Coloradia pandora*) (USFS 2018b)
- **Douglas-fir Tussock moth** (*Orgyia pseudotsugata*) (USFS 2018b)

Diseases

Diseases of trees, such as parasitic plants, fungi, and bacteria, can also affect forests in the region (e.g., Inyo National Forest. These diseases impact forest systems by degrading the productivity and health of

the forest. Some of the more common forest diseases that are found in the region are described below. Trees that are killed by disease have the similar potential to increase fire hazards.

- **White Pine Blister Rust** (*Cronartium ribicola*) (USFS 2018b)
- ***Armillaria* root disease** (*Armillaria sp.)* (USFS 2018b)
- **Black stain root disease** (*Leptographium wageneri*) (USFS 2018b)
- **Heterobasidion root disease** (*Heterobasidion sp.)* (USFS 2018b)
- **Dwarf mistletoe** (*Arceuthobium campylopodum*) (USFS 2018b)

Impact of Climate Change

The rapidly shifting climate, particularly rising temperatures, combined with changing wind patterns, and increasing temporal and spatial variability of water availability, are considerably escalating wildfire risk across the state. The recurrence of severe fire weather during the autumn months has more than doubled in California since the 1980s, and, considering climate change, this prevalence is projected to increase in the future. As stated in California's Fourth Climate Change Assessment, if greenhouse gas emissions continue to increase, California is expected to experience a 50% increase in fires larger than 25,000 acres as well as a potential 77% increase in average area burned by 2100. The state has already begun to encounter the impacts of increased fire occurrence and severity. In fact, 60% of the top 20 largest wildfires in California occurred in the last 5 years, including the August Complex fire (August 2020) and the Dixie fire (July 2021). The August Complex and Dixie fires alone burned a combined total of nearly 2 million acres and well over 2,000 structures (CAL FIRE 2022b). It is clear that extreme wildfire events continue to present a significant threat to California's communities.

In addition to direct damage (e.g., structure and property damage) caused by wildfires, uncharacteristically large and severe wildfires also cause indirect impacts on the environment and ecosystem services. Wildfires are known to deteriorate local and regional air quality, pollute waterways, displace native species (animal and plant), and increase carbon dioxide emissions. The increased carbon dioxide emissions are of special concern since carbon dioxide is a greenhouse gas. Greenhouse gases are implicated in climate change, and climate change is a critical factor exacerbating frequency and severity of wildfires (CA GOPR 2019).

It is important to note that fire is a natural part of California's diverse landscapes and is essential to many ecosystems across the state. Almost all of California's diverse ecosystems are fire-dependent or fire-adapted (California Department of Fish and Wildlife [CDFW] 2021). Frequent, uncharacteristically large, high-severity wildfires are the primary source of the catastrophic damage listed above. Wildfire, when not intensified by human actions, works to balance ecosystems, and restore their natural functions.

Tree Mortality

Rising temperatures, extensive droughts, extreme wildfires, and insect outbreaks have contributed to widespread tree mortality in the Inyo National Forest (USFS 2018b). Tree mortality due to the aforementioned factors is a natural process in forest ecosystems. However, if due to compound disturbances or other factors, many trees die in a brief time period over large regions, forest health may be negatively affected. In addition to disrupting ecosystem functions, widespread tree mortality near developed or recreational areas present hazards as they can fall and potentially endanger the public and infrastructure (National Park Service [NPS 2021]). Furthermore, the level of risk posed by hazard trees is contingent on the amount of time that has passed since the individual or population has died and the

amount of fuel that has fallen to the forest floor. In the Sierra Nevada, recent droughts and rising temperatures have contributed to an increase in dead woody fuels that persist for a long period of time and present a significant wildfire hazard. As such, any increase in tree mortality results in increased fuel loading which contributes to the potential for high severity fire and extreme fire behavior in the region (UCANR 2020).

During the 2012-2016 drought, tree mortality increased significantly. Rising temperatures and reduced water availability have stressed trees, thereby increasing their physiological stress and their susceptibility to insect and pathogen infestations (California Office of Environmental Health Hazard Assessment 2019). Roughly 129 million trees were estimated to have died between 2012 and 2017. In 2016 alone, 62 million trees died, with 95% of tree mortality occurring in the Sierra Nevada (UCANR 2017). Recent surveys indicate that the tree mortality trend is likely to continue. In its 2021 annual aerial survey, the U.S. Forest Service (USFS) detected 9.5 million dead trees statewide, mostly fir, followed by ponderosa pine, bringing the cumulative total to 173 million dead trees since 2010 (USFS 2021c). Most of the surveyed tree mortality occurred in the southern areas of the Sierra Nevada range. In Inyo County, 10,000 acres with 68,000 deceased trees were detected (USFS 2021c).

While it is known that tree mortality affects several aspects of wildfire behavior, the extent to which tree mortality influences wildfire severity has not been established. Researchers from the University of California Davis and the USFS conducted a study to answer this question (Wayman and Safford 2021). The researchers focused on the 2015 Rough Fire and the 2016 Cedar Fire areas for their assessment. These areas presented the perfect opportunity to study the effects of tree mortality on wildfire severity since they had recently burned and had existing tree mortality. The researchers found that two measures of wildfire severity (area killed by fire and canopy torch) were significantly influenced by pre-fire tree mortality. That is, the higher the degree of tree mortality in an area, the higher the potential for a canopy fire and fire-killed trees. Considering that deceased trees pose an increased risk of intense wildfire, the researchers emphasized that fuel reduction treatments, such as thinning and prescribed fire, not only reduce the risk of catastrophic wildfire but can also reduce the severity of future bark beetle outbreaks (Wayman and Safford 2021).

WILDLIFE

Vegetation management treatments could be applied around 40 Acres to benefit habitat for general wildlife species or game habitat. Most native wildlife species found in the region evolved with a frequent fire regime.

Threatened and Endangered Species

According to the U.S. Fish and Wildlife Service's Information for Planning and Consultation Tool, a few endangered or threatened species have the potential to occur within and around the Planning Area. These endangered or threatened species include one mammal (Fisher [*Pekania pennanti*]), two birds (Southwestern Willow Flycatcher [*Empidonax traillii extimus*] and Yellow-billed Cuckoo [*Coccyzus americanus*]), and two fishes (Owens Pupfish [*Cyprinodon radiosus*] and Owens Tui Chub [*Gila bicolor ssp. snyderi*]) (U.S Fish and Wildlife Service n.d.).

Although the U.S. Fish and Wildlife Service's Information for Planning and Consultation Tool suggests potential habitat for a few threatened or endangered species, the coarse-level information is not consistent with assessments by biologists familiar with the Planning Area. The riparian areas may occasionally be visited by the Southwestern Willow Flycatcher and Yellow-billed cuckoos.

Treatments on federal land adjacent to 40 Acres would be subject to NEPA and associated analysis of impacts to these species. Treatments in areas that may impact threatened and endangered species would require application of certain mitigation measures to prevent degradation to habitat. As an example of a mitigation measure, fuels treatment activities on federal lands may be subject to restrictions according to limited operating periods. Limited operating periods decrease the time frame for which fuels treatment activities may occur.

PUBLIC EDUCATION AND OUTREACH PROGRAMS

LOCAL AND STATE PROGRAMS

40 Acres Fire Safe Council

40 Acres Fire Safe Council (FSC) was established in 2020 by community volunteers to promote fire safety and prevention, provide education, and exchange information in the community. The Council offers various educational resources such as brochures on hardened homes and defensible space, evacuation guides, disaster readiness guides, and home evaluation guides. The Council has a fire prevention grant from CAL FIRE via the Whitebark Institute to reduce hazardous fuel loads on 29 acres of BLM and LADWP land surrounding the community as well as within the community.

The 40 Acres Fire Safe Council may add a webpage on the Eastern Sierra Wildfire Alliance site in 2023: https://www.eswildfirealliance.org/fire-safe-councils

California Department of Forestry and Fire Protection (CAL FIRE)

CAL FIRE is an all-risk emergency services provider that specializes in wildfire response. CAL FIRE is responsible for wildfire response on all California SRA lands except for six counties (Kern, Los Angeles, Marin, Orange, Santa Barbara, and Ventura). In addition, CAL FIRE provides a plethora of fire education resources to ensure Californians are prepared for wildfire. These educational materials include but are not limited to:

- CAL FIRE Fire and Emergency Response Guide
- California Fire Plan Overview
- CAL FIRE Cooperative Emergency Response
- Ready Set Go! Wildfire Action Plan
- Are You Ready? Defensible Space and Home Hardening
- Are You Set? Wildfire Preparedness
- Defensible Space Guide
- Before, During, and After a Wildfire

NATIONAL PROGRAMS

Ready, Set, Go!

The Ready, Set, Go! Program, which is managed by the International Association of Fire Chiefs, was launched in 2011 at the WUI conference. The program seeks to develop and improve the dialogue between fire departments and residents, providing teaching for residents who live in high-risk wildfire areas—and the WUI—on how to best prepare themselves and their properties against fire threats (International Association of Fire Chiefs 2021).

The tenets of Ready, Set, Go! as included on the website (http://www.wildlandfirersg.org) are:

Ready – Take personal responsibility and prepare long before the threat of a wildland fire so your home is ready in case of a fire. Create defensible space by clearing brush away from your home. Use fire-resistant landscaping and harden your home with fire-safe construction measures. Assemble emergency supplies and belongings in a safe place. Plan escape routes and ensure all those residing within the home know the plan of action.

Set – Pack your emergency items. Stay aware of the latest news and information on the fire from local media, your local fire department, and public safety.

Go – Follow your personal wildland fire action plan. Doing so will not only support your safety but will allow firefighters to best maneuver resources to combat the fire.

National Fire Protection Association

The NFPA is a global non-profit organization devoted to eliminating death, injury, property, and economic loss due to fire, electrical, and related hazards. Its 300 codes and standards are designed to minimize the risk and effects of fire by establishing criteria for building, processing, design, service, and installation around the world.

The NFPA develops easy-to-use educational programs, tools, and resources for all ages and audiences, including Fire Prevention Week, an annual campaign that addresses a specific fire safety theme. The NFPA's Firewise Communities program (www.firewise.org) encourages local solutions for wildfire safety by involving homeowners, community leaders, planners, developers, firefighters, and others in the effort to protect people and property from wildfire risks.

The NFPA is a premier resource for fire data analysis, research, and analysis. The Fire Analysis and Research division conducts investigations of fire incidents and produces a wide range of annual reports and special studies on all aspects of the nation's fire problem.

National Interagency Fire Center

The National Interagency Fire Center (NIFC) provides a wide array of fire resources and services. The National Interagency Coordination Center offers communication assistance to over 32,000 firefighters and 50 major events at one given time (NIFC 2021c). The Predictive Services group provides decision support information to be more proactive in anticipating significant fire activity and determining resource allocation needs, based on current fire danger, climate and forecasted weather. The Predictive Services group uses weather data from over 2,000 remote automated weather stations to assist in their analysis and predictions. The National Wildfire Coordinating Group, which is nested under the NIFC, provides operational coordination to federal, state, local, tribal, and territorial partners (NIFC

2021c). The NIFC also has a training branch where training curriculums are developed to be used across the nation. For those too young to participate in the standard trainings, the NIFC offers FireWorks, an educational program designed for kids K-12. The program teaches children topics such as wildland fire science, ecosystem fluctuations, human interaction on the environment, and other environmental science topics (NIFC 2021d). The NIFC also provides public education resources (NIFC 2021e):

- Wildfire Readiness – Home
- Wildfire Readiness – Business
- Wildfire Readiness – Farm and Ranch
- Weekend Wildfire Preparedness
- What to Do if a Wildfire is Approaching
- Wildfire Risk – Community
- Prepare and Protect Your Home
- Prepare Your Community
- One Less Spark, One Less Wildfire
- Only You Can Prevent Wildfires

U.S. Fire Administration's WUI Toolkit

The U.S. Fire Administration (USFA) is an entity of the U.S. Department of Homeland Security's Federal Emergency Management Agency (FEMA) that aids in the preparation for and response to fire. Their WUI toolkit consists of a list of websites and other information regarding risk assessments, public outreach, and community training. Find the toolkit here: https://www.usfa.fema.gov/wui/.

Wildfire Research Center (WiRē)

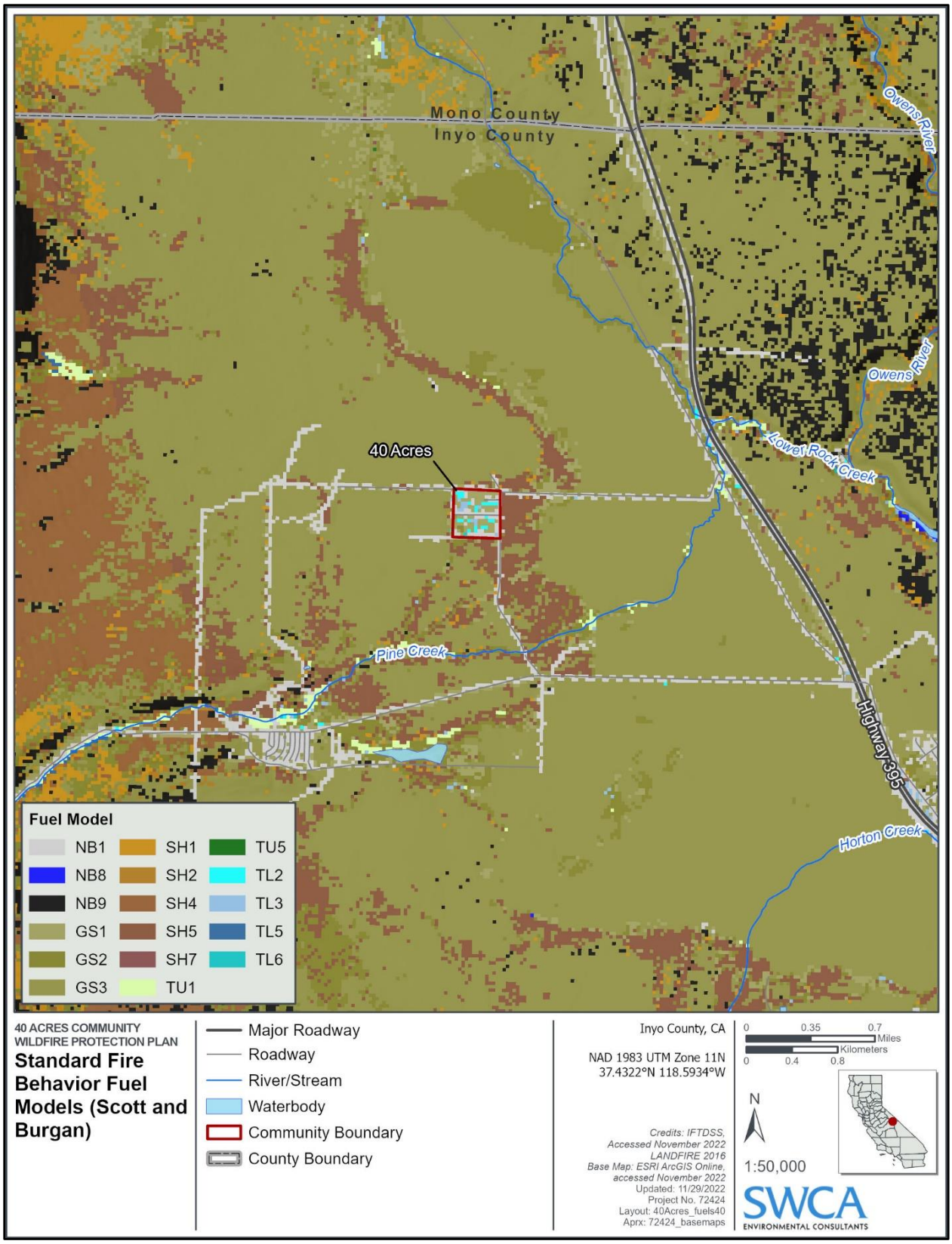
Wildfire Research Center (WiRē) is a non-profit organization that works with local wildfire services to achieve community-tailored pathways which reduce risk to wildfire while simultaneously promoting pathways to fire adaptation. WiRē's mission states that fire adaptation is "about living with fire", while "creating safe and resilient communities that reduce wildfire risk on their properties before a fire, and supporting effective response when fires threaten a community." WiRē states that wildfire is an integral component of many ecosystems, and that fire must be allowed, when safe, to ensure the health of forests. Core to WiRē's approach are four main concepts. One, residents are critical actors in the wildland-urban interface wildfire problem. Two, action is central to adaptation. Three, people and their decisions are complex. Finally, four, decisions are not made in a vacuum. To achieve its goals and serve communities, WiRē will typically conduct a "rapid wildfire risk assessment," which assesses what contributes to wildfire risk, such as, building materials, vegetation near homes, background fuels, local topography, and access to emergency fire services. Additionally, they also conduct "social surveys", which assess residents' perceptions about wildfire, wildfire risk, risk mitigation behavior, and assess their willingness towards taking action to reduce wildfire risk.

For more information, please visit https://wildfireresearchcenter.org/.

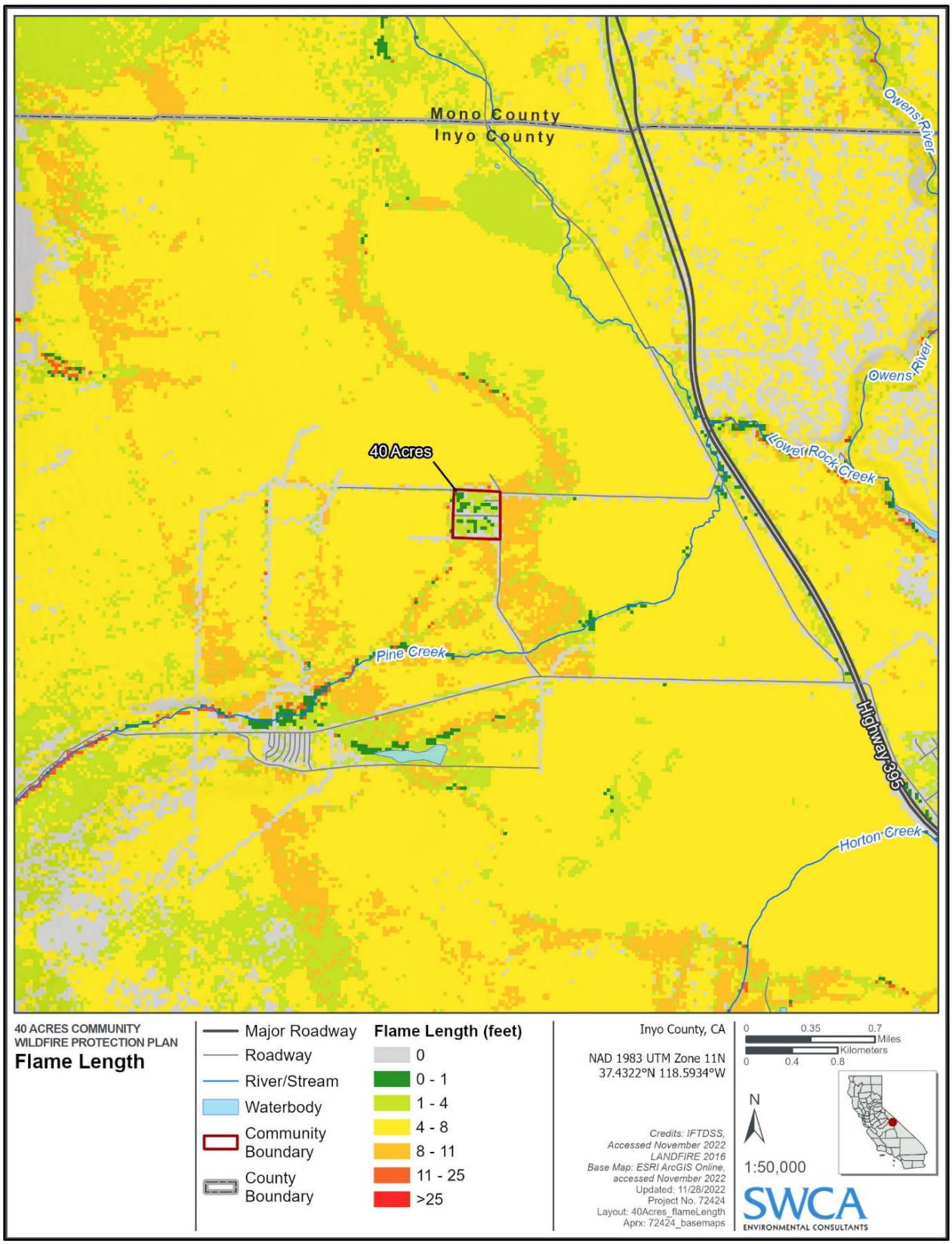
APPENDIX C:

Additional Mapping

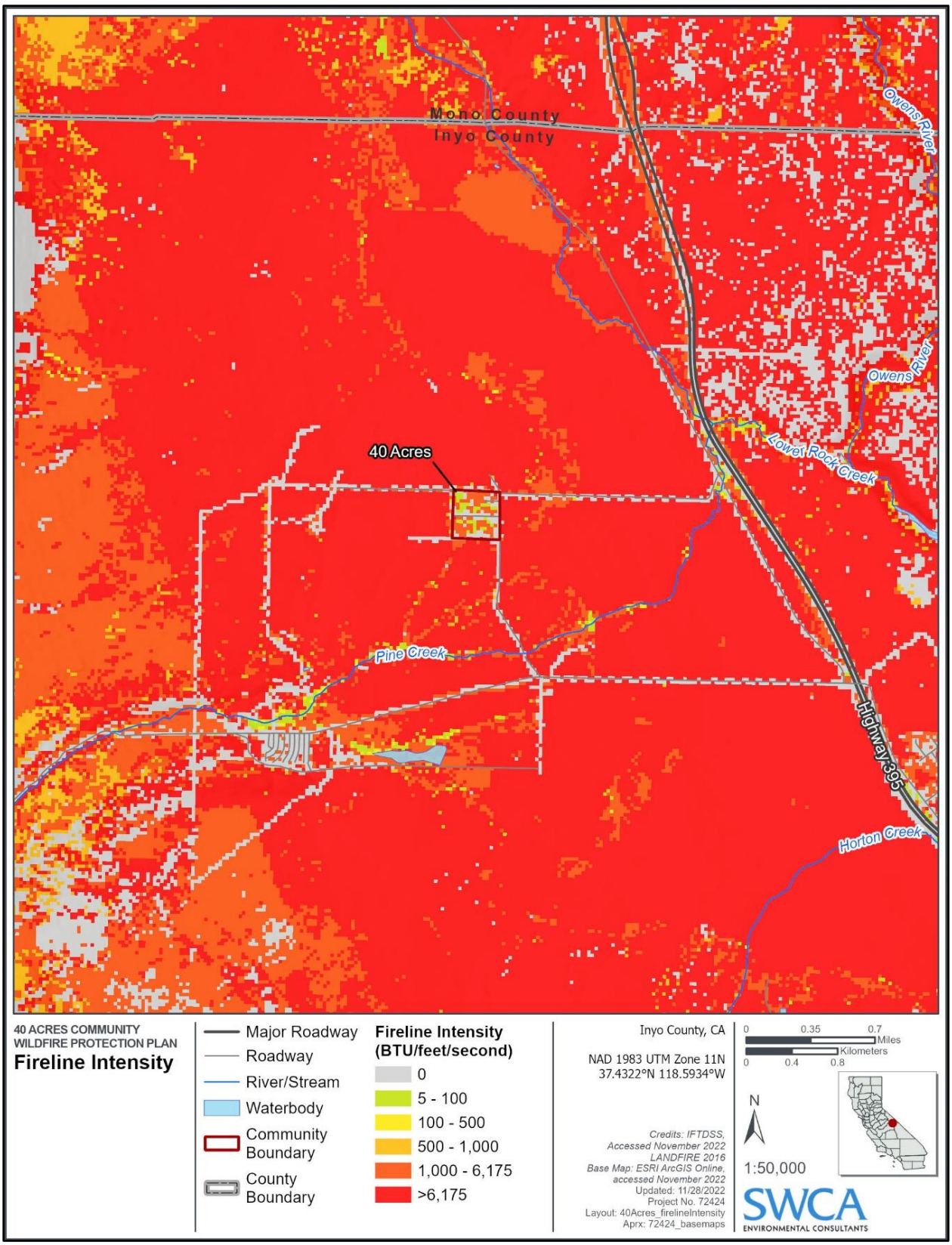
This page intentionally left blank.



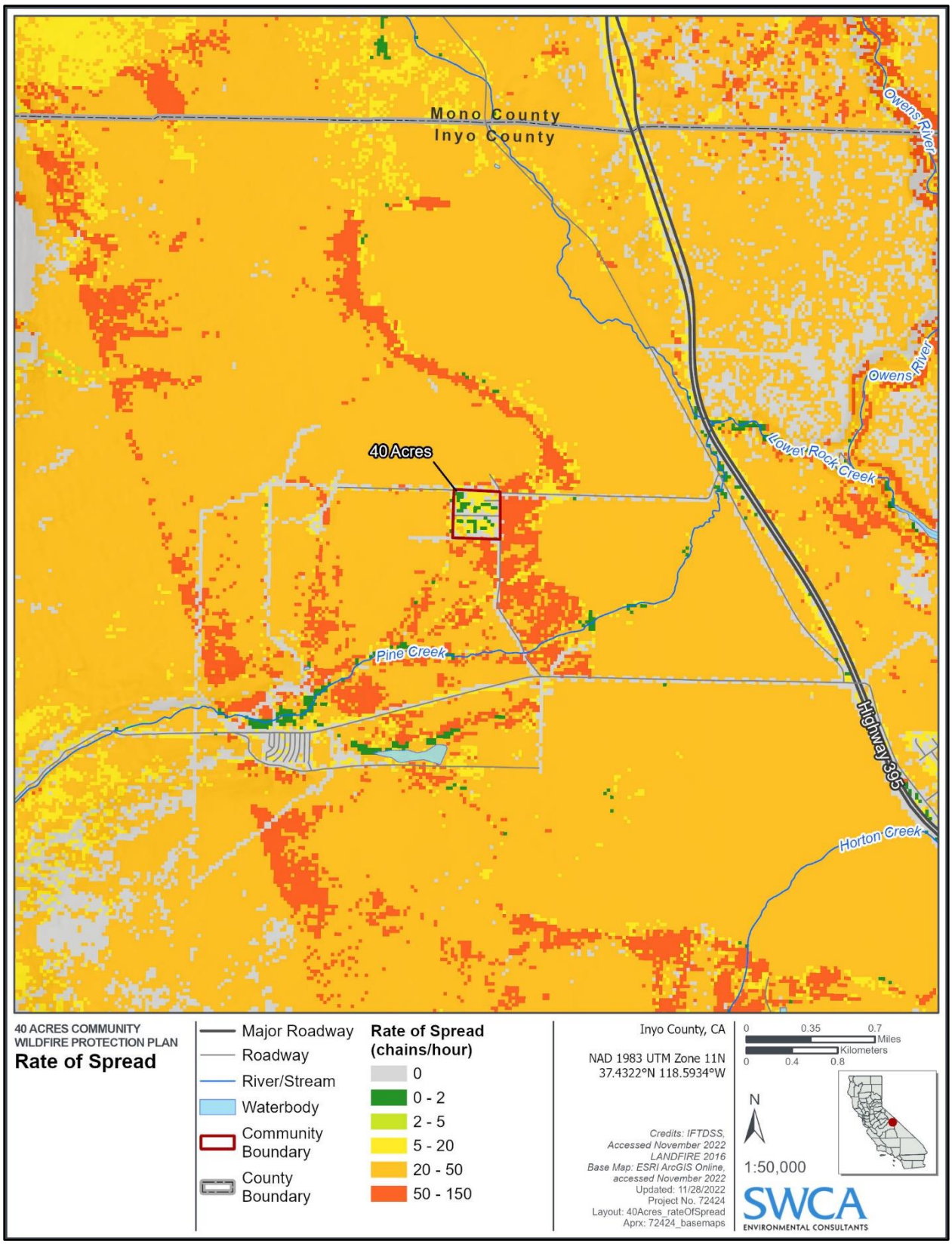
Map C.1. Scott and Burgan 40 Fire Behavior Fuel Models.



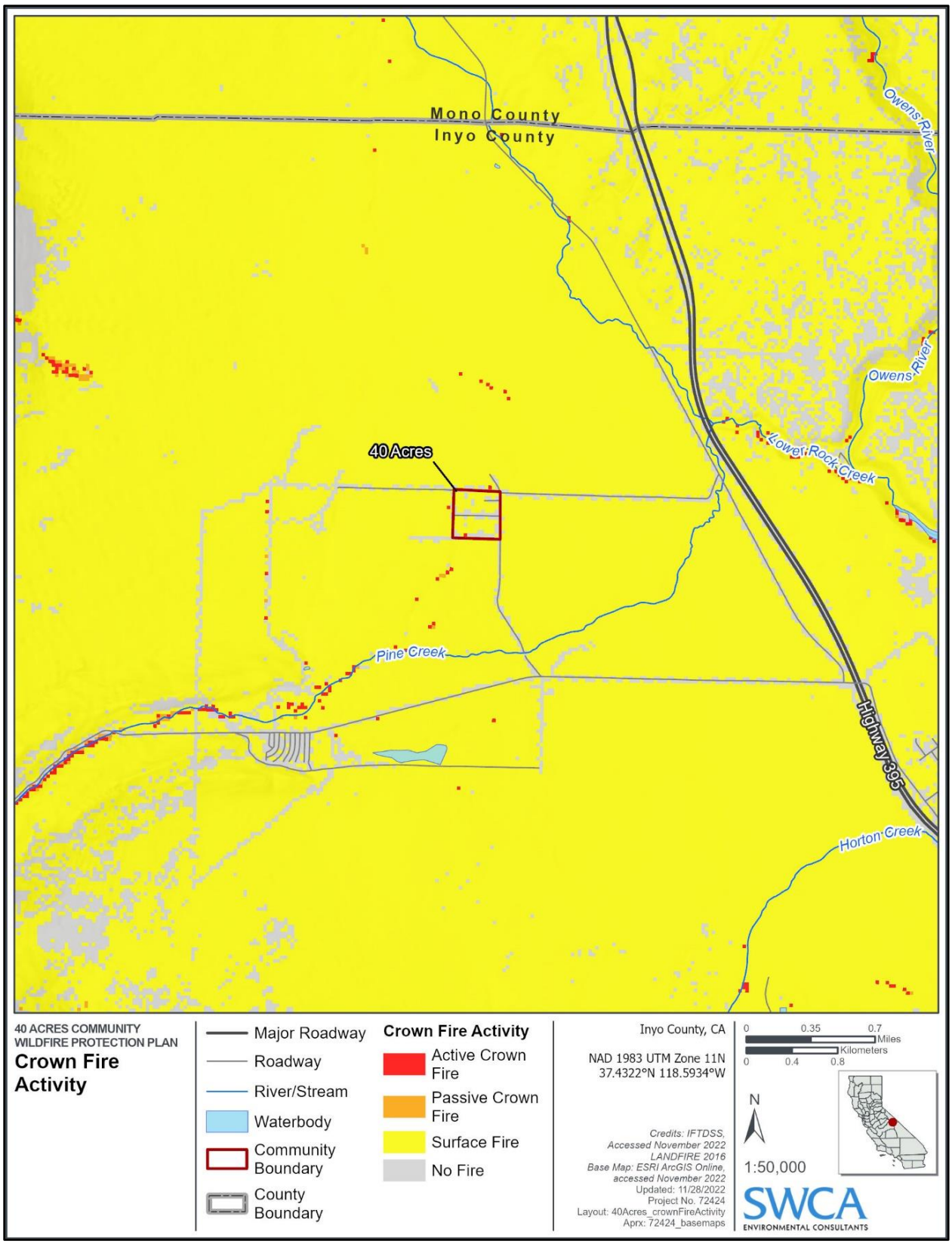
Map C.2. Risk-Hazard Assessment inputs: flame length.



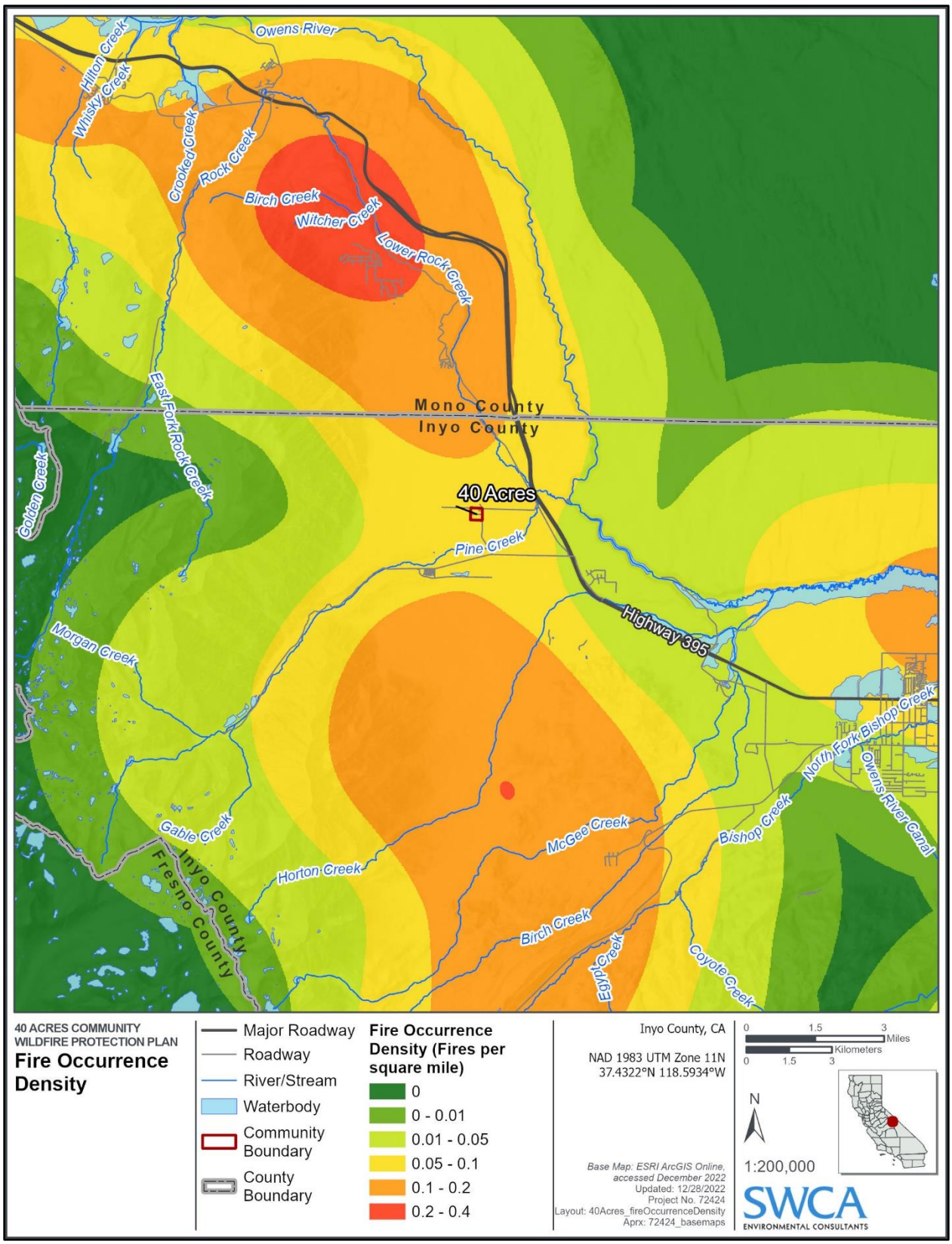
Map C.3. Risk-Hazard Assessment inputs: fireline intensity.



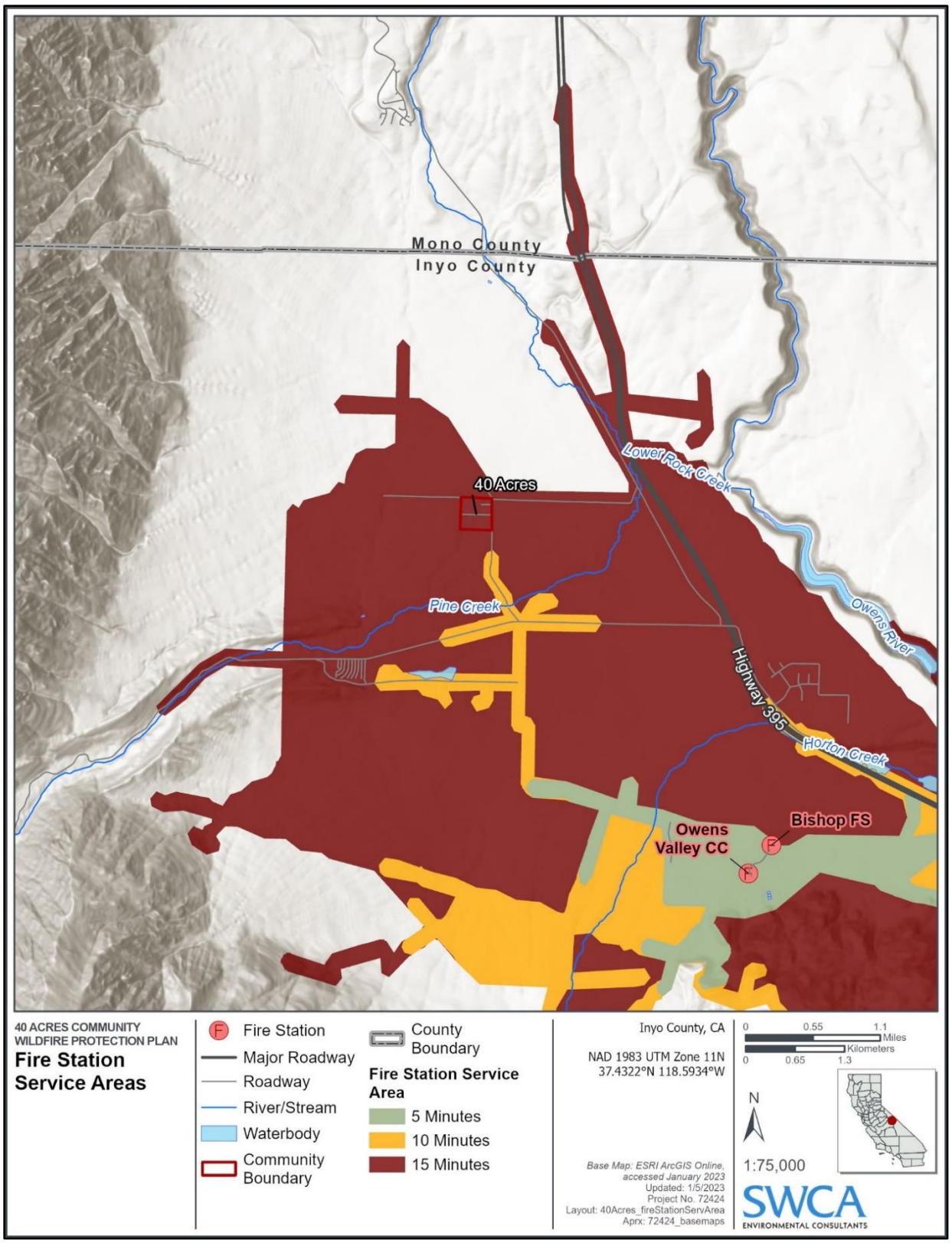
Map C.4. Risk-Hazard Assessment inputs: rate of spread.



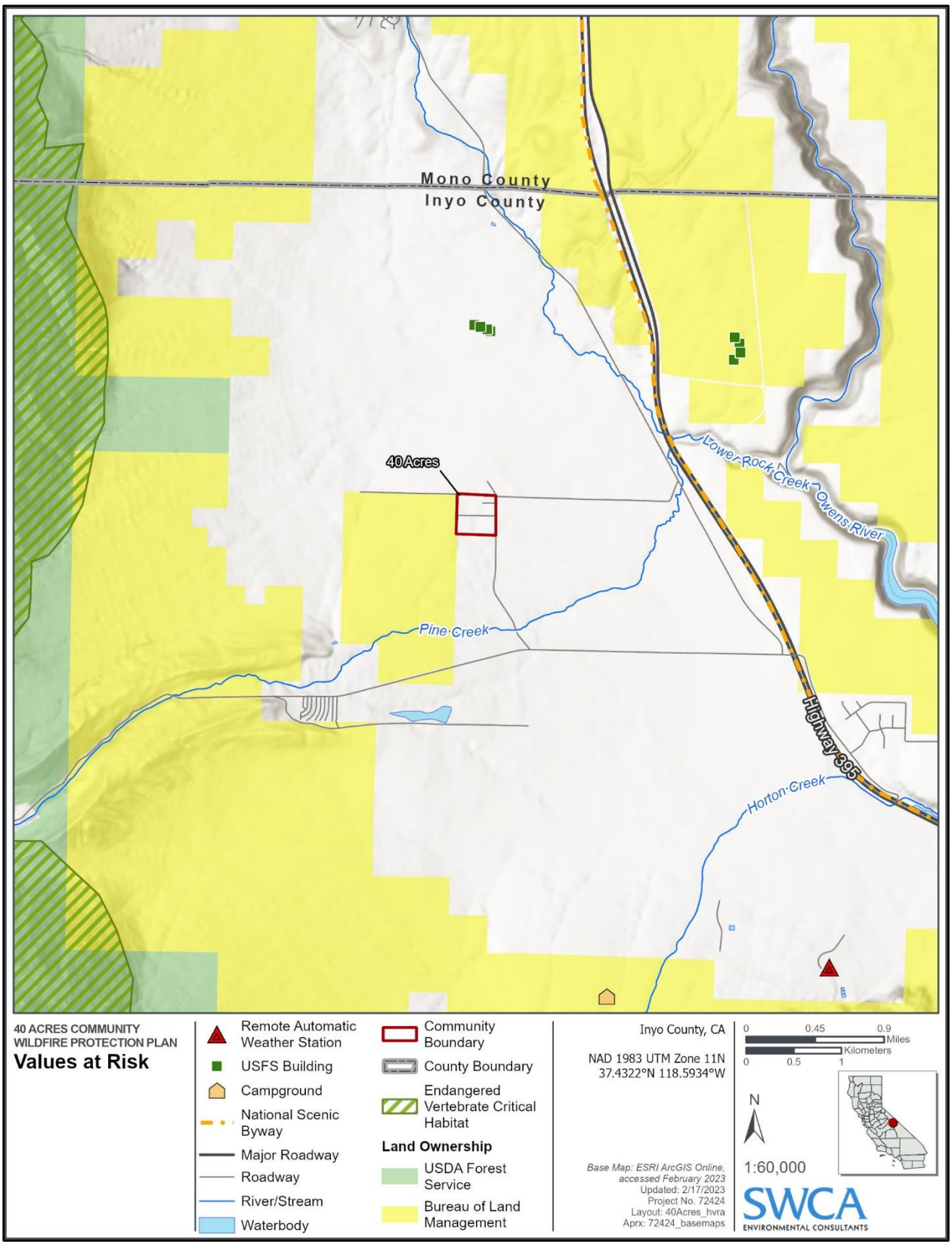
Map C.5. Risk-Hazard Assessment inputs: crown fire activity.



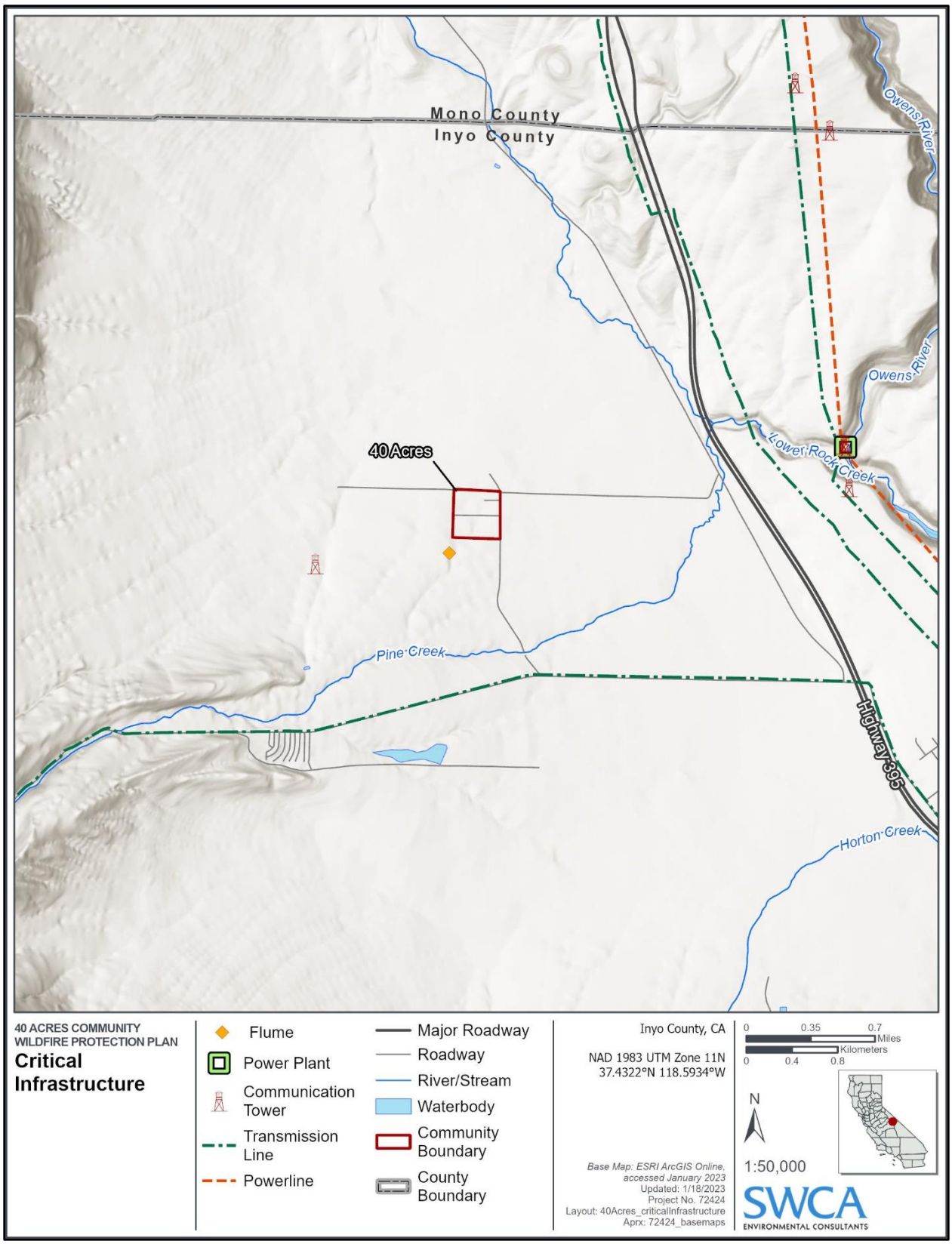
Map C.6. Risk-Hazard Assessment inputs: fire occurrence density.



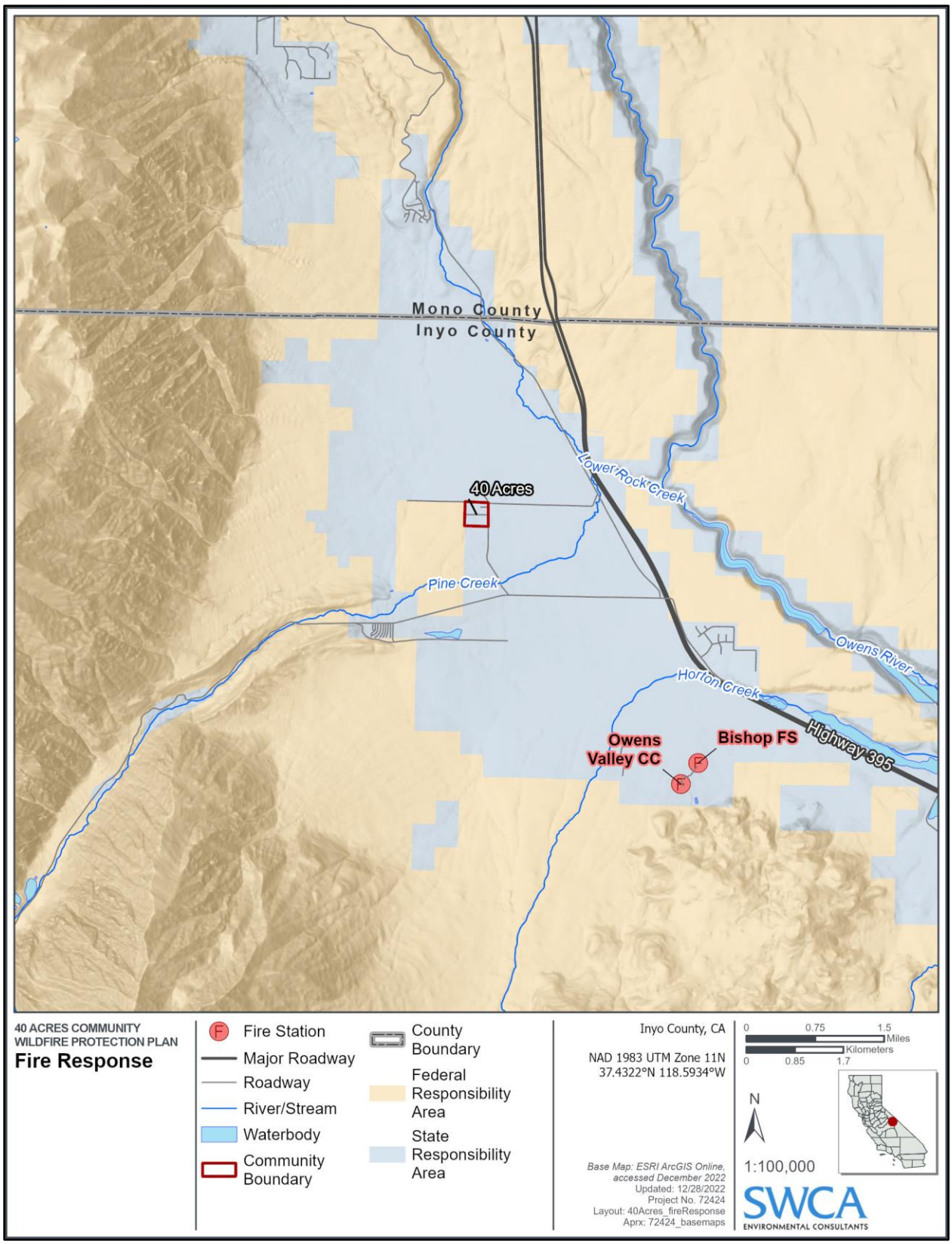
Map C.7. Risk-Hazard Assessment inputs: fire station service areas. Note: The fire response drive times were calculated when N Round Valley Road was closed. Response times to 40 Acres will decrease once N Round Valley Road opens.



Map C.8. Values at risk.



Map C.9. Critical infrastructure. Note: critical infrastructure such as irrigation ditches and pipes and water tanks within 40 Acres can be viewed at a closer scale in Figure B.5 in Appendix B.



Map C.10. Fire responsibility areas and fire stations.

APPENDIX D:

Community and Parcel Risk-Hazard Assessments for WUI Communities

This page intentionally left blank.

40 ACRES

COMMUNITY ASSESSMENT SUMMARY

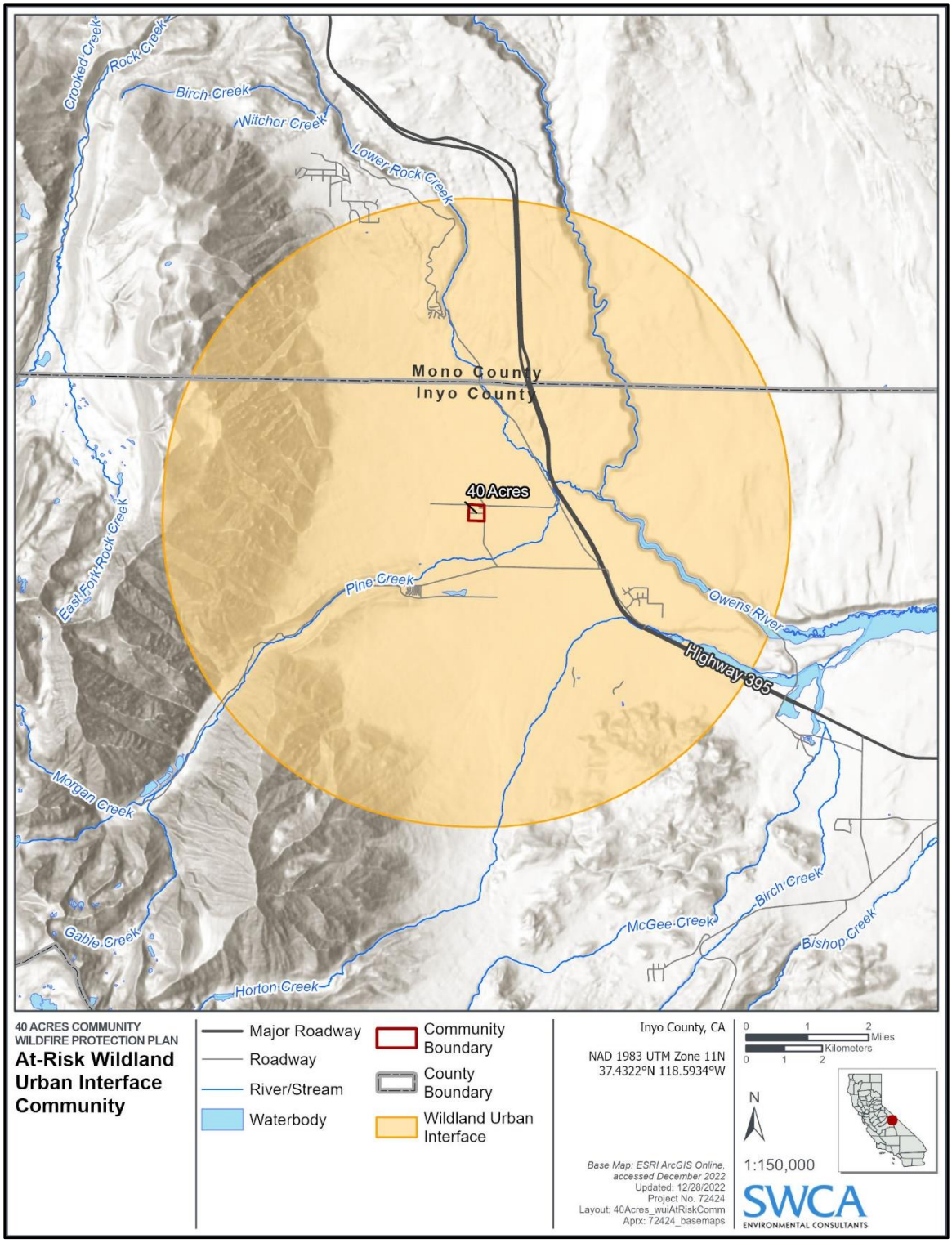


Figure D.1. 40 Acres community boundary and WUI.

40 ACRES COMMUNITY-LEVEL ASSESSMENT SUMMARY

40 ACRES SUMMARY STATISTICS

Community Polygon Background		
Community Polygon Name: 40 Acres	**Total Score:** 87 (high)	**Land Area (acres):** 43

Percent of Community by Modeled/Calculated Wildfire Risk Inputs
Drive Time from Fire Station
0-5 (min): 0%
5-10 (min): 0%
10-15 (min): 100%*
15+ (min): 0%

* Note – when Round Valley Road opens, the driving time from the fire station will be minimized to 0-5 minutes.

Fire Department Statistics:

Fire Department: CAL FIRE Bishop Forestry Fire Station

Fulltime Firefighters: 2 | On-call Firefighters: 6 | Volunteer Firefighters: --

Water Tender: --

Wildland Engines			
Type 1: --	Total Number:	4WD/AWD:	Brush Breaker:
Type 2: --	Type 3: 1	1	--
Type 3: --	Type 4: --	--	--
Structure Engines:	Type 5: --	--	--
Type 1: --	Type 6: --	--	--
Type 2: --	Type 7: --	--	--

Port-A-Tanks: --

Portable Pumps: -- | Primary water source: hydrant

1144 Survey Summary Highlights

Positive Attributes (Low Scores)

- 2 or more roads in and out of community
- Surfaced roads with < 5% grade
- Street signs present and reflective
- Low angle slopes around structures, decks, and fences
- Good water source (3 water tanks)

Negative Attributes (High Scores)

- Narrow roads < 20 ft in width
- < 30 ft of defensible space for most structures
- Fire access is < 300 ft with no turnaround
- Hazardous topographic features
- History of high fire occurrence
- Potential for severe fire weather
- Little separation of adjacent structures
- Combustible house siding
- Predominantly combustible roofing material
- Predominantly combustible deck and fence material
- > than 5 mi from a fire station
- Gas and electric utilities are above ground
- Grass Shrub (GS) is primary predominant vegetation
- Significant dead and dying fuels within community and adjacent areas/ditches

1

Suggested Mitigation Focus Area

Areas of Concern:

- North, east, and south sides have high grass-shrub loading
- North and east sides have heavy riparian fuels with some dead and downed logs along ditches
- Southwest corner has a heavy riparian fuel bed leading into the community from the wildlands

Fire Department Concerns:

- Ingress and egress
  - Ocean View Rd with no outlet
  - Potential bottlenecks with fire response vehicles going in and residents going out
  - Round Valley Rd is currently closed, causing longer response times
- Lack of defensible space in the community
  - Improper propane tank and woodpile clearance
- Compliance with evacuation orders
- Trees and/or branches leaning on power poles and lines

2



Figure D.2. 40 Acres.

DRAFT

40 ACRES
PARCEL-LEVEL ASSESSMENT SUMMARIES

In addition to the overall community assessment, SWCA conducted parcel-level assessments for 40 Acres (Figure D.3). Several homeowners invited SWCA to walk around their property to get a more thorough assessment. These homeowners also gave SWCA permission to include assessments of their properties in the CWPP. The parcels were assessed with the NFPA 1144 form and each section in the form was given a rating. However, since the community is compact and relatively homogeneous throughout, many of the features received the same rating. For example, features like road width, road grade, fire access, street signs, topography, fire history, and distance from fire station received the same rating. To reduce repetition, only those features that are unique to each parcel are presented here.

In general, for those parcels that SWCA did not enter the premises, the parcels exhibited limited defensible space, combustible construction materials (siding, decks, fences, and roofs), and improper placement of woodpiles and propane tanks. On the other hand, several of the parcels that SWCA was invited to assess had relatively good defensible space, more integration of fire-resistant materials (siding, roofs, decks, and fences), and better placement of woodpiles and propane tanks. Moreover, the owners of these properties were proactive in fire risk reduction in and around their properties.



Figure D.3. Parcels within 40 Acres.

120 OCEAN VIEW RD ASSESSMENT SUMMARY

Property assessed:	120 Ocean View Rd & 118* Ocean View Rd
Total score:	51 (Moderate)
Defensible space:	• Good defensible space around property • Tree branches around the back are touching the house
Roofing materials:	• Fire-resistive roofing materials
Building construction:	• Mostly fire-resistive materials; could use finer mesh screens and vent covers
Deck and fencing:	• Wooden fencing • Deck is made of Trex • Woodpiles underneath deck
Adjacent structures:	• Good separation between structures
Water source:	• Underground tank with 2-inch hose • Ditch that runs through property • Pond
Vegetation:	• Some trees on the property; maintained yard and lawn; some ornamentals • There is mulch present on the yard to limit shrub growth; vines close to shed; woodpiles next to wooden shed and propane tank; firewood placed next to wooden fence
Placement of gas and electric utilities:	• Both are above ground
Values at risk:	• Residential • Solar panels
Other notes:	• Exposed on the east side to shrubland fuels, but the road acts as a fuel break

*The 120 property was assessed up close and the 118 property (Airbnb) was evaluated from a distance.

SUMMARY OF MITIGATION NEEDS BASED ON FIELD ASSESSMENTS

- Install finer mesh screens and vent covers
- Remove woodpiles from underneath decks and away from wooden fences/sheds and propane tanks
- Install gutter shields to limit buildup of leaf litter
- Remove vines that are encroaching on structures
- Reduce tree to structure contact by trimming back branches that are in contact
- Continue implementation of defensible space

DRAFT



Figure D.4. 118 and 120 Ocean View Rd properties. The structures have good defensible space and are accessible from Ocean View Rd and Round Valley Rd. The blue boundary is the parcel boundary.

Source: Google Earth. Acquisition date: 09/2019.

DRAFT

1441 BIRCHIM LANE ASSESSMENT SUMMARY

Property assessed:	1441 Birchim Lane
Total score:	89 (High)
Defensible space:	• Limited defensible space around property
Roofing materials:	• Non-combustible roofing materials
Building construction:	• Combustible siding materials
Deck and fencing:	• Wooden fence is far from property
Adjacent structures:	• Generally good separation of structures, but some structures are close to each other
Water source:	• Ditch and pond
Vegetation:	• Mostly trees
Placement of gas and electric utilities:	• Both are above ground
Values at risk:	• Residential
Other notes:	• Propane tank is close to the home • Adjacent property has a big wood pile and dead branches on the fence

SUMMARY OF MITIGATION NEEDS BASED ON FIELD ASSESSMENTS

- Continue to implement defensible space standards around all the structures
  - Keep combustible materials to a safe distance from the home (more than 30 feet)
- Continue to do fuel reductions around the property
- Work with 40 Acres Fire Safe Council to explore options to work with the neighbor to relocate combustible materials
- Investigate options to harden the home and other structures

DRAFT



Figure D.5. 1441 Birchim Lane property. This image was taken prior to the defensible space work that had recently been conducted. Our field assessment on 10/29/2022 noted improvements in defensible space. The property is accessible only via a single-lane road that connects to Birchim Lane. The blue boundary is the parcel boundary.

Source: Google Earth. Acquisition date: 09/2019.

DRAFT

160 OCEAN VIEW RD ASSESSMENT SUMMARY

Property assessed:	160 Ocean View Rd
Total score:	80 (High)
Defensible space:	• Good defensible space
Roofing materials:	• Fire-resistive roofing materials
Building construction:	• Mostly combustible (3-4 sides with wood)
Deck and fencing:	• Non-combustible deck and fence
Adjacent structures:	• Separation between structures is generally good
Water source:	• Ditch
Vegetation:	• Trees, lawn, ornamental, conifers, sparse shrubs
Placement of gas and electric utilities:	• Both above ground
Values at risk:	• Residential
Other notes:	• Potential for soffit ember intrusion • Firewood is away from the house and has a metal covering

SUMMARY OF MITIGATION NEEDS BASED ON FIELD ASSESSMENTS

- Continue implementation of defensible space
- Continue with structural hardening efforts

DRAFT



Figure D.6. 160 Ocean View Rd property. Structures have good defensible space, and Ocean View Rd is the only point of access to the property. The blue boundary is the parcel boundary.

Source: Google Earth. Acquisition date: 09/2019.

DRAFT

180 OCEAN VIEW RD ASSESSMENT SUMMARY

Property assessed:	180 Ocean View Rd
Total score:	79 (High)
Defensible space:	• Good defensible space
Roofing materials:	• Fire-resistive roofing materials
Building construction:	• Mostly combustible materials
Deck and fencing:	• Non-combustible deck and fence
Adjacent structures:	• Separation between structures is generally good
Water source:	• Ponds, ditch
Vegetations:	• Trees, lawn, ornamental, conifers, sparse shrubs
Placement of gas and electric utilities:	• Both above ground
Values at risk:	• Residential
Other notes:	• Good separation from propane tanks • The bottom siding of house is concrete • Woodpiles are well maintained and separated from the house • Good water flow on ditch outside of property

SUMMARY OF MITIGATION NEEDS BASED ON FIELD ASSESSMENTS

- Continue implementation of defensible space
- Continue with structural hardening efforts

DRAFT



Figure D.7. 180 Ocean View Rd property. Structures have good defensible space. Ocean View Rd is the only point of access to the property. The blue boundary is the parcel boundary.

Source: Google Earth. Acquisition date: 09/2019.

DRAFT

220 OCEAN VIEW RD ASSESSMENT SUMMARY

Property assessed:	220 Ocean View Rd
Total score:	84 (High)
Defensible space:	• Defensible space is fair, some branches in contact with the roof
Roofing materials:	• Fire-resistive roofing materials
Building construction:	• Combustible siding materials
Deck and fencing:	• Combustible deck and fence
Adjacent structures:	• Structures are close to each other
Water source:	• Pond, ditch
Vegetation:	• Lawn with trees • Overhanging tree from adjacent property
Placement of gas and electric utilities:	• Both above ground
Values at risk:	• Residential
Other notes:	• Woodpile on porch

SUMMARY OF MITIGATION NEEDS BASED ON FIELD ASSESSMENTS

- Continue to maintain defensible space
  - Relocate woodpiles to a safe distance (more than 30 feet) from the home
- Investigate opportunities to harden the home
  - Upgrade siding materials
  - Upgrade deck and fence materials

DRAFT



Figure D.8. 220 Ocean View Rd property. Defensible space is fair, although some branches are in contact with the roof. The property is located just before the dead-end road comes to an end. The blue boundary is the parcel boundary.

Source: Google Earth. Acquisition date: 09/2019.

DRAFT

33 OCEAN VIEW RD ASSESSMENT SUMMARY

Property assessed:	33 Ocean View Rd
Total score:	73 (High)
Defensible space:	• Good defensible space
Roofing materials:	• Fire resistive roofing materials
Building construction:	• Combustible siding materials
Deck and fencing:	• Non-combustible deck and fencing materials
Adjacent structures:	• Adjacent structures have relatively good separation
Water source:	• Ditch
Vegetation notes:	• Trees and lawn
Placement of gas and electric utilities:	• Both above ground
Values at risk:	• Residential
Other notes:	--

SUMMARY OF MITIGATION NEEDS BASED ON FIELD ASSESSMENTS

- Continue maintenance of defensible space
- Explore opportunities to harden the home (siding materials)

DRAFT



Figure D.9. 33 Ocean View property. Structures have good defensible space. The property is accessible from Ocean View Rd and is very close to Round Valley Rd. The blue boundary is the parcel boundary.

Source: Google Earth. Acquisition date: 09/2019.

DRAFT

53 OCEAN VIEW RD ASSESSMENT SUMMARY

Property assessed:	53 Ocean View Rd
Total score:	108 (High)
Defensible space:	• Poor defensible space
Roofing materials:	• Fire-resistive roofing materials
Building construction:	• Combustible siding materials
Deck and fencing:	• Combustible deck and fencing materials
Adjacent structures:	• Structures are close to each other
Water source:	• Ditch
Vegetation:	• Trees and thick stands of ornamental vegetation
Placement of gas and electric utilities:	• Both above ground
Values at risk:	• Residential
Notes:	• --

SUMMARY OF MITIGATION NEEDS BASED ON FIELD ASSESSMENTS

- Implement defensible space standards around all the structures
- Investigate opportunities to harden the home
  - Upgrade siding materials
  - Upgrade deck and fence materials

DRAFT



Figure D.10. 53 Ocean View Rd property. Structures have poor defensible space, with some branches resting on the roof. Wooden deck and fence in the southwest corner are connected to vegetation. The property is accessible only via Ocean View Rd. The blue boundary is the parcel boundary.

Source: Google Earth. Acquisition date: 09/2019.

DRAFT

148 OCEAN VIEW RD ASSESSMENT SUMMARY

Property assessed:	148 Ocean View Rd
Total score:	84 (High)
Defensible space:	• Limited defensible space • Woodpiles adjacent to house
Roofing materials:	• Fire-resistive roofing materials
Building construction:	• Fire-resistive siding materials: stucco mixed with wood
Deck and fencing:	• Combustible deck and fencing materials
Adjacent structures:	• Structures are close to each other
Water source:	• Ditch, pond, and water tank
Vegetation:	• Tall trees and lawn
Placement of gas and electric utilities:	• Both above ground
Values at risk:	• Residential • Livestock
Notes:	• Garage is made of cinder blocks

SUMMARY OF MITIGATION NEEDS BASED ON FIELD ASSESSMENTS

- Implement defensible space standards around all the structures
  - Relocate woodpiles to a safe distance (more than 30 feet) from the home
- Investigate opportunities to harden the home
  - Upgrade siding materials (wood portion)
  - Upgrade deck and fence materials

DRAFT



Figure D.11. 148 Ocean View Rd property. Structures have limited defensible space, with some branches contacting roofs. The property is accessible only via Ocean View Rd. The blue boundary is the parcel boundary.

Source: Google Earth. Acquisition date: 09/2019.

DRAFT

137 OCEAN VIEW RD ASSESSMENT SUMMARY

Property assessed:	137 Ocean View Rd
Total score:	78 (High)
Defensible space:	• Defensible space is fair, some branches in contact with the roof and siding
Roofing materials:	• Fire-resistive roofing materials
Building construction:	• Fire-resistive siding materials
Deck and fencing:	• Non-combustible deck and fence
Adjacent structures:	• Structures are close to each other
Water source:	• Tank
Vegetation:	• Trees and grass
Placement of gas and electric utilities:	• Both above ground
Values at risk:	• Residential
Other notes:	--

SUMMARY OF MITIGATION NEEDS BASED ON FIELD ASSESSMENTS

- Continue to implement defensible space standards around all the structures
  - Relocate woodpiles and other objects to a safe distance (more than 30 feet) from the home. If 30 feet is not possible for woodpiles, consider installing a fire-resistant barrier.
  - Keep branches 10 feet away from the roof

DRAFT



Figure D.12. 137 Ocean View Rd property. Defensible space is fair, although some branches are in contact with the roof and siding. A water tank on the property is accessible via the driveway on the west side. The property is accessible only via Ocean View Rd. The blue boundary is the parcel boundary.

Source: Google Earth. Acquisition date: 09/2019.

DRAFT

150 HARDY RD ASSESSMENT SUMMARY

Property assessed:	150 Hardy Rd
Total score:	83 (High)
Defensible space:	• Defensible space is limited • Large trees are very close to the home; tree crown is touching the roof • Propane tank is close to the home
Roofing materials:	• Fire-resistive roofing materials
Building construction:	• Combustible siding materials
Deck and fencing:	• Combustible deck and fence materials (fence has mixed materials: wood and metal)
Adjacent structures:	• Structures within the property have good separation
Water source:	• Ditch and pond
Vegetation:	• Trees and grass; grass is well maintained • Exposed to shrubland fuels across Hardy Rd
Placement of gas and electric utilities:	• Both above ground
Values at risk:	• Residential
Other notes:	--

SUMMARY OF MITIGATION NEEDS BASED ON FIELD ASSESSMENTS

- Continue to implement defensible space standards around all the structures
  - Keep branches and tree crowns 10 feet away from the roof
  - Work with the Fire Safe Council to explore opportunities to remove trees that are too close to the home
- Investigate opportunities to harden the home
  - Upgrade siding materials
  - Upgrade deck and fence materials

DRAFT



Figure D.13. 150 Hardy Rd property. Defensible space is limited, with large trees in contact with the home. The property is accessible only via Hardy Rd, a relatively wide and paved road. The blue boundary is the parcel boundary.

Source: Google Earth. Acquisition date: 09/2019.

DRAFT

This page intentionally left blank.

DRAFT

APPENDIX E:

NFPA 1144 Assessment Forms

This page intentionally left blank.

1144 NATIONAL FIRE PROTECTION ASSOCIATION ASSESSMENT FORM

SWCA – 1144 Assessment		
Community		**Notes:**
Surveyor		
Survey Date/Time		
Means of Access		
Ingress and Egress		
2 or more roads in and out score | 0		
1 road in and out | 7		
Road Width		
> 24 ft | 0		
> 20 ft < 24 ft | 2		
< 20 ft | 4		
Road Conditions		
Surfaced road, grade < 5% | 0		
Surfaced road, grade > 5% | 2		
Non-surfaced road, grade < 5% | 2		
Non-surfaced road, grade > 5% | 5		
Other than all season | 7		
Fire Access		
< 300 ft with turnaround | 0		
> 300 ft with turnaround | 2		
< 300 ft with no turnaround | 4		
> 300 ft with no turnaround | 5		
Street Signs		
Present – reflective | 0		
Present – non-reflective | 2		
Not present | 5		
Notes:		
Vegetation (Fuel Models)		
Predominant Vegetation		
Primary Predominant Vegetation		
Non-Burnable (NB) Score | 2		
Grass (GR) Score | 5		
Grass-Shrub (GS) Score | 10		
Shrub (SH) Score | 15		
Timber-Understory (TU) Score | 20		

DRAFT

Timber-Litter (TL) Score | 25	
Slash-Blow (TU) Score | 30	
Notes:	
Defensible Space	
> 100 ft around structure | 1	
> 70 ft < 100 ft around structure | 3	
> 30 ft < 70 ft around structure | 10	
< 30 ft around structure | 25	
Topography Within 300 ft of Structures	
Slope	
< 9% | 1	
10% to 20% | 4	
21% to 30% | 7	
31% to 40% | 8	
>41% | 10	
Additional Rating Factors (rate all that apply)	
Topographic features | 1-5	
History of high fire occurrence | 1-5	
Severe fire weather potential | 1-5	
Separation of adjacent structures | 1-5	
Notes:	
Roofing Assembly	
Roofing	
Class A - metal roof, clay/concrete tiles, slate, asphalt shingles | 0	
Class B - pressure treated composite shakes and shingles | 3	
Class C - untreated wood shingle, plywood, particle board | 15	
Unrated - Extremely poor roofing conditions | 25	
Notes:	
Building Construction	
Siding Materials (predominant)	
Non-combustible (brick/concrete) | 5	
Fire Resistive (stucco/adobe) | 10	
Combustible (wood or vinyl) | 12	
Deck and fencing (predominant)	
No deck or fence/non-combustible | 0	
Combustible deck and fence | 5	

DRAFT

Building Set-Back	
> 30 ft to slope | 1	
< 30 ft to slope | 5	
Notes:	
Available Fire Protection	
Water Sources	
Water Source? | yes/no	
Water Source Type | hydrant, water tank, other	
Other Water Source	
Water Source Score | Hydrant = 1 Water Tank = 3	
Organized Response	
Station < 5 mi from community | 1	
Station > 5 mi from community | 3	
Notes:	
Placement of Gas and Electric Utilities	
Both underground | 0	
One above, one below | 3	
Both above ground | 5	
Values at Risk Observations	
Forest Health Observations	
Land Use Observations	
Misc Observations	
Total	

Hazard Rating Scale	**<40 Low**	**>40 Moderate**	**>70 High**	**>112 Extreme**

1

DRAFT

This page intentionally left blank.

DRAFT

APPENDIX F:

Funding Sources

This page intentionally left blank.

FUNDING SOURCES

The following section provides information on federal, state, and private funding opportunities for conducting wildfire mitigation projects.

FEDERAL FUNDING INFORMATION

Source: **2022 Infrastructure Investments and Jobs Act**

Agency: **Multiple**

Website: https://www.congress.gov/bill/117th-congress/house-bill/3684

Description: The Infrastructure Investments and Jobs act allocated funding through various departments for infrastructure projects including, but not limited to roads, bridges, and major projects; passenger and freight rail; highway and pedestrian safety; public transit; broadband; ports and waterways; airports; water infrastructure; power and grid reliability and resiliency; resiliency, including funding for coastal resiliency, ecosystem restoration, and weatherization; clean school buses and ferries; electric vehicle charging; addressing legacy pollution by cleaning up Brownfield and Superfund sites and reclaiming abandoned mines; and Western Water Infrastructure.

Specifically, the Community Wildfire Defense Grant Program is a $1 billion program where the Department of Agriculture will provide grants to communities at risk from wildfire to develop or revise their community wildfire protection plans and carry out projects described within those plans. It will include a mix of formula and competitive funds. Applications are expected to open early in 2023.

Section 40803 addresses wildfire risk reduction, section 40804 deals with ecosystem restoration, section 40806 handles the establishment of fuel breaks in forests and other wildland vegetation, and section 70302 addresses reforestation. To learn more about the Act, please see guidebook located here https://www.whitehouse.gov/wp-content/uploads/2022/01/BUILDING-A-BETTER-AMERICA_FINAL.pdf?msclkid=48f8f465b51911ec85e010228d808d4d.

Source: **Access to Ancestral Lands Grant Opportunity (AALG)**

Agency: First Nations Development Institute

Website: https://www.firstnations.org/

Description: For more than 41 years, First Nations Development Institute (First Nations), a Native-led 501(c)(3) nonprofit organization, has worked to strengthen American Indian economies to support healthy Native communities by investing in and creating innovative institutions and models that strengthen asset control and support economic development for American Indian people and their communities. First Nations began its national grantmaking program in 1993. Through mid-year 2021, First Nations has successfully managed 2,276 grants totaling more than $46 million to tribal and community institutions across Indian Country. The California Tribal Fund was created to support California-based, California-Native-led nonprofits and tribal programs in controlling and protecting their food systems, water, languages, traditional ecological knowledge, and land. Currently, the fund is operated as a project of First Nations Development Institute. You can find more information on the AALG here: https://www.firstnations.org/rfps/california-tribal-fund-access-to-ancestral-lands-grant-opportunity/

Source: **Building Resilient Infrastructure and Communities (BRIC) Grant Program**

Agency: Department of Homeland Security (DHS) Federal Emergency Management Agency (FEMA)

Website: https://www.fema.gov/grants/mitigation/building-resilient-infrastructure-communities

Description: BRIC will support states, local communities, tribes, and territories as they undertake hazard mitigation projects, reducing the risks they face from disasters and natural hazards. The BRIC program guiding principles are supporting communities through capability- and capacity-building; encouraging and enabling innovation; promoting partnerships; enabling large projects; maintaining flexibility; and providing consistency. You can find more information on the BRIC program here: https://www.fema.gov/grants/mitigation/building-resilient-infrastructure-communities

Source: **Hazard Mitigation Grant Program (HMGP)**

Agency: FEMA

Website: https://www.fema.gov/grants/mitigation/hazard-mitigation

Description: The HMGP provides funding to state, local, tribal, or territorial governments (and individuals or businesses if the community applies on their behalf) to rebuild with the intentions to mitigate future losses due to potential disasters. This grant program is available after a presidentially declared disaster.

Source: **Hazard Mitigation Grant Program (HMGP) – Post Fire**

Agency: FEMA

Website: https://www.fema.gov/grants/mitigation/post-fire

Description: The HMGP Post Fire grant program provides assistance to communities for the purpose of implementing hazard mitigation measures following a wildfire. Mitigation measures may include:

- Soil stabilization
- Flood diversion
- Reforestation

Source: **Flood Mitigation Assistance (FMA) Grant**

Agency: FEMA

Website: https://www.fema.gov/grants/mitigation/floods

Description: The Flood Mitigation Assistance Program is a competitive grant program that provides funding to states, local communities, federally recognized tribes, and territories. Funds can be used for projects that reduce or eliminate the risk of repetitive flood damage to buildings insured by the National Flood Insurance Program. FEMA chooses recipients based on the applicant's ranking of the project and the eligibility and cost-effectiveness of the project.

Source: **Emergency Management Performance Grant (EMPG)**

Agency: FEMA

Website: https://www.fema.gov/grants/preparedness/emergency-management-performance

DRAFT

Description: The EMPG program provides funding to state, local, tribal, and territorial emergency management agencies with the overall goal of creating a safe and resilient nation. The two main objectives of the program are 1) closing capability gaps that are identified in the state or territory's most recent Stakeholder Preparedness Review (SPR); and 2) building or sustaining those capabilities that are identified as high priority through the Threat and Hazard Identification and Risk Assessment (THIRA)/SPR process and other relevant information sources. The grant recipient and Regional Administrator must come to an agreement on program priorities, which are crafted based on National, State, and regional priorities.

Source: Fire Management Assistance Grant (FMAG)

Agency: FEMA

Website: https://www.fema.gov/assistance/public/fire-management-assistance

Description: Fire Management Assistance is available to state, local, and tribal governments for the mitigation, management, and control of fires on publicly or privately owned forests or grasslands, which threaten such destruction as would constitute a major disaster. The Fire Management Assistance declaration process is initiated when a state submits a request for assistance to the FEMA Regional Director at the time a "threat of major disaster" exists. The entire process is accomplished on an expedited basis and a FEMA decision is rendered in a matter of hours. Before a grant can be awarded, a state must demonstrate that total eligible costs for the declared fire meet or exceed either the individual fire cost threshold, which applies to single fires, or the cumulative fire cost threshold, which recognizes numerous smaller fires burning throughout a state.

Source: Regional Catastrophic Preparedness (RCP) Grants

Agency: FEMA

Website: https://www.fema.gov/grants/preparedness/regional-catastrophic

Description: The Regional Catastrophic Preparedness Grant program provides funding to increase collaboration and capacity in regard to catastrophic incident response and preparation.

Source: Emergency Forest Restoration Program (EFRP)

Agency: USDA Farm Service Agency (FSA)

Website: https://www.fsa.usda.gov/programs-and-services/disaster-assistance-program/emergency-forest-restoration/index

Description: The Emergency Forest Restoration Program (EFRP) helps the owners of non-industrial private forests restore forest health damaged by natural disasters. The EFRP does this by authorizing payments to owners of private forests to restore disaster damaged forests. The local FSA County Committee implements EFRP for all disasters with the exceptions of drought and insect infestations. Eligible practices may include debris removal, such as down or damaged trees; site preparation, planting materials, and labor to replant forest stand; restoration of forestland roads, fire lanes, fuel breaks, or erosion-control structures; fencing, tree shelters; wildlife enhancement.

To be eligible for EFRP, the land must have existing tree cover; and be owned by any nonindustrial private individual, group, association, corporation, or other private legal entity.

DRAFT

Source: **Emergency Conservation Program (ECP)**

Agency: USDA Farm Service Agency (FSA)

Website: https://www.fsa.usda.gov/programs-and-services/conservation-programs/emergency-conservation/index

Description: The Emergency Conservation Program (ECP) helps farmers and ranchers to repair damage to farmlands caused by natural disasters and to help put in place methods for water conservation during severe drought. The ECP does this by giving ranchers and farmers funding and assistance to repair the damaged farmland or to install methods for water conservation. The grant could be used for restoring conservation structures (waterways, diversion ditches, buried irrigation mainlines, and permanently installed ditching system).

Source: **Environmental Quality Incentives Program (EQIP)**

Agency: National Resource Conservation Service (NRCS)

Website: https://www.nrcs.usda.gov/wps/portal/nrcs/main/co/programs/financial/eqip/

Description: The Environmental Quality Incentives Program (EQIP) is a voluntary program authorized under the Agricultural Act of 2014 (2014 Farm Bill) that helps farmers, ranchers and forest landowners who own or rent agricultural land to implement practices and/or install measures to protect soil, water, plant, wildlife, and other natural resources while ensuring sustainable production on their farms, ranches, and working forest lands. California EQUIP ranking pools include Catastrophic Fire Recovery and Forest Tree Mortality.

Source: **Emergency Watershed Protection (EWP) Program**

Agency: National Resource Conservation Service (NRCS)

Website: https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/landscape/ewpp/

Description: The program offers technical and financial assistance to help local communities relieve imminent threats to life and property caused by floods, fires, windstorms, and other natural disasters that impair a watershed.

Eligible sponsors include cities, counties, towns, conservation districts, or any federally recognized Native American tribe or tribal organization. Interested public and private landowners can apply for EWP Program recovery assistance through one of those sponsors.

The EWP Program covers the following activities.

- Debris removal from stream channels, road culverts, and bridges
- Reshape and protect eroded streambanks
- Correct damaged drainage facilities
- Establish vegetative cover on critically eroded lands
- Repair levees and structures
- Repair conservation practices

DRAFT

Source: **Funding for Fire Departments and First Responders**

Agency: DHS, U.S. Fire Administration

Website: https://www.usfa.fema.gov/grants/

Description: Includes grants and general information on financial assistance for fire departments and first responders. Programs include the Assistance to Firefighters Grant Program, Reimbursement for Firefighting on Federal Property, State Fire Training Systems Grants, and National Fire Academy Training Assistance.

Source: **Tribal Environmental General Assistance Program (GAP)**

Agency: Environmental Protection Agency (EPA)

Website: https://www.epa.gov/tribal-pacific-sw/epa-region-9-tribal-environmental-gap-funding

Description: Funding under this program is used to aid Native American tribes in establishing and implementing their own reservation-specific environmental protection programs. To find out more about this funding opportunity please contact Tribal Branch Manager, Jeremy Bauer, at bauer.jeremy@epa.gov.

Source: **Specific EPA Grant Programs**

Agency: Environmental Protection Agency (EPA)

Website: https://www.epa.gov/tribal-pacific-sw/epa-region-9-tribal-environmental-gap-funding

Description: Various grant programs are listed under this site. Listed below are examples of grants offered:

- Multipurpose Grants to States and Tribes: https://www.epa.gov/grants/multipurpose-grants-states-and-tribes
- Environmental Education Grants: https://www.epa.gov/education/grants
- Environmental Justice Grants: https://www.epa.gov/environmentaljustice/environmental-justice-grants-funding-and-technical-assistance

Source: **Conservation Innovation Grants (CIG)**

Agency: National Resource Conservation Service

Website: Conservation Innovation Grant (CIG) | NRCS California (usda.gov)

Description: CIG State Component. CIG is a voluntary program intended to stimulate the development and adoption of innovative conservation approaches and technologies while leveraging federal investment in environmental enhancement and protection, in conjunction with agricultural production. Under CIG, Environmental Quality Incentives Program (EQIP) funds are used to award competitive grants to non-federal governmental or nongovernmental organizations, tribes, or individuals. CIG enables the Natural Resources Conservation Service (NRCS) to work with other public and private entities to accelerate technology transfer and adoption of promising technologies and approaches to address some of the nation's most pressing natural resource concerns. CIG will benefit agricultural producers by providing more options for environmental enhancement and compliance with federal, state, and local regulations. The NRCS administers the CIG program. The CIG requires a 50/50 match between the agency and the applicant. The CIG has two funding

components: national and state. Funding sources are available for water resources, soil resources, atmospheric resources, and grazing land and forest health.

Source: **Urban and Community Forestry Program, National Urban and Community Forestry Challenge Cost Share Grant Program**

Agency: U.S. Forest Service

Website: https://www.fs.usda.gov/managing-land/urban-forests/ucf

Description: U.S. Forest Service funding will provide for Urban and Community Forestry Programs that work with local communities to establish climate-resilient tree species to promote long-term forest health. The other initiative behind this program is to promote and carry out disaster risk mitigation activities, with priority given to environmental justice communities. For more information, contact a Forest Service Regional Program Manager.

Source: **Catalog of Federal Funding Sources; Land Resources**

Agency: Multiple

Website: https://ordspub.epa.gov/ords/wfc/f?p=165:512:10535656593775:::512::

Description: The Land Finance Clearing House is a catalogue of Federal funding sources for all things land related.

Examples of the types of grants found at this site are:

- Forest and Woodlands Resource Management Grant: https://sam.gov/fal/a798ad78cac749639b48270db3e86fdc/view?index=cfda&page=2&organization_id=100011100
- Environmental Education Grant: https://www.epa.gov/education/grants
- Public Assistance Grant Program: https://www.fema.gov/assistance/public
- Hazard Mitigation Grant: https://www.fema.gov/grants/mitigation/hazard-mitigation

Source: **Catalog of Federal Funding Sources; Water Resources**

Agency: Multiple

Website: https://ofmpub.epa.gov/apex/wfc/f?p=165:12:6483383318137:::12::

Description: The Water Finance Clearing House is a catalogue of Federal funding sources for all things water related.

Examples of the types of grants found at this site are:

- Water Conservation Field Services Program: https://www.usbr.gov/waterconservation/
- California Community Development Block Grant: https://www.grants.ca.gov/grants/community-development-block-grant-cdbg/
- California Clean Water State Revolving Fund Program (CWSRF): https://www.waterboards.ca.gov/water_issues/programs/grants_loans/srf/index.html

DRAFT

Source: **Firewise Communities**

Agency: Multiple

Website: http://www.firewise.org

Description: Many different Firewise Communities activities are available to help homes and whole neighborhoods become safer from wildfire without significant expense. Community cleanup days, awareness events, and other cooperative activities can often be successfully accomplished through partnerships among neighbors, local businesses, and local fire departments at little or no cost.

The kind of help you need will depend on who you are, where you are, and what you want to do. Among the different activities that individuals and neighborhoods can undertake, the following often benefit from seed funding or additional assistance from an outside source:

- Thinning/pruning/tree removal/clearing on private property—particularly on very large, densely wooded properties
- Retrofit of home roofing or siding to non-combustible materials
- Managing private forest
- Community slash pickup or chipping
- Creation or improvement of access/egress roads
- Improvement of water supply for firefighting
- Public education activities throughout the community or region

Source: **The National Fire Plan (NFP)**

Agency: DOI & USDA

Website: http://www.forestsandrangelands.gov/

Description: Many states are using funds from the NFP to provide funds through a cost-share with residents to help them reduce the wildfire risk to their private property. These actions are usually in the form of thinning or pruning trees, shrubs, and other vegetation and/or clearing the slash and debris from this kind of work. Opportunities are available for rural, state, and volunteer fire assistance.

Source: **Staffing for Adequate Fire and Emergency Response (SAFER)**

Agency: FEMA

Website: https://www.fema.gov/grants/preparedness/firefighters/safer

Description: The purpose of SAFER grants is to help fire departments increase the number of frontline firefighters. The goal is for fire departments to increase their staffing and deployment capabilities and ultimately attain 24-hour staffing, thus ensuring that their communities have adequate protection from fire and fire-related hazards. The SAFER grants support two specific activities: (1) hiring of firefighters and (2) recruitment and retention of volunteer firefighters. The hiring of firefighters activity provides grants to pay for part of the salaries of newly hired firefighters over the five-year program.

DRAFT

Source: **The Fire Prevention and Safety Grants (FP&S)**

Agency: FEMA

Website: https://www.fema.gov/grants/preparedness/firefighters/safety-awards

Description: FP&S offers support to projects that enhance the safety of the public and firefighters who may be exposed to fire and related hazards. The primary goal is to target high risk populations and mitigate high incidences of death and injury. Examples of the types of projects supported by FP&S include fire-prevention and public-safety education campaigns, juvenile fire-setter interventions, media campaigns, and arson prevention and awareness programs. In fiscal year 2005, Congress reauthorized funding for FP&S and expanded the eligible uses of funds to include firefighter safety research and development.

Source: **GSA-Federal Excess Personal Property**

Agency: USFS

Website: https://gsaxcess.gov/

Description: The Federal Excess Personal Property (FEPP) program refers to Forest Service-owned property that is on loan to State Foresters for the purpose of wildland and rural firefighting. Most of the property originally belonged to the Department of Defense (DoD). Once acquired by the Forest Service, it is loaned to State Cooperators for firefighting purposes. The property is then loaned to the State Forester, who may then place it with local departments to improve local fire programs. State Foresters and the USDA Forest Service have mutually participated in the FEPP program since 1956.

Source: **Assistance to Firefighters Grants (AFG)**

Agency: FEMA

Website: https://www.fema.gov/grants/preparedness/firefighters.

Description: The AFG program provides resources to assist fire departments in attaining critical resources such as training and equipment.

STATE FUNDING INFORMATION

Source: **CAL FIRE Grant Programs**

Agency: CAL FIRE

Website: https://www.fire.ca.gov/grants/

Description: The CAL FIRE Grant Program offers a range of forest-related grants with differing scopes and funding details. Some of the Grants include:

1. Forest Health Grants: https://www.fire.ca.gov/grants/forest-health-grants/
2. California Forest Improvement Program: https://www.fire.ca.gov/grants/california-forest-improvement-program-cfip/
3. Fire Prevention Grants Program: https://www.fire.ca.gov/grants/fire-prevention-grants/
4. Urban & Community Forestry Grant Programs: https://www.fire.ca.gov/grants/urban-and-community-forestry-grant-programs/

DRAFT

5. Wildfire Resilience and Forestry Assistance Grant- Prop 68: https://www.fire.ca.gov/programs/resource-management/resource-protection-improvement/landowner-assistance/forest-stewardship/

Source: California Fire Safe Council Grant Programs

Agency: California Fire Safe Council

Website: https://cafiresafecouncil.org/grants-and-funding/apply-for-a-grant/

Description: The California Fire Safe Council provides a range of Federal, State, and Private funding sources in addition to administering the USFS State Fire Assistance (SFA) Grant Programs.

Source: California Environmental Protection Agency (EPA) Loans and Grants

Agency: Multiple

Website: https://calepa.ca.gov/loansgrants/

Description: The California EPA Loans and Grants hosts a wide variety of EPA grants specifically for California. While these funding sources may not tie directly to fuel management or fire recovery, there is a wide array of funding opportunities for water and air resources which are directly impacted by wildfire.

Source: Northern California Forests and Watersheds Program

Agency: Multiple

Website: https://www.nfwf.org/programs/northern-california-forests-and-watersheds

Description: The National Fish and Wildlife Foundations and the U.S. Forest Service have partnered to restore and enhance National Forests and watersheds affected by wildfires in northern California. This program will administer an initial $6 million in grants to projects that increase wildfire resiliency for northern California National Forests and watersheds.

Source: Adaptation Clearinghouse

Agency: Multiple

Website: https://resilientca.org/

Description: This resource has numerous wildfire-related resources such as funding opportunities, assessments, case studies, educational materials, data and tools, example plans and strategies, and additional policy guidance.

Source: State of California's Grants Portal

Agency: Multiple

Website: https://www.grants.ca.gov/

Description: The California Grants Portal helps users identify the latest grants that could support fire hazard planning or related implementation efforts that support wildfire risk mitigation, fuels management, and other related projects.

DRAFT

Source: **California Air Resources Board Funding Wizard**

Agency: Multiple

Website: https://fundingwizard.arb.ca.gov/web/

Description: The Funding Wizard aggregates current federal, state, regional, private, and other funding opportunities for environmental and sustainability projects.

Source: **California Fire Foundation Grant Programs**

Agency: California Fire Foundation

Website: https://www.cafirefoundation.org/programs/fireprevention/

Description: The California Fire Foundation (CFF) offers grant opportunities to fire departments, firefighter associations, and community-based organizations whose projects help address wildfire and disaster prevention, preparedness, relief, and recovery needs within the state of California. The CFF directly supports high fire threat and/or under-resourced communities.

Source: **Wildfire Recovery Fund**

Agency: California Community Foundation

Website: https://www.calfund.org/wildfirerecoveryfund/

Description: The Wildfire Recovery Fund supports intermediate and long-term recovery efforts for major California wildfires. The Fund also supports wildfire prevention and preparedness efforts. Since 2003, the fund has granted more than $32 million to support relief and recovery efforts in the aftermath of destructive wildfires.

PRIVATE FUNDING INFORMATION

Source: **State Farm Good Neighbor Citizenship (GNC) Grants**

Agency: State Farm

Website: https://www.statefarm.com/about-us/corporate-responsibility/community-grants/good-neighbor-citizenship-grants

Description: State Farm funding is directed at:

- Auto and roadway safety
- Teen Driver Education
- Home safety and fire prevention
- Disaster preparedness
- Disaster recovery

Source: **The Urban Land Institute (ULI)**

Website: http://www.uli.org

Description: ULI is a 501(c)(3) nonprofit research and education organization supported by its members. The institute has more than 22,000 members worldwide, representing the entire spectrum

of land use and real estate development disciplines, working in private enterprise and public service. The mission of the ULI is to provide responsible leadership in the use of land to enhance the total environment. ULI and the ULI Foundation have instituted Community Action Grants that could be used for Firewise Communities activities. Applicants must be ULI members or part of a ULI District Council. Contact actiongrants@uli.org or review the web page to find your District Council and the application information.

Source: Environmental Systems Research Institute (ESRI)

Website: http://www.esri.com/grants

Description: ESRI is a privately held firm and the world's largest research and development organization dedicated to geographic information systems. ESRI provides free software, hardware, and training bundles under ESRI-sponsored Grants that include such activities as conservation, education, and sustainable development, and posts related non-ESRI grant opportunities under such categories as agriculture, education, environment, fire, public safety, and more. You can register on the website to receive updates on grant opportunities.

Source: National Forest Foundation; Innovative Finance for National Forests Grant Program

Website: https://www.nationalforests.org/grant-programs/innovative-finance-for-national-forests-grant-program

Description: The Innovative Finance for National Forests Grant Program aims to bring in non-USFS funds to increase forest resilience. There are three main topics for funding: Wildfire Resilience and Recovery, Sustainable Recreation Access and Infrastructure, and Watershed Health. In addition, three types of projects are funded. Pilot Programs with on-the-ground implementation, Scaling Projects to deliver backlogs of unfunded work, and Research and Development to provide to new forest information.

Source: Matching Awards Program

Agency: National Forest Foundation (NFF)

Website: https://www.nationalforests.org/grant-programs/map

Description: The NFF is soliciting proposals for its Matching Awards Program (MAP) to provide funds for direct on-the-ground projects benefitting America's National Forests and Grasslands. By pairing federal funds provided through a cooperative agreement with the U.S. Forest Service with non-federal dollars raised by award recipients, MAP measurably multiplies the resources available to implement stewardship projects that benefit the National Forest System.

Source: Patagonia Environmental Grants and Support

Agency: Patagonia

Website: https://www.patagonia.com/how-we-fund/

Description: Patagonia supports innovative work that addresses the root causes of the environmental crisis and seeks to protect both the environment and affected communities. Patagonia focuses on places where they have built connections through outdoor recreation and through their network of retail stores, nationally and internationally.

Source: **Leonardo DiCaprio Foundation Grants**

Agency: Leonardo DiCaprio Foundation

Website: https://www.rewild.org/

Description: The foundation supports projects around the world that build climate resiliency, protect vulnerable wildlife, and restore balance to threatened ecosystems and communities.

Source: **U.S. Endowment for Forestry and Communities**

Agency: U.S. Environmental Protection Agency, Natural Resources Conservation Service (NRCS), U.S. Forest Service, U.S. Department of Defense, U.S. Economic Development Agency

Website: https://www.usendowment.org/

Description: As the nation's largest public charity dedicated to keeping our working forests working and ensuring their bounty for current and future generations, the Endowment deploys the creativity and power of markets to advance their mission: The Endowment works collaboratively with partners in the public and private sectors to advance systemic, transformative and sustainable change for the health and vitality of the nation's working forests and forest-reliant communities.

OTHER FUNDING INFORMATION

The following resources may also provide helpful information for funding opportunities:

- Western Forestry Leadership Coalition: https://www.thewflc.org/
- USDA Information Center: https://www.nal.usda.gov/main/information-centers
- Forest Service Fire Management website: https://www.fs.usda.gov/managing-land/fire
- Insurance Services Office Mitigation Online (town fire ratings): http://www.isomitigation.com/
- National Fire Protection Association: http://www.nfpa.org
- National Interagency Fire Center, Wildland Fire Prevention/Education: https://www.nifc.gov/fire-information/fire-prevention-education-mitigation
- Department of Homeland Security U.S. Fire Administration: https://www.usfa.fema.gov/index.html

DRAFT

APPENDIX G:

Homeowner Resources

This page intentionally left blank.

ADDITIONAL LINKS AND RESOURCES

CALIFORNIA DEPARTMENT OF FORESTRY AND FIRE PROTECTION (CAL FIRE)

Home and Fuels Management

- Homeowners Checklist; How to Make Your Home Fire Safe: https://www.lakeshastina.com/Docs_PDFs/Checklist.pdf
- Hardening Your Home: https://www.readyforwildfire.org/prepare-for-wildfire/get-ready/hardening-your-home/
- Home Hardening Toolkit: https://www.readyforwildfire.org/campaign-toolkits/home-hardening-toolkit/
- Defensible Space: https://www.readyforwildfire.org/prepare-for-wildfire/get-ready/defensible-space/
- Defensible Space Toolkit: https://www.readyforwildfire.org/campaign-toolkits/defensible-space-toolkit/
- Fire-Resistant Landscaping: https://www.readyforwildfire.org/prepare-for-wildfire/get-ready/fire-resistant-landscaping/
- What Property Owners Need to Know to Reduce Wildfire Risk Each Season: https://www.readyforwildfire.org/forest-health/seasonal-actions/
- Prescribed Fire Toolkit: https://www.readyforwildfire.org/campaign-toolkits/prescribed-fires-toolkit/

Preparing for Wildfire

- Wildfire Action Plan: https://www.readyforwildfire.org/prepare-for-wildfire/get-set/wildfire-action-plan/
- How to Prepare to Evacuate From a Wildfire: https://www.readyforwildfire.org/prepare-for-wildfire/get-set/prepare-your-family/
- Pre-Evacuation Preparation Steps: https://www.readyforwildfire.org/prepare-for-wildfire/go-evacuation-guide/pre-evacuation-preparation-steps/
- Evacuation Steps: https://www.readyforwildfire.org/prepare-for-wildfire/go-evacuation-guide/evacuation-steps/
- Animal Evacuation: https://www.readyforwildfire.org/prepare-for-wildfire/go-evacuation-guide/animal-evacuation/
- GO! Evacuation Guide: https://www.readyforwildfire.org/prepare-for-wildfire/go-evacuation-guide/
- GO! Evacuation Toolkit: https://www.readyforwildfire.org/campaign-toolkits/go-evacuation-toolkit/
- Emergency Supply Kit: https://www.readyforwildfire.org/prepare-for-wildfire/get-set/emergency-supply-kit/

DRAFT

- Insurance Preparedness: https://www.readyforwildfire.org/prepare-for-wildfire/get-set/insurance-preparedness/
- Power Outage Information: https://www.readyforwildfire.org/prepare-for-wildfire/go-evacuation-guide/power-outage-information/
- What To Do If Trapped: https://www.readyforwildfire.org/prepare-for-wildfire/go-evacuation-guide/what-to-do-if-trapped/

Preventing Wildfire

- Equipment Use: https://www.readyforwildfire.org/prevent-wildfire/equipment-use/
- Debris Burning: https://www.readyforwildfire.org/prevent-wildfire/debris-burning/
- Vehicle Use: https://www.readyforwildfire.org/prevent-wildfire/vehicle-use/
- Campfire Safety: https://www.readyforwildfire.org/prevent-wildfire/campfire-safety/
- Target Shooting Safety: https://www.readyforwildfire.org/prevent-wildfire/target-shooting-safety/
- One Less Spark, One Less Wildfire Toolkit: https://www.readyforwildfire.org/prevent-wildfire/one-less-spark-campaign/
- Forest Health: https://www.readyforwildfire.org/forest-health/
- Forest Health Toolkit: https://www.readyforwildfire.org/campaign-toolkits/forest-health-toolkit/

After the Fire

- Returning Home After a Wildfire: https://www.readyforwildfire.org/post-wildfire/
- What to Expect After a Wildfire: https://www.readyforwildfire.org/post-wildfire/after-a-wildfire/
- Immediate Safety: https://www.readyforwildfire.org/post-wildfire/returning-home/
- Rebuilding, Mobilizing Your Community: https://www.readyforwildfire.org/post-wildfire/rebuilding/
- Who Can Help? https://www.readyforwildfire.org/post-wildfire/who-can-help/

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA):

Protecting Your Home

- Understanding the Wildfire Threat to Homes: https://www.nfpa.org/News-and-Research/Publications-and-media/Blogs-Landing-Page/Fire-Break/Blog-Posts/2020/12/08/Interactive-online-resource-helps-build-understanding-of-wildfire-risks
- Preparing Homes for Wildfire: https://www.nfpa.org/Public-Education/Fire-causes-and-risks/Wildfire/Preparing-homes-for-wildfire
- If your Home Doesn't Ignite, It Can't Burn: https://www.youtube.com/watch?v=RqKFDDBGd5o
- How do Homes Burn in a Wildfire? https://www.youtube.com/watch?v=3QthynXympI
- Wildfire Community Preparedness Day Toolkit: https://go.nfpa.org/l/14662/2022-01-11/8j6nqh

DRAFT

- 5 Key Areas Around the Home You Must Examine When Assessing Wildfire Risk: https://www.youtube.com/watch?v=MIUQVL3BvVg
- Your Home and Wildfire, Choices That Make a Difference: https://www.youtube.com/watch?v=pfbEcMeYFFA
- Home Hardening Fact Sheets: https://www.nfpa.org/Public-Education/Fire-causes-and-risks/Wildfire/Firewise-USA/Firewise-USA-Resources/Research-Fact-Sheet-Series

Preparation and Evacuation

- Wildfire Preparedness Tips: https://www.nfpa.org/Public-Education/Fire-causes-and-risks/Wildfire/Wildfire-safety-tips
- Wildfire Preparedness for Household Pets: https://www.nfpa.org//-/media/Files/Public-Education/Campaigns/TakeAction/TakeActionPetsChecklist.pdf
- Wildfire Preparedness for Horses and Livestock: https://www.nfpa.org/-/media/Files/Public-Education/Campaigns/TakeAction/TakeActionHorseChecklist.ashx
- Backpack Emergency GO! Kit: https://www.nfpa.org/-/media/Files/Public-Education/Campaigns/TakeAction/TakeActionBackPackGoKit.ashx
- Outthink a Wildfire; Wildfire Action Policies: https://www.nfpa.org/wildfirepolicy

MISC.

- Non-Renewals for California Homeowners: https://strongerca.com/wp-content/uploads/2021/06/Non-renewals-for-CA-Homeowners.pdf
- Mass Tree Mortality, Fuels, and Fire: A Guide for Sierra Nevada Forest Landowners: https://anrcatalog.ucanr.edu/pdf/8683.pdf
- Instructor Guide; The ability to identifying, analyzing, and using relevant situational information about topographic features can help predict wildland fire behavior is the responsibility of everyone on the fireline: https://www.nwcg.gov/sites/default/files/training/docs/s-190-ig04.pdf
- WiRē – Wildfire Research, an interdisciplinary collaboration on community adaptability to wildland fire: https://wildfireresearchcenter.org/
- Wildfire Ready App:
    - App Store: https://apps.apple.com/us/app/wildfire-ready-virtual/id1540773278?msclkid=4eac0069a71411ecb26fa03c0b08eba2
    - Google Play: https://play.google.com/store/apps/details?id=com.BaltiVirtual.Wildfire&gl=US&msclkid=4eabc8f6a71411ecbfe27aa64cd6d835

DRAFT

This page intentionally left blank.

DRAFT

APPENDIX H:

Project Outreach

This page intentionally left blank.

COMMUNITY OUTREACH

Table H.1 presents examples of the public outreach completed as part of the CWPP development. Online resources were used to provide information to the public and solicit feedback. A community event was held by the 40 Acres Fire Safe Council, SWCA, and the Whitebark Institute. Figure H.1 shows an online announcement of the community event and Figure H.2 shows the community event. In addition, the Whitebark institute conducted an online survey of wildfire concerns and priorities. The survey and results are shown in pages H.3 through H.7.

Feedback, comments, and suggestions received from community members during community events (e.g., meetings and walkthroughs), the community survey, and project recommendations review were synthesized and utilized to craft project recommendations for the 40 Acres CWPP. Therefore, the project recommendations (see Chapter 4 or Appendix J) are specifically tailored to address the concerns and priorities of the community.

Table H.1. Public Outreach Resources

Resource Description	Location	Figure Number(s)	Date
Community Event Announcement	Facebook	H.2	10/28/2022
Neighborhood Meeting	40 Acres	H.1	10/29/2022
Community Survey	40 Acres (distributed via email)	See pages H-3 to H-7	December 2022



Figure H.1. Community event announcement



Figure H.2. 40 Acres neighborhood meeting.

DRAFT

COMMUNITY SURVEY RESULTS

40 Acres CWPP:

Survey Responses: 6

December 2022

Question 1. Please enter as much information about your home location as possible (If you wish to remain anonymous, please provide general location information)

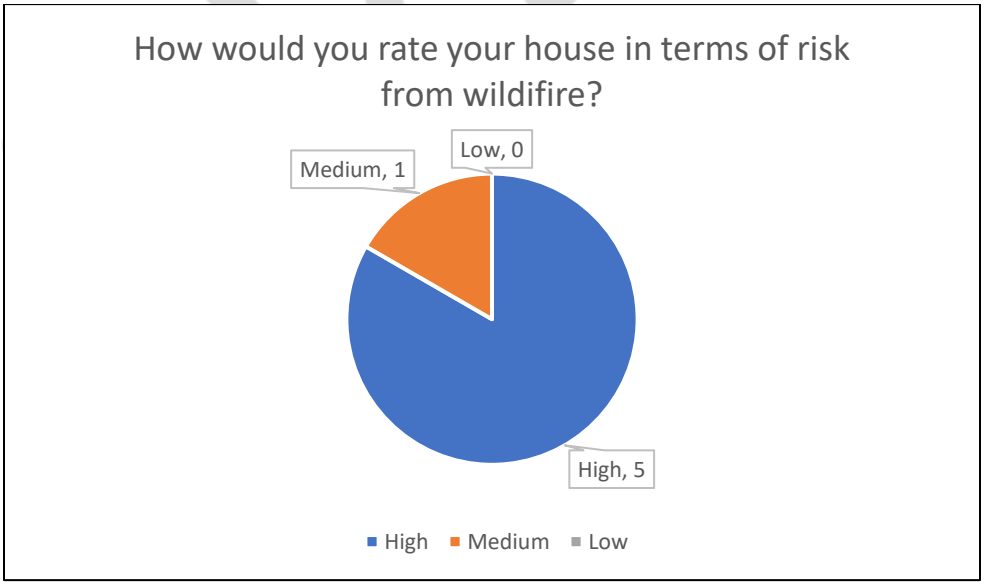
Addresses removed for privacy

Question 2. How would you rate your house in terms of risk from wildfire? (*Consider the proximity of your house to tracts of undeveloped land, vegetated land, emergency response and access*)

_____ Low

_____ Medium

_____ High



DRAFT

Question 3. My home is vulnerable to wildfire because of…… (*Select all that apply*)

_____ Surrounding fuels on your property - (i.e., live and dead trees, shrubs, grass, wood piles)

_____ Surrounding fuels on neighboring property - (i.e., dense vegetation, wood piles, dead and downed trees

_____ Building materials - (i.e., wood shingles, clap board siding, wooden decks, wood fences)

_____ Lack of water supply - (i.e., dependence on well water, far from hydrant)

_____ Accessibility challenges - (i.e., long narrow driveway, dead end road, can a fire truck easily access your property?)

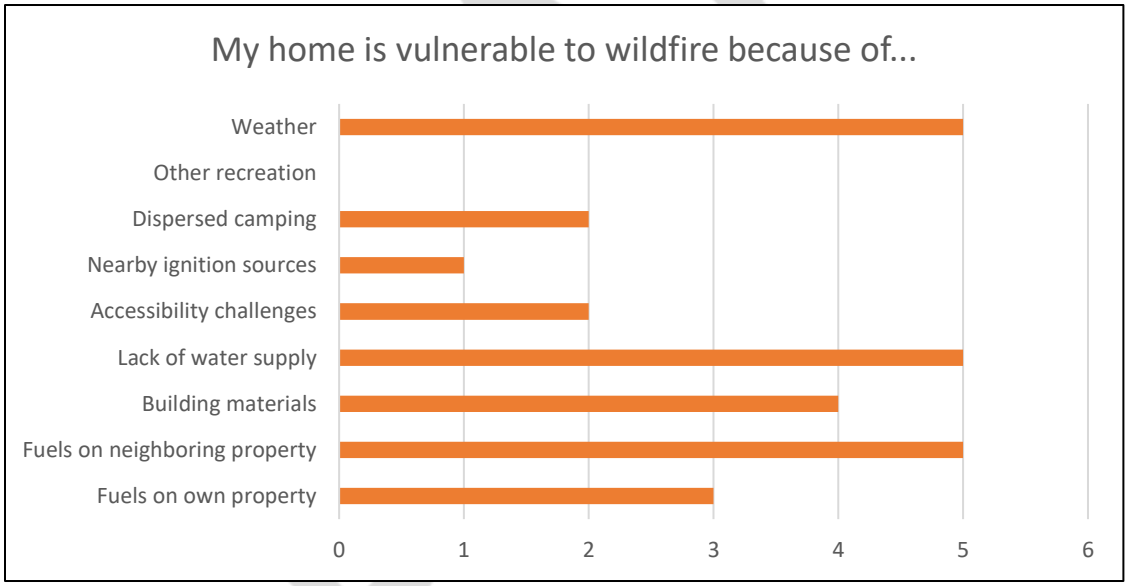
_____ Ignition sources from neighboring areas - (i.e., disposal of cigarette butts from trails or roads)

_____ Dispersed camping

_____ Other forms of recreation (i.e., hunting, off-roading, etc.)

_____ Weather (wind, drought)

_____ Other: _____

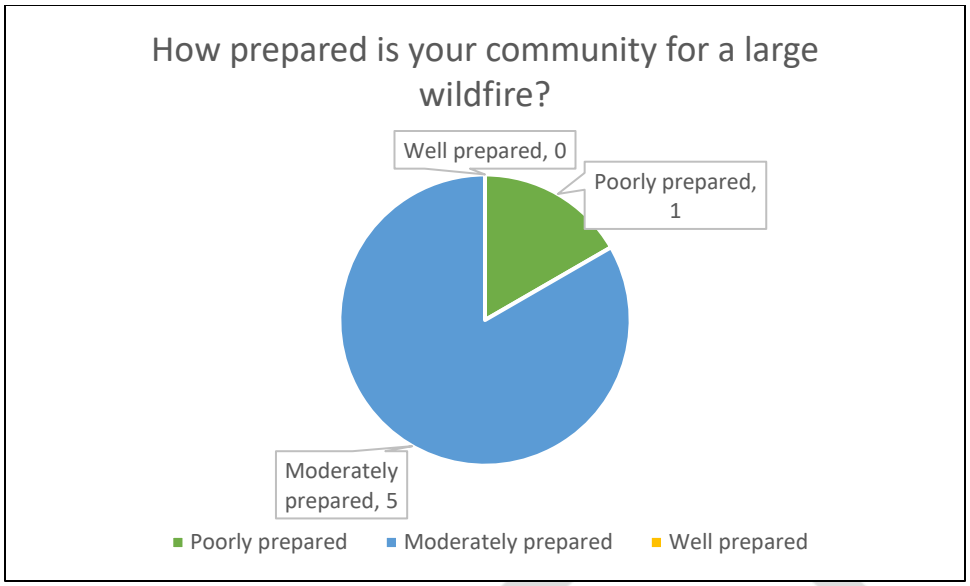


Question 4. How prepared is your community for a large wildfire? (*Select one*)

_____ Poorly prepared

_____ Moderately prepared

_____ Well prepared



Question 5. Score each of the following actions from 1 to 5 in its importance to making the community better prepared for wildfire (1=not important, 5=very important)

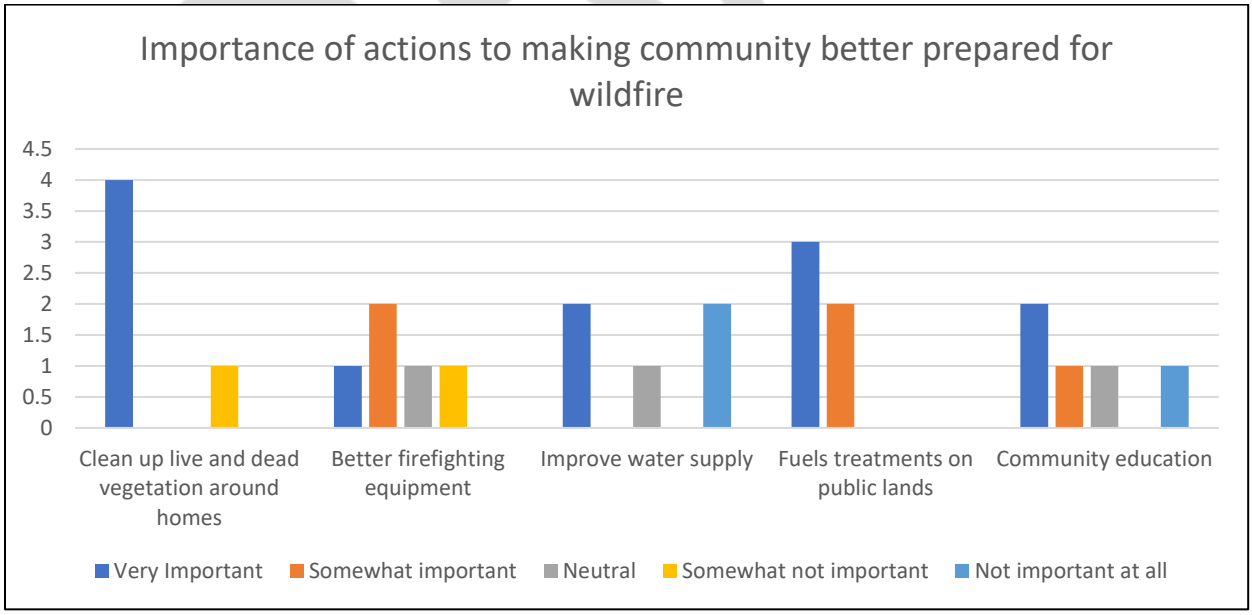
_____ Clean up live and dead vegetation and yard debris around homes by individual property owners

_____ Better firefighting equipment

_____ Improved water supply – (i.e., expansion of public water systems, increased number of hydrants, installation of wells)

_____ Fuel treatments on public lands to reduce the amount of live and dead vegetation available to burn in a fire

_____ Community education on wildfire prevention and awareness



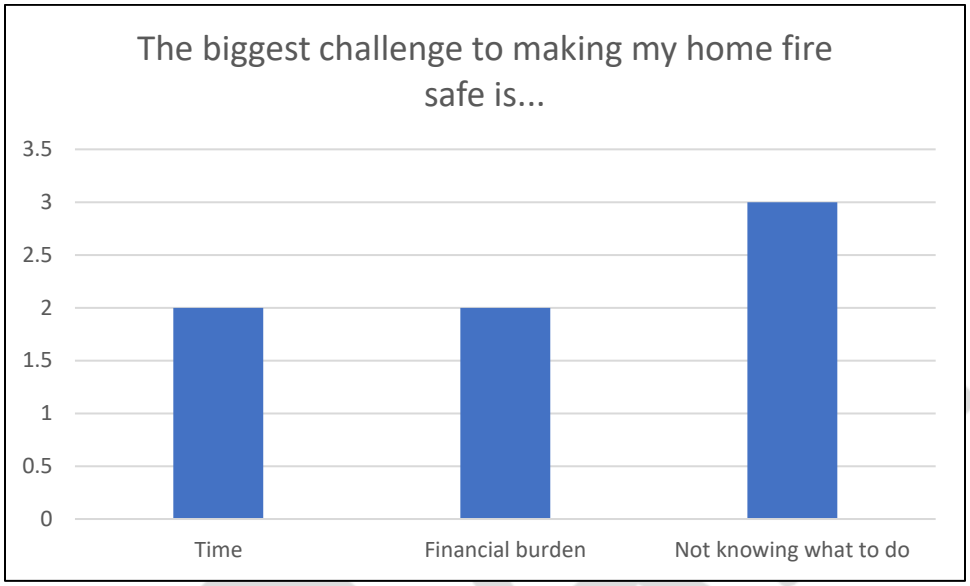
Question 6. My biggest challenge to making my home fire safe is…. (*select all that apply*)

_____ Time

_____ Financial burden of carrying out mitigation measures and maintaining clearance

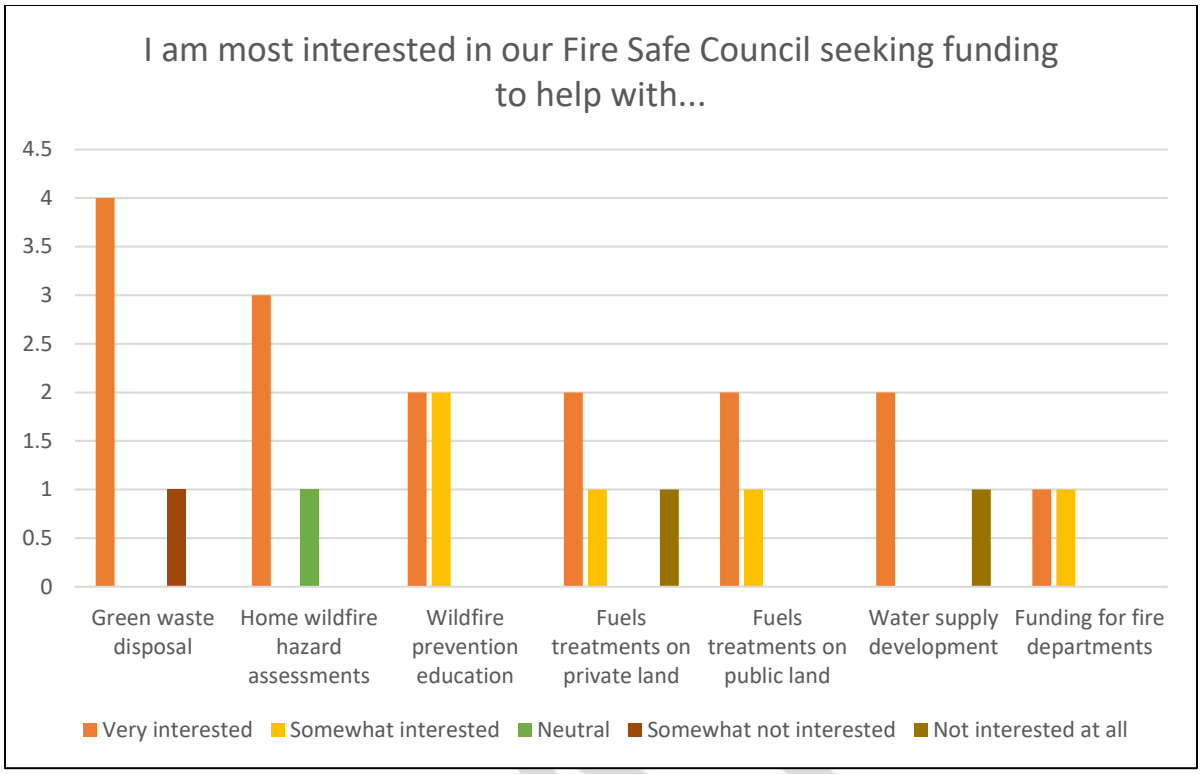
_____ Not knowing what to do

_____ Other: _____



Question 7. I am most interested in our Fire Safe Council seeking funding to help with: (*Please score 1-5, 1=not interested, 5=very interested*)

_____ Green waste disposal - (i.e., removal of leaves, branches, wood from cleared areas)
_____ Home wildfire hazard assessments
_____ Wildfire prevention education
_____ Timber/fuel treatments on private land
_____ Timber/fuel treatments on public land
_____ Water supply development - (i.e., extend public water systems, add additional hydrants, install fire wells, and acquire portable water supplies)
_____ Funding for fire departments - (i.e., to secure additional apparatus/equipment, fund training, fund additional staff)



Question 8. Do you burn on your property?

Yes _____
No _____

Two respondents answered "yes", though one of those answers referred to a wood stove.

Four respondents answered "no".

Question 9. Name any community resources you would most like to see prioritized for protection from wildfire (*e.g., natural areas, cultural sites, town infrastructure, parks, campgrounds*).

Please note that written comments and responses are in the project files and are available upon request.

Question 10. Any other comments?

Please note that written comments and responses are in the project files and are available upon request.

STAKEHOLDER OUTREACH

To convene an all-inclusive Core Team, SWCA, the Whitebark Institute, and 40 Acres Fire Safe Council conducted extensive stakeholder outreach that consisted of emails, calls, video conferencing, and in-person meetings with personnel from the local government, private entities, fire organizations, and federal land managers (see Figure H.2).



Figure H.3. 40 Acres 2nd Core Team meeting (October 27, 2022).

DRAFT

APPENDIX I:

Project Recommendations

This page intentionally left blank.

Table I.1. Recommendations to Create Resilient Landscapes (Fuel Treatments)

Project ID	Status	Priority (H,M,L)	Timeline for Action	Project Description	Location	Partners and/or Collaborating Agencies	Methodology/Approach	Serves To:	Monitoring/Maintenance Requirements	Funding Sources
CRL #1		H	Spring 2024	Selective thinning and removal of dead and downed vegetation, particularly light fuels (small branches, twigs, dead brush) along ditches and creeks. Consider selective and strategic removal of larger dead logs to enhance firefighter access.	Along ditches and creeks, focusing on the southwest ditch	40 Acres FSC, LADWP (to provide access and coordination), CDFW, BLM	• Work with CDFW to determine feasible projects • Treatment methods could include hand thinning and prescribed fire when appropriate • Consider creating breaks for fire apparatus access	• Limit the spread of wildland fire and increase access to water resources with strategic placement of fuel breaks • Provide for safe and effective wildfire response capabilities	• Frequent maintenance since riparian vegetation grows quickly	• CAL FIRE Forest Health Grants • California EPA Loans and Grants • U.S. Forest Service Community Wildfire Defense Grant (USFS CWDG) • California Climate Investments Fire Prevention Grant Program (CAL FIRE) • LADWP can provide letters of support for grant applications
CRL #2	Ongoing	H	According to project schedule	Follow through with the planned fuel breaks on the north, east, and south sides of the community Refer to Figure 4.1	Eastern, northern, and southern boundaries	LADWP (to provide access and coordination), CAL FIRE, 40 Acres FSC	• Work with LADWP and CDFW to install fuel breaks on the north, east, and south sides of the community	• Create resilient landscapes and address potential for extreme wildfire behavior in and around the WUI • Protect life and property by mitigating fuels • Provide defensible space for firefighters protecting structures	• Regular maintenance is needed to ensure the fuel break remains clear of dense and flammable vegetation • Monitor for invasive species	• CAL FIRE Grant Programs • USFS CWDG
CRL #3		H	Fall 2024	Work with CDFW and BLM to install fuel breaks along the ditch to the southwest Refer to Figure 4.1	Southwest ditch	40 Acres FSC, CAL FIRE, BLM	• Search for natural breaks in vegetation to create fuel breaks up to a quarter mile upstream from 40 Acres • Align treatment with CDFW land management and habitat objectives	• Balance the reduction of hazardous fuels with the protection of wildlife habitat • Protect life and property by mitigating fuels	• Regular maintenance is needed to ensure the fuel break remains clear of vegetation. • Monitor for invasive species	• FEMA Building Resilient Infrastructure and Communities Grant (BRIC) • USFS CWDG Grants • CAL FIRE Grant Programs
CRL #4		H	Fall 2024	Increase workforce and firefighting personnel capacity	40 Acres and surrounding area	CAL FIRE	• Develop workforce to implement and maintain needed hazardous fuels projects and to perform defensible space inspections • Seek recruitment opportunities with non-profits such as the California Conservation Corps	• Reduce wildfire risk through greater capacity for wildfire projects • Create resilient landscapes and address potential for extreme wildfire behavior in and around the WUI.	• Assess capacity on an annual basis	• FEMA Staffing for Adequate Fire and Emergency Response • FEMA Assistance to Firefighters Grants • California Fire Foundation Grant Program • USFS CWDG
CRL #5		H	Spring 2024	Support fuel reduction efforts on private property by addressing green waste management	40 Acres	Inyo County, 40 Acres FSC, CAL FIRE, BLM	• County to investigate how to acquire, rent, or borrow a chipper from BLM or CAL FIRE • 40 Acres FSC to coordinate/ establish chipper days for the communities • Consider liability concerns if trained personnel are not on-site to operate equipment	• Support community defensible space efforts • Reduce fuel loading within the community	• Springtime, yearly	• CAL FIRE Forest Health Grants • Firewise Communities Grants • California Fire Safe Council Grants • USFS CWDG
CLR #6	Ongoing	H	According to project schedule	Maintain the fuel break on the west side of 40 Acres Refer to Figure 4.1	40 Acres	BLM, CAL FIRE, 40 Acres FSC	• Continue to apply the current approach	• Create resilient landscapes and address potential for extreme wildfire behavior in and around the WUI	• As scheduled	• CAL FIRE Grant Programs • USFS CWDG Grants • FEMA Building Resilient Infrastructure and Communities Grant (BRIC)

Table I.2. Recommendations for Creating Fire-Adapted Communities (Public Education and Reducing Structural Ignitability)

Project ID	Status	Priority (H,M,L)	Timeline for Action	Project Description	Location	Partners and/or Collaborating Agencies	Methodology/Approach	Serves To:	Monitoring/Maintenance Requirements	Funding Sources
FAC #1		H	Winter 2023	Inform the public on how to mitigate risk and damage from wildfire	40 Acres	40 Acres FSC, CAL FIRE, and Inyo County OES	• Create wildfire information and education documents to distribute • Increase awareness and knowledge through community workshops and training classes on defensible space, fire safe landscaping, and structural hardening concepts • Provide a printed list of mitigation measures to homeowners. Utilize Ready, Set, GO! Literature. Utilize list of actions broken down by cost • Provide community-specific homeowner education media, including videos (demonstration projects on private property) • 40 Acres FSC to engage new homeowners/renters to promote fire education for property residents, even if temporary • Work with fire departments to create a checklist of what responders look for during triage so the public can see what responders look for. • Ensure that all interactions result in follow up engagement by collecting contact information for residents interested in action. • Seek opportunities to work with the Whitebark Institute for defensible space and home hardening workshops and/or community demonstrations	• Reduce wildfire risk through community collaboration • Protect communities and valued resources by raising awareness of community residents and those staying in the area about actions that can prevent fires	• Review and revise strategy on an annual basis	• FEMA Building Resilient Infrastructure and Communities (BRIC) Grants • EPA Environmental Education Grants • CAL FIRE Grant Programs • California Fire Safe Council Grants • USFS CWDG
FAC #2		H	Fall 2023	Seek Firewise Community Certification for 40 Acres	40 Acres	40 Acres FSC	• Work with Firewise USA, the California FSC, and the Inyo County Wildfire Coordinator to begin the process of Firewise certification if community supports involvement • Evaluate community interests in Firewise Certification • Conduct a cost-benefit analysis of forming a Firewise certified community • Engage local, county, and state stakeholders	• Reduce wildfire risk through community collaboration • Facilitate access to funding and assistance • Develop a framework for action	• Maintain “good standing” by reporting work completed and accomplishments on an annual basis	• Firewise Grants • California Fire Safe Council Grants • USFS CWDG
FAC #3		H	Spring 2024	Implement community events focused on vulnerable populations	40 Acres	40 Acres FSC and Inyo County OES	• Identify volunteers • Host a community-led day of yard cleanup with fire mitigation in mind to encourage large numbers within the community to carry out mitigation measures and implement defensible space • Residents to assist elderly, disabled, or vulnerable neighbors	• Reduce wildfire risk through greater adoption of Firewise and structure hardening measures	• Yearly, in preparation for the fire season • Conduct annual review to determine what works and what doesn’t	• FEMA BRIC Grants • CAL FIRE Grants • California Fire Safe Council Grants • USFS CWDG

Project ID	Status	Priority (H,M,L)	Timeline for Action	Project Description	Location	Partners and/or Collaborating Agencies	Methodology/Approach	Serves To:	Monitoring/Maintenance Requirements	Funding Sources
FAC #4		H	Fall 2024	Investigate 1) opportunities to offer financial assistance for defensible space work to seniors and low-income individuals and 2) how to use community-wide benefits to motivate individuals to create defensible space	40 Acres	Inyo County OES, 40 Acres FSC	• 40 Acres FSC to work with the County to identify funding opportunities • 40 Acres FSC to identify methods to incentivize homeowners to create defensible space • Identify grants for the FSC to hire contractors to perform defensible space work • Seek opportunities to partner with Team Rubicon (https://teamrubiconusa.org/) for free wildfire mitigation support	• Assist vulnerable populations with wildfire risk reduction • Support community defensible space efforts • Reduce fuel loading within the community	• Establish a program to determine frequency of activities	• Firewise Grants • CAL FIRE Wildfire Prevention Grants • California Fire Safe Council Grants • USFS CWDG
FAC #5		H	Summer 2023	Involve second-home owners and absentee homeowners in wildfire education and mitigation efforts	40 Acres	Inyo County OES, 40 Acres FSC	• Inyo County Wildfire Coordinator to use the county assessor's mailing list to pull contact information for second homes and absentee homeowners	• Encourage community-wide involvement in wildfire prevention and mitigation efforts	• Biannual	Not applicable
FAC #6		H	Spring 2023	Implement and maintain defensible space and structure hardening measures	40 Acres	Community residents and homeowners	• Implement defensible space standards in the community • Upgrade combustible construction materials to fire-resistive materials • Seek opportunities to partner with Team Rubicon (https://teamrubiconusa.org/) for free wildfire mitigation support	• Reduce wildfire risk through greater adoption of Firewise and structure hardening measures	• Yearly maintenance	• CAL FIRE Wildfire Prevention Grants • Firewise grants • California Fire Safe Council Grants • USFS CWDG
FAC #7		M	Spring 2024	Establish relationships with non-profit and public agencies to increase capacity	40 Acres	40 Acres FSC and Inyo County OES	• Investigate opportunities to form relationships with non-profit agencies such as California Conservation Corps, American Conservation Experience, and Team Rubicon (https://teamrubiconusa.org/)	• Create resilient landscapes and address potential for extreme wildfire behavior in and around the community	N/A	Not applicable
FAC #8		M	Spring 2024	Conduct a community walkthrough	40 Acres	40 Acres FSC, CAL FIRE, BLM	• CAL FIRE and BLM staff to host a community walkthrough day with community residents to determine potential projects and needs for defensible space, fuel breaks, and fire response	• Increase wildfire preparedness and community safety • Engage and involve community members	• Conduct on an annual basis	Not applicable
FAC #9		M	Spring 2025	Address excess rubbish and debris on private properties	40 Acres	Inyo County OES, Inyo County Board of Supervisors	• Investigate the feasibility of establishing a county ordinance to mandate the clearing of hazardous rubbish and debris	• Decrease hazardous combustible materials from the community • Enhance community safety	N/A	Not applicable
FAC #10		H	Summer 2024	Establish a community pre-fire plan	40 Acres	40 Acres FSC, 40 Acres homeowners, CAL FIRE, Inyo County OES	• Collaboratively develop a pre-fire plan to facilitate neighbor to neighbor information sharing and emergency readiness • Make plans for pet and livestock evacuations (e.g., contacts for evacuation assistance and shelter locations) • Create a map with backup energy sources that are independent of the grid • Distribute pre-fire plans to all residents and place in Airbnb properties • Identify elderly residents that may need assistance with evacuation	• Promote community involvement • Improve community preparedness	• Yearly updates	• CAL FIRE Wildfire Prevention Grants • California Fire Safe Council Grants • Firewise Grants • USFS CWDG

Table I.3. Recommendations for Safe and Effective Wildfire Response

Project ID	Status	Priority (H,M,L)	Timeline for Action	Project Description	Location	Land Ownership/ Lead Agency	Methodology/Approach	Serves To:	Monitoring/Maintenance Requirements	Funding Sources
SEWR #1		H	Fall 2024	Identify roads and shelter-in-place locations and inform residents about evacuation procedures	40 Acres	40 Acres FSC, Inyo County OES	• Identify shelter-in-place locations and distribute maps to all residents • Distribute information regarding County designated community shelters • Distribute evacuation materials using resources from CAL FIRE, Firewise, and Ready, Set, GO! • Increase education through community workshops and mock evacuation drills • Develop a map that clearly shows all roads with potential ingress and egress points into 40 Acres and distribute to all residents	• Improve wildfire response and readiness • Facilitate evacuation procedures	• Update as needed to reflect changes in evacuation routes and shelter-in-place locations	• EPA Environmental Education Grants • FEMA Fire Prevention and Safety Grants • Firewise Communities Grants • CAL FIRE Fire Prevention Grants • USFS CWDG
SEWR #2		M	Spring 2025	Expand coverage of Alert California live cameras	40 Acres	Alert California Core University Partners	• Investigate opportunities to install cameras where there is limited coverage	• Enhance wildfire response and readiness • Support early attack plans • Facilitate emergency notifications such as evacuation orders	• Follow existing maintenance schedule	• FEMA Building Resilient Infrastructure and Communities Grants • CAL FIRE Fire Prevention Grants • USFS CWDG
SEWR #3		H	Fall 2024	Improve wildfire emergency notification systems	40 Acres	Sheriff's Office and Inyo County OES	• Investigate the feasibility of installing a siren system in the community • Establish a reliable source (website or notification system) to relay alerts and messages quickly and consistently • Inyo County to continue the process of upgrading the Inyo OES website	• Provide timely emergency alerts • Facilitate evacuation efforts	• Periodic testing of siren system	• FEMA BRIC Grants • CAL FIRE Community Wildfire Prevention Grants • USFS CWDG
SEWR #4		H	Winter 2023	Create additional means of ingress and egress	40 Acres	40 Acres FSC, BLM	• Connect Ocean View Road to the BLM road to the west • Work with CAL FIRE to determine road width specifications and requirements	• Provide alternative evacuation routes • Provide additional access points for fire responders	• As needed to prevent encroachment of vegetation	• FEMA Fire Prevention and Safety Grants • FEMA BRIC Grants • CAL FIRE Community Wildfire Prevention Grants • USFS CWDG

SEWR #5		M	Summer 2023	Provide sufficient clearance between power lines and trees	40 Acres	40 Acres FSC, Southern California Edison (SCE), LADWP	• Utilize SCE's tree removal/maintenance program to maintain safe clearance between power lines/poles and trees
							  ○ Report hazard trees (trees that are in contact with powerlines or poles) at (800) 655-4555
							• Use LADWPs hotline to report hazard trees that are leaning and/or touching powerlines and poles (760) 873-0251
							  ○ LADWP patrols will evaluate reports and determine if treatment is needed
								• Reduce hazard tree encroachment
								• Enhance firefighter safety
									• As needed	• Not applicable

SEWR #6		M	Spring 2024	Maintain dirt roads and trails	40 Acres	CAL FIRE, BLM, Inyo County OES	• Maintain existing road and trail networks using mechanical treatments	• Provide access to fire personnel • Establish fuel breaks and fire containment lines	• Annually	• USFS Community Wildfire Defense Grant • CAL FIRE Community Wildfire Prevention Grants • FEMA BRIC Grants
SEWR #7		M	Spring 2025	Assess existing water supply for fire suppression and develop a map of backup power sources		CAL FIRE, Inyo County OES	• Conduct an assessment of water resources in 40 Acres to determine if improvements are needed • Identify backup power sources (e.g., solar power and generators) in the community and create a map to distribute to fire agencies and 40 Acres residents	• Protect life and property though improved firefighting response • Improve firefighter safety	• As needed	• FEMA BRIC Grants • USFS CWDG

APPENDIX J:

Fuel Treatment Types & Methods

This page intentionally left blank.

FUELS TREATMENT SCALES AND METHODS

DEFENSIBLE SPACE

Defensible space is perhaps the fastest, most cost-effective, and most efficacious means of reducing the risk of loss of life and property. Although fire agencies can be valuable in providing guidance and assistance, creating defensible space is the responsibility of the individual homeowner (Figure J.1).

The definition of defensible space via state and local codes, its maintenance by homeowners, and enforcement by fire agencies as needed is a common part of wildfire risk mitigation. The California State Board of Forestry issued General Guidelines for Creating Defensible Space in 2008, following a change in Public Resources Code 4291 that expanded defensible space clearance requirements from 30 to 100 feet around buildings and structures within SRAs or very high fire hazard severity zones within LRAs. The Public Resources Code was amended in January 2021 to require an ember-resistant zone within 5 feet of the home/structure on or before January 1, 2023. This translates to having a clearance of 5 feet between the home/structure and any materials that would likely be ignited by embers (CAL FIRE 2022d).

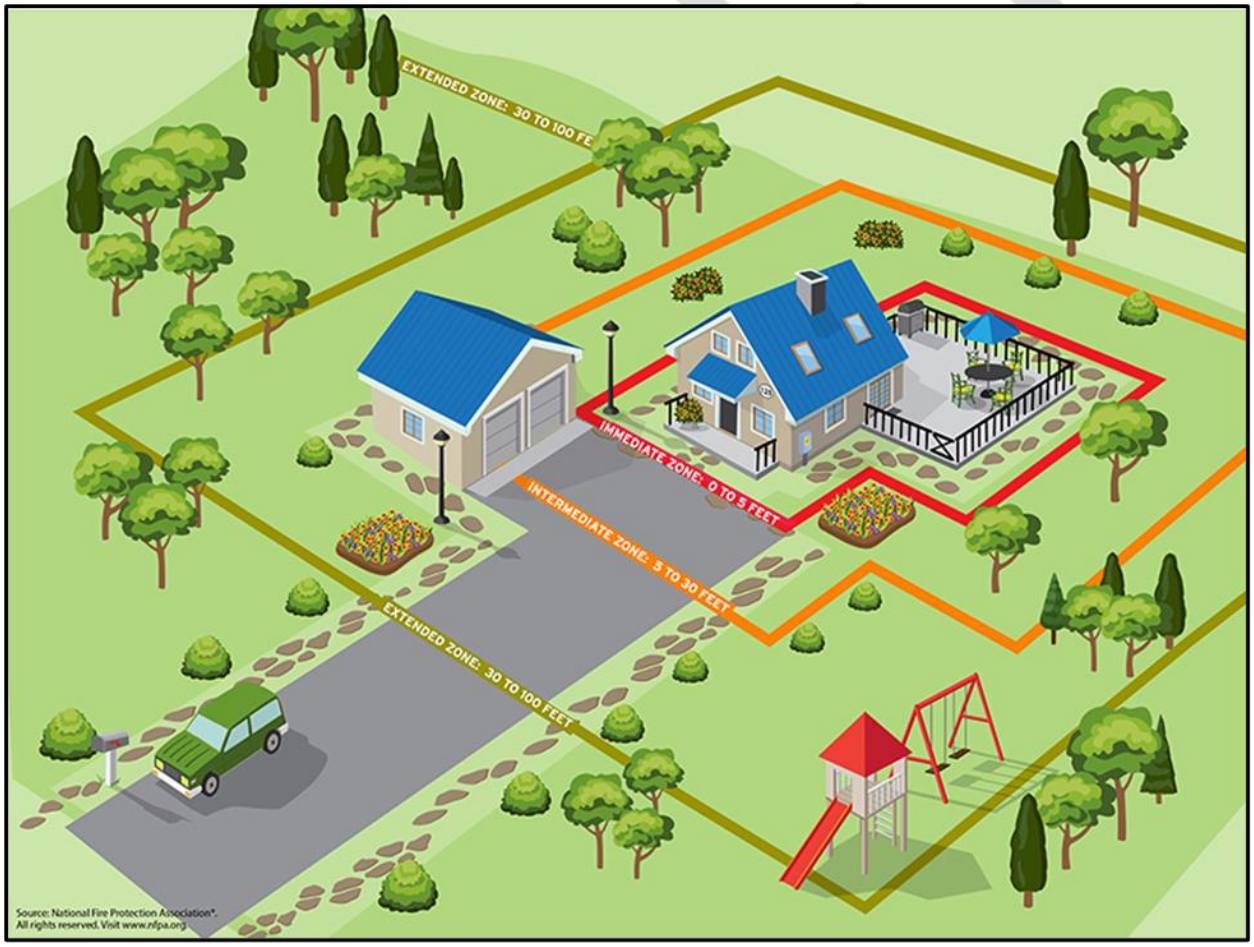


Figure J.1. Defensible space zones providing clearance between a structure and adjacent woodland or forest fuels.
Source: NFPA

Some aspects about WUI defensible space that are often overlooked include:

- The amount of defensible space needed may vary due to local conditions, such as slope, fuel density, building materials, or location.
- Fuel reduction has more to do with disrupting fuel continuity so that the spread of fire is impeded, rather than creating a denuded zone around a home. For example, pruning the lower limbs of trees creates a break between ground fuels and tree canopies, reducing the chances that a fire will move from a ground fire to a crown fire.
- Communities may wish to develop defensible space areas that are greater than 100 feet for even better protection; the code sets only a minimum distance. However, expanding treatments beyond property lines can only be done if allowed by state law, local ordinance, rule, or regulation.
- Defensible space also provides a safer environment within which firefighters can work. This environment is more than vegetation clearance; defensible space also involves emergency vehicle access, water supply, and clear street signs and addresses. All these factors, and many more as identified by previous community-level CWPPs, affect the usefulness of defensible space in structure protection.
- Vegetation fuel reduction projects require compliance with all federal, state, or local environmental protection laws.

Effective defensible space is an essentially fire-free zone adjacent to the home, a treated secondary zone that is thinned and cleaned of surface fuels, and (if the parcel is large enough) a transitional third zone that is basically a managed forest area (Figure J.2). These components work together in a proven and predictable manner. Zone 1 keeps fire from burning directly to the home; Zone 2 reduces the adjacent fire intensity and the likelihood of torching, crown fire, and ember production; and Zone 3 does the same at a broader scale, keeping the fire intensity lower by maintaining a more natural, historic condition (Figure J.2).

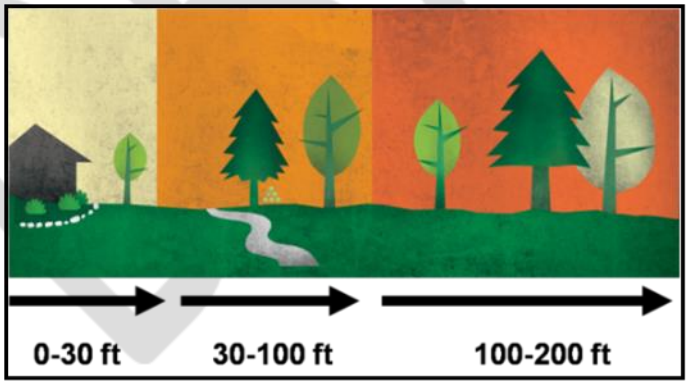


Figure J.2. Defensible space zones.
Source: Firewise.org

It should be emphasized that defensible space is just that—an area that allows firefighters to work effectively and with some degree of safety to defend structures. While defensible space may increase a home's chance of surviving a fire on its own, a structure's survival is not guaranteed, with or without firefighter protection. Nevertheless, when these principles are consistently applied across a

neighborhood, everyone benefits. The three zones for defensible space actions are described below (CAL FIRE 2022d):

Zone 0 – Immediate Zone, Ember Resistant**:** This zone is not currently required by state law. However, as of January 1, 2023, Assembly Bill 3074 will require the Board of Forestry and Fire Protection to develop the regulation for Zone 0. While not yet required, Zone 0 has been proven to be the most important defensible space zone for protecting a home against wildfire. This zone consists of the immediate area around a home and is defined as 0 to 5 feet from the property structure, including areas under and around all structure attachments, such as sheds or decks. Zone 0 requires the most stringent wildfire fuel reduction methods as actions taken within this zone can directly influence whether a property ignites. Recommendations for treating Zone 0 include (CAL FIRE 2022d):

- Use non-combustible landscaping materials, such as gravel in place of mulch.
- Clear all dead and dying debris from around a structure, including branches, dead leaves, pinecones, pine needles, grasses, and shrubs. Remember to check areas where the debris can accumulate, such as gutters, stairways, porches, and roofs.
- Clear all branches or vegetation within 10 feet of any chimney or stovepipe outlet.
- To keep vegetation within the 5-foot buffer around a structure, make sure plants are thoroughly watered, and keep non-woody, low-growing plant species if possible.
- Limit the use of combustible materials, such as outdoor furniture, on decks or patios.
- Relocate firewood or lumber to Zone 2.
- Replace structures attached to a home, such as fencing or gates, with non-combustible materials.
- If possible, keep garbage receptacles outside of Zone 0.
- If possible, keep all vehicles, boats, ATVs, and any other machines outside of Zone 0.

Zone 1 – Intermediate Zone, Clean and Green: Zone 1 consists of the first 30 feet from structures, including home, decks, garages, etc. If a property line extends less than 30 feet, Zone 1 is the distance from structures to the property line. This zone features fuel reduction efforts and serves as a transitional area between Zones 0 and 2. Recommendations for treating Zone 1 include (CAL FIRE 2022d):

- Remove all dead and dying vegetation, including vegetation debris such as leaf litter. Be sure to check the roof and gutters as well.
- Maintain a minimum buffer of 10 feet between a chimney and any vegetation, including dead or overhanging branches. Be sure to remove all branches that hang over the roof.
- Maintain trees by trimming them regularly and keeping a minimum 10-foot buffer between tree canopies.
- Relocate fire or lumber to Zone 2.
- Trim or remove any flammable vegetation near windows.
- Remove any items or vegetation that could catch fire and ignite other property structures, such as vegetation under decks or stairs.
- Separate any items that could ignite, such as trees, shrubs, swing sets, patio furniture, etc.

DRAFT

Zone 2 – Extended Zone, Reduced Fuel: This zone encompasses an area 30 feet from a structure out to 100 feet, or the property line, whichever is closer. This zone addresses fuel reduction to prevent wildfires from spreading. Recommendations for treating Zone 2 include (CAL FIRE 2022d):

- Maintain all grasses to reach a maximum height of 4 inches.
- For shrubs or trees, maintain a distance between plants of at least two times a plant's size. Additional space between vegetation is needed for properties on slopes (Figure J.3).
    - Flat to mild slope (less than 20%): Minimum distance of 10 feet between trees and two times the size of other plants. Example: For shrubs 2 feet in diameter, at least 4 feet are needed between shrubs.
    - Mild to moderate slope (20%–40%): Minimum distance of 20 feet between trees and four times the size of other plants. Example: For shrubs 2 feet in diameter, at least 8 feet are needed between shrubs.
    - Moderate to steep slope (greater than 40%): Minimum distance of 30 feet between trees and six times the size of other plants. Example: For shrubs 2 feet in diameter, at least 12 feet are needed between shrubs.
- Create vertical space between vegetation by clearing all branches at least 6 feet from the ground for isolated trees, or for trees with nearby shrubs, clear at least 3 times the shrub height (Figure J.4).
    - Example: A 4-foot shrub is growing near a tree; a clearance of 12 feet (3 × 4) is needed between the top of the shrub and the lowest tree branch.
- Vegetation debris such as dead leaves, branches, twigs, pinecones, etc., may be allowed up to 3 inches in depth. However, it is best to remove vegetation debris.
- All wood or lumber piles must have a 10-foot buffer of bare mineral soil in all directions; no vegetation is allowed.

In addition to the recommendations listed above, CAL FIRE suggests maintaining a clearance zone of 10 feet around any outbuildings or liquid propane gas storage tanks, and an additional 10-foot clearance zone with no flammable vegetation (CAL FIRE 2022d).

DRAFT

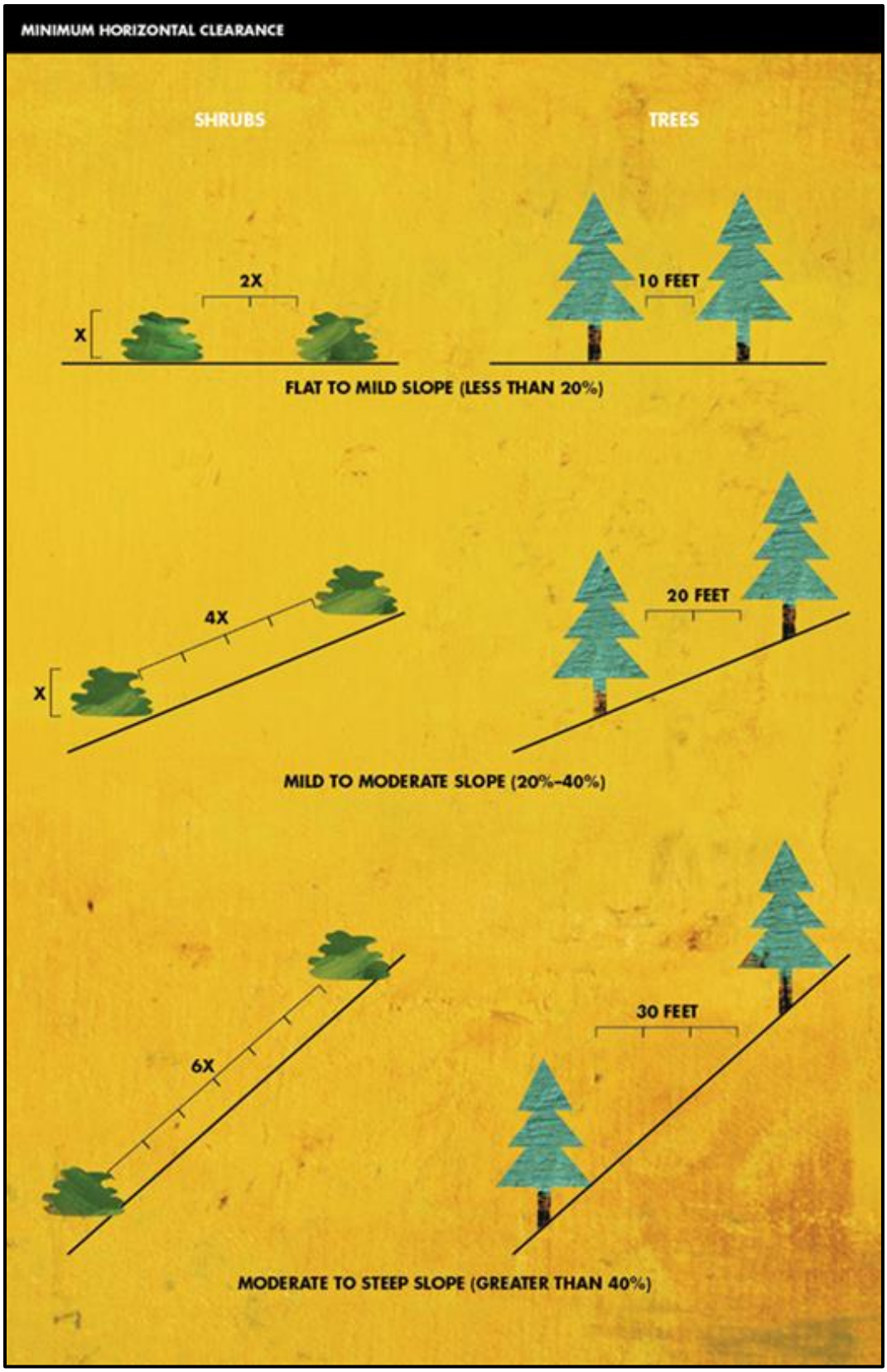


Figure J.3. Minimum horizontal clearance.

Source: CAL FIRE 2022



Figure J.4. Minimum vertical clearance.
Source: CAL FIRE 2022

Specific recommendations should be based on the hazards adjacent to a structure such as slope steepness and fuel type. Firewise guidelines and the Homeowner Resources appendix (see Appendix G) are excellent resources but creating defensible space does not have to be an overwhelming process. The NFPA offers a free Community Wildfire Risk Assessment Tutorial and an online learning module: Understanding the Wildfire Threat to Homes. Both tools are great resources for learning about, and implementing, defensible space.

Assisting neighbors may be essential in many cases. Homeowners should consider assisting the elderly, sharing ladders for gutter cleaning, and assisting neighbors with large thinning needs. Homeowner actions have been found to also motivate neighbors to act, increasing the scope of wildfire mitigation across a community (Evans et al. 2015). Adopting a phased approach can make the process more manageable and encourage maintenance (Table J.1).

Table J.1. Example of a Phased Approach to Mitigating Home Ignitability

Year	Project	Actions
1	Basic yard cleanup (annual)	Dispose of clutter in the yard and under porches. Remove dead branches from the yard. Mow and rake. Clean off roofs and gutters. Remove combustible vegetation near structures. Coordinate disposal as a neighborhood or community. Post 6-inch reflective address numbers visible from road.

Year	Project	Actions
2	Understory thinning near structures	Repeat basic yard cleanup. Limb trees up to 6–10 feet. Trim branches back 15 feet from chimneys. Trim or cut down brush. Remove young trees that can carry fire into forest canopy. Coordinate disposal as a neighborhood or community.
3	Understory thinning on private property along roads and drainages	Limb trees up to 6–10 feet. Trim or cut down brush. Remove young trees that can carry fire into forest canopy. Coordinate disposal as a neighborhood or community.
4	Overstory treatments on private property	Evaluate the need to thin mature or diseased trees. Prioritize and coordinate tree removal within neighborhoods to increase cost effectiveness.
5	Restart defensible space treatment cycle	Continue the annual basic yard cleanup. Evaluate need to revisit past efforts or catch those that were bypassed.

FUEL BREAKS AND OPEN SPACE CLEANUP

The next location priority for fuels treatments should be where the community meets wildland. This may be the outer margins of a town or an area adjacent to occluded open spaces such as a park. Fuel breaks (also known as shaded fuel breaks) are strips of land where fuel (for example, living trees and brush, dead branches, leaves or downed logs) has been modified or reduced to limit the fire's ability to spread rapidly. Fuel breaks should not be confused with firebreaks, which are areas where vegetation and organic matter are removed down to mineral soil. Shaded fuel breaks may be created to provide options for suppression resources or to provide opportunities to introduce prescribed fire. In many cases, shaded fuel breaks may be created by thinning along roads. This provides access for mitigation resources and firefighters, as well as enhancing the safety of evacuation routes.

LARGER SCALE TREATMENTS

Farther away from WUI communities, the emphasis of treatments often becomes broader. While reducing the buildup of hazardous fuels remains important, other objectives are often included, such as forest health and resiliency to catastrophic wildfire and climate change considerations. Wildfires frequently burn across jurisdictional boundaries, sometimes on landscape scales. As such, these larger treatments need to be coordinated on a strategic level. This requires coordination between projects and jurisdictions, as is currently occurring.

ACTION ITEMS FOR HOMEOWNERS TO REDUCE STRUCTURAL IGNITABILITY

Low or No Cost Investment (<$50)	Regularly check fire extinguishers and have a 100-foot hose available to wet perimeter.
	Maintain defensible space for 30 feet around home. Work with neighbors to provide adequate fuels mitigation in the event of overlapping property boundaries.
	Install an environmentally appropriate xeriscape yard instead of grass
	Screen vents with non-combustible meshing with mesh opening not to exceed nominal 1/8-1/16-inch size.
	Ensure that house numbers are easily viewed from the street.
	Keep wooden fence perimeters free of dry leaves and combustible materials. If possible, non-combustible material should link the house and the fence.
	Keep gutters free of vegetative litter. Gutters can act as collecting points for fire brands and ashes.
	Store combustible materials (firewood, propane tanks, grills) away from the house; in shed, if available.
	Clear out materials from under decks and/or stacked against the structure. Stack firewood at least 30 feet from the home, if possible.
	Reduce your workload by considering local weather patterns. Because prevailing winds in the area are often from the west-southwest, consider mitigating hazards on the west corner of your property first, then work around to cover the entire area.
	Seal up any gaps in roofing material and enclose gaps that could allow fire brands to enter under the roof tiles or shingles.
	Remove flammable materials from around propane tanks.
Minimal Investment (<$250)	When landscaping in the home ignition zone (HIZ) (approximately 30 feet around the property), select non-combustible plants, lawn furniture, and landscaping material. Combustible plant material like junipers and ornamental conifers should be pruned and kept away from siding. If possible, trees should be planted in islands and no closer than 10 feet to the house. Tree crowns should have a spacing of at least 18 feet when within the HIZ. Vegetation at the greatest distance from the structure and closest to wildland fuels should be carefully trimmed and pruned to reduce ladder fuels, and density should be reduced with approximately 6-foot spacing between trees crowns.
	Box in eaves, attic ventilation, and crawl spaces with non-combustible material.
	Work on mitigating hazards on adjoining structures. Sheds, garages, barns, etc., can act as ignition points to your home.
	Enclose open space underneath permanently located manufactured homes using non-combustible skirting.
	Clear and thin vegetation along driveways and access roads so they can act as a safe evacuation route and allow emergency responders to access the home.
	Purchase or use a National Oceanic and Atmospheric Administration weather alert radio to hear fire weather announcements.

DRAFT

Moderate to High Investment (>$250)	Construct a non-combustible wall or barrier between your property and wildland fuels. This could be particularly effective at mitigating the effect of radiant heat and fire spread where 30 feet of defensible space is not available around the structure.
	Construct or retrofit overhanging projections with heavy timber that is less combustible.
	Replace exterior windows and skylights with tempered glass or multilayered glazed panels.
	Invest in updating your roof to non-combustible construction. Look for materials that have been treated and given a fire-resistant roof classification of Class A. Wood materials are highly combustible unless they have gone through a pressure-impregnation fire-retardant process.
	Construct a gravel turnaround in your driveway to improve access and mobilization of fire responders.
	Treat construction materials with fire-retardant chemicals.
	Install a roof irrigation system.
	Replace wood or vinyl siding with nonflammable materials.
	Relocate propane tanks underground.

Additional resources regarding home hardening can be found in Appendix G.

FUEL TREATMENT METHODS

Several fuels reduction methods are outlined in the following narrative.

Several treatment methods are commonly used for hazardous fuels reduction, including manual treatments, mechanized treatments, prescribed fire, and grazing (Table J.2). This brief synopsis of treatment options is provided for general knowledge; specific projects will require further planning. The appropriate treatment method and cost will vary depending on factors such as the following:

- Diameter of materials
- Proximity to structures
- Acreage of project
- Fuel costs
- Steepness of slope
- Area accessibility
- Density and type of fuels
- Project objectives

It is imperative that long-term monitoring and maintenance of all treatments is implemented. Post-treatment rehabilitation such as seeding with native plants and erosion control may be necessary. In addition, post-treatment fuel clean-up is a must as neglected piles of vegetation may result in increased fire risk.

DRAFT

Table J.2. Summary of Fuels Treatment Methods

Treatment	Comments
Machine mowing	Appropriate for large, flat, grassy areas on relatively flat terrain.
Manual treatment with chipping or pile burning	Requires chipping, hauling, and pile burning of slash in cases where lop and scatter is inappropriate. Pile burning must comply with smoke management policy.
Brush mastication	Brush species tend to re-sprout vigorously after mechanical treatment. Frequent maintenance of treatments is typically necessary. Mastication tends to be less expensive than manual (chainsaw) treatment and eliminates disposal issues.
Timber mastication	Materials up to 10 inches in diameter and slopes up to 30% can be treated. Eliminates disposal issues. Environmental impact of residue being left on-site is still being studied.
Prescribed fire	Can be very cost effective for public land but not close to the city. Ecologically beneficial. Can be used as training opportunities for firefighters. May require manual or mechanical pretreatment. Carries risk of escape. Unreliable scheduling due to weather and smoke management constraints.
Feller buncher	Mechanical treatment on slopes more than 30% or of materials more than 10 inches in diameter may require a feller buncher rather than a masticator. Costs tend to be considerably higher than masticator.
Grazing (goats)	Can be cost effective. Ecologically beneficial. Can be applied on steep slopes and shrubby and flashy fuels. Requires close management.

MANUAL TREATMENT

Manual treatment refers to crew-implemented cutting with chainsaws. Although it can be more expensive than mechanized treatment, crews can access many areas that are too steep or otherwise inaccessible with machines. Treatments can often be implemented with more precision than prescribed fire or mechanized methods allow. Merchantable materials and firewood can be removed while non-merchantable materials are often lopped and scattered, chipped, or piled and burned on-site. Care should be exercised to not increase the fire hazard by failing to remove or treat discarded material in a site-appropriate manner.

Strategic timing and placement of fuels treatments is critical for effective fuels management practices and should be prescribed based on the conditions of each treatment area. Some examples of this would be to place fuel breaks in areas where the fuels are heavier and in the path of prevailing winds and to mow grasses just before they cure and become flammable. Also, fuel reductions on slopes/ridgelines extending from the WUI to enhance community protection. In areas where the vegetation is sparse and not continuous, fuels treatments may not be necessary to create a defensible area where firefighters can work. In this situation, where the amount of fuel to carry a fire is minimal, it is best to leave the site in its current condition to avoid the introduction of exotic species.

MECHANIZED TREATMENTS

Mechanized treatments include mowing, mastication (ground-up timber), and whole tree felling. These treatments allow for more precision than prescribed fire and are often more cost-effective than manual treatment.

Mowing, including ATV and tractor-pulled mower decks, can effectively reduce grass fuels adjacent to structures and along highway rights-of-way and fence lines. For heavier fuels, several different masticating machines can be used, including drum- or blade-type masticating heads mounted on machines and ranging in size from a small skid-steer to large front-end loaders. Some masticators can grind standing timber up to 10 inches in diameter. Other masticators are more effective for use in brush or surface fuels. Mowing and mastication do not actually reduce the amount of on-site biomass but alter the fuel arrangement to a less combustible profile.

In existing fuel break areas maintenance is crucial especially in areas of encroaching shrubs or trees. In extreme risk areas more intensive fuels treatments may be necessary to keep the fire on the ground surface and reduce flame lengths. Within the fuel break, shrubs should be removed, and the branches of trees should be pruned from the ground surface to a height of 4 to 8 feet, depending on the height of the fuel below the canopy, and thinned with a spacing of at least two to three times the height of the trees to avoid movement of an active fire into the canopy.

Mechanical shears mounted on feller bunchers are used for whole tree removal. The stems are typically hauled off-site for utilization while the limbs are discarded. The discarded material may be masticated, chipped, or burned to reduce the wildfire hazard and to speed the recycling of nutrients.

GRAZING

Fuel modifications targeted toward decreasing both vertical and horizontal continuity in fuels is critical as a prevention method against fire proliferation. The primary objectives for these modifications are treating surface fuels and producing low-density and vertically disconnected stands. Goat grazing is an effective, nontoxic, nonpolluting, and practically carbon-neutral vegetation treatment method. A goat grazing system typically consists of a high density of goats enclosed by a metallic or electrified fence guided by herders. Goats feed on a variety of foliage and twigs from herbaceous vegetation and woody plants (Lovreglio et al. 2014).

PRESCRIBED BURNING

Prescribed burning is also a useful tool to reduce the threat of extreme fire behavior by removing excessive standing plant material, litter, and wood debris while limiting the encroachment of shrubby vegetation. Where possible, prescribed fire could occur on public land since fire is ecologically beneficial to this fire-adapted vegetation community and wildlife habitat.

All prescribed fire operations will be conducted in accordance with federal and state guidelines, laws, and regulations. Public safety would be the primary consideration in the design of any prescribed burn plan so as to not negatively impact the WUI. Agency use of prescribed fire on public land would be carried out within the confines of the agency's fire management planning documents and would require individual prescribed burn plans that are developed for specific burn units and consider smoke management

DRAFT

concerns and sensitive receptors within the WUI. Smoke monitors could be placed in areas where smoke concerns have been raised in the past.

Following any type of fuels reduction treatment, post-treatment monitoring should continue to ensure that management actions continue to be effective throughout the fire season. The vegetation within this ecosystem can change rapidly in response to drought or moisture from year to year and during the season, so fuels treatments should be adjusted accordingly. To learn more about firing techniques, visit the EFIRE Fire Techniques webpage: https://efire.cnr.ncsu.edu/efire/fire-techniques/.

Several burns may be needed to meet full resource management objectives, so a solid maintenance plan is needed to ensure success.

Cultural Burning

Within the Pacific West, fire has historically been a means forest management and restoration by Indigenous communities (Long et al. 2021). Cultural burning has been defined as the "purposeful use of fire by a cultural group (e.g., family unit, Tribe, clan/moiety, society) for a variety of purposes and outcomes," and is included under the terms Indigenous fire management, Indigenous burning, and Indigenous stewardship (Long et al. 2021).

Rather than focusing solely on fuel reduction, as a means of wildfire mitigation, cultural burning is done with a more holistic view, under the philosophy of "reciprocal restoration," meaning, as stewardship responsibilities to the land are fulfilled, those actions will in turn benefit the peoples who depend on those ecosystems (Long et al. 2021). Cultural burning is typically performed with a variety of objectives, such as landscape management, ecosystem and species biodiversity and health, transmission of environmental and cultural knowledge, ceremonies and spiritual wellbeing, a sense of place, and material services (i.e., food, medicine, plan materials, etc.). Extensive site preparation is typically done before a burn, and post-burn monitoring and additional cultural practices are a common factor of the land stewardship tradition (Long et al. 2021).

Impacts of Prescribed Fire on Communities

Prescribed fires can have impacts on air quality that may impact local communities. Impacts on a regional scale are typically only acute when many acres are burned on the same day. Local problems are occasionally acute due to the large quantities of smoke that can be produced in a given area during a short period of time. Residents with respiratory problems may be impacted during these burning periods since smoke consists of small particles of ash, partly consumed fuel, and liquid droplets that are considered air pollutants. Other combustion products include invisible gases such as carbon monoxide, carbon dioxide, hydrocarbons, and small quantities of nitrogen oxides. Oxides of nitrogen are usually produced at temperatures only reached in piled or windrowed slash or in very intense wildfires that are uncommon in the region. In general, prescribed fires produce inconsequential amounts of these gases. Inappropriate management of prescribed fires can be bothersome to residents, and it can negatively affect community health.

Smoke from burning vegetation produces air pollutants that are regulated by both the U.S. Environmental Protection Agency (EPA) and the state of California (EPA 2019). Additionally, smoke can increase ambient air pollution levels to a point where it exceeds air quality standards (California Air Resources Board [CARB] 2023). Therefore, effective smoke management is a vital component of planning and conducting prescribed fires (Figure J.5). The California Air Resources Board has smoke management guidelines that protect the health and welfare of Californians from the impacts of smoke (CARB 2001).

In Inyo County, a permit from the local fire agency must be obtained to start a prescribed burn and can only do so during "permissive burn days," which are determined by the State Air Resources Board or the local air district (Great Basin Unified Air Pollution Control District n.d.).

In addition, the NWCG released the NWCG Smoke Management Guide for Prescribed Fire in 2020 (NWCG 2020). This plan is designed to act as a guide to all those who use prescribed fire. Smoke management techniques, air quality regulations, public perception of prescribed fire, foundational science behind prescribed fire, modeling, smoke tools, air quality impacts, and more are all discussed in this plan. The document is meant to pair with NWCG's Interagency Prescribed Fire Planning and Implementation Procedures Guide for planning and addressing smoke when prescribed fire is used (NWCG 2020). To view the plan, please visit: https://www.nwcg.gov/sites/default/files/publications/pms420-3.pdf.

Effects of smoke can be managed by burning on days when smoke will blow away from smoke-sensitive areas. Precautions are taken when burning near populated areas, highways, airports, and other smoke sensitive areas. Any smoke impact downwind is considered before lighting a fire. Smoke management is a significant component of all prescribed burn plans. Other mitigating actions include alerting the public of upcoming burning activities, including the purpose, best conditions for ensuring good smoke dispersal, duration, size, and location of projects. Local radio, newspapers, social media, and TV can provide broad coverage for alerts. Land management agencies in the Planning Area consistently work with concerned citizens regarding smoke management and attempt to provide solutions such as the placement of smoke monitors at sensitive sites.

DRAFT



Figure J.5. Photograph showing a prescribed pile burn in the Inyo National Forest.
Source: https://www.fs.usda.gov/detail/inyo/news-events/?cid=FSEPRD1074645

Thinning and Prescribed Fire Combined

Combining thinning and prescribed fire can be the most effective treatment (Graham et al. 2004). In forests where fire exclusion or disease has created a buildup of hazardous fuels, prescribed fire cannot be safely applied, and pre-burn thinning is required. The subsequent use of fire can further reduce residual fuels and reintroduce this ecologically imperative process.

MANAGEMENT OF NON-NATIVE PLANTS

The USDA maintains a list of introduced, invasive, and noxious plants by state (USDA 2022). Fuel treatment approaches should always consider the potential for introduction or proliferation of invasive non-native species as a result of management actions.

APPENDIX K:

Post-fire Response and Restoration

This page intentionally left blank.

POST-FIRE RESPONSE AND REHABILITATION

The recent increase in severe fires has highlighted the numerous complexities of post-fire response. Research indicates that high-severity burn areas may produce erosion and runoff rates 5 to 10 times higher than the rates produced by moderate-severity burn areas (Sierra Nevada Conservancy 2021). Following a fire, heavy rains may result in widespread floods carrying trees, boulders, and soil through canyons, ultimately damaging communities and critical infrastructure. In the region, the areas that are susceptible to debris flows and landslides include the base of the Sierra Nevada, particularly along alluvial fans and canyons (Inyo County and City of Bishop 2017).

There are many facets to post-fire recovery, including but not limited to:

- Ensuring public health and safety—prompt removal of downed and hazard trees, addressing watershed damage, and mitigating potential flooding.
- Rebuilding communities and assessing economic needs—securing the financial resources necessary for communities to rebuild homes, business, and infrastructure.
- Restoring the damaged landscape—restoration of watersheds, soil stabilization, and tree planting.
- Reducing fire risk in the future—identifying hazard areas and implementing mitigation.
- Prioritizing the needs of vulnerable and disadvantaged communities during response and disaster recovery efforts.
- Reducing post-fire recovery time by replanting native species.
- Ensuring fire protection measures enhance sustainability of restoration projects e.g., introducing prescribed fire to a fire-dependent ecosystem where fire had previously been excluded.
- Retaining downed logs for erosion control and habitat maintenance.
- Evaluating and updating disaster recovery plans every 5 years to respond to changing needs and characteristics of the community.
- Coordinating with planning, housing, health and human services, and other local, regional or state agencies to develop contingency plans for meeting short-term, temporary housing needs of those displaced during a catastrophic wildfire event.
- Incorporating forecasted impacts from climate change intro trends and projections of future risk and consideration of policies to address identified risk.
- Updating codes and ordinances to specify procedures and standards for planning and permitting the reconstruction of buildings destroyed by wildfire.

COMMUNITY RESPONSE AND RECOVERY

Recovery of the vegetated landscape is often more straightforward than recovery of the human environment. Assessments of the burned landscape are often well-coordinated through the use of interagency crews who are mobilized immediately after a fire to assess the post-fire environment and make recommendations for rehabilitation efforts.

DRAFT

For the community impacted by fire, however, there is often very little planning at the local level to guide their return after the fire. Residents impacted by the fire need assistance making insurance claims; finding temporary accommodation for themselves, pets, and livestock; rebuilding or repairing damaged property; removing debris and burned trees; stabilizing the land for construction; mitigating potential flood damage; repairing infrastructure; reconnecting to utilities; and mitigating impacts to health. Oftentimes, physical impacts can be mitigated over time, but emotional impacts of the loss and change to surroundings are long-lasting and require support and compassion from the community.

Emergency Assistance: Before, During, and After a Fire

Team Rubicon is a veteran-led humanitarian organization that serves communities around the world before, during, and after disasters such as earthquakes, floods, hurricanes, tornadoes, and wildfire. Team Rubicon focuses on serving vulnerable and at-risk populations affected by disasters, and all services are provided free of charge. Services include incident management, debris management, hazard mitigation, volunteer management, home repair, and emergency medicine. With respect to fire-related assistance, Team Rubicon assists with any action that would limit the impact of a wildfire, such as helping homeowners to make their home fire safe, providing staff to assist with mitigation projects (e.g., fuels reduction), and removing debris and hazardous trees (Team Rubicon 2022).

To find out more about Team Rubicon, please visit https://teamrubiconusa.org/capabilities-services/.

After the Fire

Rebuilding and recovery from wildfire can vary greatly across income levels and demographics. Rural areas, low-income neighborhoods, and immigrant communities generally do not have the necessary resources to cover insurance and rebuilding expenses that occur after a fire. Due to this, many of these areas take more time to recover than those with greater access to resources. In addition, the occurrence of wildfire can worsen existing mental health conditions and lead to post-traumatic stress (PTS), low self-esteem, and depression for at-risk populations (CA GOPR 2020).

Returning Home

First and foremost, follow the advice and recommendations of emergency management agencies, fire departments, utility companies, and local aid organizations regarding activities following the wildfire. Do not attempt to return to your home until fire personnel have deemed it safe to do so.

When driving, watch for trees, brush, and rock which may have been weakened or loosened by the fire. Be aware of any damage or debris on roads and driveways. Traffic may be delayed, or lanes closed due to firefighter operations. Use extreme caution around trees, power poles, and any other tall objects that may have been weakened by the fire (CAL FIRE 2020b).

Even if the fire did not damage your house, do not expect to return to normal routines immediately. Expect that utility infrastructure may have been damaged and repairs may be necessary. When you return home, check for hazards, such as gas or water leaks and electrical shorts. Turn off damaged utilities if you did not do so previously. Request that the fire department or utility companies turn the utilities back on once the area is secured. Similarly, water supply systems may have been damaged; do not drink from the tap until you have been advised that it is safe to do so. Finally, keep a “fire watch”; look

for smoke or sparks in houses and other buildings. Once at home, check for the following (CAL FIRE 2019b):

- Check the roof and exterior areas for sparks or embers
- Check grounds for hot spots, smoldering stumps, and vegetation
- Check for fire damage to your home, turn off all appliances and make sure the meter is not damaged before turning on the main circuit breaker
- Check the attic and throughout your house for any hidden burning sparks or embers
- Do not drink water from the faucet until emergency officials say it is okay, water supply systems can be damaged and become polluted during wildfires
- Discard any food that has been exposed to heat, smoke, flood water, or soot
- If you have a propane tank or natural gas, leave valves closed until the supplier or utilities can inspect your system
- If you have a solar electrical system, this system should be inspected by a licensed technician to verify that the solar panels and electrical wiring are safe for continued operation
- Consult local experts on the best way to restore and plant your land with fire-safe landscaping
- Contact 911 if any danger is perceived
- Ash contains toxic substances and may be irritating to the eyes, nose, throat, and skin. Ash is harmful to breathe and may trigger asthma attacks. Follow these tips to reduce your exposure to ash (California Department of Public Health 2017):
- Do not allow children to play in the ash and wash off children's toys before children play with them.
- Immediately wash any part of your body that touches ash to avoid irritation.
- Wash fruits and vegetables from your garden thoroughly before eating them.
- Keep pets out of ash areas.
- Frequently clean indoor surfaces by wet mopping.
- Wear protective clothing and a respirator when working outside.

Insurance Claims

Your insurance agent is the best source of information for submitting a claim. It is recommended you take photos of your home, of both the inside and outside, in preparation for an emergency. Keep the photos in a safe place as this will make the insurance claim process easier. Most expenses incurred during the time you are forced to live elsewhere may be reimbursed, so be sure to keep all receipts. Additional items that may be covered are extra transportation costs to and from work or school, telephone installation, furniture rental, extra food costs, and water damage. Do not start any repairs without the approval of your claims adjuster (California Department of Insurance 2021).

Natural disasters aren't always predictable, but there are steps homeowners can make to better prepare for an emergency.

- Review your insurance policy annually to see if your home is adequately insured

- Know your "loss of use" section – this covers living expenses should your home become unlivable due to fire, smoke, or otherwise

You can view a guide on creating a home inventory here: https://www.iii.org/article/how-create-home-inventory

Community Safety: Post-Fire Floods and Debris Flows

There are numerous natural hazards after a wildfire. Perhaps the most dangerous are potential flash floods and landslides following rainfall in a burned area upstream of a community. Wildfires increase the risk of flooding because burned soil is unable to absorb rainfall and it becomes hydrophobic. Factors that contribute to flooding and debris flows are steep slopes, heavy rainfall, weak or loose rock and soil, and improper construction and grading. Even small rainfall can cause a flash flood, transporting debris and damaging homes and other structures. Listen and look for emergency updates, weather reports, and flash flood warnings (California Department of Conservation 2019). Develop an evacuation plan with your family and stay away from waterways, storm channels, and arroyos. Be aware of your risk, pay attention to weather forecasts, listen to local authorities, and have a household inventory with copies of critical documents (California Department of Water Resources 2021).

Mobilizing Your Community

Wildfires that produce extensive damage require a community-scale response for recovery efforts. The local Emergency Manager will collaborate with state and federal partners to manage disaster response and urgent needs. Still, mobilizing a response and recovery team or a group of teams in a community can function as a vital part of the recovery procedure. Coordinated and informed direction throughout community-level volunteers and all levels of government are necessary for successful recovery (California Silver Jackets Team [California SJT] 2019).

As opposed to wildfire response, post-fire response is not typically managed by a unified state or federal team. Rather, each organization and each tier of government acts on its own authority. This produces a greater demand for coordination at the local level and the sharing of information between organizations to coordinate recovery efforts (California SJT 2019).

Residents throughout California are encouraged to join forces to create local Fire Safe Councils (FSCs) to minimize and prevent wildfire losses. FSCs are community-based organizations that mobilize residents to protect their properties, communities, and environments from disastrous wildfires. FSCs educate homeowners about community wildfire preparedness activities while collaborating with local fire officials to plan and implement projects that increase the wildfire resilience of their communities (California Fire Safe Council 2021).

In addition, each community is encouraged to create its own type of a Post-Fire Coordination Group (PFCG) to direct the response to any ensuing post-wildfire natural hazards and aid in determining post-fire mitigation actions. The PFCG should work directly with local, state, or federal agencies, emergency response officials, and others to aid in a coordinated response. Primary duties of the PFCG include coordinating the exchange of information among agencies and the risk assessment, assembling and exchanging geospatial data, assisting public communications, and coordinating with elected officials (California SJT 2019).

Communities are also encouraged to establish a post-fire coordinator. The post-fire coordinator is appointed by the community to assist in a coordinated response to a wildfire and to aid the community's post-fire recovery efforts. The post-fire coordinator is likely to collaborate with local, state, and federal

organizations that participate in emergency response and post-fire recovery efforts. It is important that the post-fire coordinator have demonstrated management, internet, and social media skills, community knowledge, and experience with government agencies and programs (California SJT 2019).

The recovery coordinator should become familiar with representatives from local, state, and government agencies that will be helping with coordination or funding of post-fire recovery. The following resources may be helpful for the post-fire and volunteer coordinators (California SJT 2019):

1. Housing
    a. FEMA
    b. Federal Housing Administration
    c. California Department of Housing and Community Development
    d. The Salvation Army
2. Debris Removal
    a. California Department of Resources Recycling and Recovery
    b. USACE
3. Debris Modeling
    a. USGS
4. Hazardous Waste and Pollution
    a. California Environmental Protection Agency
5. Pets and Livestock
    a. American Society for the Prevention of Cruelty to Animals
    b. CDFA
6. Food
    a. USDA Supplemental Nutrition Assistance Program
    b. California Department of Social Services, Disaster CalFresh
7. Social Services
    a. California Employment Development Department
    b. FEMA Disaster Unemployment Assistance
    c. U.S. Administration for Children and Families
    d. Office of Access and Functional Needs
    e. California Foundation for Independent Living Centers
8. Farm Rehabilitation
    a. Farm Service Agency
    b. USDA Rural Development Disaster Assistance
    c. Natural Resources Conservation Service (NRCS) General Environmental Quality Incentives Program Financial Assistance

DRAFT

9. General
    a. The American Red Cross
    b. California Governor's Office of Emergency Services
    c. USFS
    d. NPS
    e. CAL FIRE

Any large wildfire will also involve an Incident Command System (ICS), an appropriately sized team assigned to aid in post-fire recovery. Learn more are https://www.nps.gov/articles/wildland-fire-incident-command-system-levels.htm.

Communication

After a team is assembled and immediate tasks are identified, find the best way to spread information in your community. You may distribute flyers, set up a voicemail box, work to find pets or livestock that have been displaced, develop a mailing list for property owners, hold regular public meetings, etc. It is important that a long-term communications plan is developed (California SJT 2019). Applying the following steps can aid in successful communication (California SJT 2019):

- Convey post-wildfire hazards to the public.
- Develop and maintain emergency notification systems that allow authorized officials to alert residents of emergency situations.
- Public meetings to inform the public about programs and services available in the community.
- Determine the best way to relay information, e.g., phone calls, radio, TV, or social media.
- Find out how emergency response teams, local officials, and volunteers will communicate with the community.

Post-Fire Rehabilitation and Resources

Wildfires that cause extensive damage necessitate dedicated efforts to avert issues afterwards. As aforementioned, loss of vegetation increases soil susceptibility to erosion; water runoff may increase and lead to flooding; sediments and debris may be transported downstream and damage properties or saturate reservoirs putting endangered species and water reserves at risk (USFS 2021d). Following a fire, the primary priority is emergency stabilization to prevent additional damage to life, property, or natural resources. The soil stabilization work starts immediately and may proceed for up to a year. The rehabilitation effort to restore damage caused by the fire starts after the fire is out and may persist for various years. For the most part, rehabilitation efforts focus on the lands not likely to recover naturally from wildfire damage (USFS 2021d).

The USFS and the Department of the Interior (DOI) post-fire emergency stabilization program is called the Burned Area Emergency Response (BAER) program. The goal of the BAER program is to discover post-wildfire threats to human life and safety, property, and critical natural or cultural resources on USFS, DOI, and Tribal trust lands and take appropriate actions to mitigate unacceptable risks (NIFC 2022). BAER teams are composed of trained professionals in different fields: soil scientists, engineers, hydrologists, biologists, botanists, archaeologists, and others who quickly assess the burned area and advise emergency stabilization treatments (NIFC 2022).

The NRCS Emergency Watershed Protection (EWP) program provides technical and financial services for watershed repair on **public (state and local) and private land**. The goal is to reduce flood risk via funding and expert advice for land treatments. The EWP program can provide up to 75% of funds; remaining funds can be paid with in-kind volunteer labor (Coalition for the Upper South Platte [CUSP] 2016). This funding is used by the State Emergency Rehabilitation Team (a multi-agency group assembled by the NRCS) to develop specific recovery and treatment plans.

Examples of potential treatments include (USFS 2021e):

- Hillside stabilization (for example, placing bundles of straw parallel to the slope to slow erosion)
- Hazard tree cutting
- Felling trees perpendicular to the slope contour to reduce runoff
- Mulching areas seeded with native vegetation
- Stream enhancements and construction of catchments to control erosion, runoff, and debris flows
- Planting or seeding native species to limit spread of invasive species

The USFS provides a science-based framework to guide post-fire restoration efforts in National Forest lands in California. The framework is based on a five-step process that leads to the development of a restoration portfolio that can inform project planning and monitoring (USFS 2021e). The framework is available at: https://www.fs.usda.gov/psw/publications/documents/psw_gtr270/psw_gtr270.pdf

A comparison of potential hillside, channel, and road treatments is available at: https://www.afterwildfirenm.org/post-fire-treatments/which-treatment-do-i-use

Specific Treatment Details

Hillslope Treatments

Cover Applications:

Dry mulch: provides immediate ground cover with mulch to reduce erosion and downstream flow.

Wet mulch (hydromulch): provides immediate cover to hold moisture and seeds on slopes using a combination of organic fibers, glue, suspension agents, and seeds (most effective on inaccessible slopes).

Slash spreading: provides ground cover to reduce erosion by felling trees in burned areas.

Seeding: reduces soil erosion over time with an application of native seed mixtures (most successful in combination with mulching). Breaking up and loosening topsoil to break down the hydrophobic layer on top of the soil is also effective.

Erosion Barrier Applications:

Erosion control mat: organic mats staked on the soil surface to provide stability for vegetation establishment.

Log erosion barrier: trees felled perpendicular to the hillslope to slow runoff.

DRAFT

Fiber rolls (wattles): rolls placed perpendicular to the hillslope to reduce surface flows and reduce erosion.

Silt fencing: permeable fabric fencing installed parallel to the slope contour to trap sediment as water flows down the hillslope.

Channel Treatments

Check dam: small dams built to trap and store sediment in stream channels.

In-channel tree felling: felling trees in a staggered pattern in a channel to trap debris and sediment.

Grade stabilizer: structures made of natural materials placed in ephemeral channels for stabilization.

Stream bank armoring: reinforcing streambanks with natural materials to reduce bank cutting during stream flow.

Channel deflector: an engineered structure to direct flow away from unstable banks or nearby roads.

Debris basin: constructed to store large amounts of sediment moving in a stream channel.

Road and Trail Treatments

Outsloping and rolling dips (water bars): alter the road shape or template to disperse water and reduce erosion.

Overflow structures: protect the road by controlling runoff and diverting stream flow to constructed channels.

Low water stream crossing: culverts replaced by natural fords to prevent stream diversion and keep water in the natural channel.

Culvert modification: upgrading culvert size to prevent road damage.

Debris rack and deflectors: structure placed in a stream channel to collect debris before reaching a culvert.

Riser pipes: filter out debris and allow the passage of water in stream channels.

Catchment-basin cleanout: using machinery to clean debris and sediment out of stream channels and catchment basins.

Trail stabilization: constructing water bars and spillways to provide drainage away from the trail surface.

These treatments and descriptions are further detailed at: https://afterwildfirenm.org/post-fire-treatments/treatment-descriptions

For more information about how to install and build treatments, see the Wildfire Restoration Handbook at: https://www.rmfi.org/sites/default/files/hero-content-files/Fire-Restoration-HandbookDraft_2015_2.compressed_0.pdf

Timber Salvage

Many private and federal landowners may decide to harvest trees killed in the fire, a decision that can be highly controversial. Trees remaining post-fire can be instrumental for soil and wildlife habitat recovery,

but dead standing trees may also pose safety concerns and fuel loadings may still be conducive to future high intensity wildfires. Burned soil is especially susceptible to soil compaction and erosion so it is recommended to have professionals perform the timber salvage. Several programs assist landowners with timber salvage, including the NRCS Environmental Quality Incentives Program (EQIP) (CUSP 2016).

Invasive Species Management and Native Revegetation

Wildfire provides opportunity for many invasive species to dominate the landscape because many of these species thrive on recently burned landscapes. It is imperative that landowners prevent invasive establishment by eradicating weeds early, planting native species, and limiting invasive seed dispersal (CUSP 2016).

Planting native seeds is an economical way to restore a disturbed landscape. Vegetation provides protection against erosion and stabilizes exposed soils. In order to be successful, seeds must be planted during the proper time of year and using correct techniques. Use a native seed mixture with a diversity of species and consider the species' ability to compete with invasive species. Before planting, the seedbed must be prepared with topsoil and by raking to break up the hydrophobic soil layer. If you choose to transplant or plant native species, consider whether the landscape has made a sufficient recovery to ensure the safety of the individuals (CUSP 2016).

Long-Term Community Recovery

On non-federal land, recovery efforts are the responsibility of local governments and private landowners. Challenges associated with long-term recovery include homes that were severely damaged or were saved but are located in high severity burn areas. Furthermore, homes saved but located on unstable slopes or in areas in danger of flooding or landslides present a more complicated challenge. Economically, essential businesses that were burned or were otherwise forced to close pose a challenge to communities of all sizes. Given these complications, rebuilding and recovery efforts can last for years, with invasive species control and ecosystem restoration lasting even longer (CUSP 2016). It is critical that a long-term plan is in place and there is sufficient funding and support for all necessary ecosystem and community recovery. To learn about more post-fire recovery resources, visit the After the Flames website here: https://aftertheflames.com/resources/.

DRAFT

Learn how UC is closely monitoring updates from the federal government.

How Santa Ana winds fueled the deadly fires in Southern California

January 9, 2025

Jon Keeley, UCLA via The Conversation



Over 1,000 structures burned in the span of two days, Jan 7-8, 2025, near Los Angeles.
Credit: AP Photo/Ethan Swope

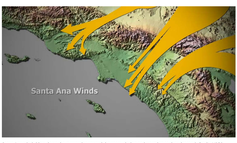
Powerful Santa Ana winds, near hurricane strength at times, swept down the mountains outside Los Angeles and pushed wildfires into several neighborhoods starting Jan. 7, 2025. Well over 1,4000 homes and several schools had burned by Jan. 8, and at least five people had died. Officials urged more than 100,0000 residents to evacuate at the height of the fires, but with the winds so strong, there was little firefighters could do to control the flames.

Jon Keeley, a research ecologist in California with the U.S. Geological Survey and adjunct professor at UCLA, explains what causes extreme winds like this in Southern California, and why they create such a dangerous fire risk.

What causes the Santa Ana winds?

The Santa Ana winds are dry, powerful winds that blow down the mountains toward the Southern California coast.

The region sees about 10 Santa Ana wind events a year on average, typically occurring from fall into January. When conditions are dry, as they are right now, these winds can become a severe fire hazard.



Santa Ana winds blow down the mountains toward the coast, drying and warming as they descend. Credit: NOAA

The Santa Ana winds occur when there is high pressure to the east, in the Great Basin, and a low-pressure system off the coast. Air masses move from high pressure to low pressure, and the more extreme the difference in the pressure, the faster the winds blow.

Topography also plays a role.

As the winds rush downslope from the top of the San Gabriel Mountains, they become drier and hotter. That's a function of the physics of air masses. By the time the winds get to the point where the Eaton Fire broke out in Altadena on Jan. 7, it's not uncommon for them to have less than 5 percent relative humidity, meaning essentially no moisture at all.

Canyons also channel the winds. I used to live in the Altadena area, and we would get days during Santa Ana wind events when the wind wasn't present at all where we lived, but, a few blocks away, the wind was extremely strong.

These strong, dry winds are often around 30 to 40 mph. But they can be stronger. The winds in early January 2025 were reported to have reached 60 to 70 mph.

How you can help those impacted by the wildfires

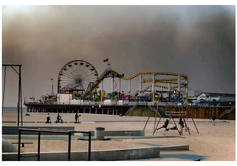
The current wildfires continue to have a devastating effect on Los Angeles County's people and infrastructure. With thousands of residents displaced and many having lost their homes and businesses, UCLA and local organizations have mobilized to support both the campus community and the broader public.

Here's how you can donate, help and find assistance.

Why was the fire risk so high this time?

Typically, Southern California has enough rain by now that the vegetation is moist and doesn't readily burn. A study a few years ago showed that autumn moisture reduces the risk of Santa Ana wind-driven fires.

This year, however, Southern California has very dry conditions, with very little moisture over the past several months. With these extreme winds, we have the perfect storm for severe fires.



Dark smoke from the fires was evident from the Santa Monica, Calif., pier on Jan. 8, 2025. Credit: AP Photo/Richard Vogel

It's very hard to extinguish a fire under these conditions. The firefighters in the area will tell you, if there's a Santa Ana wind-driven fire, they will evacuate people ahead of the fire front and control the edges – but when the wind is blowing like this, there's very little chance of stopping it until the wind subsides.

Other states have seen similar fires driven by strong downslope winds. During the Chimney Tops 2 Fire in Tennessee in November 2016, strong downslope winds spread the flames into homes in Gatlinburg, killing 14 people and burning more than 2,500 homes. Boulder County, Colorado, lost about 1,000 homes when powerful winds coming down the mountains there spread the Marshall Fire in December 2021.

Have the Santa Ana winds changed over time?

Santa Ana wind events aren't new, but we're seeing them more often this time of year.

My colleagues and I recently published a paper comparing 73 years of Santa Ana wind events, starting in 1948. We found about the same amount of overall Santa Ana wind activity, but the timing is shifting from fewer events in September and more in December and January. Due to well-documented trends in climate change, it is tempting to ascribe this to global warming, but as yet there is no substantial evidence of this.

California is seeing more destructive fires than we saw in the past. That's driven not just by changes in the climate and the winds, but also by population growth.

More people now live in and at the edges of wildland areas, and the power grid has expanded with them. That creates more opportunities for fires to start. In extreme weather, power lines face a higher risk of falling or being hit by tree branches and sparking a fire. The area burnt because of fires related to power lines has greatly expanded; today it is the major ignition source for destructive fires in Southern California.



Firefighters work to extinguish burning homes in the Pacific Palisades neighborhood of Los Angeles on Jan. 8, 2025. Credit: AP Photo/Damian Dovarganes

The Eaton Fire, which has burned many homes, is at the upper perimeter of the San Gabriel Basin, at the base of the San Gabriel Mountains. Fifty years ago, fewer people lived there. Back then, some parts of the basin were surrounded by citrus orchards, and fires in the mountains would burn out in the orchards before reaching homes.

Today, there is no buffer between homes and the wildland. The point of ignition for the Eaton Fire appears to have been near or within one of those neighborhoods.

Homes are made of dried materials, and when the atmosphere is dry, they combust readily, allowing fires to spread quickly through neighborhoods and creating a great risk of destructive fires.

This article was originally published on The Conversation and has been republished under a Creative Commons license. View the original article here.

Keep reading



Thursday, October 10, 2024

Airborne plastic chemical levels shock researchers

A new study shows how Southern Californians are being chronically exposed to toxic airborne chemicals.

Thursday, July 18, 2024

The salmon diaries: Life before and after Klamath Dam...

Salmon 'tell' scientists their life story as decades-old dams come down.



Copyright © The Regents of the University of California

STATE OF CALIFORNIA
LEGISLATIVE COUNSEL BUREAU
AUTHENTICATED
ELECTRONIC LEGAL MATERIAL

State of California

PUBLIC RESOURCES CODE

Section 4291

4291. (a) A person who owns, leases, controls, operates, or maintains a building or structure in, upon, or adjoining a mountainous area, forest-covered lands, shrub-covered lands, grass-covered lands, or land that is covered with flammable material, shall at all times do all of the following:

(1) (A) Maintain defensible space of 100 feet from each side and from the front and rear of the structure, but not beyond the property line, except as provided in subparagraph (B). The amount of fuel modification necessary shall consider the flammability of the structure as affected by building material, building standards, location, and type of vegetation. Fuels shall be maintained and spaced in a condition so that a wildfire burning under average weather conditions would be unlikely to ignite the structure. This subparagraph does not apply to single specimens of trees or other vegetation that are well-pruned and maintained so as to effectively manage fuels and not form a means of rapidly transmitting fire from other nearby vegetation to a structure or from a structure to other nearby vegetation or to interrupt the advance of embers toward a structure. The intensity of fuels management may vary within the 100-foot perimeter of the structure, with more intense fuel reductions being utilized between 5 and 30 feet around the structure, and an ember-resistant zone being required within 5 feet of the structure, based on regulations promulgated by the board, in consultation with the department, to consider the elimination of materials in the ember-resistant zone that would likely be ignited by embers. Consistent with fuels management objectives, steps should be taken to minimize erosion, soil disturbance, and the spread of flammable nonnative grasses and weeds. For purposes of this subparagraph, "fuel" means any combustible material, including petroleum-based products, cultivated landscape plants, grasses, and weeds, and wildland vegetation.

(B) A greater distance than that required under subparagraph (A) may be required by state law, local ordinance, rule, or regulation. Fuel modification beyond the property line may only be required by state law, local ordinance, rule, or regulation in order to maintain 100 feet of defensible space from a structure. Fuel modification on adjacent property shall only be conducted following written consent by the adjacent landowner. Any local ordinance related to fuel modification shall be in compliance with all applicable state laws, regulations, and policies. Any local ordinance may include provisions to allocate costs for any fuel modification beyond the property line.

(C) An insurance company that insures an occupied dwelling or occupied structure may require a greater distance than that required under subparagraph (A) if a fire expert, designated by the director, provides findings that the fuel modification is necessary to significantly reduce the risk of transmission of flame or heat sufficient

to ignite the structure, and there is no other feasible mitigation measure possible to reduce the risk of ignition or spread of wildfire to the structure. The greater distance may not be beyond the property line unless allowed by state law, local ordinance, rule, or regulation.

(2) Remove that portion of a tree that extends within 10 feet of the outlet of a chimney or stovepipe.

(3) Maintain a tree, shrub, or other plant adjacent to or overhanging a building free of dead or dying wood.

(4) Maintain the roof of a structure free of leaves, needles, or other vegetative materials.

(5) Before constructing a new building or structure or rebuilding a building or structure damaged by a fire in an area subject to this section, the construction or rebuilding of which requires a building permit, the owner shall obtain a certification from the local building official that the dwelling or structure, as proposed to be built, complies with all applicable state and local building standards, including those described in subdivision (b) of Section 51189 of the Government Code, and shall provide a copy of the certification, upon request, to the insurer providing course of construction insurance coverage for the building or structure. Upon completion of the construction or rebuilding, the owner shall obtain from the local building official, a copy of the final inspection report that demonstrates that the dwelling or structure was constructed in compliance with all applicable state and local building standards, including those described in subdivision (b) of Section 51189 of the Government Code, and shall provide a copy of the report, upon request, to the property insurance carrier that insures the dwelling or structure.

(b) A person is not required under this section to manage fuels on land if that person does not have the legal right to manage fuels, nor is a person required to enter upon or to alter property that is owned by any other person without the consent of the owner of the property.

(c) (1) Except as provided in Section 18930 of the Health and Safety Code, the State Fire Marshal may adopt regulations exempting a structure with an exterior constructed entirely of nonflammable materials, or, conditioned upon the contents and composition of the structure, the director may vary the requirements respecting the removing or clearing away of flammable vegetation or other combustible growth with respect to the area surrounding those structures.

(2) An exemption or variance under paragraph (1) shall not apply unless and until the occupant of the structure, or if there is not an occupant, the owner of the structure, files with the State Fire Marshal, in a form as the State Fire Marshal shall prescribe, a written consent to the inspection of the interior and contents of the structure to ascertain whether this section and the regulations adopted under this section are complied with at all times.

(d) The State Fire Marshal may authorize the removal of vegetation that is not consistent with the standards of this section. The State Fire Marshal may prescribe a procedure for the removal of that vegetation and make the expense a lien upon the

building, structure, or grounds, in the same manner that is applicable to a legislative body under Section 51186 of the Government Code.

(e) (1) The board, in consultation with the State Fire Marshal, shall develop, periodically update, and post on its internet website a guidance document on fuels management pursuant to this chapter. The guidance document shall include, but not be limited to, regionally appropriate vegetation management suggestions that preserve and restore native species that are fire resistant or drought tolerant, or both, minimize erosion, minimize water consumption, and permit trees near homes for shade, aesthetics, and habitat; and suggestions to minimize or eliminate the risk of flammability of nonvegetative sources of combustion, such as woodpiles, propane tanks, decks, outdoor furniture, barbecue equipment, and outdoor fire pits.

(2) On or before January 1, 2023, the board, in consultation with the State Fire Marshal, shall update the guidance document to include suggestions for creating an ember-resistant zone within five feet of a structure, based on regulations promulgated by the board, in consultation with the department, to consider the elimination of materials in the ember-resistant zone that would likely be ignited by embers.

(f) The State Fire Marshal shall do both of the following:

(1) Recommend to the board the types of vegetation or fuel that are to be excluded from an ember-resistant zone based on the probability that vegetation and fuel will lead to ignition by ember of a structure as a part of the update to the guidance document pursuant to paragraph (2) of subdivision (e).

(2) Make reasonable efforts to provide notice to affected residents describing the requirements added by the amendments to paragraph (1) of subdivision (a) made in Assembly Bill 3074 of the 2019–20 Regular Session before the imposition of penalties for violating those requirements.

(g) (1) The requirement for an ember-resistant zone pursuant to paragraph (1) of subdivision (a) shall not take effect for new structures until the board updates the regulations, pursuant to paragraph (1) of subdivision (a), and the guidance document, pursuant to paragraph (2) of subdivision (e).

(2) The requirement for an ember-resistant zone pursuant to paragraph (1) of subdivision (a) shall take effect for existing structures one year after the effective date for the new structures.

(h) The department shall not change defensible space inspection practices and forms or enforcement to implement the requirement for an ember-resistant zone until the State Fire Marshal makes a written finding, which the State Fire Marshal shall post on the department's internet website, that the Legislature has appropriated sufficient resources to do so.

(i) For purposes of this section, a structure for the purpose of an ember-resistant zone shall include any attached deck. This section does not limit the authority of the board or the department to require the removal of fuel or vegetation on top of or underneath a deck pursuant to this section.

(j) As used in this section, "person" means a private individual, organization, partnership, limited liability company, or corporation.

(Amended by Stats. 2021, Ch. 382, Sec. 9.5. (SB 63) Effective January 1, 2022.)

PROPERTY INSPECTION GUIDE



CAL FIRE

Office of the State Fire Marshal

Community Wildfire Preparedness & Mitigation Division

Wildfire Preparedness Program

2023 EDITION

TABLE OF CONTENTS

SECTION I

1. INTRODUCTION

2. PROPERTY FIRE PREVENTION INSPECTIONS

2.1 Fire Prevention Inspections
2.2 General Guidelines
2.3 Inspection Programs
2.4 Pre-Inspection Program
2.5 Authority to Inspect
2.6 Legal Considerations
2.7 Interior Structure Inspections
2.8 Liability

3. PROPERTY FIRE PREVENTION INSPECTION SCOPE

3.1 General Scope
3.2 Defensible Space Concept
3.3 Fuel Breaks and Fuel Modification Around Structures
- 3.3.1 Law
- 3.3.2 Regulations
- 3.3.3 Enforcement
- 3.3.4 Board of Forestry General Guidelines for Creating Defensible Space
- 3.3.5 Defensible Space Fuel Break
- 3.3.6 Zone 1 Clearance Requirements
- 3.3.7 Zone 2 Clearance Requirements
- 3.3.8 Single Specimens of Flammable Vegetation
- 3.3.9 Overhanging and Adjacent Vegetation
- 3.3.10 Roof and Structural Surfaces
- 3.3.11 Logs and Stumps
- 3.3.12 Chimney and Stovepipe Outlets
- 3.3.13 Woodpiles
- 3.3.14 Outbuildings
- 3.3.15 LPG Tanks
- 3.3.16 Other Flammable Debris and Materials
- 3.3.17 Special Concerns

3.4 Fire Hazards and Ignition Sources
- 3.4.1 Debris Burning
- 3.4.2 Campfires and Cooking Fires
- 3.4.3 Proper Disposal of Ashes
- 3.4.4 Spark Arresting Screen on Chimney and Stovepipe
- 3.4.5 Mechanical Equipment Use
- 3.4.6 Metal Cutting, Welding, and Grinding
- 3.4.7 Use of Wood Preservatives, Oils and Stains
- 3.4.8 Gas Stoves, Lanterns, and Heaters
- 3.4.9 Flammable Liquid Storage

SECTION II

1. INSPECTOR QUALIFICATIONS

1.1 General Qualifications
1.2 Training
1.3 Tools of the Inspector

2. CONDUCTING THE INSPECTION

2.1 Inspection Procedure
2.2 Real Estate Inspections
2.3 Time of Day and Day of the Week
2.4 Time of the Year
2.5 Approaching the Property
2.6 Personal Safety
2.7 Contacting the Owner/Occupant
2.8 Conducting the Inspection
2.9 Explaining Fire Behavior to Homeowner

3. CLOSING OUT THE INSPECTION

3.1 Reviewing Inspection Findings
3.2 Documenting the Inspection on the LE-100a
3.3 Documenting the Inspection Electronically
3.4 Explaining Follow-up and Reinspection
3.5 Closeout with Homeowner

SECTION III

1. PUBLIC RESOURCES CODE 4290 – SRA FIRE SAFE REGULATIONS

1.1 Law
1.2 Regulations
1.3 Emergency Vehicle Access
1.4 Signing and Building Numbering
1.5 Emergency Water Standards
1.6 Vegetation Modification

2. IGNITION RESISTANT CONSTRUCTION

2.1 Regulations
2.2 Roofs
2.3 Siding
2.4 Vents
2.5 Eaves
2.6 Windows
2.7 Doors
2.8 Decks and Balconies
2.9 Accessory Structures

3. HOMEOWNER WILDFIRE PREPAREDNESS

3.1 Homeowner Questions
3.2 Wildfire Action Plan
3.3 Preparing for Evacuation
3.4 Evacuation
3.5 Trapped by a Wildfire
3.6 Informational Resources

4. FIRE RESISTIVE LANDSCAPING

4.1 Lean, Clean, and Green Planning
4.2 Characteristics of Fire Resistive Vegetation
4.3 Informational Resources

APPENDICES

A. Resources
B. LE-100a
C. Statutes and Regulations

FOREWORD

This *2023 edition* of the *Property Inspection Guide* contains standards, practices, statutes, and regulations for the mitigation of loss of life and property from wildfire in the State of California. This Guide is designed for use by fire prevention inspectors and those persons with the responsibility to conduct inspections of structures and improvements in wildfire-prone areas of the state. It was developed to provide the necessary information and procedures required to establish and maintain a uniform system to ensure fire-safe compliance by homeowners in the state's wildlands and the Wildland Urban Interface (WUI). This version contains major changes from prior editions due to revisions of the laws and regulations pertaining to the defensible space clearance requirements around all structures in and adjacent to California's wildlands. It also references changes made to the minimum wildfire fire safety building standards related to perimeters and access of all residential, commercial, and industrial building construction in the State's fire-prone areas.

Except for sample copies retained for historical or reference purposes, all copies of prior editions should be withdrawn from circulation and destroyed. Moreover, regardless of the inferences that any reader may draw from any statement in this Guide, the law must be obeyed. Thus, if there is any conflict between any statement in this Guide and any applicable statute, regulation, or order, the statute, regulation, or order shall take precedence. Applicable statutes and regulations are set forth in the STATUTES AND REGULATIONS section of this Guide.

It is expected that all personnel who conduct or supervise property inspections will be thoroughly familiar with the contents of this Guide. They should use it, refer to it regularly, and observe the principles, practices, and guidance included herein. The Guide is not to be used as a substitute for proper training but as a reference for personnel already familiar with the subject.

SECTION I

1. INTRODUCTION

State law requires that all structures within or adjacent to hazardous vegetative fuel conditions will have certain minimum defensible space clearances surrounding their exterior. The law referenced is Public Resource Code (PRC) 4291. This law was originally enacted in the 1960s to prevent fires that originated in structures or on their premises from spreading into forested areas. It included among other requirements, a minimum of 30 feet clearance of flammable vegetation surrounding the exterior of a structure, which could be increased to 100 feet if certain hazardous conditions were present. As California's population dramatically increased post WWII, more people moved from population centers into the state's wildlands creating the Wildland Urban Interface (WUI). This increased development in fire-prone areas; increased the hazards to life and property from wildfires. The history of damaging fires has shown the most devastating danger is the risk of fire originating in the wildland and transmitting itself into improved areas. As more and more large and damaging fires occurred across the state in the latter third of the century, it became clear that new regulations and additions to existing statutes needed to be enacted to mitigate the loss of life and property from wildfire.

Major changes to PRC 4291 were enacted in 2005, accompanied by additions in 2008 and 2009. These changes expanded the defensible space clearance requirement around structures from 30 feet to 100 feet and created the formation of two zones around a structure. The first zone, 30 feet immediately surrounding the structure, is considered a firebreak with all readily flammable vegetation removed. The second zone extending 30 feet from the structure to 100 feet is a reduced fuel zone. Part of the PRC 4291 law changes requires that the California Department of Forestry and Fire Protection (CAL FIRE) develop and post on the web a guidance document for use by homeowners in obtaining proper defensible space in compliance with the law. That guidance document is found in its entirety in the Appendix section of this manual. PRC 4291 does not apply to a specific agency jurisdiction but does apply to the specific fuel conditions identified in the opening section of the law.

In addition to the changes made to PRC 4291, the State enacted PRC 4290 in 1965 which set fire-safe standards for all building permits issued in the State Responsibility Area (SRA) after January 1, 1991. Known as the SRA Fire Safe Regulations, these standards included emergency fire equipment access, street identification and building numbering, emergency firefighting water supply, and fuel modification. These regulations were updated in 2021 and are further discussed in this Guide. Recent changes to the California Building Code (CBC) and the California Fire Code (CFC) have also set new standards for Firewise building in the state's SRA including building components that resist ignition on the roof, siding, eaves, decks, balconies, and windows.

The primary focus of property inspections should be on the education and compliance of the homeowner with PRC 4291, however, it is incumbent upon the inspector to point out and address other hazardous conditions observed during the inspection. These include the identification and mitigation of potential ignition sources, the Fire Safe Regulations contained in PRC 4290, and the Firewise Building Standards found in the CBC Chapter 7A and CFC Chapter 49 among others. Inspectors should also be familiar with fire-resistive landscape techniques and homeowner wildfire disaster preparedness such as Ready-Set-Go (See Appendix A).

2. PROPERTY FIRE PREVENTION INSPECTIONS

2.1 Fire Prevention Inspections

A key goal of the Department's fire prevention program is to educate the public of the state in measures they can take to prevent the ignition and spread of unwanted human-caused fires. Emphasis should be placed on life safety, loss reduction, the prevention of large and damaging fires, and to provide firefighter safety. One of the necessary tools utilized to accomplish this goal is the structural fire prevention inspection, which is a fire prevention engineering activity. They are also the first step in the law enforcement process, should that become a necessity. Coordinated with other ignition management activities, the inspections are aimed at eliminating or reducing fire hazards and risks by changing the environment surrounding the structure into a defensible space.

2.2 General Guidelines

The success of the program depends on the participation of all personnel, including fire prevention, fire control, and resource management staff. All contacts should be handled so the public will understand and participate in the fire prevention efforts. Public participation leads to reductions in total wildfire costs and losses. To the extent resources are available, local inspection programs should concentrate on areas that have the greatest potential for large and damaging fires with the accompanying loss of life and property.

All personnel involved in inspection activities should have a department identification card, nameplate, uniform, and badge if issued to facilitate proper identification. Unit fire prevention plans should contain local inspection policies and procedures, including minimum training requirements for property inspectors.

All inspections conducted for the purpose of ascertaining compliance with the State Forest and Fire Laws should be recorded on the Notice of Defensible Space Inspection (LE-100a -Appendix B). This provides uniform law enforcement a record for timely follow-up, public education, standardized written notice, and documentation of inspection activity for program effectiveness and direction.

2.3 Inspection Programs

Units should develop yearly inspection programs that concentrate on areas that have the greatest potential for large and damaging fires with the accompanying loss of life and property. These programs should be outlined and coordinated under the Unit's Fire Prevention Plan. The use of Department Inspectors, Volunteers in Prevention, as well as permanent and seasonal firefighting personnel is a key component in accomplishing the goal of each Unit's inspection program. Provisions must be made to ensure all inspectors involved in the program receive minimum training and are thoroughly familiar with applicable laws and regulations, and the contents of this Guide. Programs should include advance notice to the homeowner, the scheduling of pre- and early-season field inspections, the carrying out of timely follow-up inspections, and provisions for law enforcement follow-up activities when necessary.

2.4 Pre-Inspection Program

A pre-inspection program can improve compliance, foster good public relations with homeowners, reduce law enforcement action, and reduce overall staffing and cost requirements. Pre-inspection activities include media notification of potential inspection areas, mail-out information, and homeowner self-inspection mail-outs with a return of compliance confirmation. A pre-inspection program should include the following considerations to be effective:

- Time of year (emphasize the spring months).
- Areas with large numbers of absentee ownership, i.e., summer homes.
- Limited availability of personnel, including fire crews.

- Emphasis placed on very high and critical fire hazard severity areas where there is a large potential for property loss.

Advance notice mailers and self-inspection forms used in combination with Departmental inspections produce the most effective results for the amount of time and work invested. The advance notice should include the following:

- The necessity of fire hazard reduction.
- Notice that the Department will be contacting the homeowner to make a fire prevention inspection and the approximate date.
- What the inspection will consist of?
- The measures necessary for the owner to complete to adequately reduce the fire hazards. This can be keyed to an enclosed Fire Law Excerpts pamphlet or other attachment.
- Agency contact, address, and phone number for more information.
- Self-inspection form with a return address.

2.5 Authority to Inspect

Authority for Departmental personnel to enforce the State Forest and Fire Laws is contained in PRC 4119. Agency personnel may inspect all properties, except the interior of structures, subject to the States Forest and Fire Laws, for the purpose of ascertaining compliance with such laws. United States Forest Service (USFS) personnel that can do routine inspections for the reduction of fire hazards around buildings as described under PRC 4291 must be designated, in writing, by the Director of CAL FIRE or his designee. This designation allows certain USFS employees to act as authorized agents for CAL FIRE to do routine fire inspections as specified in the California Master Cooperative Wildland Fire Management and Stafford Act Response Agreement (CFMA). These inspections would be conducted on private lands (SRA) contained within the USFS Direct Protection Area (DPA). If a violation of state law is found, USFS personnel should follow the procedure outlined in their local operating agreement with the CAL FIRE Unit that administers their forest.

2.6 Legal Considerations

Though PRC 4119 authorizes Department inspectors to conduct property inspections, there are certain restrictions that apply. These are based on the property owner's expectation of privacy and protection from unreasonable searches as stated in the 4th Amendment of the Constitution of the United States. Inspectors may enter private property and attempt to contact the homeowner at the property's front entrance. Once permission has been requested and granted the inspector may enter the side and backyard to freely conduct the inspection. Without the homeowner's permission, the inspector may only observe and note violations of PRC 4291 from the front entranceway, the front sidewalk, and the adjoining street. If the inspector has consented to inspect an adjoining property and can freely observe the neighboring property, those observations are also permissible.

2.7 Interior Structure Inspections

PRC 4291 does not authorize CAL FIRE and USFS personnel to inspect the interior of a structure. Local fire agencies or CAL FIRE under a local government contractual agreement may have the authority and should be encouraged to inspect single-family structures and business interiors upon request of the owner.

2.8 Liability

If fire law violations are observed, or significant hazards or risks are evident, the violations and hazards should be recorded on an appropriate inspection form. Corrective information, such as handout material, should be provided to the homeowner to facilitate correction and compliance. The homeowner should

understand that they are responsible for any fire that escapes their control or property. Explain that if a fire should start on their property, because of certain hazards, and spread to a neighbor's property, the neighbor may have civil recourse for damages through the courts. In addition, the wildland fire agency has the authority to recover suppression costs and the occupant may face criminal charges for negligence in the cause of the fire.

3. PROPERTY FIRE PREVENTION INSPECTION SCOPE

3.1 General Scope

The primary focus of property inspections is the defensible space clearance requirements set forth in PRC 4291. All structures in fire-prone areas of the state are covered under the statute including all structures in the SRA. The definition of a building/structure is further defined in Section 3.3.1. These requirements are key elements; in providing a defensible space for a structure from an encroaching wildfire, minimizing the possibility that a fire in a structure or its surroundings will spread to the wildland, and for a safe working environment for firefighters. Property inspections should also be used to identify and mitigate potentially hazardous conditions or practices, which could lead to a fire ignition on the homeowner's property. Examples are unsafe burning practices, cutting, welding, or grinding without proper clearance, the use of gasoline-powered equipment without a spark arrester, etc.

In addition, property inspections may be used to advise property owners of additional steps they should take to further fire-safe their home and property including bringing their home up to the fire-safe standards required for new homes built under PRC 4290 regulations and the ignition-resistant building standards included in the CBC and CFC. Both PRC 4290 and Firewise building standards are discussed in further detail in Section III.

3.2 Defensible Space Concept

The term "Defensible Space" was first coined in the 1980 publication *Fire Safe Guide for Residential Development in California*. It now provides the cornerstone of the Board of Forestry and Fire Protection's (BOF) Fire Safe Regulations, and CAL FIRE's wildland fire prevention planning program. Defensible space as defined by the BOF; *the area within the perimeter of a parcel, development, neighborhood, or community where basic wildfire protection practices are implemented, providing the key point of defense from an approaching wildfire or defense against encroaching wildfires or escaping structure fire. The area is characterized by the establishment and maintenance of emergency vehicle access, emergency water reserves, street names and building identification, and fuel modification measures.*

Good defensible space around a structure provides firefighters a safe working environment to protect the structure from an encroaching wildfire as well as minimizing the chance that if the structure were on fire, the fire would not escape into the surrounding wildland. A defensible structure is a building that, besides having adequate clearances to hazardous fuels, incorporates Firewise construction components such as ignition-resistant roofing, siding, and decking, enclosed eaves, metal screened vents, and multi-paned windows. Defensible space is addressed in various areas of the state statutes and regulations including PRC 4290, PRC 4291, Title 14 California Code of Regulations (CCR) 1270.00 – 1276.03, 1299.01 – 1299.05, the CBC, the CFC, and the Health and Safety Code (HSC).

3.3 Fuel Breaks and Fuel Modification Around Structures

3.3.1 The Law

The law, which requires 100ft of defensible space clearance around a structure, is PRC 4291. It is further defined by the BOF's 'General Guidelines for Creating Defensible Space' (BOF General Guidelines) and Title 14 CCR 1299.01 – 1299.05. The clearance requirement is divided into two zones; a fuel break of 30ft immediately surrounding the structure (Zone 1), and a reduced fuel zone starting at 30ft and extending to 100ft (Zone 2). The law does not require a homeowner to extend the clearance beyond the property line, so the requirement is to 100ft or the property line, whichever comes first. In addition, the law requires all limbs be removed

within 10ft of chimney or stove outlets, all trees and shrubs adjacent to and overhanging the roof be maintained free of dead or dying wood, and the roof and all structural surfaces susceptible to ignition by flying embers be kept free of any leaves, needles, or vegetative material.

The law applies to all buildings or structures which are defined in the 14 CCR 1299.02 as *"Anything constructed that is designed or intended for support, enclosure, shelter, or protection of persons, animals, or property, having a permanent roof that is supported by walls or posts that connect to or rest on the ground."* Buildings less than 120 square feet in size and not used for human habitation within Zones 1 and 2 are considered outbuildings. The clearance requirements for outbuildings are discussed in Section 3.3.14 of this Guide.

PRC 4291 is required year-round whenever flammable vegetative conditions exist and applies to any building or structure on or adjacent to land covered with flammable material including grass, brush, and forest. This includes all the SRA in the State as well as select Local Responsibility Areas (LRA) as just described.

PRC 4291 States in part (the entire text of the law can be found in Appendix C):

(a) A person who owns, leases, controls, operates, or maintains a building or structure in, upon, or adjoining a mountainous area, forest-covered lands, brush-covered lands, grass-covered lands, or land that is covered with flammable material, shall at all times do all of the following:

(4) Maintain defensible space of 100 feet from each side and from the front and rear of the structure, but not beyond the property line, except as provided in subparagraph (B). The amount of fuel modification necessary shall consider the flammability of the structure as affected by building material, building standards, location, and type of vegetation. Fuels shall be maintained and spaced in a condition so that a wildfire burning under average weather conditions would be unlikely to ignite the structure. This subparagraph does not apply to single specimens of trees or other vegetation that are well-pruned and maintained so as to effectively manage fuels and not form a means of rapidly transmitting fire from other nearby vegetation to a structure or from a structure to other nearby vegetation or to interrupt the advance of embers toward a structure. The intensity of fuels management may vary within the 100-foot perimeter of the structure, with more intense fuel reductions being utilized between 5 and 30 feet around the structure, and an ember-resistant zone being required within 5 feet of the structure, based on regulations promulgated by the board, in consultation with the department, to consider the elimination of materials in the ember-resistant zone that would likely be ignited by embers. Consistent with fuels management objectives, steps should be taken to minimize erosion, soil disturbance, and the spread of flammable nonnative grasses and weeds. For purposes of this subparagraph, "fuel" means any combustible material, including petroleum-based products, cultivated landscape plants, grasses, and weeds, and wildland vegetation. Remove that portion of a tree that extends within 10 feet of the outlet of a chimney or stovepipe.

(5) Maintain a tree, shrub, or other plant adjacent to or overhanging a building free of dead or dying wood.

(6) Maintain the roof of a structure free of leaves, needles, or other vegetative materials.

(b) A person is not required under this section to manage fuels on land if that person does not have the legal right to manage fuels, nor is a person required to enter upon or to alter property that is owned by any other person without the consent of the owner of the property.

(e) The board, in consultation with the State Fire Marshal, shall develop, periodically update, and post on its internet website a guidance document on fuels management pursuant to this chapter. The guidance document shall include, but not be limited to, regionally appropriate vegetation

management suggestions that preserve and restore native species that are fire resistant or drought tolerant, or both, minimize erosion, minimize water consumption, and permit trees near homes for shade, aesthetics, and habitat; and suggestions to minimize or eliminate the risk of flammability of nonvegetative sources of combustion, such as woodpiles, propane tanks, decks, outdoor furniture, barbecue equipment, and outdoor fire pits. As used in this section, "person" means a private individual, organization, partnership, limited liability company, or corporation.

3.3.2 Regulations

The regulations established for the implementation of PRC 4291 in the SRA are found in the California Code of Regulations, Title 14, Sections 1299.01 – 1299.05 (14 CCR 1299). The entire text of the 1299 Regulations is included in the Appendix Section C of this manual.

3.3.3 Enforcement

A violation of PRC 4291 is an infraction, punishable by a fine. Repeated violations increase the fine, and under certain conditions increase the crime to a misdemeanor. Property inspectors provide the first steps in the enforcement of PRC 4291. They do this through notification to the homeowner of violations, and through documentation of observed violations which will be used later by the Department's Law Enforcement Section for further enforcement actions. Though most property inspectors generally are not involved or authorized in the issuance of citations for noncompliance with the PRC, they should be aware of the legal consequences to a homeowner who fails to abide by the statute. Encouragement to the homeowner to abide with the statute should be from the aspect that it is for their life safety and the protection of their home and property from fire.

PRC 4291.1 States:

(a) Notwithstanding Section 4021, a violation of Section 4291 is an infraction punishable by a fine of not less than one hundred dollars ($100), nor more than five hundred dollars ($500). If a person is convicted of a second violation of Section 4291 within five years, that person shall be punished by a fine of not less than two hundred fifty dollars ($250), nor more than five hundred dollars ($500). If a person is convicted of a third violation of Section 4291 within five years, that person is guilty of a misdemeanor and shall be punished by a fine of not less than five hundred dollars ($500). If a person is convicted of a third violation of Section 4291 within five years, the department may perform or contract for the performance of work necessary to comply with Section 4291 and may bill the person convicted for the costs incurred, in which case the person convicted, upon payment of those costs, shall not be required to pay the fine. If a person convicted of a violation of Section 4291 is granted probation, the court shall impose as a term or condition of probation, in addition to any other term or condition of probation, that the person pay at least the minimum fine prescribed in this section.

(b) If a person convicted of a violation of Section 4291 produces in court verification prior to imposition of a fine by the court, that the condition resulting in the citation no longer exists, the court may reduce the fine imposed for the violation of Section 4291 to fifty dollars ($50).

3.3.4 Board of Forestry and Fire Protection General Guidelines for Creating Defensible Space

Section (*e*) of PRC 4291 requires the BOF to develop and post on the Internet, a guidance document for homeowners on the proper fuel management methods to obtain compliance with the statute. Inspectors shall use these Guidelines along with the regulations found in 14 CCR

1299.01 – 1299.05 (Appendix C) as a standard when inspecting a property for compliance with the PRC.

3.3.5 Defensible Space Fuel Break

Important Note:

> Zones 1 and 2 currently make up the 100 feet of defensible space required by law. Assembly Bill 3074, passed into law in 2020, requires a third zone for defensible space. This law requires the Board of Forestry and Fire Protection to develop the regulation for a new ember-resistant zone (Zone 0) within 0 to 5 feet of the home.
>
> The intensity of fuels management may vary within the 100-foot perimeter of the structure, with more intense fuel reductions being utilized between 5 and 30 feet around the structure, and an ember-resistant zone being required within 5 feet of the structure, based on regulations promulgated by the board, in consultation with the department, to consider the elimination of materials in the ember-resistant zone that would likely be ignited by embers.

As required by PRC 4291, a defensible space around a structure consists of 100ft of flammable fuel reduction and removal. This 100ft is divided into two zones called Zone 1 and Zone 2. Zone 1 extends out in all directions from the structure 30ft or to the property line whichever comes first. It consists of a fuel break where all the hazardous flammable vegetation and fuel have been removed. It is also referred to and characterized as the 'Lean and Clean' zone or the 'Home Defense Zone'. Zone 2 extends out from 30ft to 100ft or the property line, whichever comes first. It is commonly referred to as the 'Reduced Fuel Zone'. This area is characterized by the removal of dead fuel, the elimination of ladder fuels, and the breaking up of the continuity of the living fuel. The overall concept of the 100ft is that a fire entering the space will decrease its intensity through the Reduced Fuel Zone and die out upon reaching the 30ft fuel break. This reduces the chance of direct flame contact on the building and reduces the intensity of radiated heat from the approaching wildfire. It also slows the rate of spread, reduces flame lengths, reduces the duration of heat, and decreases the overall heat which makes a much safer environment for firefighters to work in.

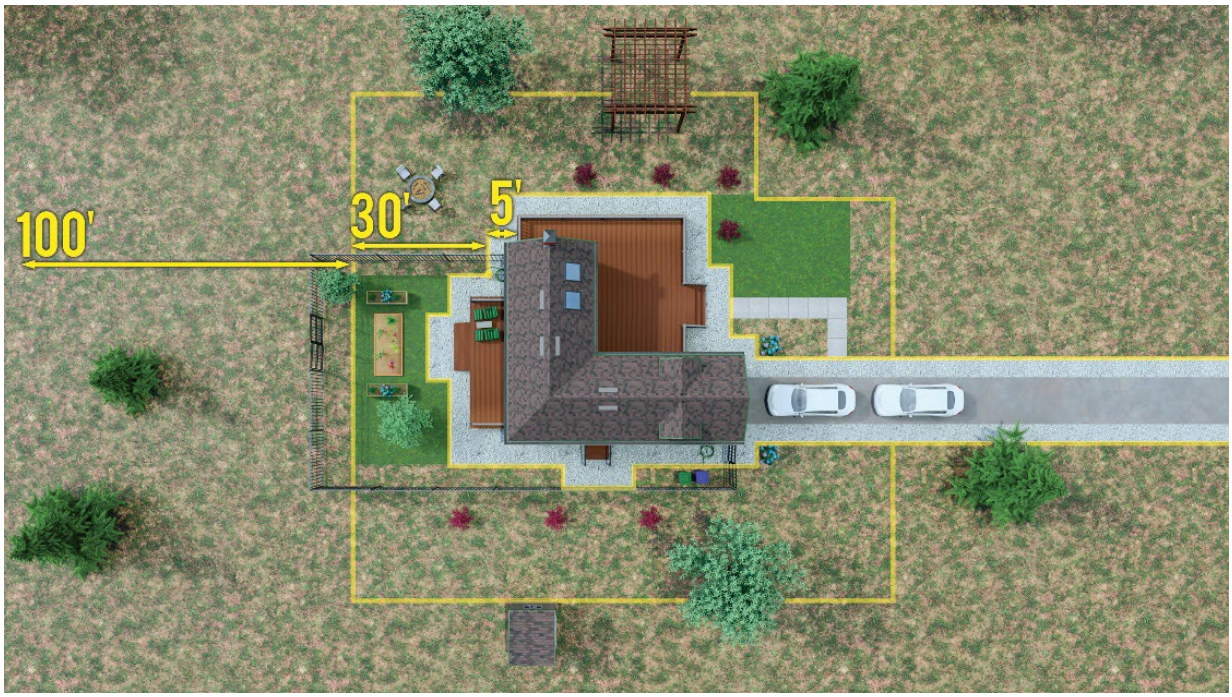
There are three basic techniques a homeowner should use to achieve a defensible space fuel break around their property. These are fuel removal, fuel reduction, and type conversion. These also are referred to as the 3 R's of defensible space; Removal, Reduction, and Replacement.

Fuel removal is most commonly used in Zone 1 to eliminate all hazardous fuels near the structure. Though it is recommended that all flammable native vegetation and highly flammable ornamental vegetation be removed in this area, individual specimen trees or shrubs may be kept as long as this vegetation has had all dead material removed and it cannot readily transmit fire to the structure or other adjacent vegetation. Periodic maintenance of these trees and shrubs is required to provide adequate fire safety.

Type conversion is another technique for achieving a fire-resistive fuel break in Zone 1. This includes the removal of highly flammable vegetation and replacement with green lawns, well-irrigated low-volume herbaceous plants, or nonflammable landscaping such as gravel, brick, or rock.

Fuel reduction is most commonly used in Zone 2. It is characterized by the removal of all dead and downed brush and trees, the thinning of all species to break up the fuel continuity, the elimination of ladder fuels, and the trimming up of all living fuels. Fuel reduction means the

arranging of trees, shrubs, and other fuel in such a way that it is difficult for the fire to transfer from one fuel source to another. The requirement for reduction will be greater for those properties with steeper terrain, larger and denser fuels, highly volatile fuels, and areas subject to frequent fires.



3.3.6 Zone 1 Clearance Requirements

In general, PRC 4291 requires the removal of all dead or dying standing and lying vegetation within 30ft of any building or structure and on its roof and deck surfaces. It also requires the removal of all flammable and other combustible growth (BOF General Guidelines). Exceptions include single specimens of living flammable vegetation, logs, and stumps, ground cover for prevention of soil erosion, and woodpiles as outlined in Sections 3.3.8, 3.3.11, 3.3.13, & 3.3.17. Specific fuel removal provisions apply to vegetation overhanging and adjacent to the structure, fuel accumulations on structural surfaces, and special hazardous fuels as specified in Sections 3.3.9, 3.3.10, 3.3.12 & 3.3.16.

3.3.7 Zone 2 Clearance Requirements

The fuel treatment requirements for the **Reduced Fuel Zone**, 30ft to 100ft, depending on the slope, vegetation type (trees, brush, grass), and the fuel characteristics (fuel compaction, chemical content, etc.) present. Two methods of fuel treatment, or a combination of both apply. **Fuel Separation** method should be used where there is an intermixing of fuel types. Where there is a stand of trees the **Continuous Tree Canopy** method should be used. In all cases, the removal of all dead and dying surface and aerial fuels is required, however, surface litter may be retained to a maximum depth of 3 inches, and grass and forb stubble to a maximum height of 4 inches. An exception for standing dead trees referred to as 'snags' is permitted provided they are spaced no more than one per acre, are well spaced from other vegetation, and cannot fall on the structure or across the roadway/driveway.

The **Fuel Separation** method requires a minimum spacing of fuels from 4ft to 40ft in all directions, both horizontally and vertically. The spacing is based on the slope, fuel type, and

fuel size. For purposes of establishing size, fuels of similar type growing in groups no larger than 10ft in total foliage width are treated as a single plant. Standing grass and forbs should not exceed 4 inches in height.

Plant and Tree Spacing

The spacing between grass, shrubs, and trees is crucial to reduce the spread of wildfires. The spacing needed is determined by the type and size of the brush and trees, as well as the slope of the land. For example, a property on a steep slope with larger vegetation requires greater spacing between trees and shrubs than a level property that has small, sparse vegetation.

Vertical Spacing

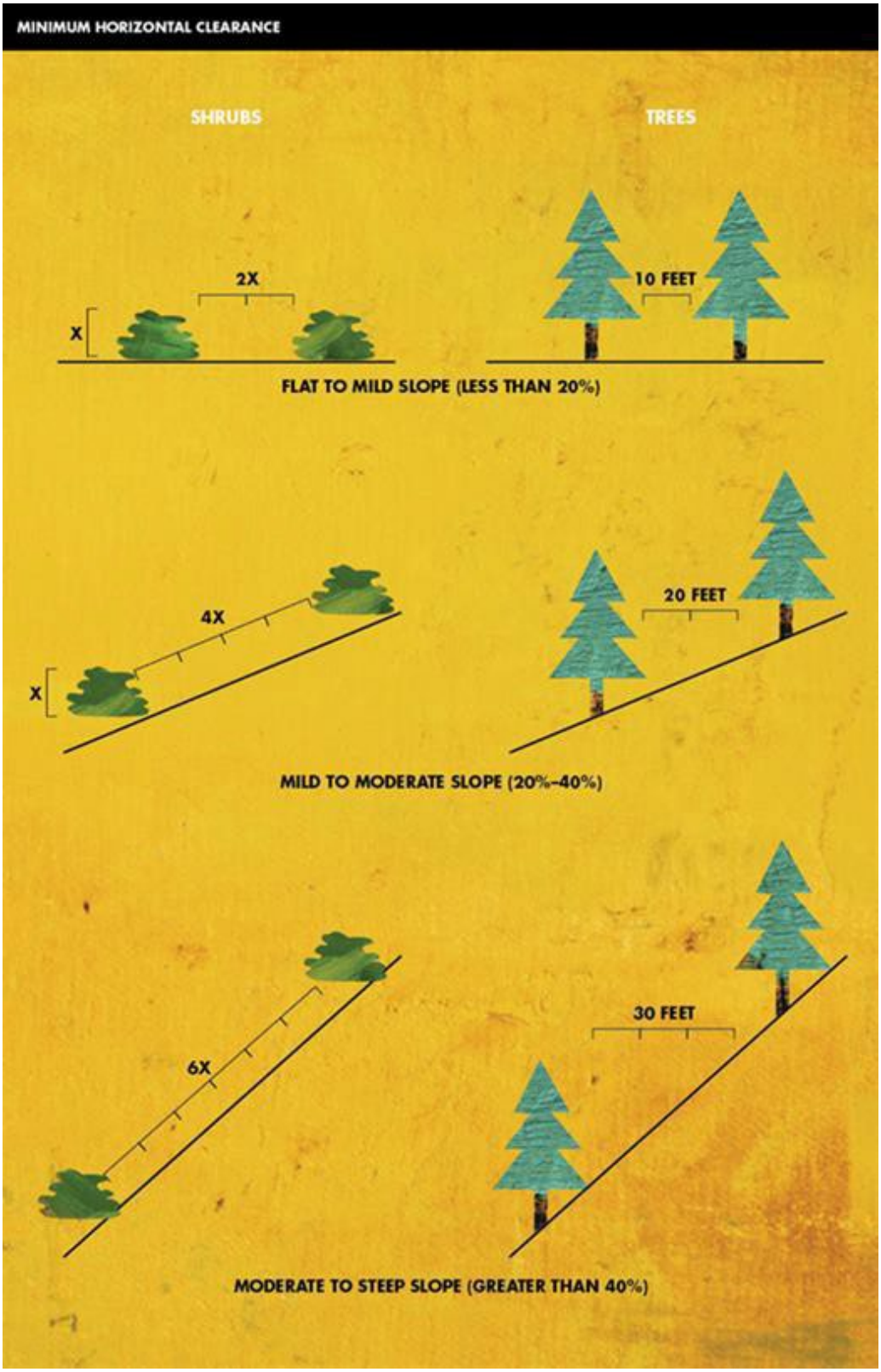
- Remove all tree branches at least 6 feet from the ground.
- Allow extra vertical space between shrubs and trees. Lack of vertical space can allow a fire to move from the ground to the brush to the treetops like a ladder. This leads to more intense fire closer to your home.
- To determine the proper vertical spacing between shrubs and the lowest branches of trees, use the formula below.



Example: A five-foot shrub is growing near a tree. 3x5 = 15 feet of clearance needed between the top of the shrub and the lowest tree branch.

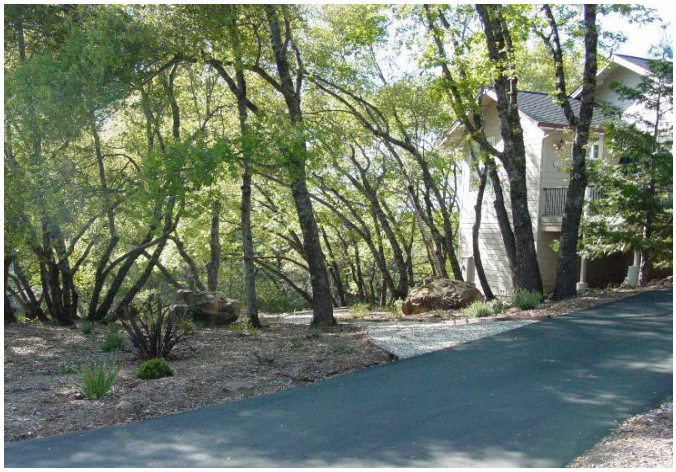
Horizontal Spacing

Horizontal spacing depends on the slope of the land and the height of the shrubs or trees. Check the chart below to determine spacing distance.



The **Continuous Tree Canopy** method requires the removal of surface fuels greater than 3 inches in height and the removal of lower tree limbs a minimum of 6ft and up to 15ft. For trees smaller than 18ft, the lower 1/3 of the limbs should be removed. Slope and fire danger are the determining factors in limb removal at the upper end of the scale. Single specimens of trees or other vegetation may be retained provided they are well-spaced, well-pruned, and do not create a condition that allows fire to spread to other vegetation or to the structure.





3.3.8 Single Specimens of Flammable Vegetation

PRC 4291 allows an exception for single specimens of flammable vegetation within Zone 1 provided they are well spaced, well pruned, and do not provide a condition that allows fire to spread to other vegetation or to the structure itself.



3.3.9 Overhanging and Adjacent Vegetation

PRC 4291 requires that all trees, shrubs, and vegetation overhanging the roof, and adjacent to its siding and windows be maintained free of any dead or dying limbs, branches, or other vegetative material. Additionally, flammable vegetation and material that could catch on fire shall be removed below and adjacent to any combustible deck, balcony, and stair (14 CCR 1299.03).



3.3.10 Roof and Structural Surfaces

PRC 4291 requires that all roofs and gutters be maintained free of flammable debris. Additionally, flammable debris and materials must be removed from on and below structural surfaces vulnerable to ignition from flying embers including combustible decks, balconies, and stairs. Leaves and needles fall throughout the year and homeowners need to schedule periodic maintenance of their roofs, decks, stairs, and balconies to prevent any flammable debris accumulation. Special attention should be taken during the fall and after wind events. Leaf and needle accumulation provide ideal fuel receptors for flying embers during a wildfire.



3.3.11 Logs and Stumps



The Board of Forestry (BOF) General Guideline allows logs and stumps embedded in the soil within both Zone 1 and Zone 2 to remain provided they are of sound wood and isolated from other vegetation and the structural surfaces of a building. Logs and stumps that are decaying and display punky surface materials should be removed.

3.3.12 Chimney and Stovepipe Outlets

PRC 4291 requires the removal of the portion of any branch that extends within 10ft of the outlet of any chimney or stovepipe.



3.3.13 Woodpiles

PRC 4291 identifies exposed woodpiles as a fuel for the purpose of fuel reduction around a structure. 14 CCR 1299.03 requires that woodpiles be located outside of Zone 1. Woodpiles within Zone 2 must have a minimum of 10ft of clearance around their exterior to bare mineral soil. Should woodpiles need to be located within Zone 1, such as properties that do not extend past 30ft to the property line, woodpiles should be totally covered with a fire resistive material to prevent flying brands from entering and igniting the pile (14 CCR 1299.03). On properties that are located on hillsides, it is recommended that the woodpile be located on the uphill side of the structure. This is due to fire's natural tendency to travel uphill.



3.3.14 Outbuildings

14 CCR 1299.02 defines an outbuilding as any structure less than 120 square feet in size and not being used for human habitation. The minimum clearance requirements around an outbuilding are 10ft clearance to bare mineral soil and the elimination of all flammable vegetation 10ft from the
structure's exterior surfaces (14 CCR 1299.03). Additionally, roof surfaces and gutters should be maintained free of all flammable materials.



3.3.15 LPG Tanks

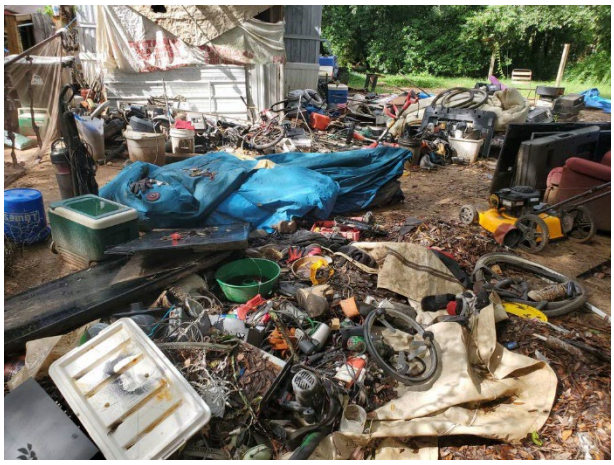
14 CCR 1299.03 requires that all LPG storage tanks have 10ft minimum clearance to bare mineral soil and the elimination of all flammable vegetation 10ft in all directions from their exterior surface. The 2019 CFC 6104.3 requires that all stationary LPG tanks (propane and butane), 125 to 500 gallons of storage, should be located at least 10 feet from any structure, lot line, or public way.





3.3.16 Other Flammable Debris and Material

PRC 4291 identifies all combustible material as fuel including petroleum-based products. All fuel hazards should be removed or properly covered/enclosed in Zone 1. This includes, but is not limited to wood scrap piles, leaf piles, lawn clippings, cardboard boxes, uncovered garbage containers, etc. Items such as flammable furniture, swing sets, gazebos, unattached decks, etc. should have an effective separation from flammable vegetation.



3.3.17 Special Concerns

Homeowners who do fuel reduction activities should be made aware of Local, State, and Federal environmental laws. They should also be aware of permits they may need to obtain. Environmental protection laws include and are not limited to; threatened or endangered species, water quality, air quality, and cultural/archeological resources. Tree removal permits may be required in certain local jurisdictions, and CAL FIRE requires compliance with Public Resources Code Chapter 8 to remove trees that will be used for commercial purposes.

The requirement of fuel removal must be balanced with the need to prevent soil erosion, soil disturbance, and the introduction of non-native invasive plants. Homeowners should keep soil disturbance to a minimum on steep or erosive soils. They should use soil erosion control techniques such as covering exposed disturbed soil areas, minimizing the use of heavy equipment, keeping clear of streams, drainages, and riparian areas, and only using mobile equipment during dry conditions. PRC 4291 allows the use of ground covers for soil erosion prevention in both Zone 1 and 2 provided they are kept free of dead or dying materials.

3.4 Fire Hazards and Ignition Sources

One of the goals of the property inspection is the mitigation of fire ignitions on the homeowner's dooryard premises. During the inspection, it is important that the inspector look for and note unsafe practices, hazardous conditions, and violations of the States Forest and Fire Laws that could lead to the ignition of a fire on the homeowner's property. The following are common homeowner practices and conditions that should be closely observed and noted by the inspector.

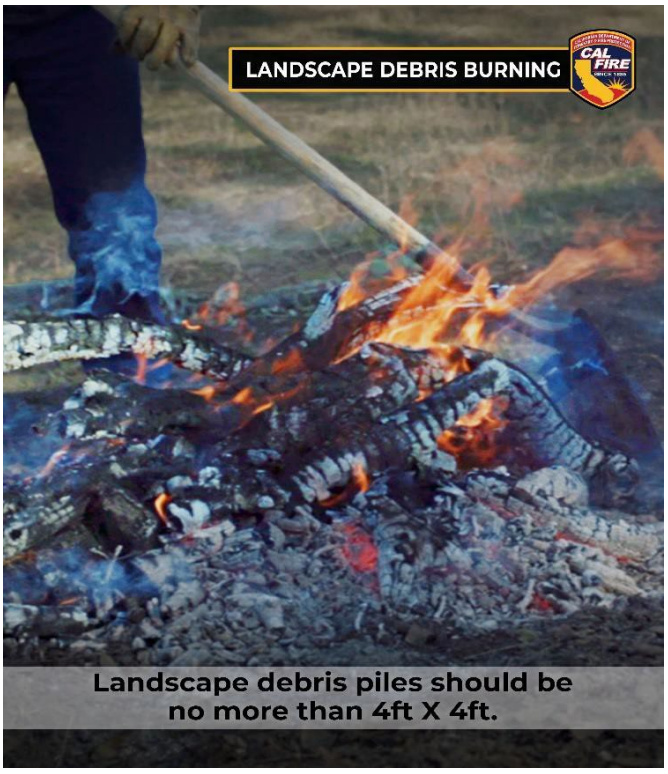
3.4.1 Debris Burning

Homeowners must obtain the required burn permit prior to any burning on their property and only burn according to the terms of the burning permit (PRC 4423). CAL FIRE Residential Burn Permits (LE-62A) are available online at https://burnpermit.fire.ca.gov/. They must also abide by Local Air District regulations and burn only on Declared Permissive Burn Days and during the

permitted specified hours. Most local regulations only permit the burning of natural vegetation and untreated lumber. In no case should burning take place during hot, dry, or windy conditions. Most areas of the State suspend burning permits during the peak of the fire season. The regulations concerning safe dooryard burning require:

- Piles be constructed no larger than 4ft in diameter.
- Piles should not be located under overhanging tree limbs.
- Piles must have 10ft of clearance to bare mineral soil around their exterior.
- An adult must be in attendance at all times.
- There must be a water source and shovel available at the burn site.

Many of the Air Pollution Control Districts in the state prohibit the use of incinerators. Some give exceptions for certain conditions such as lack of rural trash pickup and higher elevation burn locations. **The inspector should be familiar with all the local conditions and restrictions in their area**. Incinerator burning requires a burn permit and the same terms of burning as open piles, with the additional requirement of a screen constructed of a nonflammable material, with a no greater than 1/4-inch mesh, over the top of the incinerator to prevent the escape of sparks and embers (PRC 4446).



3.4.2 Campfires and Cooking Fires

Permits are not required for homeowners using a campfire on their own property. Homeowners must practice fire safety, however, as they are liable if a fire escapes their control.

- Always clear a minimum of 5 feet to bare soil in all directions around the fire pit.
- Always completely extinguish the fire before departing (PRC 4432).
- To properly extinguish, drown the fire with water while mixing the ashes with soil.
- Feel the ashes to make sure they are out.





3.4.3 Proper Disposal of Ashes

Homeowners should be especially careful when cooking outdoors. Charcoal briquettes and fireplace ashes should be extinguished by dumping them into a metal bucket and soaking them in water. Charcoal briquettes can hold heat for 24 hours and longer if left unextinguished.

3.4.4 Spark Arresting Screen on Chimney and Stovepipe

Chimney and stovepipe outlets should be equipped with a spark-arresting screen of a minimum ½’ wire mesh screen to prevent sparks and embers from exiting and falling onto the roof surface (2022 CBC 2113.9.2).



3.4.5 Mechanical Equipment Use

When internal combustion engine equipment is operated off-road or near dry vegetation, legal spark arresters are required on their exhaust system to prevent the expulsion of sparks. Examples of internal combustion engines requiring spark arresters are lawnmowers, chainsaws, weed trimmers, generators, motorcycles, off-highway vehicles, agricultural equipment, and many types of construction equipment (PRC 4442).



To ascertain if a spark arrester is legal, the inspector should look the model up in the United States Department of Agriculture (USDA) Spark Arrester Guide. Consult the manufacturer's guide for proper maintenance procedures and intervals. Do not assume that if a piece of equipment is new it has a spark arrester attached as it is not a requirement in the State to sell them with one installed. It is required that the equipment have a written notice that to operate the equipment under certain conditions one must be attached (PRC 4442.5). Spark arresters with screens should be visually inspected to ensure they have no holes larger than 0232" in diameter or are otherwise burned out. Retention-type arresters have clean-out plugs or bands that allow the operator to periodically clean them out

of any built-up carbon. The inspector should direct the operator to remove the plug or band to ensure carbon has not built up to the point that the arrester is full and thus nonfunctioning. For additional information on spark arresters, the inspector should consult the Industrial Operations Fire Prevention Field Guide and the USDA Spark Arrester Guide.

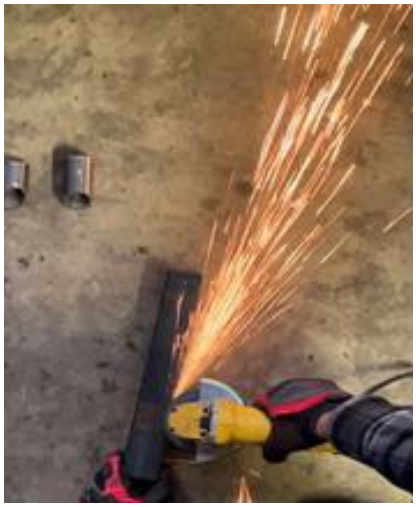
In addition to the requirement for spark arresters, portable gas-powered tools such as chainsaws require that a serviceable fire extinguisher and a serviceable round point shovel with a minimum overall length of 46in be within 25ft of the operating area (PRC 4431). This requirement is specific to the time of year burn permits are required in that area.

Inspectors should advise homeowners on the dangers of metal cutting blades and exhaust systems on their lawnmowers and weed trimmers. Metal cutting blades on lawnmowers are a fire hazard. On hot, low-humidity, summer days, metal blades striking rocks or other metal while mowing can produce sparks which can readily ignite dry vegetation. Grass-cutting activities utilizing mowers with metal cutting blades should be conducted in the morning hours prior to 10:00 AM.

Inspectors should encourage homeowners to use nylon-string trimmers rather than lawnmowers to cut dry weeds and grass due to their inherent fire causing problems.

An additional hazard of mowers and push trimmers with cutting decks is the build-up of chaff around the pulley system. If the chaff is not cleaned out regularly, the compaction around the pulley and belt can be ignited by frictional heating causing the equipment to catch fire.

3.4.6 Metal Cutting, Welding, and Grinding



Metal cutting, welding, and grinding in and around dry vegetation is very hazardous due to thrown sparks and molten metal. For this reason, most local Units require burn permits for this type of activity in the SRA. CAL FIRE General Burn Permits (LE-5) are available online at burnpermit.fire.ca.gov. The area of operation must have a minimum 10ft clearance of all flammable material in all directions, and there must be a serviceable round point shovel with a minimum overall length of 46in and a backpack pump water-type extinguisher within the immediate area (PRC 4427). This requirement is specific to the time of year burn permits are required for that area. Additionally, the 2019 CFC Section 105.6.23 requires a Hot Work Permit in a wildland fire risk area. Hot Work is defined as any cutting, welding, and grinding.

3.4.7 Use of Wood Preservatives, Oils, and Stains

Homeowners should be made aware of the hazards of using wood preservatives, oils, and stains that contain natural oils as they have the ability to spontaneously ignite when left on rags. Rags used to apply or cleanup these products should be either stored in an Underwriter Laboratories approved airtight metal container or thoroughly rinsed in water and left flat to air dry. Similar care should also be used with other product applicators such as brushes and mops.



3.4.8 Gas Stoves, Lanterns, and Heaters

Gas lanterns, stoves, and heaters that have been in operation should be allowed to cool off prior to filling or storage. When filling, they should be allowed to cool and placed in a cleared area prior to being fueled. Propane heaters should have a minimum 5ft clearance of flammable material while in use (CFC 0603.4.2.1.3).





3.4.9 Flammable Liquid Storage

All flammable liquids should be stored in approved metal safety containers and away from any ignition sources such as pilot lights. It is also recommended that all flammable liquids be stored a minimum of 30ft from the structure.



SECTION II

1. INSPECTOR QUALIFICATIONS

1.1 General Qualifications

Below are some qualities of a good fire prevention inspector. Of primary importance is personal appearance and professional demeanor. The inspector should:

- Be neat and clean.
- Be in proper uniform and possess departmental identification.
- Be well-mannered and respectful.
- Possess self-confidence - be firm, fair, and friendly.
- Be aware of people's demeanor.
- Know when a situation may be escalating into a confrontation and politely back off.
- Have a keen interest in the job and a sense of responsibility toward the public.
- Have the fortitude and perseverance to see the job through.
- Have personal initiative, be able to plan assignments, and carry out work without direct supervision.
- Have the ability to spot unusual or dangerous conditions, and foresee the potential creation of a dangerous situation. Maintain situational awareness.
- Be tactful in pointing out hazards and criticizing situations to the property owner/tenant.
- Know not to answer questions he/she is unsure of, but instead ask their supervisor and then get back to the property owner/tenant with the correct answer.
- Be dependable.

Additionally, the property inspector should possess the following knowledge:

- Familiarity with agency policies pertaining to property inspections.
- Knowledge of the State's Forest and Fire Laws pertaining to property inspections**.**
- Have a familiarity with hazardous activities that could lead to a fire ignition.
- Have a familiarity with the Defensible Space Concept.
- Have a familiarity with the State's Fire Safe Regulations
- Have a familiarity with WUI construction standards.
- Have a familiarity with a homeowner Wildfire Preparedness Plan.
- Have a familiarity with the Wildfire Action Plan brochure
- Have a familiarity with fire-resistant landscaping.
- Have a good working knowledge of fire behavior.
- Be familiar with the inspection area and its fire history and fire behavior.

1.2 Training

Unit Fire Prevention Plans should list the minimum training required for new property inspectors. The minimums for inspectors conducting property inspections in the SRA should include at least:

1. Orientation
   a. Property Inspection Guide
   b. Local/regional/agency policy

2. Minimum Qualifications
   a. Local requirements

3. Forest and Fire Laws
   a. Excerpts from State Laws & Regulations (Appendix C)
   b. Detailed instruction in the BOF General Guidelines and Title 14 CCR 1299.

4. Local Regulations
    a. Local Air Districts
    b. Unit burn permit policies and requirements
    c. Local weed abatement ordinances when applicable

5. Fuel Management Techniques for Homeowners
    a. Available educational handouts for distribution

6. Property Inspections
    a. Defensible space concept
    b. Fuel management for homeowners
    c. Access for emergency equipment
    e. WUI construction standards
    f. Potential ignition sources
    g. Homeowner wildfire preparedness plans
    h. Fire resistive landscaping
    i. Wildfire Action Plan brochure

7. Conducting the Inspection
    a. Local policies
    b. Obtaining permission to inspect

8. Documenting the Inspection
    a. Legal requirement
    b. State, regional, and local requirements
    c. Notice of Defensible Space Inspection (LE-100a)
    d. Use of local forms

9. Follow-Up Inspections
    a. Local policy
    b. Enforcement procedures

10. Training Courses
    a. FEMA IS-100 (online): Introduction to ICS
    b. ICS-200 (classroom): Basic NIMS/ICS for Operational First Responder
    c. FEMA IS-700 (online): National Response Framework, An Introduction
    d. NWCG S-190 (online): Introduction to Wildland Fire Behavior
    e. IBHS California Guide
    f. Home Ignition Zone/Defensible Space Inspector (DSI) Course
    g. Damage Inspection Specialist (DINS) AH-221 Course

1.3 Tools of the Inspector

Below are tools and materials that will help the inspector carry out a thorough inspection;

- A map of the area to be inspected.
- Smart Device (Tablet or phone).
- Inspection forms and notebook. Notes should be taken of observed hazards and risks during inspections. Sketches, photos, or maps may also be an aid to future inspections as well as firefighting operations.
- Call log to keep a record of calls from the public.
- Radio, Handheld Transceiver (HT), or Cell Phone communications.

- Smart device with camera – Digital images of violations where compliance is not expected are desirable both for potential future legal action and for information and education purposes
- Binoculars to inspect chimney screens.
- 30ft & 100ft measuring tapes or range finder to determine adequate clearances, etc.
- A Clinometer or other measuring device to determine the properties percent of slope.
- Flashlight – which may assist in checking for certain hazards such as below decks and stairs.
- Red Tags, spark arrester stickers, and other notification systems.
- USDA Spark Arrester Guide.
- Copy of applicable laws and ordinances.
- Records of prior inspections of the inspection area.
- Defensible Space and Wildfire Preparedness Handout material for the homeowner.

2. CONDUCTING THE INSPECTION

2.1 Inspection Procedure

The inspection for clearance around structures differs from other statutory fire prevention inspections since the inspector is essentially critiquing the public's personal property. Great care must be taken to assure the property owner/tenant you are there to protect and enhance their personal safety as well as prevent the loss or damage of their property from a fire. Emphasis should be directed to their key role in achieving the desired effect of a fire-safe environment for themselves, their family, and their neighbors. Additionally, it is important to point out that their efforts will provide a critical safety zone for the fire department to protect their home and attack the fire should one occur.

2.2 Real Estate Inspections

Beginning July 1, 2021, Civil Code section 1102.19 (Appendix C) requires the seller of a property that's located in a high or a very high fire hazard severity zone to provide buyers with documentation that the property is in compliance with PRC 4291defensible space requirements, or local vegetation management ordinances. This law also allows that if documentation of compliance cannot be obtained by the close of escrow, the seller and buyer can enter into a written agreement that the buyer agrees to obtain documentation of compliance within one year of the close of escrow.

The Fire Hardening and Defensible Space Disclosure and Addendum referred to as the FHDS will be required if the property meets the following conditions: it's considered a residential property that contains one to 4 units, the sellers are required to complete a real estate transfer disclosure statement, and the property is in a high or very high fire hazard severity zone.

2.3 Time of Day and Day of the Week

The time of day that premise inspections are conducted will vary with the type of premises. Any time after 8:00 a.m. may be fine for inspections of business establishments or recreational camps. Inspection of permanent and seasonal dwellings usually requires the inspection be made after 10:00 a.m. If inspections are conducted before this time, the inspector may encounter some resistance or ill feeling, especially by weekend homeowners who usually like to sleep late. The same will apply to rural-dwelling occupants on weekends. Inspections on Sundays and Holidays are not advised and should be avoided.

2.4 Time of the Year

There is a small optimum window of the year for conducting inspections. Unit inspection programs should be responsive to address the time of the year the inspections take place. Inspections conducted prior to the arrival of the seasonal flammable conditions may have an effect on the large woody fuel accumulations but will not be able to address the flashy fuels which will not have yet cured into a flammable condition. Similarly, Units with elevation changes that include snow zones will have flammable conditions at lower elevations normally much earlier than the higher elevations. Another consideration is conducting inspections once normal summer conditions have arrived. Homeowners using mechanical means to clear vegetation should use great caution with their equipment as they can start a fire from exhaust sparks or rock strikes by metal blades.

2.5 Approaching the Property

When driving onto the property to be inspected, give attention to the general vegetative and topographical surroundings of the buildings and their exposures to other structures. Also, observe the general construction, the construction type, occupancy, and overall condition of the buildings. These observations will be of assistance during the inspection and will be of value should a fire occur or threaten the property.

Approach:

- Drive up slowly.
- Avoid raising dust.
- Leave gates as found.
- If a gate is locked, leave a locked gate notice advising the occupant to call and schedule an inspection. Drop an Uninspected point on the data collection app.

Observe:

- The grade/condition of the road and accessibility of approach for ease and safety of responding emergency equipment.
- The general surroundings of buildings and exposures to other structures and vegetation.
- The structures, mechanical equipment, human activities, etc., in relation to their use and exposure to hazardous fuels.

2.6 Personal Safety

Property inspections in rural areas can present inspectors with special concerns for their personal safety. Among those concerns are coming across illegal marijuana grows and drug labs and contacting aggressive animals such as dogs and livestock. Additionally, signs or postings indicating threatening warnings can be an indication of individuals conducting illegal activities or not wanting any intrusion onto their property by the public or government agencies. These warnings should not be ignored, and rather than attempting to contact the property occupant, the address should be turned over to a supervisor for further action. When contact with the property occupant becomes confrontational, leave the area immediately and contact your supervisor at your earliest convenience.
When conducting inspections in unfamiliar or remote areas, or areas identified as elevated life risk, the inspector should consider working in pairs or following safe practices as outlined in the Firescope *Firefighter Incident Safety and Accountability Guidelines ICS 910*;

- Develop a plan or general strategy for the day's work.
- Inform your supervisor of your destination, travel route, and expected return time.
- Assure that communication equipment Mobile radio, Handheld Transceiver (HT), and or cell phone is available and in good working condition.
- Consider the need to travel in pairs, and if warranted a Peace Officer escort.
- If a situation becomes confrontational leave immediately and request backup.

2.7 Contacting the Homeowner

The inspector's first duty is to contact the property owner, or whoever is in charge of the premises. The inspector should:

- Be in an official vehicle and uniform.
- Introduce him/herself and show identification.
- Establish communications, avoiding technical or slang language.
- Explain the purpose of the contact and present the idea that the inspection will help protect the residents and their property from wildfire.
- Create the idea you are there to help.
- Rather than immediately jumping into a discussion of fire prevention, try a few "icebreakers." This will put the contact on a friendlier basis.
- Obtain permission to inspect and ask if the inspector may walk around and behind the structures on the property. If permission to inspect is refused, withdraw as cordially as possible and notify your supervisor.

- Request that someone accompany the inspector during the inspection. This will allow the inspector to point out potentially hazardous conditions as they are observed and provide the resident with a more detailed remedy to mitigate them.
- If the resident states it is not an appropriate time or it causes inconvenience, offer to return at a more convenient time. Establish a return time and date if possible.
- If a resident is uncooperative, leave the property and notify your supervisor.

2.8 Conducting the Inspection

Once permission has been granted to inspect the property, the inspector should walk completely around the structure. The inspector should make handwritten or mental notes of all hazardous conditions observed and note additional structures that should be inspected. Measurements should be taken from the building and any attached structures or decks to establish boundaries of the two defensible space zones. The inspector should ascertain from the homeowner the boundaries of the property to determine how far the homeowner must carry out the clearances from the structure. Inspection of the roof and the chimney/stovepipe should be done from the ground. If the homeowner is present during the inspection, stop as hazards are noted to point them out and provide remedies.

2.9 Explaining Fire Behavior to the Homeowner

During the inspection, it is helpful to provide the homeowner with a brief understanding of fire behavior. There are three factors that influence the way fire behaves:

Fuel

- Vegetation dead or alive is **fuel**, as is the structure.
- "**Fuel**" means any combustible material, including petroleum-based products, cultivated landscape plants, grasses, and weeds, and wildland vegetation. (PRC 4291)
- Point out the **volume** of fuel surrounding the structure and in the adjacent area.
- Explain the **fuel types**- grass, brush, trees, and structures.
- Trees and structures – point out that **heavy** fuels will burn longer and with greater sustained heat.
- Grass and shrubs – are considered **light and flashy** and are easily ignitable.
- Woodpiles, accumulation of leaves, needles, and trash all provide **fuel beds** for **flying brands**.
- **Ladder fuels** allow fire to travel vertically into the crowns of the trees.
- **Continuous fuels** allow the fire to spread horizontally unimpeded.
- Fuels that have had their **continuity** broken up are less likely to allow a fire to continue its forward travel.

Topography

- Fire travels faster **uphill** than on flat ground.
- **South-facing slopes** cure earlier in the year and sustain more heat exposure from the sun during the daylight hours. They also tend to have faster-moving fires up their slopes.
- **Saddles** and **drainages** on a ridge act like a chimney. Structures built in these locations will take an approaching wildfire full force.

Weather

- **Wind** provides fire with more oxygen making flames more intense. It will also push them into the adjoining fuels causing them to travel faster.
- In a **firestorm**, flames can be so intense the fire can make its own wind.
- **Burning embers** will be carried in the convection column of the fire and can easily land on the homeowner's property and roof. The embers can travel in the smoke column distances up to a mile.

- Periods of **low humidity** and **high temperatures** increase fire danger due to the drying out of the fuels allowing them to ignite more easily.
- During drought periods, wildland fuels have less **fuel moisture** making them more susceptible to ignition and ease of spread.

3. CLOSING OUT THE INSPECTION

3.1 Reviewing Inspection Findings

Clearly explain all observed fire law violations during the property inspection in a professional but friendly manner. Include any observed potential ignition sources. Also, point out additional hazardous conditions that make the property vulnerable to wildfire including WUI building standards and Fire Safe Regulations. Try to get the homeowner involved in the solution for corrective action of the fire law violations. If the homeowner has an unreasonable solution or is at a loss for a solution, assume the role of an advisor and offer suggestions. In this manner, the inspector can work out a satisfactory and practical solution to the problem. This has definite advantages: the homeowner who is allowed to work out the problem is not only going to feel more satisfied but also is quite likely to be proud of the work. Be constantly on guard to make sure that suggestions are both reasonable and practical. The inspector has not completed the inspection responsibility until all known fire hazards and risks observed on the premises have been pointed out to the homeowner.

3.2 Documenting the Inspection on the LE-100a

Note all fire law violations and observed hazards and risks on the Notice of Defensible Space Inspection (LE-100a) or approved local form, and set a reasonable, but definite time limit for compliance. The later in the fire season and the more critical the fire weather situation, the more urgent compliance becomes. Also, record other observed hazards and risks including potential ignition sources and non-compliant mechanical equipment.

3.3 Documenting the Inspection Electronically

The Department has developed an automated process to document defensible space inspections electronically with mobile devices utilizing the approved electronic data collection application. The application allows CAL FIRE to customize the data collection fields to meet the needs of the Department and provides the Department with a consistent and centralized electronic database.

Document the inspection information in the approved electronic data collection application on the provided tablet or other smart device. It is recommended that inspectors download an offline map of their work area and sync the data as frequently as possible.

Information on electronic data collection and training materials can be found on the Intranet, Wildfire Preparedness | Cal Fire Intranet.

3.4 Explaining Follow-up and Reinspection

Reinspection is the next major step to gaining compliance. If the inspector makes a commitment to return on a particular date and time, make every effort to keep the appointment. A follow-up system is necessary to make the system effective.

3.5 Closeout with Homeowner

When you and the homeowner have concluded the inspection, it is important to cover the following points;

- Thank the homeowner for his/her time.
- Be sure to leave the homeowner a copy of the Notice of Defensible Space Inspection (LE-100a).
- Point out the inspector's contact number on the form.

- Explain follow-up procedures and re-inspection times and dates.
- Provide fire prevention educational handouts as appropriate.
- Ask if there are any questions concerning the inspection that you can answer.
- Don't leave inspection notices on the door when no one is home. It may signal to burglars that the homeowner is away. Put the notice under the mat or mail the notice. Never leave an inspection notice on the door or jamb with tape or tacks as this can cause damage.
- Leave the property slowly.
- Leave the property exactly the way you found it.

SECTION III

4. Public Resources Code 4290 – SRA Fire Safe Regulations

1.1 Law

PRC 4290 became law in 1991 and established minimum fire-safe regulations for all building permits issued after January 1, 1991. The regulations apply to perimeters and access to all residential, commercial, and industrial buildings constructed in the SRA. They do not apply to existing buildings and developments built or approved prior to 1991. The regulations include emergency access, signing and building numbering, emergency water standards, and vegetation modification. Though property inspectors do not have the authority to enforce these regulations, they should be familiar with them so as to provide homeowners with additional measures they may take to make their home and property fire-safe and defendable.

PRC 4290 states:

(a) The board shall adopt regulations implementing minimum fire safety standards related to defensible space that are applicable to state responsibility area lands under the authority of the department, and to lands classified and designated as very high fire hazard severity zones, as defined in subdivision (i) of Section 51177 of the Government Code. These regulations apply to the perimeters and access to all residential, commercial, and industrial building construction within state responsibility areas approved after January 1, 1991, and within lands classified and designated as very high fire hazard severity zones, as defined in subdivision (i) of Section 51177 of the Government Code after July 1, 2021. The board may not adopt building standards, as defined in Section 18909 of the Health and Safety Code, under the authority of this section. As an integral part of fire safety standards, the State Fire Marshal has the authority to adopt regulations for roof coverings and openings into the attic areas of buildings specified in Section 13108.5 of the Health and Safety Code. The regulations apply to the placement of mobile homes as defined by National Fire Protection Association standards. These regulations do not apply where an application for a building permit was filed prior to January 1, 1991, or to parcel or tentative maps or other developments approved prior to January 1, 1991, if the final map for the tentative map is approved within the time prescribed by the local ordinance. The regulations shall include all of the following:

(1) Road standards for fire equipment access.
(2) Standards for signs identifying streets, roads, and buildings.
(3) Minimum private water supply reserves for emergency fire use.
(4) Fuel breaks and greenbelts.

(b) The board shall, on and after July 1, 2021, periodically update regulations for fuel breaks and greenbelts near communities to provide greater fire safety for the perimeters of all residential, commercial, and industrial building construction within state responsibility areas and lands classified and designated as very high fire hazard severity zones, as defined in subdivision (i) of Section 51177 of the Government Code, after July 1, 2021. These regulations shall include measures to preserve undeveloped ridgelines to reduce fire risk and improve fire protection. The board shall, by regulation, define
"ridgeline" for purposes of this subdivision.
(c) These regulations do not supersede local regulations which equal or exceed minimum regulations adopted by the state.
(d) The board may enter into contracts with technical experts to meet the requirements of this section.

1.2 Regulations

The regulations established by PRC 4290 are found in Title 14, California Code of Regulations, Sections 1270 through 1276. They are referred to as the Board of Forestry's SRA Fire Safe Regulations and are a key component of the State's Defensible Space Regulations. Significant changes were adopted to the

regulations in 2019. Local jurisdictions often enforce the regulations, and in many cases make them more stringent through local code. Inspectors should be familiar with these local codes. A summarization of the regulations is as follows in subsections 1.3, 1.4, 1.5, and 1.6 and do not include details or exceptions.

1.3 Emergency Vehicle Access

Roadways shall have a minimum of two ten-foot traffic lanes providing two-way traffic (14 CCR 1273.01). Roadway surfaces shall provide access to fire apparatus with a minimum of 75,000-pound load (14 CCR 1273.02). Roadway grades shall not exceed 16 percent (14 CCR 1273.03). Roadway radius turns shall have a minimum specified curvature of fifty feet. (14 CCR 1273.04).

Dead-end roads shall have either a terminus bulb or hammerhead "T" of a specified size at their end and at specified intervals (14 CCR 1273.05). Dead-end roads shall be limited in length based on the parcel size they access (14 CCR 1273.08).

One-way roads are allowed provided they serve no more than 10 dwelling units and are no longer than 2640ft in length. They shall have a minimum 12' traffic lane, a turnout at approximately its midpoint, and connect on both ends to a two-lane roadway. (14 CCR 1273.01)

Bridges and culverts on all roadways including driveways shall be constructed to support emergency response vehicles (14 CCR 1273.07). Load limits shall be posted on either side of a bridge (14 CCR 1273.07).

Driveways shall have a minimum 10ft traffic lane and an unobstructed vertical clearance of 13' 6" along its entire length (14 CCR 1273.02). Driveways shall have a turnaround at their end and turnouts at specified intervals depending on their length. (14 CCR 1273.05). Driveways shall be no greater than 16 percent grade and must support a minimum 40,000-pound vehicle (14 CCR 1273.02, 1273.03).

Gates shall be a minimum of 2' wider than the traffic lane they serve, a minimum of 14' width, and 13' 6" vertical clearance. All driveway gates shall be located at least 30ft from the roadway, and the gate swing shall be such that a vehicle may stop in the driveway without obstructing traffic on the roadway. Security gates must have prior approval from the local authority (14 CCR 1273.09).

1.4 Signing and Building Numbering

All **street and road signs** will have a minimum 4" letter height of 1/2" stroke and reflectorized with contrasting background color. Signs will be placed at all intersections, be of standard height, and be visible for 100ft from both directions of vehicle traffic. (14 CCR 1274.01, 1274.02)

All homes and businesses shall permanently post their **address** plainly visible from the road facing the property. Address numbers and letters shall conform to the standards in the CFC and be reflectorized (14 CCR 1274.03, 1274.04).

1.5 Emergency Water Standards

Emergency **water supplies** shall be available for each address. These specified supplies shall be either in the form of fire agency mobile water tenders, man-made containment structures, or naturally occurring (14 CCR 1275.02). On-site sources shall have a **hydrant/water valve** at specified locations with a 2 ½" National Hose male threaded outlet or a 4 ½"head for draft systems (14 CCR 1275.03).
All water sources will be properly identified by specified reflectorized blue signage a minimum 3" in size (14 CCR 1275.04).

1.6 Vegetation Modification

All structures on parcels will have a minimum **30ft setback** from all property lines (14 CCR 1276.01).
All developments proposing **greenbelts** shall strategically locate them to separate structures from wildland fuels (14 CCR 1276.04).

2. Ignition Resistant Construction

2.1 Regulations

Firesafe building regulations can be found in various State statutes and regulations, including the Health and Safety Code, the California Building Code and the California Fire Code. These regulations apply to all homes built or substantially remodeled from the date the Code became effective. They include the use of ignition-resistant building materials and construction design. A partial listing of the statutes and regulations can be found in Appendix C. Property inspectors should be familiar with these standards to give homeowners additional steps they can take to fire-safe their homes and property. Inspectors should advise the homeowner to contact their local building department for further details and advice. Currently, approved building materials by the Office of the State Fire Marshal can be found at the following website:

https://osfm.fire.ca.gov/divisions/fire-engineering-and-investigations/building-materials-listing/

2.2 Roofs

One of the single most vulnerable locations for flying brands and embers from a wildfire to lodge on a structure is the roof surface. Flammable roof coverings such as untreated wooden shingles and shakes stand little chance of surviving a wildfire. Additionally, unscreened vents allow blowing embers to enter the attic space. Open gutters and open-ended tiles also provide entry points.

Pursuant to **HSC 13132.7**, fire retardant roofing is required in all SRA and Wildland-Urban Interface Fire Areas of the State for all new structures and all existing structures for any repair or replacement. Additionally, if 50% or more of a roof covering is replaced within an anyone-year period, the entire roof covering shall be replaced with fire retardant roofing as required by state and/or local regulations. The type of roof covering required is based on the fire hazard severity zone that the building is located in. A minimum Class C covering is required in all areas of the SRA with Class B and A required in accordance with the greater hazard zoning.

Test methods have been developed to evaluate the fire hazards of roof coverings. NFPA 256, *Methods of Fire Tests of Roof Coverings*, describes the appropriate procedures. The test evaluates the flammability of the roof covering, the protection it provides to a combustible roof deck, and the potential for producing flaming brands. Roof materials are classified as Class A, Class B, and Class C. To receive one of the classifications, the roof covering is given a series of fire tests of varying degrees of severity. After all roof-covering tests have been conducted, roof coverings are classified based on test results:

- Class A roof covering is one that is effective against severe fire exposure, affords a high degree of fire protection to the roof deck, does not slip from position, and does not present a flying brand hazard. This type of roof covering is required in all SRA and LRA areas classified as Very High Fire Hazard Severity Zones (VHFHSZ).
- Class B roof covering is one that is effective against moderate fire exposure, affords a moderate degree of fire protection to the roof deck, does not slip from position, and does not present a flying brand hazard. This type of roof covering is required in all SRA areas rated as High Fire Hazard Severity Zones.
- Class C roof covering is effective against light test exposure, provides a light degree of fire protection to the roof deck, does not slip from position, and does not present a flying brand hazard. This type of roof covering contains the lowest degree of fire resistance allowed in the State of California.

The specific definition of each roofing classification is dependent upon the roofing material, roofing support construction and sheathing. With a given surface material, the classification may change, depending on whether the sheathing is solid (plywood) or lath, and whether the underlay material is foil,

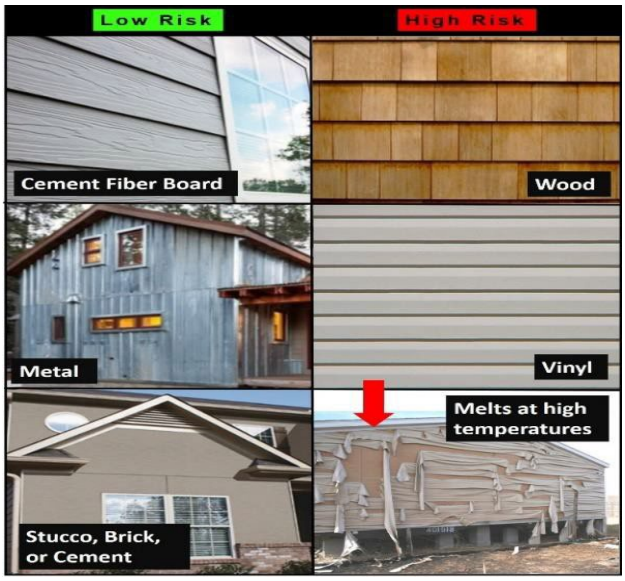
tar paper, or felt (different weights available). The Class A rating provides the most fire-resistive characteristics.



2.3 Siding

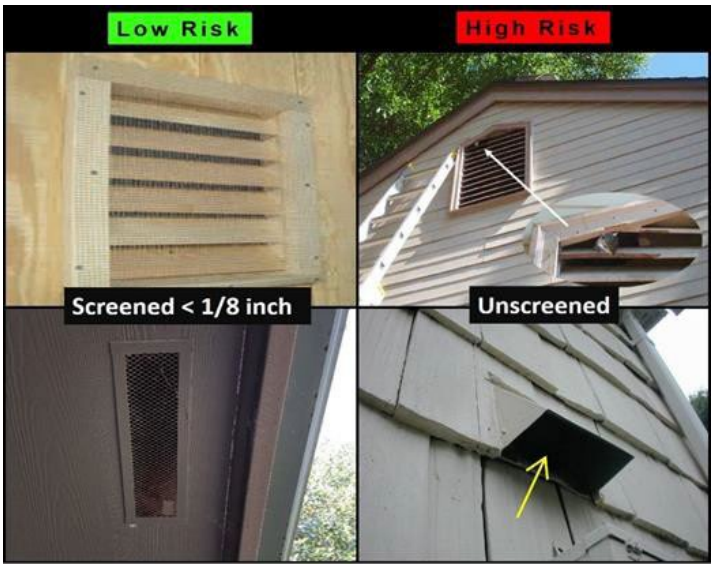
Exterior wall coverings should be ignition-resistant materials (CBC 707A). Homeowners should be educated on the hazards of wood siding due to its vulnerability to radiant heat and direct flame contact during a wildfire. They should also know that some sidings such as vinyl will soften and melt even under mild, radiant heat conditions. Materials such as stucco and masonry stand up better to heat and fire exposure.

Log and heavy timbered exteriors are rated ignition resistant. Siding with untreated wooden shingles is extremely flammable.



2.4 Vents

All vents should be covered with a minimum 1/16" to 1/8" noncombustible mesh screen to prevent embers from being drawn into the structure by air currents (CBC 706A). This includes roof vents, eave vents, and subfloor vents.



2.5 Eaves

All eaves should be enclosed to prevent flame entry and fire spread (CBC 707A).



2.6 Windows

Regular single-pane plate glass windows can thermally fracture due to radiant heat from a nearby fire even though the heat may not be enough to ignite the home's exterior wood. Homeowners should replace them with multipaned glass with a minimum of one tempered pane or other approved glazing (CBC 708A). Additionally, homeowners should be aware of the potential for plastic skylights to melt under intense heat.

2.7 Doors

Exterior doors should be either approved solid core or clad in a noncombustible or ignition-resistant material (CBC 708A.3.1). Door glazing should comply with approved window glazing standards (CBC 708A.3.1)

2.8 Decks and Balconies

Decks and balconies should be built using ignition-resistant surface materials. Their undersides should be enclosed using ignition-resistant materials to prevent flame and flying ember entry (CBC 709A.3).



2.9 Accessory Structures

All structures within 50ft of a building shall comply with the ignition-resistant building standards of the regulations. This includes trellises, arbors, patio covers, gazebos, and similar structures (CBC 710A).





3. Homeowner Wildfire Preparedness

3.1 Homeowner Questions

While conducting property inspections, inspectors should be prepared to answer homeowners' questions on what to do if a wildfire is threatening and they must evacuate. They may ask what they should gather to take with them, what they should do with their pets and livestock, where they should go, what condition they should leave the home and property in, how will they know when they can return, and what should they do if they get trapped by the wildfire. Inspectors should have available handout material that can help them prepare for a wildfire in advance.

3.2 Wildfire Action Plan

Homeowners should prepare a written Family Disaster Plan that includes a predetermined emergency meeting location in a low-risk area outside the fire hazard area the home is located in. If possible, it should identify multiple evacuation routes. It should also include a communications plan with a family/friend phone tree, emergency number list, and locations of important family documents and valuables to take when evacuating. If homeowners have pets and large animals such as horses, they need to include considerations for them in their evacuation plan. All family members need to be part of this plan and know where it is kept in the home.

Family preparedness should also include:

- Knowledge of all fire extinguishers on hand and how to use them.
- Knowledge of the location and operation of all utility shutoffs including gas, electricity, and water.
- Assembling an emergency supply kit as recommended by the American Red Cross.
- Having a portable radio or scanner and batteries to keep updated on the fire and evacuation orders.
- Having available at least a three-day supply of drinking water and nonperishable food.
- Having available flashlights, lanterns, portable cookstoves, fuel, and batteries.

3.3 Preparing for Evacuation

3.3.1 Inside

- Shut all windows and doors including the garage, leaving them unlocked.
- Shut off the air conditioning and fan.
- Shut off the gas at the meter and shut off the pilot lights.
- Remove lightweight curtains and flammable window shades from all windows.
- Close all venetian blinds and nonflammable window coverings.
- Move flammable furniture away from windows.
- Leave lights on so firefighters can see the home during smoky conditions.

3.3.2 Outside

- Turn off propane tanks.
- Put a ladder up to the roof on the side facing away from the oncoming fire.
- Attach garden hoses with a nozzle to all exterior hose bibs.
- Do not leave sprinklers running as this may drain critical water supplies and pressures.
- Leave exterior lights on so firefighters can see the home during smoky conditions.
- Gather flammable items (lawn chairs, tables, boxes, brooms, etc.) from decks and near the sides of the building and put them in the house or garage or a minimum of 30ft away from the structure.

- Assemble firefighting tools such as shovels, hoes, and rakes and keep them available near the home.
- Fill buckets with water and have them available near other firefighting tools.
- Vehicles should be backed into the garage with the keys in the ignition, the doors shut, and the windows rolled up.
- Detach the electric garage door opener.
- Load the evacuation vehicle with the emergency supply kit, important family papers, and medications.

3.4 Evacuation

Keep updated on current fire conditions on the TV and local radio stations. Observe the fire and its speed and direction of travel. Remember that fires burning under windy conditions will travel at rapid speeds. Immediately prepare to evacuate upon knowledge of a nearby out of control wildfire. Evacuate as soon as you are set rather than waiting for an evacuation order. Plan your evacuation route away from the oncoming fire. Notify family members you are evacuating, your evacuation route, and your predetermined meeting location. Wear long sleeve tops and long pants made of natural fibers such as cotton. Stay hydrated.

3.5 Trapped by a Wildfire

- Call 911.
- Make sure you are wearing long sleeve tops and long pants made of natural fibers such as cotton.
- Stay hydrated.
- Shelter inside the home away from exterior walls and away from the oncoming fire.
- If unable to call 911, notify an emergency contact of your location, and notify them of your safety after the fire has passed.
- Be sure all windows and doors are closed including the garage door.
- Be sure the air conditioner and fan are shut off.
- Be sure you can exit the home if it catches on fire.
- Fill sinks and tubs with water for emergency water supply.
- As the fire passes, patrol the house for any spot fires.
- Have fire extinguishers and buckets of water available to extinguish any spot fires inside the home as the fire passes.
- After fire has passed check exterior of the building for spot fires. Pay close attention to the roof and gutters. Check inside the attic.
- Patrol the property and extinguish all small fires found.

3.6 Informational Resources

The following Websites offer additional information and suggestions to the homeowner on disaster preparedness:

- www.redcross.org
- www.fema.gov
- www.fire.ca.gov
- www.readyforwildfire.org

4. Fire Resistive Landscaping

4.1 Lean and Clean Planning

Property inspectors are often asked by homeowners for advice on how to plan a fire-resistant landscape around their homes. Often, they are afraid that the requirements of PRC 4291 demand that they maintain bare earth around all their structures. This is not at all the case. The area within 30ft of a fire-safe home or building should be limited in the amount of flammable vegetation, free of all dead and dying vegetation and other flammable debris, and irrigated to keep plants green and healthy during the fire season.
Keep in mind that cultural practices and landscape management have more of an impact on whether a plant ignites than the species. A well-planned fire resistive landscape should include:

- The liberal use of open space and mosaic plant spacing.
- An emphasis on the use of low-growing herbaceous (non-woody) plants that are kept green during the fire season through irrigation. These include lawn, clover, groundcovers, bedding plants, bulbs, perennial flowers, and perennial grasses.
- An emphasis on the use of rock, and non-combustible hard surfaces such as sidewalks, patios, and driveways.
- No combustible mulch or bark within 5ft of structures or attached decks.
- The use of fences and barriers constructed of nonflammable material such as rock, brick, or stucco to provide fuel breaks.
- Short deciduous shrubs, and deciduous ornamental trees provided they are kept green, free of dead plant material, and do not provide a means of conveying a fire from the adjacent wildland fuels to the structure.
- Minimization of the placement of evergreen coniferous shrubs and trees and tall exotic grasses. When used they should be well separated from other vegetation as well as the structure.
- Keeping the area closest to buildings, structures, and decks clear of vegetation will prevent embers from igniting materials that can spread the fire to a home.



4.2 Characteristics of Fire-Resistive Vegetation

All plants will burn under extreme fire weather conditions, especially during a drought. However, all plants have differing ease of ignition, rate of consumption, and generation of heat while burning. Fire-resistive plants burn with relatively low intensity, slow rates of spread, and short flame lengths. This makes them a more desirable choice in the defensible space around a home. The following are characteristics of fire resistive vegetation:

- Plants that have high moisture content (lawns, ground covers, herbaceous species).
- Low-growing plants (less than 18") with a low sap or resin content.
- Non-resinous deciduous shrubs and trees (willow, poplar, or tulip trees).
- Plants with open branching habits and fewer total branches and leaves.
- Plants with little or no accumulation of dead vegetation.
- Drought tolerant plants (deeply rooted plants with thick heavy leaves).
- Plants requiring little maintenance (slow-growing plants which, when maintained require little care).

4.3 Informational Resources

- https://www.fire.ca.gov/
- https://marinmg.ucanr.edu/BASICS/FIRESMARTLANDSCAPING/
- https://forests.berkeley.edu/the-center-for-fire-research-and-outreach
- https://cafiresafecouncil.org/
- https://www.nfpa.org/Public-Education/Fire-causes-and-risks/Wildfire/Firewise-USA

Appendices

Appendix A

Resources

American Red Cross: https://www.redcross.org/.

Board of Forestry Memorandums and Guidance Documents: https://bof.fire.ca.gov/regulations/board- memorandums-and-guidance-documents/.

CAL FIRE: https://www.fire.ca.gov/.

CAL FIRE Defensible Space: https://www.fire.ca.gov/dspace.

CAL FIRE Wildfire Action Plan: https://www.paperturn-view.com/cal-fire-communications/cal-fire-ready-set-go-brochure-final-files-v4-print?pid=MjU252417&v=2

California FireSafe Council: https://cafiresafecouncil.org/.

California Legislative Information: https://leginfo.legislature.ca.gov/.

Federal Emergency Management Agency: https://www.fema.gov/.

Firewise USA: https://www.nfpa.org/Public-Education/Fire-causes-and-risks/Wildfire/Firewise-USA.

Office of the State Fire Marshal Building Materials List: https://osfm.fire.ca.gov/divisions/fire-engineering-and-investigations/building-materials-listing/

The Center for Fire Research and Outreach at Berkeley Forests: https://forests.berkeley.edu/the-center- for-fire-research-and-outreach.

Ready for Wildfire: https://www.readyforwildfire.org/.

Sample Spanish LE-100a: 2https://inside.fire.ca.gov/media/wbgddzke/2-22_le100a_spanish.pdf

USDA Spark Arrester Guide: https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5319644.pdf

Wildfire Prevention Field Guides: https://osfm.fire.ca.gov/divisions/community-wildfire-preparedness- and-mitigation/wildfire-preparedness/prevention-field-guides/

Appendix B

LE-100a

State of California, Natural Resources Agency
Department of Forestry and Fire Protection
Notice of Defensible Space Inspection
LE-100a (2/22)

Date: _____

NOTICE OF DEFENSIBLE SPACE INSPECTION

A fire department representative has inspected your property for fire hazards.
You are hereby notified to correct the violation(s) indicated below. Failure to correct these violations may result in a citation and fine.

OWNER/TENANT:	INSPECTION ADDRESS:		
INSPECTOR NAME:	CONTACT NUMBER:	Inspection No. 1 2 3	No Violations Observed ☐

CHECKED BOXES INDICATE VIOLATIONS

Zone 1 / Within 30 feet of all structures or to the property line (Refer to illustration below):

- ☐ A. Remove all branches within 10 feet of any chimney or stovepipe outlet, pursuant to PRC § 4291(a)(2) and 14 CCR § 1299.03(a)(2).
- ☐ B. Remove leaves, needles or other vegetation on roofs, gutters, decks, porches, stairways, etc. pursuant to PRC § 4291 (a)(4) and 14 CCR § 1299.03(a)(1).
- ☐ C. Remove all dead and dying trees, branches and shrubs, or other plants adjacent to or overhanging buildings, pursuant to PRC § 4291 (a)(3) and 14 CCR § 1299.03(a)(2).
- ☐ D. Remove all dead and dying grass, plants, shrubs, trees, branches, leaves, weeds and needles, pursuant to 14 CCR § 1299.03(a)(2).
- ☐ E. Remove or separate live flammable ground cover and shrubs, pursuant to PRC § 4291(a)(1) and BOF General Guidelines item1.
- ☐ F. Remove flammable vegetation and items that could catch fire which are adjacent to, or below, combustible decks, balconies, and stairs, pursuant to 14 CCR § 1299.03(a)(4).
- ☐ G. Relocate exposed wood piles outside of Zone1 unless completely covered in a fire-resistant material, pursuant to 14 CCR § 1299 .03(a)(3).

Zone 2 / Within 30–100 feet of all structures or to the property line (Refer to illustration below):

- ☐ H. Cut annual grasses and forbs down to a maximum height of 4 inches, pursuant to 14 CCR § 1299.03(b)(2)(B).
- ☐ I. Remove fuels in accordance with the Fuel Separation or Continuous Tree Canopy guidelines (see back), pursuant to BOF General Guidelines item 4.
- ☐ J. All exposed woodpiles must have a minimum of 10 feet clearance, down to bare mineral soil, in all directions, pursuant to 14 CCR § 1299.03(b)(2)(C).
- ☐ K. Dead and dying woody surface fuels and aerial fuels shall be removed. Loose surface litter, normally consisting of fallen leaves or needles, twigs, bark, cones, and small branches, shall be permitted to a maximum depth of 3 inches, pursuant to 14 CCR § 1299.03(b)(2)(A).

Defensible and Reduced Fuel Zone / Within 100 feet of all structures or to the property line (Refer to illustration below):

- ☐ L. Logs or stumps embedded in the soil must be removed or isolated from other vegetation, pursuant to BOF General Guidelines item 3.

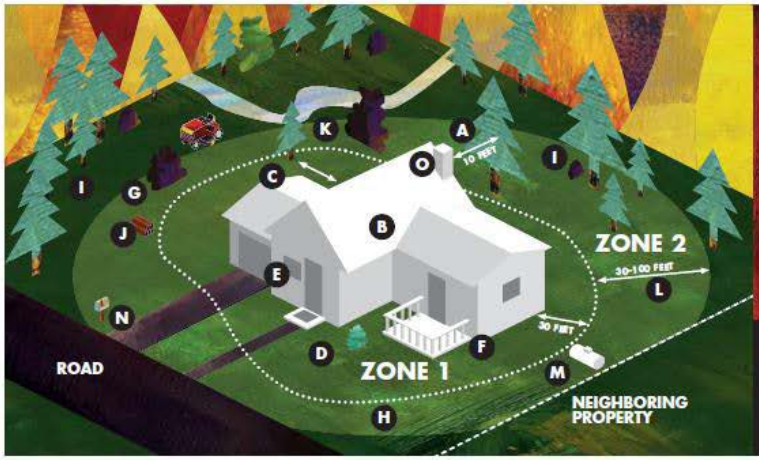
Other Requirements:

- ☐ M. Outbuildings and Liquid Propane Gas (LPG) storage tanks shall have 10 feet of clearance to bare mineral soil and no flammable vegetation for an additional 10 feet around their exterior, pursuant to 14 CCR § 1299.03(c)(1).
- ☐ N. Address numbers shall be displayed in contrasting colors (4" min. size) and readable from the street or access road, pursuant to 2016 CFC § 505.1.
- ☐ O. Equip chimney or stovepipe openings with a metal screen having openings between 3/8 inch and 1/2 inch, pursuant to 2016 CBC § 2113.9.2.

COMMENTS:

LEARN MORE:

IMPORTANT All violations marked must be addressed by the owner/tenant. A re-inspection of the property will occur on or after _____



KNOW THE LAW
BE FIRE SMART

100 feet of Defensible Space is required under the Public Resources Code (PRC) 4291. California Building Code Chapter 7A requires certain construction materials and methods for homes in wildland areas. Be sure to contact your local fire department for additional requirements to ensure your home is compliant with the law.

READYFORWILDFIRE.ORG/THELAW

PRC § 4119. The department, or its duly authorized agent, shall enforce the state forest and fire laws. The department may inspect all properties, except the interior of dwellings, subject to the state forest and fire laws, for the purpose of ascertaining compliance with such laws.

WILDFIRE IS COMING.
ARE YOU READY?

HARDENING YOUR HOME

Flying embers can destroy homes up to a mile ahead of a wildfire. Prepare (harden) your home now before a fire starts.

Priority list for building or remodeling with ignition-resistant* materials:

- **Roof** (Above all else your roofing is the most important hardening feature)
- **Eaves and Soffits**
- **Walls**
- **Decks**
- **Patio Cover**
- **Fencing**

Other priority activities:

- **Vents:** Cover and protect all openings.
- **Windows:** Protect against blow-outs and install dual-paned windows.
- **Rain Gutters:** Screen or enclose.
- **Chimney:** Cover outlets with non-combustible screens.
- **Garage:** Have an accessible fire extinguisher.
- **Driveways:** Ensure access to your home complies with local fire codes.
- **Water Supply:** Have multiple garden hoses that are long enough to reach all areas of your home.

*Visit ReadyforWildfire.org/hardening-your-home for detailed information on ignition-resistant building materials and all home hardening activities.

CAL FIRE SINCE 1885

ONE LESS SPARK
ONE LESS WILDFIRE

VERTICAL SPACING

Eliminate opportunities for a vertical "fire ladder" by:

- Remove branches beneath large trees for a 6-foot minimum clearance.
- Create proper vertical spacing between shrubs and the lowest branches of trees by using the formula shown.



HORIZONTAL SPACING

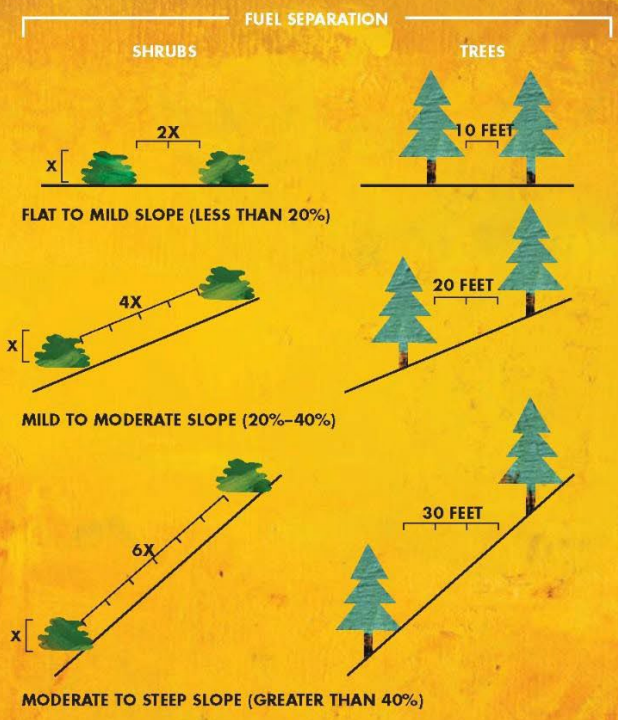
The spacing between grass, shrubs, and trees is crucial to reduce the spread of wildfire. The spacing needed is determined by the type and size of the shrubs and trees, as well as the slope of the land. For example, a property on a steep slope with larger plant life will require greater spacing between trees and shrubs than a level property that has small, sparse vegetation.

Fire-Safe Landscaping

Fire-safe landscaping isn't necessarily the same thing as a well-maintained yard. Fire-safe landscaping uses fire-resistant plants that are strategically planted to resist the spread of fire to your home.

Dead Tree Removal

If you have dead or dying trees on your property the entire tree needs to be removed to reduce wildfire risk. Visit ReadyforWildfire.org/dead-tree-removal to learn about permit requirements.



DOWNLOAD THE READY FOR WILDFIRE APP

It's never been more important to keep on top of preparing your family, home and property for a wildfire. Fires are on the rise, and are burning hotter, faster and more unpredictably than ever before. Download the app to:

Get custom wildfire alerts

Track your progress
% PREPARED

Get detailed action steps
☑1. ☐2. ☐3.

Download on the App Store
GET IT ON Google Play



Appendix C

STATUTES AND REGULATIONS

This appendix has been designed to present only those laws and regulations, or portions thereof, which pertain directly to Defensible Space property inspections, Firewise building construction, and Fire Safe practices around structures. As such, this appendix should only be used as a quick field reference. For full and current text, meaning, and proper context of laws and regulations reference should be made to the applicable codes, manuals, directives, etc.

I. STATE LAWS

A. Health and Safety Code (HSC)

Section 13108.5 - Buildings in Fire Hazard Severity Zones

(a) The State Fire Marshal, in consultation with the Director of Forestry and Fire Protection and the Director of Housing and Community Development, shall, pursuant to Section 18930, propose fire protection building standards for roofs, exterior walls, structure projections, including, but not limited to, porches, decks, balconies, and eaves, and structure openings, including, but not limited to, attic and eave vents and windows of buildings in fire hazard severity zones, including very high fire hazard severity zones designated by the State Fire Marshal pursuant to Article 9 (commencing with Section 4201) of Chapter 1 of Part 2 of Division 4 of the Public Resources Code.

(b) (1) Building standards adopted pursuant to this section shall also apply to buildings located in very high fire hazard severity zones designated pursuant to Chapter 6.8 (commencing with Section 51175) of Part 1 of Division 1 of Title 5 of the Government Code, and other areas designated by a local agency following a finding supported by substantial evidence in the record that the requirements of the building standards adopted pursuant to this section are necessary for effective fire protection within the area.
(2) Upon identification by the Director of Forestry and Fire Protection pursuant to Section 51178 of the Government Code of high fire hazard severity zones and by a local agency pursuant to Section 51179 of the Government Code, the Office of the State Fire Marshal and the Department of Housing and Community Development shall propose, and the California Building Standards Commission shall adopt, expanded application of the building standards adopted pursuant to this section to high fire hazard severity zones during the next triennially occurring code adoption cycle.
(3) The State Fire Marshal and the Department of Housing and Community Development shall, after consulting with interested stakeholders, including local fire officials, consider if it is appropriate to expand the application of the building standards adopted pursuant to this section to moderate fire hazard severity zones. If it is found appropriate, the State Fire Marshal and the Department of Housing and Community Development shall, pursuant to Section 18930, recommend expanding the application of the building standards adopted pursuant to this section to moderate fire hazard severity zones.

(c) Building standards adopted pursuant to this section shall also apply to buildings located in urban-wildland interface communities. A local agency may, at its discretion, include in or exclude from the requirements of these building standards any area in its jurisdiction following a finding supported by substantial evidence in the record at a public hearing that the requirements of these building standards are necessary or not necessary, respectively, for effective fire protection within the area. Changes made by a local agency to an urban-wildland interface community area following a finding supported by substantial evidence in the record shall be final and shall not be rebuttable.

(d) For purposes of subdivision (c), "urban wildland interface community" means a community listed in "Communities at Risk from Wild Fires," produced by the California Department of Forestry and Fire Protection, Fire and Resource Assessment Program, pursuant to the National Fire Plan, federal Fiscal Year 2001 Department of the Interior and Related Agencies Appropriations Act (Public Law 106-291).

Section 13132.7 – Roof Replacement

(a) Within a very high fire hazard severity zone designated by the Director of Forestry and Fire Protection pursuant to Article 9 (commencing with Section 4201) of Chapter 1 of Part 2 of Division 4 of the Public Resources Code and within a very high hazard severity zone designated by a local agency pursuant to Chapter 6.8 (commencing with Section 51175) of Part 1 of Division 1 of Title 5 of the Government Code, the entire roof covering of every existing structure where more than 50 percent of the total roof area is replaced within any one-year period, every new structure, and any roof covering applied in the alteration, repair, or replacement of the roof of every existing structure, shall be a fire retardant roof covering that is at least class B as defined in the Uniform Building Code, as adopted and amended by the State Building Standards Commission.

(b) In all other areas, the entire roof covering of every existing structure where more than 50 percent of the total roof area is replaced within anyone-year period, every new structure, and any roof covering applied in the alteration, repair, or replacement of the roof of every existing structure, shall be a fire- retardant roof covering that is at least class C as defined in the Uniform Building Code, as adopted and amended by the State Building Standards Commission.

(c) Notwithstanding subdivision (b), within state responsibility areas classified by the State Board of Forestry and Fire Protection pursuant to Article 3 (commencing with Section 4125) of Chapter 1 of Part 2 of Division 4 of the Public Resources Code, except for those state responsibility areas designated as moderate fire hazard responsibility zones, the entire roof covering of every existing structure where more than 50 percent of the total roof area is replaced within any one-year period, every new structure, and any roof covering applied in the alteration, repair, or replacement of the roof of every existing structure, shall be a fire retardant roof covering that is at least class B as defined in the Uniform Building Code, as adopted and amended by the State Building Standards Commission.

(d) (1) Notwithstanding subdivision (a), (b), or (c), within very high fire hazard severity zones designated by the Director of Forestry and Fire Protection pursuant to Article 9 (commencing with Section 4201) of Chapter 1 of Part 2 of Division 4 of the Public Resources Code or by a local agency pursuant to Chapter
6.8 (commencing with Section 51175) of Part 1 of Division 1 of Title 5 of the Government Code, the entire roof covering of every existing structure where more than 50 percent of the total roof area is replaced within any one-year period, every new structure, and any roof covering applied in the alteration, repair, or replacement of the roof of every existing structure, shall be a fire retardant roof covering that is at least class A as defined in the Uniform Building Code, as adopted and amended by the State Building Standards Commission.

(2) Paragraph (1) does not apply to any jurisdiction containing a very high fire hazard severity zone if the jurisdiction fulfills both of the following requirements:

(A) Adopts the model ordinance approved by the State Fire Marshal pursuant to Section 51189 of the Government Code or an ordinance that substantially conforms to the model ordinance of the State Fire Marshal.

(B) Transmits, upon adoption, a copy of the ordinance to the State Fire Marshal.

(e) The State Building Standards Commission shall incorporate the requirements set forth in subdivisions (a), (b), and (c) by publishing them as an amendment to the California Building Standards Code in accordance with Chapter 4 (commencing with Section 18935) of Part 2.5 of Division 13.

(f) Nothing in this section shall limit the authority of a city, county, city and county, or fire protection district in establishing more restrictive requirements, in accordance with current law, than those specified in this section.

(g) This section shall not affect the validity of an ordinance, adopted prior to the effective date for the relevant roofing standard specified in subdivisions (a) and (b), by a city, county, city and county, or fire protection district, unless the ordinance mandates a standard that is less stringent than the standards set forth in subdivision (a), in which case the ordinance shall not be valid on or after the effective date for the relevant roofing standard specified in subdivisions (a) and (b).

(h) Any qualified historical building or structure as defined in Section 18955 may, on a case-by-case basis, utilize alternative roof constructions as provided by the State Historical Building Code.

(i) The installer of the roof covering shall provide certification of the roof covering classification, as provided by the manufacturer or supplier, to the building owner and, when requested, to the agency responsible for enforcement of this part. The installer shall also install the roof covering in accordance with the manufacturer's listing.

(j) No wood roof covering materials shall be sold or applied in this state unless both of the following conditions are met:

(1) The materials have been approved and listed by the State Fire Marshal as complying with the requirements of this section.

(2) The materials have passed at least 5 years of the 10-year natural weathering test. The 10-year natural weathering test required by this subdivision shall be conducted in accordance with standard 15-2 of the 1994 edition of the Uniform Building Code at a testing facility recognized by the State Fire Marshal.

(k) The Insurance Commissioner shall accept the use of fire-retardant wood roof covering material that complies with the requirements of this section, used in the partial repair or replacement of non-fire-retardant wood roof covering material, as complying with the requirement in Section 2695.9 of Title 10 of the California Code of Regulations relative to matching replacement items in quality, color, and size.

(l) No common interest development, as defined in Section 4100 or 6534 of the Civil Code, may require an owner to install or repair a roof in a manner that is in violation of this section. The governing documents, as defined in Section 4150 or 6552 of the Civil Code, of a common interest development within a very high fire severity zone shall allow for at least one type of fire-retardant roof covering material that meets the requirements of this section.

B. Public Resources Code (PRC)

Section 4103.5 - Campfire Defined.

"Campfire" means a fire that is used for cooking, personal warmth, lighting, ceremonial, or aesthetic purposes, including fires contained within outdoor fireplaces and enclosed stoves with flues or chimneys, stoves using jellied, liquid, solid, or gaseous fuels, portable barbecue pits and braziers, or space heating devices which are used outside any structure, mobile home, or living accommodation mounted on a motor vehicle. "Campfire" does not include portable lanterns designed to emit light resulting from a combustion process.

Section 4119 – Inspection Authority

The department, or its duly authorized agent, shall enforce the state forest and fire laws. The department may inspect all properties, except the interior of dwellings, subject to the state forest and fire laws, for the purpose of ascertaining compliance with such laws.

Section 4202 - Classification of Zones.

The State Fire Marshal shall classify lands within state responsibility areas into fire hazard severity zones. Each zone shall embrace relatively homogeneous lands and shall be based on fuel loading, slope, fire weather, and other relevant factors present, including areas where winds have been identified by the department as a major cause of wildfire spread.

Section 4203 - Designation of Zones and Fire Hazard Ratings.

(a) The State Fire Marshal shall, by regulation, designate fire hazard severity zones and assign to each zone a rating reflecting the degree of severity of fire hazard that is expected to prevail in the zone.

(b) No designation of a zone and assignment of a rating shall be adopted by the State Fire Marshal until the proposed regulation has been transmitted to the board of supervisors of the county in which the zone is located at least 45 days before the adoption of the proposed regulation and a public hearing has been held in that county during that 45-day period.

Section 4204 - Review of Zones and Maps.

The State Fire Marshal shall periodically review zones designated and rated pursuant to this article and, as necessary, shall revise zones or their ratings or repeal the designation of zones. Any revision of a zone or its rating or any repeal of a zone shall conform to the requirements of Section 4203. In addition, the revision or repeal of a zone may be petitioned pursuant to Sections 11340.6 and 11340.7 of the Government Code.

Section 4290 - Adoption of Building Standards within State Responsibility Areas

(a) The board shall adopt regulations implementing minimum fire safety standards related to defensible space that are applicable to state responsibility area lands under the authority of the department, and to lands classified and designated as very high fire hazard severity zones, as defined in subdivision (i) of Section 51177 of the Government Code. These regulations apply to the perimeters and access to all residential, commercial, and industrial building construction within state responsibility areas approved after January 1, 1991, and within lands classified and designated as very high fire hazard severity zones, as defined in subdivision (i) of Section 51177 of the Government Code after July 1, 2021. The board may not adopt building standards, as defined in Section 18909 of the Health and Safety Code, under the authority of this section. As an integral part of fire safety standards, the State Fire Marshal has the authority to adopt regulations for roof coverings and openings into the attic areas of buildings specified in Section 13108.5 of the Health and Safety Code. The regulations apply to the placement of mobile homes as defined by National Fire Protection Association standards. These regulations do not apply where an application for a building permit was filed prior to January 1, 1991, or to parcel or tentative maps or other developments approved prior to January 1, 1991, if the final map for the tentative map is approved within the time prescribed by the local ordinance. The regulations shall include all of the following:

(1) Road standards for fire equipment access.
(2) Standards for signs identifying streets, roads, and buildings.
(3) Minimum private water supply reserves for emergency fire use.
(4) Fuel breaks and greenbelts.

(b) The board shall, on and after July 1, 2021, periodically update regulations for fuel breaks and greenbelts near communities to provide greater fire safety for the perimeters to all residential, commercial, and industrial building construction within state responsibility areas and lands classified and designated as very high fire hazard severity zones, as defined in subdivision (i) of Section 51177 of the Government Code, after July 1, 2021. These regulations shall include measures to preserve undeveloped ridgelines to reduce fire risk and improve fire protection. The board shall, by regulation, define "ridgeline" for purposes of this subdivision.

(c) These regulations do not supersede local regulations which equal or exceed minimum regulations adopted by the state.

(d) The board may enter into contracts with technical experts to meet the requirements of this section.

Section 4290.1. – "Fire Risk Reduction Community" list

(a) On or before July 1, 2022, the board shall develop criteria for and maintain a "Fire Risk Reduction Community" list of local agencies located in a state responsibility area or a very high fire hazard severity zone, identified pursuant to Section 51178 of the Government Code, that meet best practices for local fire planning.

(b) The board shall consider all of the following when developing the criteria for the list required under subdivision (a):

(1) Compliance with the board's regulations, including minimum fire safety standards.
(2) Participation in the National Fire Protection Association's "Firewise USA" or the National Wildfire Coordinating Group's "Fire Adapted Communities" programs.
(3) Adoption of the board's recommendations to improve the safety element pursuant to subdivision (b) of Section 65302.5 of the Government Code.
(4) Recently developed or updated community wildfire protection plans.

(c) The board shall post the "Fire Risk Reduction Community" list on its internet website.

Section 4290.5. Subdivision Fire Safety

(a) On or before July 1, 2021, and every five years thereafter, the board, in consultation with the State Fire Marshal, shall survey local governments, including counties, cities, and fire districts, to identify existing subdivisions located in a state responsibility area or a very high fire hazard severity zone, identified pursuant to Section 51178 of the Government Code, without a secondary egress route that are at significant fire risk.

(b) (1) The board, in consultation with the State Fire Marshal and the local government that identified the subdivision, shall develop recommendations to improve the subdivision's fire safety. The recommendations may include, but are not limited to, the following:

(A) Creating secondary access to the subdivision.
(B) Improvements to the existing access road.
(C) Other additional fire safety measures.

(2) The board shall provide the final recommendations developed pursuant to this subdivision to the local government that identified the subdivision and to the residents of the subdivision.

(c) The board may enter into contracts with an independent group to conduct the survey required in subdivision (a).

(d) For purposes of this section, "subdivision" means an existing residential development of more than 30 dwelling units.

(e) The board shall maintain a list of the subdivisions identified in subdivision (a) and the status of the implementation of the recommendations provided pursuant to subdivision (b).

Section 4291 - Defensible Space.

(a) A person who owns, leases, controls, operates, or maintains a building or structure in, upon, or adjoining a mountainous area, forest-covered lands, shrub-covered lands, grass-covered lands, or land that is covered with flammable material, shall at all times do all of the following:

(1) (A) Maintain defensible space of 100 feet from each side and from the front and rear of the structure, but not beyond the property line, except as provided in subparagraph (B). The amount of fuel modification necessary shall consider the flammability of the structure as affected by building material, building standards, location, and type of vegetation. Fuels shall be maintained and spaced in a condition so that a wildfire burning under average weather conditions would be unlikely to ignite the structure. This subparagraph does not apply to single specimens of trees or other vegetation that are well-pruned and maintained so as to effectively manage fuels and not form a means of rapidly transmitting fire from other nearby vegetation to a structure or from a structure to other nearby vegetation or to interrupt the advance of embers toward a structure. The intensity of fuel management may vary within the 100-foot perimeter of the structure, with more intense fuel reductions being utilized between 5 and 30 feet around the structure, and an ember-resistant zone being required within 5 feet of the structure, based on regulations promulgated by the board, in consultation with the department, to consider the elimination of materials in the ember-resistant zone that would likely be ignited by embers. Consistent with fuel management objectives, steps should be taken to minimize erosion, soil disturbance, and the spread of flammable nonnative grasses and weeds. For purposes of this subparagraph, "fuel" means any combustible material, including petroleum-based products, cultivated landscape plants, grasses, weeds, and wildland vegetation.

(B) A greater distance than that required under subparagraph (A) may be required by state law, local ordinance, rule, or regulation. Fuel modification beyond the property line may only be required by state law, local ordinance, rule, or regulation in order to maintain 100 feet of defensible space from a structure. Fuel modification on adjacent property shall only be conducted following written consent by the adjacent landowner. Any local ordinance related to fuel modification shall be in compliance with all applicable state laws, regulations, and policies. Any local ordinance may include provisions to allocate costs for any fuel modification beyond the property line.

(C) An insurance company that insures an occupied dwelling or occupied structure may require a greater distance than that required under subparagraph (A) if a fire expert, designated by the director, provides findings that the fuel modification is necessary to significantly reduce the risk of transmission of flame or heat sufficient to ignite the structure, and there is no other feasible mitigation measure possible to reduce the risk of ignition or spread of wildfire to the structure. The greater distance may not be beyond the property line unless allowed by state law, local ordinance, rule, or regulation.

(2) Remove that portion of a tree that extends within 10 feet of the outlet of a chimney or stovepipe.

(3) Maintain a tree, shrub, or other plant adjacent to or overhanging a building free of dead or dying wood.

(4) Maintain the roof of a structure free of leaves, needles, or other vegetative materials.

(5) Before constructing a new building or structure or rebuilding a building or structure damaged by a fire in an area subject to this section, the construction or rebuilding of which requires a building permit, the owner shall obtain a certification from the local building official that the dwelling or structure, as proposed to be built, complies with all applicable state and local building standards, including those described in subdivision (b) of Section 51189 of the Government Code, and shall provide a copy of the certification, upon request, to the insurer providing course of construction insurance coverage for the building or structure. Upon completion of the construction or rebuilding,

the owner shall obtain from the local building official, a copy of the final inspection report that demonstrates that the dwelling or structure was constructed in compliance with all applicable state and local building standards, including those described in subdivision (b) of Section 51189 of the Government Code, and shall provide a copy of the report, upon request, to the property insurance carrier that insures the dwelling or structure.

(b) A person is not required under this section to manage fuels on land if that person does not have the legal right to manage fuels, nor is a person required to enter upon or to alter property that is owned by any other person without the consent of the owner of the property.

(c) (1) Except as provided in Section 18930 of the Health and Safety Code, the State Fire Marshal may adopt regulations exempting a structure with an exterior constructed entirely of nonflammable materials, or, conditioned upon the contents and composition of the structure, the director may vary the requirements respecting the removing or clearing away of flammable vegetation or other combustible growth with respect to the area surrounding those structures.

(2) An exemption or variance under paragraph (1) shall not apply unless and until the occupant of the structure, or if there is not an occupant, the owner of the structure, files with the State Fire Marshal, in a form as the State Fire Marshal shall prescribe, a written consent to the inspection of the interior and contents of the structure to ascertain whether this section and the regulations adopted under this section are complied with at all times.

(d) The State Fire Marshal may authorize the removal of vegetation that is not consistent with the standards of this section. The State Fire Marshal may prescribe a procedure for the removal of that vegetation and make the expense a lien upon the building, structure, or grounds, in the same manner that is applicable to a legislative body under Section 51186 of the Government Code.

(e) (1) The board, in consultation with the State Fire Marshal, shall develop, periodically update, and post on its Internet website a guidance document on fuel management pursuant to this chapter. The guidance document shall include, but not be limited to, regionally appropriate vegetation management suggestions that preserve and restore native species that are fire resistant or drought tolerant, or both, minimize erosion, minimize water consumption, and permit trees near homes for shade, aesthetics, and habitat; and suggestions to minimize or eliminate the risk of flammability of nonvegetative sources of combustion, such as woodpiles, propane tanks, decks, outdoor furniture, barbecue equipment, and outdoor fire pits.

(2) On or before January 1, 2023, the board, in consultation with the State Fire Marshal, shall update the guidance document to include suggestions for creating an ember-resistant zone within five feet of a structure, based on regulations promulgated by the board, in consultation with the department, to consider the elimination of materials in the ember-resistant zone that would likely be ignited by embers.

(f) The State Fire Marshal shall do both of the following:

(1) Recommend to the board the types of vegetation or fuel that are to be excluded from an ember-resistant zone based on the probability that vegetation and fuel will lead to ignition by ember of a structure as a part of the update to the guidance document pursuant to paragraph (2) of subdivision (e).

(2) Make reasonable efforts to provide notice to affected residents describing the requirements added by the amendments to paragraph (1) of subdivision (a) made in Assembly Bill 3074 of the 2019–20 Regular Session before the imposition of penalties for violating those requirements.

(g) (1) The requirement for an ember-resistant zone pursuant to paragraph (1) of subdivision (a) shall not take effect for new structures until the board updates the regulations, pursuant to paragraph (1) of subdivision (a), and the guidance document, pursuant to paragraph (2) of subdivision (e).

(2) The requirement for an ember-resistant zone pursuant to paragraph (1) of subdivision (a) shall take effect for existing structures one year after the effective date for the new structures.

(h) The department shall not change defensible space inspection practices and forms or enforcement to implement the requirement for an ember-resistant zone until the State Fire Marshal makes a written finding, which the State Fire Marshal shall post on the department's internet website, that the Legislature has appropriated sufficient resources to do so.

(i) For purposes of this section, a structure for the purpose of an ember-resistant zone shall include any attached deck. This section does not limit the authority of the board or the department to require the removal of fuel or vegetation on top of or underneath a deck pursuant to this section.

(j) As used in this section, "person" means a private individual, organization, partnership, limited liability company, or corporation.

Section 4291.1 - Defensible Space; Violation.

(a) Notwithstanding Section 4021, a violation of Section 4291 is an infraction punishable by a fine of not less than one hundred dollars ($100), nor more than five hundred dollars ($500). If a person is convicted of a second violation of Section 4291 within five years, that person shall be punished by a fine of not less than two hundred fifty dollars ($250), nor more than five hundred dollars ($500). If a person is convicted of a third violation of Section 4291 within five years, that person is guilty of a misdemeanor and shall be punished by a fine of not less than five hundred dollars ($500). If a person is convicted of a third violation of Section 4291 within five years, the department may perform or contract for the performance of work necessary to comply with Section 4291 and may bill the person convicted for the costs incurred, in which case the person convicted, upon payment of those costs, shall not be required to pay the fine. If a person convicted of a violation of Section 4291 is granted probation, the court shall impose as a term or condition of probation, in addition to any other term or condition of probation, that the person pay at least the minimum fine prescribed in this section.

(b) If a person convicted of a violation of Section 4291 produces in court verification prior to imposition of a fine by the court, that the condition resulting in the citation no longer exists, the court may reduce the fine imposed for the violation of Section 4291 to fifty dollars ($50).

Section 4291.3 – Additional Firebreak

(a) Subject to any other applicable law, a state or local fire official, at their discretion, may authorize an owner of property, or the owner's agent, to construct a firebreak, or implement appropriate vegetation management techniques, to ensure that defensible space is adequate for the protection of a hospital, adult residential care facility, school, aboveground storage tank, hazardous materials facility, or similar facility on the property. The firebreak may be for a radius of up to 300 feet from the facility, or to the property line, whichever distance is shorter.

(b) The director may authorize an owner of a property not listed in subdivision (a) to construct a firebreak, or implement appropriate vegetation management techniques, within a radius of up to 300 feet from a structure, or to the property line, whichever distance is shorter, if it is determined by the director as necessary to protect life, property, and natural resources from unreasonable risks associated with wildland fires.

Section 4423 - Burn Permits.

A person shall not burn any brush, stumps, logs, fallen timber, fallows, slash, grass-covered land, brush-covered land, forest-covered land, or other flammable material, in any state responsibility area, area receiving fire protection by the department by contract, or upon federal lands administered by the United States Department of Agriculture or Department of the Interior, unless the person has a written permit

from the department or its duly authorized representative or the authorized federal officer on federal lands administered by the United States Department of Agriculture or of the Interior and in strict accordance with the terms of the permit:

(a) At any time in Zone A.
(b) At any time in Zone B between May 1st and the date the director declares, by proclamation, that the hazardous fire conditions have abated for that year, or at any other time in Zone B during any year when the director has declared, by proclamation, that unusual fire hazard conditions exist in the area. The issuing agency may require the permittee to contact the agency to determine permit suspension status prior to burning.

Section 4423.1 - Burning Suspension.

(a) Burning under permit by a person on public or private lands, except within incorporated cities, may be suspended, restricted, or otherwise prohibited by proclamation. Any of the following public officers may issue a proclamation, which shall be applicable within their respective jurisdictions:

(1) The director or the director's designee.
(2) Any county fire warden with the approval of the director.
(3) The federal officers directing activities within California of the United States Bureau of Land Management, the National Park Service, and the United States Forest Service.

(b) The proclamation may be issued when, in the judgment of the issuing public official, the menace of destruction by fire to life, improved property, or natural resources is, or is forecast to become, extreme due to critical fire weather, fire suppression forces being heavily committed to control fires already burning, acute dryness of the vegetation, or other factors that may cause the rapid spread of fire. A proclamation is effective on issuance or at a time specified therein and shall remain in effect until a proclamation removing the suspension, restriction, or prohibition is issued. The proclamation may be effective for a single day or longer. The proclamation shall declare the conditions that necessitate its issuance, designate the geographic area to which it applies, require that all or specified burning under permit be suspended, restricted, or prohibited until the conditions necessitating the proclamation abate, and identify the public official issuing the proclamation. The proclamation may be in the form of a verbal or audio-recorded telephone message, a press release, or a posted order.

(c) The proclamation may be issued without complying with Chapter 3.5 (commencing with Section 11340) and Chapter 5 (commencing with Section 11500) of Part 1 of Division 3 of Title 2 of the Government Code.

Section 4423.2. - Burning Suspension Restricted Temporary Permit

(a) Whenever the burning under permit has been suspended, restricted, or prohibited by proclamation pursuant to Section 4423.1, the officer having jurisdiction may issue a restricted temporary burning permit in instances in which the continuation of burning may be essential for reasons of public health, safety, or welfare. The permit may stipulate any special precautions that are required to be followed to reduce the risk of uncontrolled fire originating from the operation.
(b) Violation of the terms of a restricted temporary burning permit is a misdemeanor, and any person upon conviction thereof shall be punished by a fine of not less than two hundred fifty dollars ($250). No part of the fine shall be suspended. The court may permit the fine prescribed by this section to be paid in installments if the court determines that the defendant is unable to pay the fine in one lump sum.

Section 4423.3. - Campfire not Restricted Unless Specified

The use of a campfire is not restricted or prohibited by a proclamation issued pursuant to Section 4423.1, unless specifically restricted or prohibited in that or a subsequent proclamation. If restricted by proclamation, campfires shall be confined to facilities constructed for that purpose within the confines of a campground established, maintained, and open for public use, whether publicly or privately owned.

Section 4423.4. - Smoking not Restricted Unless Specified

Outdoor smoking is not restricted or prohibited by a proclamation issued pursuant to Section 4423.1, unless specifically restricted or prohibited in that or a subsequent proclamation. If restricted by proclamation, smoking shall be confined to the following: (a) Within motor vehicles while operating or parked on established roads, rest stops, or parking areas cleared of flammable vegetation. (b) Within established campgrounds open to the public. (c) Within an area that is at least three feet or approximately one meter in diameter which has been cleared to mineral soil by removal of all flammable vegetation and duff. The exempted locations may be included within the smoking ban if specifically noticed in the proclamation.

Section 4423.5 - Burn Suspension Violation

Use of open fire or burning under permit within an area closed by proclamation pursuant to the provisions of Section 4423.1, except as provided in Sections 4423.2, 4423.3, and 4423.4, is a misdemeanor and any person upon conviction thereof shall be punished by a fine of not less than one hundred dollars ($100).
No part of such fine shall be suspended. The court may permit the fine prescribed by this section to be paid in installments if the court determines that the defendant is unable to pay the fine in one lump sum.
4425. Any violation of the terms of a burning permit issued pursuant to Section 4423, a restricted temporary burning permit issued pursuant to Section 4423.2, or a campfire permit issued pursuant to Section 4433 renders the permit null and void.

Section 4427 - Clearing and Tools Required

During any time of the year when burning permits are required in an area pursuant to this article, no person shall use or operate any motor, engine, boiler, stationary equipment, welding equipment, cutting torches, tarpots, or grinding devices from which a spark, fire, or flame may originate, which is located on or near any forest-covered land, brush-covered land, or grass-covered land, without doing both of the following:

(a) First clearing away all flammable material, including snags, from the area around such operation for a distance of 10 feet.
(b) Maintain one serviceable round point shovel with an overall length of not less than forty-six (46) inches and one backpack pump water-type fire extinguisher fully equipped and ready for use in the immediate area during the operation.

This section does not apply to portable power saws and other portable tools powered by a gasoline-fueled internal combustion engine.

Section 4431 - Portable Gas Powered Tools.

During any time of the year when burning permits are required in an area pursuant to this article, no person shall use or operate or cause to be operated in the area any portable saw, auger, drill, tamper, or other portable tool powered by a gasoline-fueled internal combustion engine on or near any forest-covered land, brush-covered land, or grass-covered land, within 25 feet of any flammable material, without providing and maintaining at the immediate locations of use or operation of the saw or tool, for firefighting purposes one serviceable round point shovel, with an overall length of not less than 46 inches,

or one serviceable fire extinguisher. The Director of Forestry and Fire Protection shall by administrative regulation specify the type and size of fire extinguisher necessary to provide at least minimum assurance of controlling fire caused by the use of portable power tools under various climatic and fuel conditions. The required fire tools shall at no time be farther from the point of operation of the power saw or tool than 25 feet with unrestricted access for the operator from the point of operation.

Section 4432 - Neglecting a Campfire.

(a) A person shall not leave a campfire, kindled or attended by that person, burning or unextinguished unless one of the following requirements is satisfied:

(1) The person leaves some other person in attendance.

(2) The fire is enclosed within a stove, oven, drum, or other nonflammable container, in such a manner that the fire cannot escape from the container.

(b) A person shall not allow a campfire, kindled or attended by that person, to spread after it is built.

Section 4433 - Campfire Permit Required

(a) A person shall not light, maintain, or use a campfire upon brush-covered land, grass-covered land, or forest-covered land that is the property of another person unless the person first obtains a written permit from the owner, lessee, or agent of the owner or lessee of the property.

(b) If, however, campsites and special areas have been established by the property owner and posted as areas for camping, a permit is not necessary.

(c) A written campfire permit duly issued by or under the authority of the United States Forest Service is necessary for use on land under the jurisdiction and control of the United States Forest Service.

Section 4434 - Campfire Escape

The escape of any campfire from the control of any person who is maintaining the campfire is prima facie evidence that such person was negligent in maintaining the campfire.

Section 4442 - Spark Arresters.

(a) Except as otherwise provided in this section, no person shall use, operate, or allow to be used or operated, any internal combustion engine which uses hydrocarbon fuels on any forest-covered land, brush-covered land, or grass-covered land unless the engine is equipped with a spark arrester, as defined in subdivision (c), maintained in effective working order or the engine is constructed, equipped, and maintained for the prevention of fire pursuant to Section 4443.

(b) Spark arresters affixed to the exhaust system of engines or vehicles subject to this section shall not be placed or mounted in such a manner as to allow flames or heat from the exhaust system to ignite any flammable material.

(c) A spark arrester is a device constructed of nonflammable materials specifically for the purpose of removing and retaining carbon and other flammable particles over 0.0232 of an inch in size from the exhaust flow of an internal combustion engine that uses hydrocarbon fuels or which is qualified and rated by the United States Forest Service.

(d) Engines used to provide motive power for trucks, truck tractors, buses, and passenger vehicles, except motorcycles, are not subject to this section if the exhaust system is equipped with a muffler as defined in the Vehicle Code.

(e) Turbocharged engines are not subject to this section if all exhausted gases pass through the rotating turbine wheel, there is no exhaust bypass to the atmosphere, and the turbocharger is an ineffective mechanical condition.

(f) Motor vehicles when being operated in an organized racing or competitive event upon a closed course are not subject to this section if the event is conducted under the auspices of a recognized sanctioning body and by permit issued by the fire protection authority having jurisdiction.

Section 4442.5 - Written Notice.

No person shall sell, offer for sale, lease, or rent to any person any internal combustion engine subject to Section 4442 or 4443, and not subject to Section 13005 of the Health and Safety Code, unless the person provides a written notice to the purchaser or bailee, at the time of sale or at the time of entering into the lease or rental contract, stating that it is a violation of Section 4442 or 4443 to use or operate the engine on any forest-covered, brush-covered, or grass-covered land unless the engine is equipped with a spark arrester, as defined in Section 4442, maintained in effective working order or the engine is constructed, equipped, and maintained for the prevention of fire pursuant to Section 4443.

Section 4442.6. - Warning Label

(a) A person shall not sell, offer for sale, lease, or rent to a person any equipment that is powered by an internal combustion engine subject to Section 4442 or 4443, and not subject to Section 13005 of the Health and Safety Code, unless that equipment has a permanent warning label attached that is in plain view to the operator that states, "WARNING—Operation of This Equipment May Create Sparks That Can Start Fires Around Dry Vegetation. A Spark Arrestor May be Required. The Operator Should
Contact Local Fire Agencies For Laws or Regulations Relating to Fire Prevention Requirements."

(b) A person who manufactures equipment that is powered by an internal combustion engine described in subdivision (a) shall attach to that equipment a permanent warning label that is in plain view to the operator and that complies with subdivision (a).

(c) Notwithstanding Section 4021, a violation of subdivision (a) or (b) is an infraction punishable by a fine of not more than one hundred dollars ($100).

Section 4443 – Handheld Portable Engines

No person shall use, operate, or cause to be operated on any forest-covered land, brush-covered land, or grass-covered land any handheld portable, multi-position, internal-combustion engine manufactured after June 30, 1978, which is operated on hydrocarbon fuels, unless it is constructed and equipped and maintained for the prevention of fire.
The board shall, by regulation, specify standards for the construction, equipment, and maintenance of such engines for the prevention of fire and shall specify a uniform method of testing to be used by engine and equipment manufacturers, governmental agencies, and equipment users. The regulations shall include specifications of exhaust system standards for carbon particle retention or destruction, exposed surface temperature, gas temperature, flammable debris accumulation, durability, and serviceability. Portable power saw and other portable equipment described in this section which were manufactured prior to July 1, 1978, shall be subject to fire safety design specifications as prescribed by the board.

Section 4446 - Incinerator Permit Required

Every person shall exercise reasonable care in the disposal of flammable material so that the material does not cause the inception of or spread of uncontrolled fire. A person shall not burn any flammable material in any incinerator within any state responsibility area, within any area receiving fire protection by the director by contract, or upon federal lands administered by the United States Department of

Agriculture or Department of the Interior, unless all of the following minimum requirements are complied with:

(a) The area within 10 feet of the exterior of the incinerator is maintained free and clear of all flammable material and vegetation.

(b) A screen constructed of a nonflammable material, with no greater than $^{1}/_{4}$-inch mesh, or metal doors, close or cover each opening in the exterior of an incinerator to prevent the escape of flames, sparks, ashes, or other burning material which might cause an uncontrolled fire.

(c) A permit is obtained prior to burning for the use of the incinerator pursuant to Section 4423 and all other applicable provisions of law.

This section does not apply to the disposal of flammable material incident to the processing of forest products.

C. Civil Code (CIV)

Section 1102.19 – Disclosures Upon Transfer of Residential Property.

(a) On and after July 1, 2021, a seller of a real property subject to this article that is located in a high or very high fire hazard severity zone, as identified by the Director of Forestry and Fire Protection pursuant to Section 51178 of the Government Code or Article 9 (commencing with Section 4201) of Chapter 1 of Part 2 of Division 4 of the Public Resources Code, shall provide to the buyer documentation stating that the property is in compliance with Section 4291 of the Public Resources Code or local vegetation management ordinances, as follows:

(1) In a local jurisdiction that has enacted an ordinance requiring an owner of real property to obtain documentation that the property is in compliance with Section 4291 of the Public Resources Code or a local vegetation management ordinance, the seller shall provide the buyer with a copy of the documentation that complies with the requirements of that local ordinance and information on the local agency from which a copy of that documentation may be obtained.

(2) In a local jurisdiction that has not enacted an ordinance for an owner of real property to obtain documentation that a property is in compliance with Section 4291 of the Public Resources Code or a local vegetation management ordinance, and if a state or local agency, or other government entity, or other qualified nonprofit entity, provides an inspection with documentation for the jurisdiction in which the property is located, the seller shall provide the buyer with the documentation obtained in the six-month period preceding the date the seller enters into a transaction to sell that real property and provide information on the local agency from which a copy of that documentation may be obtained.

(b) On and after July 1, 2021, if the seller of a real property described in subdivision (a) has not obtained documentation of compliance in accordance with paragraph (1) or (2) of subdivision (a), the seller and the buyer shall enter into a written agreement pursuant to which the buyer agrees to obtain documentation of compliance with Section 4291 of the Public Resources Code or a local vegetation management ordinance as follows:

(1) In a local jurisdiction that has enacted an ordinance requiring an owner or buyer to obtain documentation of compliance with Section 4291 of the Public Resources Code or a local vegetation management ordinance, the buyer shall comply with that ordinance.

(2) In a local jurisdiction that has not enacted an ordinance requiring an owner or buyer to obtain documentation of compliance, and if a state or local agency, or other government entity, or other qualified nonprofit entity, provides an inspection with documentation for the jurisdiction in which the property is located, the buyer shall obtain documentation of compliance within one year of the date of the close of escrow.

(c) Nothing in this section, including the existence of an agreement between a buyer and seller pursuant to subdivision, shall limit the ability of a state or local agency to enforce defensible space requirements pursuant to Section 51182 of the Government Code, Section 4291 of the Public Resources Code, or other applicable statutes, regulations, and local ordinances.

II. STATE REGULATIONS

Title 14, California Code of Regulations (14 CCR), Division 1.5, Chapter 7

Subchapter 2. SRA/VHFHSZ Fire Safe Regulations

ARTICLE 1. ADMINISTRATION

Section 1270 - Title

These regulations shall be known as the "SRA/VHFHSZ Fire Safe Regulations," and shall constitute the basic wildfire protection standards of the California Board of Forestry and Fire Protection.

Section 1270.01 - Purpose.

(a) These regulations have been prepared and adopted for the purpose of establishing minimum wildfire protection standards in conjunction with building, construction and development in the State Responsibility Area (SRA) and, after July 1, 2021, the Very High Fire Hazard Severity Zones as defined in Government Code § 51177(i) (VHFHSZ).

(b) The future design and construction of structures, subdivisions and developments in the SRA and, after July 1, 2021, the VHFHSZ shall provide for basic emergency access and perimeter wildfire protection measures as specified in the following articles.

(c) These measures shall provide for emergency access; signing and building numbering; private water supply reserves for emergency fire use; and vegetation modification. The fire protection standards which follow shall specify the minimums for such measures.

Section 1270.02 - Scope.

(a) These regulations shall apply to:
(1) the perimeters and access to all residential, commercial, and industrial building construction within the SRA approved after January 1, 1991, and those approved after July 1, 2021 within the VHFHSZ, except as set forth below in subsections (b.)
(2) the siting of newly installed commercial modulars, manufactured homes, mobile homes, and factory-built housing, as defined in Health and Safety Code sections 18001.8, 18007, 18008, and 19971;
(3) all tentative and parcel maps or other developments approved after January 1, 1991; and
(4) applications for building permits on a parcel approved in a pre-1991 parcel or tentative map to the extent that conditions relating to the perimeters and access to the buildings were not imposed as part of the approval of the parcel or tentative map.

(b) These regulations do not apply where an application for a building permit is filed after January 1, 1991 for building construction on a parcel that was formed from a parcel map or tentative map (if the final map for the tentative map is approved within the time prescribed by the local ordinance) approved prior to January 1, 1991, to the extent that conditions relating to the perimeters and access to the buildings were imposed by the parcel map or final tentative map approved prior to January 1, 1991.

(c) Affected activities include, but are not limited to:
(1) permitting or approval of new parcels, excluding lot line adjustments as specified in Government Code (GC) section 66412(d);
(2) application for a building permit for new construction, not relating to an existing structure;
(3) application for a use permit;

(4) road construction including construction of a road that does not currently exist, or extension of an existing road.

(f) EXEMPTION: Roads used solely for agricultural, mining, or the management and harvesting of wood products.

Section 1270.03 –Provisions for Application of these Regulations.

This subchapter shall be applied as follows:

(a) the local jurisdictions shall provide the Director of the California Department of Forestry and Fire Protection (CAL FIRE) or their designee with notice of applications for building permits, tentative parcel maps, tentative maps, and installation or use permits for construction or development within the SRA or, after July 1, 2021, the VHFHSZ.

(b) the Director or their designee may review and make fire protection recommendations on applicable construction or development permits or maps provided by the local jurisdiction.

(c) the local jurisdiction shall ensure that the applicable sections of this subchapter become a condition of approval of any applicable construction or development permit or map.

Section 1270.04 – Local Ordinances.

(a) Nothing contained in these regulations shall be considered as abrogating the provisions of any ordinance, rule or regulation of any state or local jurisdiction provided that such ordinance, rule, regulation or general plan element is equal to or more stringent than these minimum standards.

(b) The Board may certify local ordinances as equaling or exceeding these regulations when they provide the same practical effect.

(c) Counties may submit their local ordinances for certification via email to the Board.

(d) The Board's certification of local ordinances pursuant to this section is rendered invalid when previously certified ordinances are subsequently amended by local jurisdictions without Board re-certification of the amended ordinances. The Board's regulations supersede the amended local ordinance(s) when the amended local ordinance(s) are not re-certified by the Board. Amendments made by local jurisdictions to previously certified ordinances shall be submitted for re-certification.

Section 1270.05 – Inspections.

Inspections shall conform to the following requirements:

(a) Inspection shall be made by:
(1) the Director, or
(2) local jurisdictions that have assumed state fire protection responsibility on SRA lands, or
(3) local jurisdictions where the inspection duties have been formally delegated by CAL FIRE to the local jurisdiction.

(b) Inspections made under 14 CCR § 12705.05 (a)(2) or 14 CCR § 1270.05 (a)(3) shall occur only when these regulations are incorporated into local ordinance in one of the following manners:
(1) these regulations have been incorporated verbatim or by reference into that jurisdiction's permitting or approval process for the activities described in 14 CCR § 1270.02; or
(2) the local ordinances have been certified pursuant to 14 CCR § 1270.04;

(c) Nothing in this section abrogates CAL FIRE's authority to inspect and enforce state forest and fire laws even when the inspection duties have been delegated pursuant to this section.

(d) Reports of violations shall be provided to the CAL FIRE Unit headquarters that administers SRA fire protection in the local jurisdiction.

(e) When inspections are conducted, they shall occur prior to: the issuance of the use permit or certificate of occupancy; the recordation of the parcel map or final map; the filing of a notice of completion; or the final inspection of any project or building permit.

Section 1270.06 – Exceptions to Standards

(a) Upon request by the applicant, exceptions to standards within this subchapter or to local jurisdiction-certified ordinances may be allowed by the inspection entity listed in 14 CCR § 1270.05, where the exceptions provide the same practical effect as these regulations towards providing defensible space. Exceptions granted by the inspection entity listed in 14 CCR § 1270.05 shall be made on a case-by-case basis only. Exceptions granted by the inspection entity listed in 14 CCR § 1270.05 shall be forwarded to the appropriate CAL FIRE Unit Office that administers SRA fire protection in that county and shall be retained on file at the Unit Office.

(b) Requests for an exception shall be made in writing to the inspection entity listed in 14 CCR § 1270.05 by the applicant or the applicant's authorized representative. At a minimum, the request shall state the specific section(s) for which an exception is requested, material facts supporting the contention of the applicant, the details of the exception proposed, and a map showing the proposed location and siting of the exception. Local jurisdictions listed in 14 CCR section 1270.05 may establish additional procedures or requirements for exception requests.

(c) Where an exception is not granted by the inspection entity, the applicant may appeal such denial to the local jurisdiction. The local jurisdiction may establish or utilize an appeal process consistent with existing local building or planning department appeal processes.

(d) Before the local jurisdiction makes a determination on an appeal, the inspection authority shall be consulted and shall provide to that local jurisdiction documentation outlining the effects of the requested exception on wildfire protection.

(e) If an appeal is granted, the local jurisdiction shall make findings that the decision meets the intent of providing defensible space consistent with these regulations. Such findings shall include a statement of reasons for the decision. A written copy of these findings shall be provided to the CAL FIRE Unit headquarters that administers SRA fire protection in that local jurisdiction.

Section 1271.00 - Definitions.

Agriculture: Land used for agricultural purposes as defined in a local jurisdiction's zoning ordinances.
Building: Any structure used or intended for supporting or sheltering any use or occupancy, except Utility and Miscellaneous Group U buildings.
CAL FIRE: California Department of Forestry and Fire Protection.

Dead-end road: A road that has only one point of vehicular ingress/egress, including cul-de-sacs and looped roads.
Defensible space: The area within the perimeter of a parcel, development, neighborhood or community where basic wildland fire protection practices and measures are implemented, providing the key point of defense from an approaching wildfire or defense against encroaching wildfires or escaping structure fires. The perimeter as used in this regulation is the area encompassing the parcel or parcels proposed for construction and/or development, excluding the physical structure itself. The area is characterized by the establishment and maintenance of emergency vehicle access, emergency water reserves, road names and building identification, and fuel modification measures.
Development: As defined in section 66418.1 of the California Government Code.
Director: Director of the Department of Forestry and Fire Protection or their designee.
Driveway: A vehicular access that serves up to two (2) parcels with no more than two (2) residential units and any number of non-commercial or industrial buildings on each parcel.
Distance Measurements: All specified or referenced distances are measured along the ground, unless otherwise stated.
EXCEPTION: An alternative to the specified standard requested by the applicant that may be necessary due to health, safety, environmental conditions, physical site limitations or other limiting conditions, such as recorded historical sites, that provides mitigation of the problem.
Fire valve: see hydrant.
Fuel modification area: An area where the volume of flammable vegetation has been reduced, providing reduced fire intensity and duration.
Greenbelts: A facility or land-use, designed for a use other than fire protection, which will slow or resist the spread of a wildfire. Includes parking lots, irrigated or landscaped areas, golf courses, parks, playgrounds, maintained vineyards, orchards or annual crops that do not cure in the field.
Hammerhead/T: A road or driveway that provides a "T" shaped, three-point turnaround space for emergency equipment, being no narrower than the road that serves it.
Hydrant: A valved connection on a water supply or storage system, having either one two and a half (2 1/2) inch or one four and a half (4 1/2) inch outlet, with male American National Fire Hose Screw Threads (NH), used to supply fire apparatus and hoses with water.
Local Jurisdiction: Any county, city/county agency or department, or any locally authorized district that issues or approves building permits, use permits, tentative maps or tentative parcel maps, or has authority to regulate development and construction activity.
Occupancy: The purpose for which a building, or part thereof, is used or intended to be used.
One-way road: A minimum of one traffic lane width designed for traffic flow in one direction only.
Residential unit: Any building or portion thereof which contains living facilities, including provisions for sleeping, eating, cooking and/or sanitation for one or more persons. Manufactured homes, mobile homes, and factory-built housing are considered residential units for the purposes of mandatory measures required in 14 CCR § 1270.01(c).
Road: Vehicular access to more than two (2) parcels; more than four (4) residential units; or access to any industrial or commercial occupancy. Includes public and private streets and lanes.
Road or driveway structures: Bridges, culverts, and other appurtenant structures which supplement the traffic lane or shoulders.
Same Practical Effect: As used in this subchapter, means an exception or alternative with the capability of applying accepted wildland fire suppression strategies and tactics, and provisions for fire fighter safety, including:

(a) access for emergency wildland fire equipment,
(b) safe civilian evacuation,
(c) signing that avoids delays in emergency equipment response,
(d) available and accessible water to effectively attack wildfire or defend a structure from wildfire, and
(e) fuel modification sufficient for civilian and fire fighter

safety. Shoulder: Vehicular access adjacent to the traffic lane.
State Board of Forestry and Fire Protection (Board): As defined in Public Resources Code section 730.
State Responsibility Area (SRA): As defined in Public Resources Code sections 4126-4127; and the California Code of Regulations, title 14, division 1.5, chapter 7, article 1, sections 1220-1220.5.

Structure: That which is built or constructed, an edifice or building of any kind, or any piece of work artificially built up or composed of parts joined together in some definite manner.
Subdivision: As defined in section 66424 of the Government Code.
Traffic lane: The portion of a road or driveway that provides a single line of vehicle travel.
Turnaround: A road or driveway, unobstructed by parking, which allows for a safe opposite change of direction for emergency equipment. Design of such area may be a hammerhead/T or terminus bulb.

Turnouts: A widening in a road or driveway to allow vehicles to pass.
Utility and Miscellaneous Group U building: A structure of an accessory character or a miscellaneous structure not classified in any specific occupancy permitted, constructed, equipped, and maintained to conform to the requirements of Title 24, California Building Standards Code.
Vertical clearance: The minimum specified height of a bridge or overhead projection above the road or driveway.
Wildfire: As defined in Public Resources Code Section 4103 and 4104.

ARTICLE 2. - EMERGENCY ACCESS and EGRESS

Section 1273.00 - Intent.

Roads and driveways, whether public or private, unless exempted under 14 CCR § 1270.02(d), shall provide for safe access for emergency wildfire equipment and civilian evacuation concurrently, and shall provide unobstructed traffic circulation during a wildfire emergency consistent with 14 CCR §§ 1273.00 through 1273.09.

Section 1273.01 - Width.

(a) All roads shall be constructed to provide a minimum of two ten (10) foot traffic lanes, not including shoulder and striping. These traffic lanes shall provide for two-way traffic flow to support emergency vehicles and civilian egress unless other standards are provided in this article or additional requirements are mandated by local jurisdictions or local subdivision requirements. Vertical clearances shall conform to the requirements in California Vehicle Code section 35250.

(b) All one-way roads shall be constructed to provide a minimum of one twelve (12) foot traffic lane, not including shoulders. The local jurisdiction may approve one-way roads.

(1) All one-way roads shall, at both ends, connect to a road with two traffic lanes providing for travel in different directions, and shall provide access to an area currently zoned for no more than ten (10) residential units.

(2) In no case shall a one-way road exceed 2,640 feet in length. A turnout shall be placed and constructed at approximately the midpoint of each one-way road.

(c) All driveways shall be constructed to provide a minimum of one (1) ten (10) foot traffic lane, fourteen (14) feet unobstructed horizontal clearance, and unobstructed vertical clearance of thirteen feet, six inches (13' 6”).

Section 1273.02 - Road Surfaces.

(a) Roads shall be designed and maintained to support the imposed load of fire apparatus weighing at least 75,000 pounds and provide an aggregate base.

(b) Driveways and road and driveway structures shall be designed and maintained to support at least 40,000 pounds.

(c) Project proponent shall provide engineering specifications to support design if requested by the local authority having jurisdiction.

Section 1273.03 - Grades.

(a) At no point shall the grade for all roads and driveways exceed 16 percent.

(b) The grade may exceed 16%, not to exceed 20%, with approval from the local authority having jurisdiction and with mitigations to provide for the same practical effect.

Section 1273.04 - Radius.

(a) No road or road structure shall have a horizontal inside radius of curvature of less than fifty (50) feet. An additional surface width of four (4) feet shall be added to curves of 50-100 feet radius; two (2) feet to those from 100-200 feet.

(b) The length of vertical curves in roadways, exclusive of gutters, ditches, and drainage structures designed to hold or divert water, shall be not less than one hundred (100) feet.

Section 1273.05 - Turnarounds.

(a) Turnarounds are required on driveways and dead-end roads.

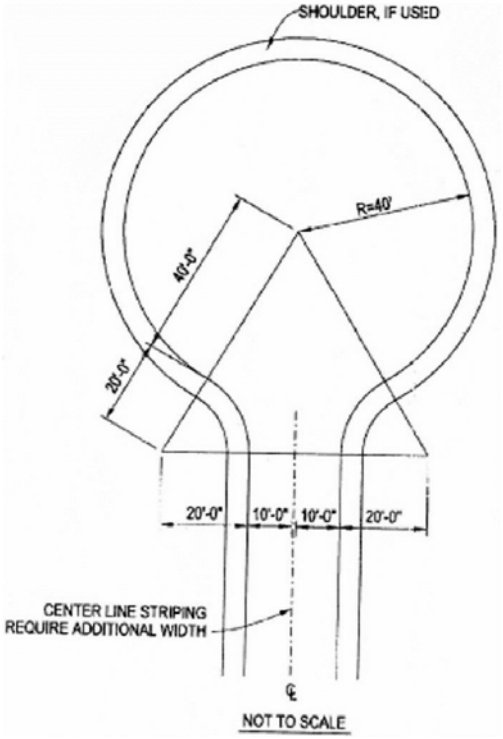
(b) The minimum turning radius for a turnaround shall be forty (40) feet, not including parking, in accordance with the figures in 14 CCR §§ 1273.05(e) and 1273.05(f). If a hammerhead/T is used instead, the top of the "T" shall be a minimum of sixty (60) feet in length.

(c) Driveways exceeding 150 feet in length, but less than 800 feet in length, shall provide a turnout near the midpoint of the driveway. Where the driveway exceeds 800 feet, turnouts shall be provided no more than 400 feet apart.

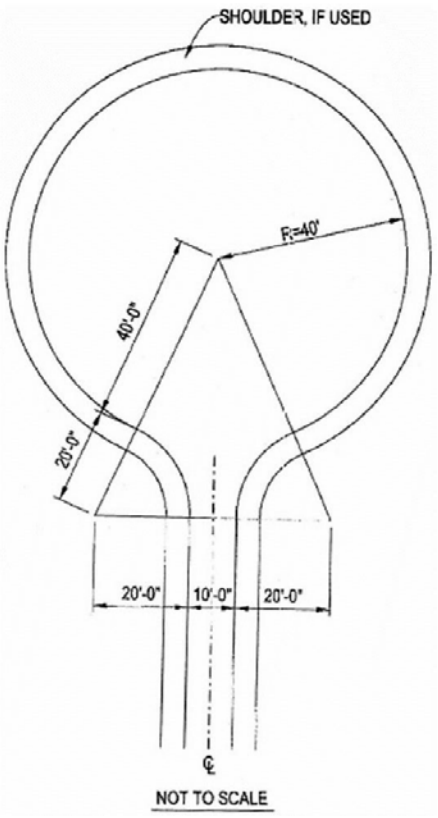
(d) A turnaround shall be provided on driveways over 300 feet in length and shall be within fifty (50) feet of the building.

(d) Each dead-end road shall have a turnaround constructed at its terminus. Where parcels are zoned five (5) acres or larger, turnarounds shall be provided at a maximum of 1,320ft intervals.

(e) Figure A. Turnarounds on roads with two ten-foot traffic lanes.



(f) Figure B. Turnarounds on driveways with one ten-foot traffic lane.



Section 1273.06 - Turnouts.

Turnouts shall be a minimum of twelve (12) feet wide and thirty (30) feet long with a minimum twenty-five (25) foot taper on each end.

Section 1273.07 – Road and Driveway Structures.

(a) Appropriate signing, including but not limited to weight or vertical clearance limitations, one-way road or single traffic lane conditions, shall reflect the capability of each bridge.

(b) Where a bridge or an elevated surface is part of a fire apparatus access road, the bridge shall be constructed and maintained in accordance with the American Association of State and Highway Transportation Officials Standard Specifications for Highway Bridges, 17th Edition, published 2002 (known as AASHTO HB-17), hereby incorporated by reference. Bridges and elevated surfaces shall be designed for a live load sufficient to carry the imposed loads of fire apparatus. Vehicle load limits shall be posted at both entrances to bridges when required by the local authority having jurisdiction.

(c) Where elevated surfaces designed for emergency vehicle use are adjacent to surfaces which are not designed for such use, barriers, or signs, or both, as approved by the local authority having jurisdiction, shall be installed and maintained.

(d) A bridge with only one traffic lane may be authorized by the local jurisdiction; however, it shall provide for unobstructed visibility from one end to the other and turnouts at both ends.

Section 1273.08- Dead-End Roads.

(a) The maximum length of a dead-end road, including all dead-end roads accessed from that dead-end road, shall not exceed the following cumulative lengths, regardless of the number of parcels served: parcels zoned for less than one acre - 800 feet
parcels zoned for 1 acre to 4.99 acres - 1,320 feet
parcels zoned for 5 acres to 19.99 acres - 2,640 feet
parcels zoned for 20 acres or larger - 5,280 feet
All lengths shall be measured from the edge of the road surface at the intersection that begins the road to the end of the road surface at its farthest point. Where a dead-end road crosses areas of differing zoned parcel sizes requiring different length limits, the shortest allowable length shall apply.

(b) See 14 CCR § 1273.05 for dead-end road turnaround requirements.

Section 1273.09 - Gate Entrances.

(a) Gate entrances shall be at least two (2) feet wider than the width of the traffic lane(s) serving that gate and a minimum width of fourteen (14) feet unobstructed horizontal clearance and unobstructed vertical
clearance of thirteen feet, six inches (13' 6").

(b) All gates providing access from a road to a driveway shall be located at least thirty (30) feet from the roadway and shall open to allow a vehicle to stop without obstructing traffic on that road.

(c) Where a one-way road with a single traffic lane provides access to a gated entrance, a forty (40) foot turning radius shall be used.

(d) Security gates shall not be installed without approval. Where security gates are installed, they shall have an approved means of emergency operation. Approval shall be by the local authority having jurisdiction. The security gates and the emergency operation shall be maintained operational at all times.

ARTICLE 3. – SIGNING AND BUILDING NUMBERING

Section 1274.00 – Intent

To facilitate locating a fire and to avoid delays in response, all newly constructed or approved roads and buildings shall be designated by names or numbers posted on signs clearly visible and legible from the road. This section shall not restrict the size of letters or numbers appearing on road signs for other purposes.

Section 1274.01 - Road Signs

(a) Newly constructed or approved roads must be identified by a name or number through a consistent system that provides for sequenced or patterned numbering and/or non-duplicative naming within each local jurisdiction. This section does not require any entity to rename or renumber existing roads, nor shall a road providing access only to a single commercial or industrial occupancy require naming or numbering.

(b) The size of letters, numbers, and symbols for road signs shall be a minimum four (4) inch letter height, half-inch (.5) inch stroke, reflectorized, contrasting with the background color of the sign.

Section 1274.02 - Road Signs Installation, Location, and Visibility

(a) Road signs shall be visible and legible from both directions of vehicle travel for a distance of at least one hundred (100) feet.

(b) Signs required by this article identifying intersecting roads shall be placed at the intersection of those roads.

(c) A sign identifying traffic access or flow limitations, including but not limited to weight or vertical clearance limitations, dead-end roads, one-way roads, or single lane conditions, shall be placed:

(i) at the intersection preceding the traffic access limitation, and

(ii) no more than one hundred (100) feet before such traffic access limitation.

(d) Road signs required by this article shall be posted at the beginning of construction and shall be maintained thereafter.

Section 1274.03 – Addresses for Buildings

(a) All buildings shall be issued an address by the local jurisdiction which conforms to that jurisdiction's overall address system. Utility and miscellaneous Group U buildings are not required to have a separate address; however, each residential unit within a building shall be separately identified.

(b) The size of letters, numbers, and symbols for addresses shall conform to the standards in the California Fire Code, California Code of Regulations title 24, part 9.

(c) Addresses for residential buildings shall be reflectorized.

Section 1274.04 – Address Installation, Location, and Visibility

(a) All buildings shall have a permanently posted address which shall be plainly legible and visible from the road fronting the property.

(b) Where access is by means of a private road and the address identification cannot be viewed from the public way, an unobstructed sign or other means shall be used so that the address is visible from the public way.

(c) Address signs along one-way roads shall be visible from both directions.

(d) Where multiple addresses are required at a single driveway, they shall be mounted on a single sign or post.

(e) Where a road provides access solely to a single commercial or industrial business, the address sign shall be placed at the nearest road intersection providing access to that site, or otherwise posted to provide for unobstructed visibility from that intersection.

(f) In all cases, the address shall be posted at the beginning of construction and shall be maintained thereafter.

ARTICLE 4. EMERGENCY WATER STANDARDS

Section 1275.00 - Intent.

Emergency water for wildfire protection shall be available, accessible, and maintained in quantities and locations specified in the statute and these regulations in order to attack a wildfire or defend property from a wildfire.

Section 1275.01 - Application.

The provisions of this article shall apply in the tentative and parcel map process when new parcels are approved by the local jurisdiction having authority.

Section 1275.02 – Water Supply

(a) When a water supply for structure defense is required to be installed, such protection shall be installed and made serviceable prior to and during the time of construction except when alternative methods of protection are provided and approved by the local authority having jurisdiction.

(b) Water systems equaling or exceeding the California Fire Code, California Code of Regulations title 24, part 9, or, where a municipal-type water supply is unavailable, National Fire Protection Association (NFPA) 1142, "Standard on Water Supplies for Suburban and Rural Fire Fighting," 2017 Edition, hereby incorporated by reference, shall be accepted as meeting the requirements of this article.

(c) Such emergency water may be provided in a fire agency mobile water tender, or naturally occurring or manmade containment structure, as long as the specified quantity is immediately available.

(d) Nothing in this article prohibits the combined storage of emergency wildfire and structural firefighting water supplies unless so prohibited by local ordinance or specified by the local fire agency.

(e) Where freeze or crash protection is required by local jurisdictions having authority, such protection measures shall be provided.

Section 1275.03 – Hydrants and Fire Valves.

(a) The hydrant or fire valve shall be eighteen (18) inches above the finished surface. Its location in relation to the road or driveway and to the building(s) or structure(s) it serves shall comply with California Fire Code, California Code of Regulations title 24, part 9, Chapter 5, and Appendix C.

(b) The hydrant head shall be a two and half (2 1/2) inch National Hose male thread with cap for pressure and gravity flow systems and four and a half (4 1/2) inch for draft systems.

(c) Hydrants shall be wet or dry barrel and have suitable freeze or crash protection as required by the local jurisdiction.

Section 1275.04 - Signing of Water Sources.

(a) Each hydrant, fire valve, or access to water shall be identified as follows:
(1) if located along a driveway, a reflectorized blue marker, with a minimum dimension of three (3) inches shall be located on the driveway address sign and mounted on a fire-retardant post, or
(2) if located along a road,

(i) a reflectorized blue marker, with a minimum dimension of three (3) inches, shall be mounted on a fire-retardant post. The signpost shall be within three (3) feet of said hydrant or fire valve, with the sign no less than three (3) feet nor greater than five (5) feet above ground, in a horizontal position and visible from the driveway, or

(ii) as specified in the State Fire Marshal's Guidelines for Fire Hydrant Markings Along State Highways and Freeways, May 1988.

ARTICLE 5. FUEL MODIFICATION STANDARDS

Section 1276.00 - Intent.

To reduce the intensity of a wildfire by reducing the volume and density of flammable vegetation, the strategic siting of fuel modification and greenbelts shall provide for increased safety for emergency fire equipment and evacuating civilians by its utilization around structures and roads, including driveways, and a point of attack or defense from a wildfire.

Section 1276.01 - Setback for Structure Defensible Space.

(a) All parcels shall provide a minimum thirty (30) foot setback for all buildings from all property lines and/or the center of a road.

(b) When a thirty (30) foot setback is not possible for practical reasons, which may include but are not limited to parcel dimensions or size, topographic limitations, or other easements, the local jurisdiction shall provide for same practical effect.

(i) Same practical effect requirements shall reduce the likelihood of home-to-home ignition.

(ii) Same practical effect options may include, but are not limited to, noncombustible block walls or fences; five (5) feet of noncombustible material horizontally around the structure; installing hardscape landscaping or reducing exposed windows on the side of the structure with a less than thirty (30) foot setback; or additional structure hardening such as those required in the California Building Code, California Code of Regulations title 24, part 2, Chapter 7A.

(c) Structures constructed in the SRA are required to comply with the defensible space regulations in Title 14. Natural Resources Division 1.5. Department of Forestry and Fire Protection Chapter 7. Fire Protection Subchapter 3. Fire Hazard.

Section 1276.02 – Maintenance of Defensible Space Measures

To ensure continued maintenance of commonly owned properties in conformance with these standards and to assure continued availability, access, and utilization of the defensible space provided by these standards during a wildfire, provisions for annual maintenance shall be provided in emergency access covenants or similar binding agreements.

Section 1276.03 - Disposal of Flammable Vegetation and Fuels.

Disposal, including chipping, burying, burning, or removal to a site approved by the local jurisdiction, of flammable vegetation and fuels caused by site development and construction, road and driveway construction, and fuel modification shall be completed prior to completion of road construction or final inspection of a building permit.

Section 1276.04 – Greenbelts

Subdivision and other developments, which propose greenbelts as a part of the development plan, shall locate said greenbelts strategically as a separation between wildland fuels and structures. The locations shall be approved by the local authority having jurisdiction and may be consistent with the CAL FIRE Unit Fire Management Plan or Contract County Fire Plan.

Title 14, California Code of Regulations (14 CCR), Division 1.5, Chapter 7

Subchapter 3. FIRE HAZARD

ARTICLE 1. FIRE HAZARD SEVERITY

Section 1280 – Definitions

The following definitions apply to Title 14 of the California Code of Regulations (14 CCR), Division 1.5, Chapter 7, Subchapter 3, Article 1.
Director: Director of the Department of Forestry and Fire Protection or their designee.
Local responsibility area (LRA): Those areas of land classified by the Board of Forestry and Fire Protection (Board) where the financial responsibility of preventing and suppressing wildfires is not that of the state or federal government, pursuant to Public Resources Code (PRC) section 4125.
Portable document format (PDF): file format used to present and exchange documents reliably, independent of software, hardware, or operating system. PDF is an open standard maintained by the International Organization for Standardization (ISO).
State Responsibility Area (SRA): As defined in Public Resources Code section 4102.
Very high fire hazard severity zone (VHFHSZ): as defined in Government Code section 51177(i).

Section 1280.1 - Fire Hazard Severity Zones in the SRA.

The fire hazard severity zones and the rating reflecting the degree of severity of fire hazard that is expected to prevail in those zones, shall be designated by the Director and delineated on a series of maps on file in the Sacramento Office of the Department of Forestry and Fire Protection, Fire and Resources Assessment Program, 1300 U St. The official maps are also filed electronically on the Department's web site, https://osfm.fire.ca.gov/divisions/community-wildfire-preparedness-and-mitigation/wildland- hazards-building-codes/fire-hazard-severity-zones-maps/. The maps are entitled "Fire Hazard Severity Zones in [State Responsibility Area] SRA," dated November 7, 2007, and are incorporated by reference.

Section 1280.2 - Very High Fire Hazard Severity Zones in the LRA.

(a) Within thirty (30) days of adopting a local ordinance designating VHFHSZ pursuant to Government Code section 51179(a), a local agency shall transmit a copy of the ordinance and a map depicting the adopted zones within the local agency to the Board of Forestry and Fire Protection (Board).

(b) The ordinance(s) and map(s) shall be delivered in a PDF file(s) and submitted electronically to the Board.

(c) The Board may request additional versions of the map(s) to establish greater clarity regarding the adopted zones. This request may ask for the maps in other file formats, such as Geographic Information System (GIS) shapefiles or similar, based on the Board's and the local agency's capabilities.

(d) Local agencies shall supply the following information, on a form provided by the Board, when they submit their ordinance(s) and map(s):

(1) the agency's name and a point of contact, including address, email, phone, and fax number.
(2) information about the agency's meeting adopting the VHFHSZ, including the date, location, agenda and agenda item number, and staff reports.
(3) information about the ordinance, including the name and/or number, copies of the signatory page(s), and the text of the ordinance.

(4) information about the section(s) of city or county code adopted or amended by the ordinance, including the name and/or number and code text.
(5) information about the decision, pursuant to Government Code section 51179(b), to include areas within the jurisdiction as VHFHSZ that were not identified as such by the director. The local agency shall provide the finding(s) supported by substantial evidence in the record that the requirements of Government Code section 51182 are necessary for effective fire protection in the area. This information may be in the form of staff reports, data analysis, mapping, or other background work that informed the local agency's decision.

ARTICLE 3. FIRE HAZARD REDUCTION AROUND BUILDINGS AND STRUCTURES

Section 1299.01. Purpose

The intent of this regulation is to provide guidance for implementation of Public Resources Code Section 4291 to improve safety for fire fighters defending a home as well as increase the survivability of a "Building or Structure" as defined, that exists in grass, brush, and forest covered lands within the designated State Responsibility Area (SRA) of California.

Section 1299.02. Definitions

The following definitions apply to this article:
(a) Defensible space. The buffer that landowners are required to create on their property between a "Building or Structure" and the plants, brush and trees or other items surrounding the "Building or Structure" that could ignite in the event of a fire.

(b) Building or Structure. Anything constructed that is designed or intended for support, enclosure, shelter, or protection of persons, animals, or property, having a permanent roof that is supported by walls or posts that connect to, or rest on the ground.

(c) Outbuilding. Buildings or structures that are less than one hundred-twenty (120) square feet in size and not used for human habitation. For purposes of this Section, an "Outbuilding" is not a "Building or Structure" as defined in subsection (b) above.

Section 1299.03. Requirements

Defensible space is required to be maintained at all times, whenever flammable vegetative conditions exist. One hundred feet (100 ft.) of defensible space clearance shall be maintained in two distinct "Zones" as follows: "Zone 1" extends thirty feet (30 ft.) out from each "Building or Structure," or to the property line, whichever comes first; "Zone 2" extends from thirty feet (30 ft.) to one hundred feet (100 ft.) from
each "Building or Structure," but not beyond the property line. The vegetation treatment requirements for Zone 1 are more restrictive than for Zone 2, as provided in (a) and (b) below. The Department of Forestry and Fire Protection's "Property Inspection Guide, 2000 version, April 2000," provides additional guidance on vegetation treatment within Zone 1 and Zone 2, but is not mandatory and is not intended as a substitute for these regulations.
(a) Zone 1 Requirements:
(1) Remove all dead or dying grass, plants, shrubs, trees, branches, leaves, weeds, and pine needles from the Zone whether such vegetation occurs in yard areas around the "Building or Structure," on the roof or rain gutters of the "Building or Structure," or any other location within the Zone.
(2) Remove dead tree or shrub branches that overhang roofs, below or adjacent to windows, or which are adjacent to wall surfaces, and keep all branches a minimum of ten feet (10 ft.) away from chimney and stovepipe outlets.
(3) Relocate exposed firewood piles outside of Zone 1 unless they are completely covered in a fire- resistant material.

(4) Remove flammable vegetation and items that could catch fire which are adjacent to or under combustible decks, balconies and stairs.

(b) Zone 2 Requirements:

(1) In this zone create horizontal and vertical spacing among shrubs and trees using the "Fuel Separation" method, the "Continuous Tree Canopy" method or a combination of both to achieve defensible space clearance requirements. Further guidance regarding these methods is contained in the State Board of Forestry and Fire Protection's, "General Guidelines for Creating Defensible Space, February 8, 2006," incorporated herein by reference, and the "Property Inspection Guide" referenced elsewhere in this regulation.

(2) In both the Fuel Separation and Continuous Tree Canopy methods the following standards apply:

(A) Dead and dying woody surface fuels and aerial fuels shall be removed. Loose surface litter, normally consisting of fallen leaves or needles, twigs, bark, cones, and small branches, shall be permitted to a maximum depth of three inches (3 in.).

(B) Cut annual grasses and forbs down to a maximum height of four inches (4 in.).

(C) All exposed wood piles must have a minimum of ten feet (10 ft.) of clearance, down to bare mineral soil, in all directions.

(c) For both Zones 1 and 2:

(1) "Outbuildings" and Liquid Propane Gas (LPG) storage tanks shall have the following minimum clearance: ten feet (10 ft.) of clearance to bare mineral soil and no flammable vegetation for an additional ten feet (10 ft.) around their exterior.

(2) Protect water quality. Do not clear vegetation to bare mineral soil and avoid the use of heavy equipment in and around streams and seasonal drainages. Vegetation removal can cause soil erosion, especially on steep slopes. Keep soil disturbance to a minimum on steep slopes.

Section 1299.04. Additional Clearance

(a) An insurance company that insures an occupied "Building or Structure" may require additional clearance beyond that required under § 1299.03 only if a fire expert designated by the Director provides findings that the clearing is necessary.

(b) Within the intent of the regulations, a fire expert designated by the Director may require more than one hundred feet (100 ft.) of defensible space. A fire expert cannot require additional defensible space clearance beyond the property line.

(c) Further guidance to property owners on implementation of this regulation is contained in the "General Guidelines for Creating Defensible Space" and the "Property Inspection Guide," both of which are referenced elsewhere in this regulation.

Section 1299.05. Alternative Methods

The provisions of these regulations are not intended to exclude alternative methods not specifically prescribed by these regulations. A fire expert designated by the Director may approve alternative practices which provide for the same practical effects as those stated in these regulations.

Genasys PROTECT – Stay Connected, Be Informed

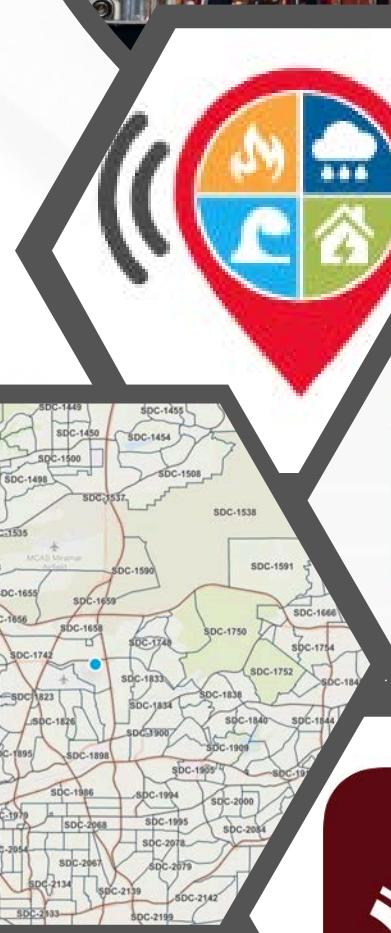


As we enter fire season, emergency communication and information are vitally important. First responders in San Diego County work tirelessly to ensure we have the best tools and resources to effectively communicate life-saving emergency information to the public.

Genasys PROTECT is San Diego County's newest effort to communicate speedy and reliable emergency information. Genasys PROTECT allows first responder agencies to provide disaster notifications, evacuation information, shelter locations, road closures and much more to the public in a timely manner. Information from Genasys Protect can be viewed at the website (https://protect.genasys.com/) or by downloading the Genasys Protect App. Using the app, you can subscribe to specific "zones", such as areas you live, work, or frequently visit. Subscribing allows you to receive push notifications and view real time updates on status changes for any incident within San Diego County.

For more information about Genasys Protect, the app, or additional preparedness resources, please visit www.AlertSD.org







DOWNLOAD THE PROTECT APP

Pre-established evacuation **zones** help fire, law, and emergency service agencies **streamline emergency notifications** and reduce confusion regarding evacuation processes.

The **Genasys Protect App** contains all the functionality of the website, with additional capabilities for users to subscribe to specific zones and **receive push notifications about status changes.**

The layered approach to keeping you informed ***before, during, and after*** disasters.

VISIT ALERTSD.COM

AlertSD.com is produced by the *County of San Diego Office of Emergency Services* to provide information before, during and after disasters. The site is the official source of information from the County of San Diego during a large-scale emergency. Preparedness materials, disaster information, and recovery topics are all covered on the website.

SDEmergency app is produced by County OES and notifies user mobile phones of evacuations and other important safety information.

COUNCIL AGENDA STATEMENT
CITY OF SANTEE

Item 10

MEETING DATE April 9, 2025

ITEM TITLE **PRESENTING THE SANTEE FIRE HAZARD SEVERITY ZONE MAP AS RECOMMENDED BY CAL FIRE FOR PUBLIC COMMENT AND ASK CITY COUNCIL TO RECEIVE THE REPORT AND PROVIDE STAFF DIRECTION**

DIRECTOR/DEPARTMENT Justin Matsushita, Fire Department

SUMMARY

Fire Hazard Severity Zones (FHSZs) are classified into Moderate, High, and Very High hazard levels based on scientific analysis of factors such as fuel loading, topography, fire weather, and historical fire patterns. These zones guide fire prevention efforts, building standards, defensible space requirements, and public safety planning. State law now requires local jurisdictions to adopt Moderate, High, and Very High FHSZs in Local Responsibility Areas (LRAs) within 120 days of receiving the California Department of Forestry and Fire Protection (CAL FIRE) recommendations. The City of Santee received these recommendations on March 24, 2025, and have until July 22, 2025, to adopt or expand said FHSZs. Upon Council direction, staff will return at a future date within the state's 120-day window with an ordinance for first and second reading prior to adoption. Additionally, the City of must publish these recommendations within 30 days of receiving them and allow for public comment. There is no timeframe or guidance on what this public comment period must or should be.

Staff seeks direction on three items as outlined in the attached staff report and will be presented during the Council Meeting.

FINANCIAL STATEMENT

The financial impacts of the adoption of FHSZs, as required by state law, are unknown at this time.

CITY ATTORNEY REVIEW ☐ N/A • ☒ Completed

RECOMMENDATION

Staff recommends that the City Council receive the Fire Marshal's report, open a public comment period, provide staff direction, and schedule ordinance hearing and adoption to comply with the 120-day adoption window.

ATTACHMENT

Staff Report on FHSZ
Santee FHSZ Map March 24, 2025
Santee FHSZ Map June 11, 2009
LRA-Legislation-Factsheet

STAFF REPORT

PRESENTING THE SANTEE FIRE HAZARD SEVERITY ZONE MAP AS RECOMMENDED BY CAL FIRE FOR PUBLIC COMMENT AND ASK CITY COUNCIL TO RECEIVE REPORT AND PROVIDE STAFF DIRECTION

CITY COUNCIL MEETING

APRIL 9, 2025

BACKGROUND

Prompted by the devastating Oakland Hills fire of 1991, Assembly Bill 337 (Bates, 1992) called for the California Department of Forestry and Fire Protection (CAL FIRE) to evaluate fire hazard severity in local responsibility areas (LRA) and to make recommendations to local jurisdictions where Very High Fire Hazard Severity Zones (FHSZ) exist. (CA GOV 51175).

Between 2008 and 2011, CAL FIRE worked with local jurisdictions to make recommendations of the Very High FHSZ within the LRAs. CAL FIRE provided the City of Santee with their recommendations on June 11, 2009. The City adopted those recommendations into the Santee Very High FHSZ Map on October 28, 2009.

New legislation, Senate Bill 63 (Stern, 2021), now requires the adoption of all three (Moderate, High, and Very High) FHSZ classes in the LRA. Previously only Very High FHSZ were required for adoption in the LRA. These new zones are based on scientific analysis of factors such as fuel loading, topography, fire weather, and historical fire patterns. In the State Responsibility Area (generally unincorporated areas), CAL FIRE directly maps and designates FHSZ and provided each jurisdiction with a FHSZ map for their area on April 1, 2024. In 2025, CAL FIRE began to roll out customized maps to LRA jurisdictions, beginning with Northern California on February 10, 2025 and finishing with the jurisdictions located in San Diego, Riverside, Orange, Imperial, San Bernadino, Mono, Inyo, and Los Angeles on March 24, 2025.

The City of Santee received its LRA map on March 24, 2025.

DISCUSSION

What Are Fire Hazard Severity Zones?

Fire Hazard Severity Zones (FHSZ) are classified on their likelihood of experiencing wildfire and the potential severity of fire behavior. These zones help guide fire prevention efforts, building standards, defensible space requirements, and public safety planning. The three classifications are:

- **Moderate:** Areas with a lower likelihood or intensity of wildfire.
- **High:** Areas with a significant risk of wildfire occurrence.
- **Very High:** Areas with the highest likelihood of wildfire occurrence and severe fire behavior.

CAL FIRE's Role

The California Department of Forestry and Fire Protection (CAL FIRE) plays a critical role in the identification and mapping of FHSZ. Using science-based models that consider vegetation, climate conditions, topography, wind patterns, and fire history, CAL FIRE develops FHSZ maps statewide that are updated periodically to reflect current conditions. CAL FIRE provides these recommendations to local jurisdictions for adoption.

Local Jurisdiction Responsibilities

State law requires local jurisdictions to take specific actions regarding the CAL FIRE recommended FHSZ:

1. The City must make the map available for public review and comment within 30 days of receiving CAL FIRE's recommendations (April 23rd).
2. The City must adopt (designate) the LRA FHSZ map within 120 days of receiving CAL FIRE's recommendations (July 22nd).
3. The City must transmit a copy of the ordinance to the Board of Forestry within 30 days of adoption.
4. The City must provide the adopted map to the county recorder, county assessor, and county planning agency.
5. The City may increase the geographical extent and hazard level of CAL FIRE's recommended zones.
6. The City may not decrease recommended zones.

By adopting these zones through an ordinance, local agencies ensure compliance with state law while enhancing community safety from wildfires.

Implications of FHSZ Designations

The adoption of the new FHSZ map has several important implications for property owners and the City:

1. **Building Standards:** The updated FHSZ map will be used by the Building Official to enforce wildfire-resistant construction standards for new buildings in the high and very high FHSZ starting on January 1, 2026.
2. **Property Disclosure Requirements:** Property owners in the Very High and High FHSZ must disclose this information during property sales as part of the Natural Hazard Disclosure Statement as soon as the map is adopted.
3. **Defensible Space Requirements:** Properties now within the Very High (VH) FHSZ zone must comply with defensible space clearance requirements (typically 100 feet around structures).
4. **Safety Element Updates:** FHSZ maps will inform updates to the Safety Element of General Plans to address wildfire risks comprehensively.
5. **Fire Safe Regulations:** New projects in the VHFHSZ must comply with the California Code of Regulations, Title 14 (Natural Resources) fire safe regulations for access and water supply.
6. **Subdivision Map Act:** Projects in the VHFHSZ must have their tentative map reviewed by the Board of Forestry.
7. **Subdivision Review (AB-2911):** Developments with 30 or more homes in the VHFHSZ must be routinely reviewed by CAL FIRE when there is only one way out of the development.
8. **CEQA:** There are additional CEQA requirements for projects in the VHFHSZ.

Discussion Items

Item 1: Fire Hazard Severity Zones (FHSZ) and Local Jurisdiction's Authority to Expand FHSZ

While local jurisdictions cannot exempt properties from zone-specific requirements, they can expand zones within their City boundary. The intent of CAL FIRE's recommendations is to inform local jurisdictions of the hazards present in their community. If local jurisdictions would like to enhance the safety requirements, they are encouraged to do so. For instance, some jurisdictions in forested areas have designated their entire area as High, even when CAL FIRE only recommended Moderate. In such cases, all new structures in the City would be built to California Building Code Chapter 7A standards, with increased wildfire exposure protection.

To expand the VHFHSZ, the City must demonstrate substantial evidence the expansion is needed. State law does not specify how this could be justified, but CAL FIRE has indicated that fire modeling could be considered such evidence.

To expand the High and Moderate FHSZ, no evidence is required and may be done at the City's discretion. A new map from the City could accomplish this.

Item 1 Discussion

Does the City of Santee want to expand any of the three zones within the City or adopt the Santee FHSZ Map that was recommended by CAL FIRE?

Item 2: Parcels that are Split Between Zones

CAL FIRE's broad recommendations have resulted in parcels being split between multiple zones, complicating compliance determination. For example, if a parcel is split between the Moderate and High zones, neither state law nor CAL FIRE provide any guidance on how to apply the differing requirements to the structure or parcel. Does part of the structure need to be complied with CBC Chapter 7A while another part doesn't? In the event of a wildfire, the entire structure will likely be exposed to embers. Current code administration practices are when there are two differing requirements, the most restrictive shall apply. Notably, 7,800 structures that burned in the Eaton fire in Altadena were not in any FHSZ.

Other jurisdictions have drafted ordinances to clarify that the most severe zone apply to the entire parcel.

If directed, City staff could create a map that extends the most severe zone to cover the entire parcel and provide clarity about what regulations are applicable.

Item 2 Discussion

How does the City of Santee want to address requirements for parcels that span multiple zones?

Item 3: Public Comment Period

Within 30 days of receiving CAL FIRE's recommendations, local jurisdictions must make the information available for public review and comment. The information must be presented in a format that is understandable and accessible to the general public, including but not limited maps. (CA GOV Section 51178.5)

There is no time period requirement for the public comment period. Some jurisdictions are limiting this to the Council Meetings while others have created surveys on their websites.

Staff can easily and quickly create a webpage dedicated to this and allow for comments for a set period of time.

Item 3 Discussion

How does the City of Santee want to address the public comment requirement of CA GOV Section 51178.5.

FISCAL IMPACT

The adoption of FHSZs is required by state law. Financial impacts for the City are unknown at this time. However, implementation may require additional staff time for enforcement activities such as building code reviews, new construction inspections, and defensible space inspections. These costs can generally be absorbed within existing departmental budgets or offset through permit fees.

ENVIRONMENTAL REVIEW

The adoption of FHSZs is exempt from environmental review as it is an administrative action mandated by state law.

CONCLUSION

To ensure compliance with state wildfire safety regulations and enhance community protection, staff recommends the following steps:

1. **Receive the Fire Marshal's Report** – Formal acceptance of CAL FIRE's Fire Hazard Severity Zone (FHSZ) recommendations specific to Santee, including the official FHSZ map.
2. **Open Public Comment Period** – Allow community input on the proposed FHSZ designations per standard municipal procedures.
3. **Provide Staff Direction** – Council guidance for drafting an ordinance aligning with CAL FIRE's hazard classifications (Moderate/High/Very High).
4. **Schedule Ordinance Adoption** – Upon Council direction, staff will return at a future date within the state's 120-day window with an ordinance for first and second reading prior to adoption.

ATTACHMENTS

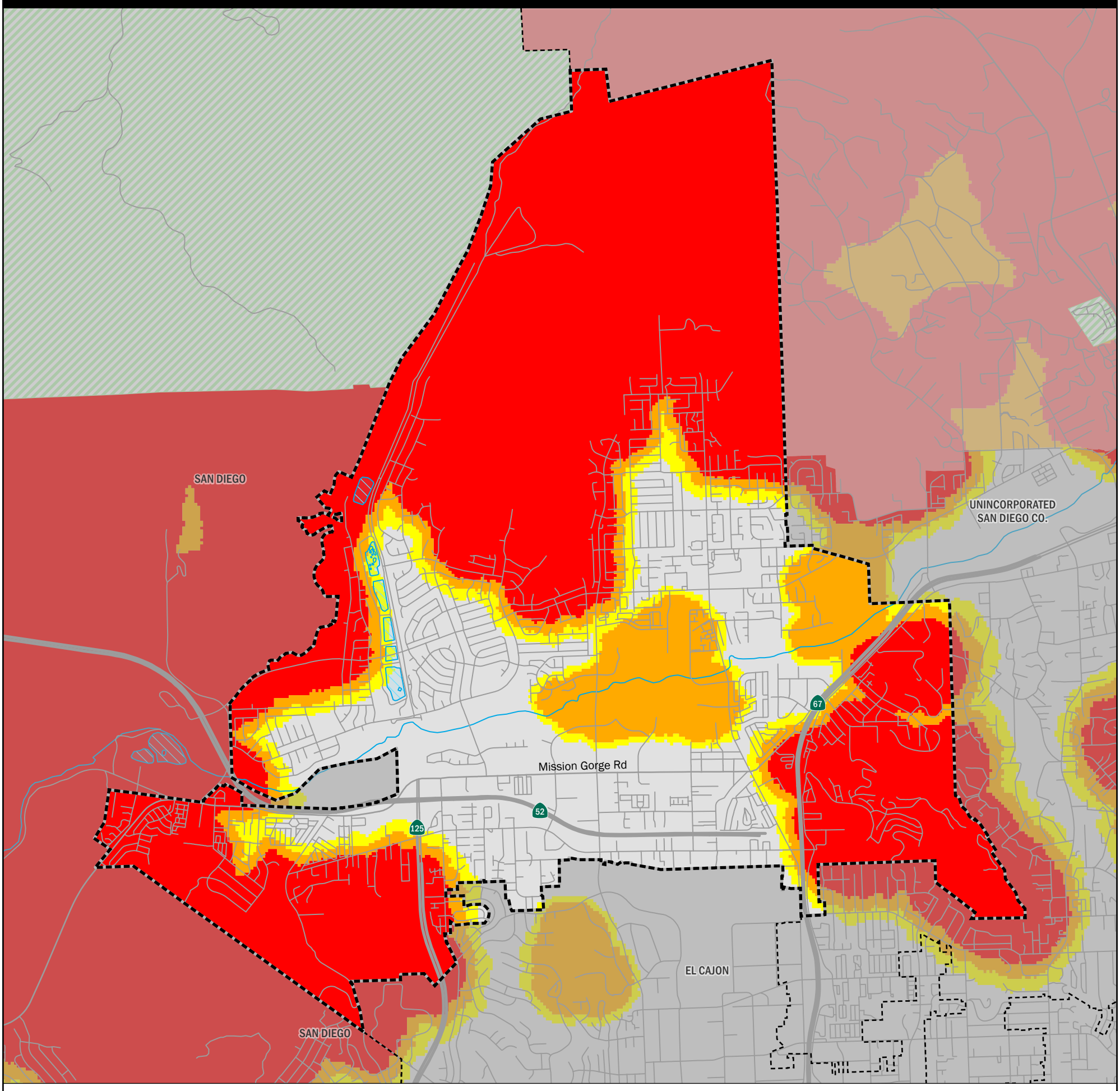
1. Previously adopted Santee VHFHSZ Map
2. New Santee FHSZ Map
3. CAL FIRE's Fire Hazard Severity Zones Local Responsibility Area FAQ sheet with applicable state laws

CITY OF SANTEE – SAN DIEGO COUNTY

Local Responsibility Area Fire Hazard Severity Zones

As Identified by the State Fire Marshal

March 24, 2025





Fire Hazard Severity Zones (FHSZ) in Local Responsibility Area (LRA), as Identified by the State Fire Marshal

Very High High Moderate

Fire Hazard Severity Zones in State Responsibility Area (SRA), Effective April 1, 2024

Very High High

Mi 0 1 2

Km 0 1 2 3

Projection: NAD 83 California Teale Albers
Scale: 1:43,000 at 11" x 17"

Incorporated City Waterbody

Unzoned LRA Federal Responsibility Area (FRA)

Government Code section 51178 requires the State Fire Marshal to identify areas in the state as moderate, high, and very high fire hazard severity zones based on consistent statewide criteria and based on the severity of fire hazard that is expected to prevail in those areas. Moderate, high, and very high fire hazard severity zones shall be based on fuel loading, slope, fire weather, and other relevant factors including areas where winds have been identified by the Office of the State Fire Marshal as a major cause of wildfire spread.

The State of California and the Department of Forestry and Fire Protection make no representations or warranties regarding the accuracy of data or maps. Neither the State nor the Department shall be liable under any circumstances for any direct, special, incidental, or consequential damages with respect to any claim by any user or third party on account of, or arising from, the use of data or maps.

Gavin Newsom, Governor, State of California

Wade Crowfoot, Secretary for Natural Resources, CA Natural Resources Agency

Joe Tyler, Director/Fire Chief, CA Department of Forestry and Fire Protection

Daniel Berlant, State Fire Marshal, CA Department of Forestry and Fire Protection

Data Sources:

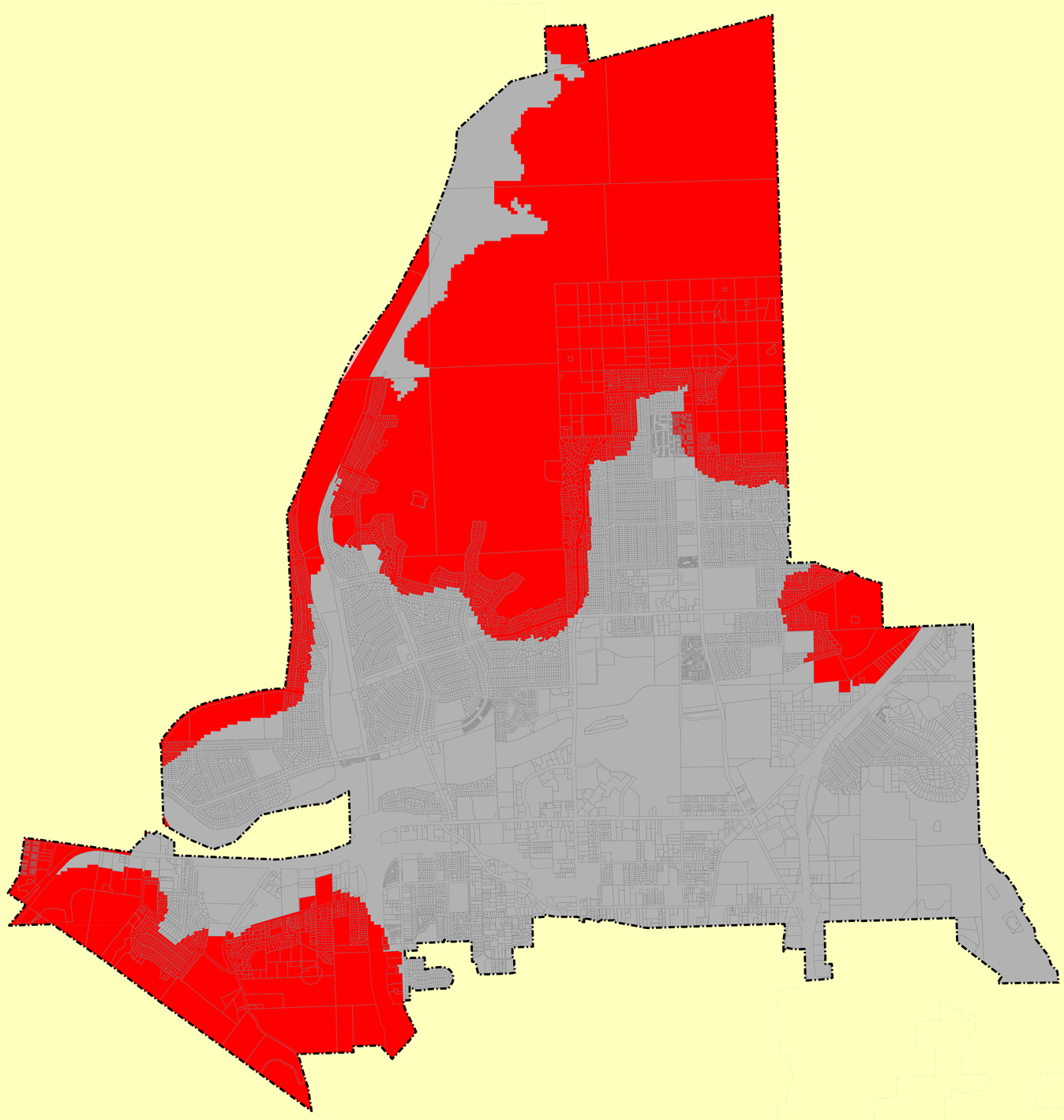
CAL FIRE Fire Hazard Severity Zones (FHSZSRA23_3, FHSZLRA_25_1)

CAL FIRE State Responsibility Areas (SRA25_1)

City and County boundaries as of 10/22/24 (CA Board of Equalization)

Santee

Very High Fire Hazard Severity Zones in LRA
As Recommended by CAL FIRE



Fire Hazard Severity Zones

Local Responsibility Area	State or Federal Responsibility Areas
VHFHSZ	VHFHSZ
Non-VHFHSZ	Non-VHFHSZ

- City Boundary
- Parcels
- County Boundary

Government Code 51175-89 directs the California Department of Forestry and Fire Protection (CAL FIRE) to identify areas of very high fire hazard severity zones within Local Responsibility Areas (LRA). Mapping of the areas, referred to as Very High Fire Hazard Severity Zones (VHFHSZ), is based on data and models of, **potential** fuels over a 30-50 year time horizon and their associated expected fire behavior, and expected burn probabilities to quantify the likelihood and nature of vegetation fire exposure (including firebrands) to buildings. Details on the project and specific modeling methodology can be found at http://frap.cdf.ca.gov/projects/hazard/methods.htm. Local Responsibility Area VHFHSZ maps were initially developed in the mid-1990s and are now being updated based on improved science, mapping techniques, and data.

In late 2005 to be effective in 2008, the California Building Commission adopted California Building Code Chapter 7A requiring new buildings in VH FHSZs to use ignition resistant construction methods and materials. These new codes include provisions to improve the ignition resistance of buildings, especially from firebrands. The updated very high fire hazard severity zones will be used by building officials for new building permits in LRA. The updated zones will also be used to identify property whose owners must comply with natural hazards disclosure requirements at time of property sale and 100 foot defensible space clearance. It is likely that the fire hazard severity zones will be used for updates to the safety element of general plans.

This specific map is based on a geographic information system dataset that depicts final CAL FIRE recommendations for Very High FHSZs within the local jurisdiction. The process of finalizing these boundaries involved an extensive local review process, the details of which are available at http://frap.cdf.ca.gov/projects/hazard/btnet/ (click on "Continue as guest without logging in"). Local government has 120 days to designate, by ordinance, very high fire hazard severity zones within its jurisdiction after receiving the recommendation. Local government can add additional VHFHSZs. There is no requirement for local government to report their final action to CAL FIRE when the recommended zones are adopted. Consequently, users are directed to the appropriate local entity (county, city, fire department, or Fire Protection District) to determine the status of the local fire hazard severity zone ordinance.

This map was developed using data products such as parcel and city boundaries provided by local government agencies. In certain cases, this includes copyrighted geographic information. The maps are for display purposes only - questions and requests related to parcel or city boundary data should be directed to the appropriate local government entity.

N
W E
S

0 2 Miles

0 3 Kilometers

Projection Albers, NAD 1983
Scale 1: 20,000
at 36" x 36"
June 11, 2009

The State of California and the Department of Forestry and Fire Protection make no representations or warranties regarding the accuracy of data or maps. Neither the State nor the Department shall be liable under any circumstances for any direct, special, incidental, or consequential damages with respect to any claim by any user or third party on account of, or arising from, the use of data or maps.

Obtain FRAP maps, data, metadata and publications on the Internet at http://frap.cdf.ca.gov
For more information, contact CAL FIRE-FRAP, PO Box 944246, Sacramento, CA 94244-2460, (916) 327-3939.

Arnold Schwarzenegger, Governor,
State of California
Mike Chrisman, Secretary for Resources,
The Natural Resources Agency
Del Walters, Director,
Department of Forestry and Fire Protection

MAP ID: FHSZL_c37_Santee

DATA SOURCES
CAL FIRE Fire Hazard Severity Zones (FHSZL06_3)

Fire Hazard Severity Zones
Local Responsibility Area

Fire Hazard Severity Zones

What is a Fire Hazard Severity Zone?
The State Fire Marshal shall identify areas in the State as Moderate, High, and Very High Hazard Severity Zones based on consistent statewide criteria and the severity of fire hazard that is expected to prevail in those areas. – CA GOV 51178

When did Fire Hazard Severity Zones begin in Local Responsibility Area?
Assembly Bill 337 (Bates 1992), prompted by the devastating Oakland Hills fire of 1991, calls for CAL FIRE to evaluate fire hazard severity in local responsibility area and to make a recommendation to the local jurisdiction where Very High FHSZ exist. – CA GOV 51175

What do Fire Hazard Severity Zones measure?
The maps evaluate "Hazard", not "Risk". Hazard is based on physical conditions that create expected fire behavior over a 50-year period without considering short-term modifications. Risk is the potential damage a fire can do to the area under existing conditions, including fuel reduction projects, defensible space, and ignition resistant building construction. - osfm.fire.ca.gov/fhsz

Will the new Fire Hazard Severity Zone maps affect my insurance?
Insurance companies use risk models, which differ from hazard models, because they consider the susceptibility of a structure to damage from fire and other short-term factors that are not included in hazard modeling. Insurance risk models incorporate additional factors that change more frequently than those the CAL FIRE includes in its hazard mapping, which is built to remain steady.
– California Department of Insurance

What are the requirements within Fire Hazard Severity Zones?

- Materials and Construction Methods for Exterior Wildfire Exposure – CBC Chapter 7A
- Natural hazard real estate disclosure at the time of sale – CA CIV 1102.19 (AB 38 2019)
- 100-foot defensible space clearance requirements – CA GOV 51182
- Property development standards such as road widths, water supply, and signage – CA PRC 4290
- Consideration during future development of Cities and Counties General Plan – CA GOV 65302



1980

Panorama Fire burns 28,800 acres, destroying 325 structures and resulting in 4 fatalities in San Bernardino.



1991

Tunnel Fire burns 1,600 acres, destroying 2,900 structures and resulting in 25 fatalities in the Oakland Hills.

1982 PRC 4201 mandates that CAL FIRE develop Fire Hazard Severity Zones.

1985 Fire Hazard Severity Zone maps are created.

1992 The "Bates Bill" calls for CAL FIRE to identify Very High Fire Hazard Severity Zones in LRA.

Frequently Asked Questions

Is there an easy way to determine the Fire Hazard Severity Zone of my property?
You can search by address to find your current designation on the website: osfm.fire.ca.gov/fhsz

Why are Fire Hazard Severity Zones being updated?
The hazard maps are being updated to more accurately reflect the zones in California that are susceptible to wildfire. The process will incorporate new science in local climate data and improved fire assessment modeling in determining hazard ratings. – PRC 4125 and GC 51178

What are the key elements of the Fire Hazard Severity Zone Model?
The model has two key elements: probability of an area burning and expected fire behavior under extreme fuel and weather conditions. The factors considered in determining fire hazard within wildland areas is fire history, flame length, terrain, local weather, and potential fuel over a 50-year period. Outside of wildlands, the model considers factors that might lead to buildings being threatened, including terrain, weather, urban vegetation cover, blowing embers, proximity to wildland, fire history, and fire hazard in nearby wildlands. This is not a structure loss model, as key information regarding structure ignition is not included. – osfm.fire.ca.gov/fhsz

Why does the model place an emphasis on the spread of embers?
Embers spread wildfire because they can travel long distances in the wind and ignite vegetation, roofs, attics (by getting into vents), and decks. – osfm.fire.ca.gov/fhsz

What is the difference between SRA and LRA?
State Responsibility Area (SRA) is a legal term defining the area where the State has financial responsibility for wildland fire protection and prevention. – CA PRC 4102
Local Responsibility Area (LRA) includes incorporated cities, urban regions, agriculture lands, and portions of the desert where the local government is responsible for wildfire protection. – CA PRC 4125

How are Fire Hazard Severity Zones determined in Local Responsibility Areas?
CAL FIRE uses an extension of the state responsibility area Fire Hazard Severity Zone model as the basis for evaluating fire hazard in Local Responsibility Area. The Local Responsibility Area hazard rating reflects flame and ember intrusion from adjacent wildlands and from flammable vegetation in the urban area.
– PRC 4202 and GC 51178



Tubbs Fire burns 36,810 acres, destroying 5,643 structures and resulting in 22 fatalities in Santa Rosa.



Camp Fire burns 153,336 acres, destroying 18,804 structures and resulting in 85 fatalities in Paradise.

2007 CAL FIRE finalizes the Statewide FHSZ Model to include Very High FHSZ in LRA.

2021 AB 642 and SB 63 require CAL FIRE to identify Moderate and High FHSZ in LRA.

2022 AB 211 requires local agency to designate by ordinance Moderate and High FHSZ in LRA.

FHSZ Frequently Asked Questions

General

What is a Fire Hazard Severity Zone or FHSZ?

Public Resource Code 4202; The State Fire Marshal shall classify lands within State Responsibility Areas into Fire Hazard Severity Zones. Each zone shall embrace relatively homogeneous lands and shall be based on fuel loading, slope, fire weather, and other relevant factors present, including areas where winds have been identified by the department as a major cause of wildfire spread. Government Code 51178; The State Fire Marshal shall identify areas in the state as Moderate, High, and Very High Fire Hazard Severity Zones based on consistent statewide criteria and based on the severity of fire hazard that is expected to prevail in those areas. Moderate, High, and Very High Fire Hazard Severity Zones shall be based on fuel loading, slope, fire weather, and other relevant factors including areas where winds have been identified by the Office of the State Fire Marshal as a major cause of wildfire spread.

Will the new Fire Hazard Severity Zones affect my ability to get or maintain insurance?

Insurance companies use risk models, which differ from hazard models, because they consider the susceptibility of a structure to damage from fire and other short-term factors that are not included in hazard modeling. It is unlikely that insurance risk models would utilize CAL FIRE Fire Hazard Severity Zones as a factor, but much of the same data that is used in the Fire Hazard Severity Zone model are likely included in the insurance companies' risk models. However, insurance risk models incorporate many additional factors and that change more frequently than those that CAL FIRE includes in its hazard mapping, which is built to remain steady for the next 10+ years.

What do Fire Hazard Severity Zones measure?

The Fire Hazard Severity Zone map reflects "hazard," not "risk". The map is like flood zone maps, where lands are described in terms of the probability level of a particular area being inundated by floodwaters, and not specifically prescriptive of impacts.

"Hazard" is based on the physical conditions that create a likelihood and expected fire behavior over a 30 to 50-year period without considering mitigation measures such as home hardening, recent wildfire, or fuel reduction efforts.

"Risk" is the potential damage a fire can do to the area under existing conditions, accounting for any modifications such as fuel reduction projects, defensible space, and ignition resistant building construction.

FHSZ Frequently Asked Questions

General

What are the key elements of the Fire Hazard Severity Zone model?

The fire hazard severity model for wildland fire has two key elements: probability of an area burning and expected fire behavior under extreme fuel and weather conditions. The zones reflect areas that have similar burn probabilities and fire behavior characteristics. The factors considered in determining fire hazard within wildland areas are fire history, flame length, terrain, local weather, and potential fuel over a 50-year period. Outside of wildlands, the model considers factors that might lead to buildings being threatened, including terrain, weather, urban vegetation cover, blowing embers, proximity to wildland, fire history, and fire hazard in nearby wildlands. FHSZs are not a structure loss model, as key information regarding structure ignition (such as roof type, etc.) is not included.

Where do Fire Hazard Severity Zones apply?

Fire Hazard Severity Zones are found in areas where the state has financial responsibility for wildfire protection and prevention, called the State Responsibility Area. More than 31 million acres are in this area. Under Senate Bill 63 (Stern, 2021) Government Code 51178 was amended to also identify the Moderate and High Fire Hazard Severity Zones with the Very High in Local Responsibility Area (LRA).

What are the uses of Fire Hazard Severity Zones?

The zones are used for several purposes including to designate areas where California's defensible space standards and wildland urban interface building codes are required. They can be a factor in real estate disclosure, and local governments may consider them in their general plan.

When were the maps last updated?

In 2007, CAL FIRE updated the FHSZs for the entire State Responsibility Area (SRA). Between 2008-2011 the department worked with local governments to make recommendations of the Very High Fire Hazard Severity Zones within Local Responsibility Area (LRA).

Why are fire hazard severity maps being updated?

The hazard maps are being updated to more accurately reflect the zones in California that are susceptible to wildfire. The hazard mapping process will incorporate new science in local climate data and improved fire assessment modeling in determining hazard ratings.

FHSZ Frequently Asked Questions

General

How do the Fire Hazard Severity Zone Maps differ from California Public Utilities Commission (CPUC) High Fire Threat District Maps?

The California Public Utilities Commission (CPUC) sponsored map, known as "CPUC High Fire Threat District Map" (HFTD), includes similar factors as those in the FHSZ maps, however the CPUC HFTD Map is designed specifically for identifying areas where there is an increased risk for utility associated wildfires. As such, the CPUC map includes fire hazards associated with historical powerline-caused wildfires, current fuel conditions, and scores areas based on where fires start, as opposed to where potential fires may cause impacts.

How are Fire Hazard Severity Zones determined?

CAL FIRE used the best available science and data to develop, and field test a model that served as the basis of zone assignments. The model evaluated the probability of the area burning and potential fire behavior in the area. Many factors were included such as fire history, vegetation, flame length, blowing embers, proximity to wildland, terrain, and weather.

What new data will be included in the new model, and how does this differ from the previous model?

A 2 km grid of climate data covering the years 2003-2018 is being used in the update. The previous model used stock weather inputs across the state to calculate wildland fire intensity scores. The updated model will adjust fire intensity scores based on the most extreme fire weather at a given location, considering temperature, humidity, and wind speed. In addition, ember transport is being modeled based on local distributions of observed wind speed and direction values instead of using a generic buffer distance for urban areas adjacent to wildlands.

FHSZ Frequently Asked Questions

General

Why does the model place an emphasis on the spread of embers?

Embers spread wildfire because they can travel long distances in the wind and ignite vegetation, roofs, attics (by getting into vents), and decks.

Why do waterbodies have a Fire Hazard Severity Zone Classification?

All areas in State Responsibility Area, including water bodies, require a Fire Hazard Severity Zone designation. The 2007 FHSZ maps zoned all water as Moderate by default. In the 2023 FHSZ model we added a buffer of FHSZ from the surrounding wildland into water bodies to account for potential threat of embers to buildings on docks and house boats, as well as variation in reservoir height that occurs with drought.

How does CAL FIRE assist Local Governments in Fire Hazard Severity Zones?

CAL FIRE's Land Use Planning Program is a specialized unit that provides support to local governments by providing fire safety expertise on the State's wildland urban interface building codes, wildfire safety codes, as well as helping in the development of the safety elements in general plans. Currently there are 189 cities and 56 counties with FHSZ.

How can I search the Fire Hazard Severity Zone of a property?

You can search by address to find your current designation on the web at:
https://egis.fire.ca.gov/FHSZ/ osfm.fire.ca.gov/FHSZ

FHSZ Frequently Asked Questions

SRA Questions

What is State Responsibility Area or SRA?

SRA is a legal term defining the area where the state has financial responsibility for wildland fire protection and prevention. Incorporated cities and federal ownership are not included. Within the SRA, CAL FIRE is responsible for fire prevention and suppression. There are more than 31 million acres in SRA, with an estimated 1.7 million people and 800,000 existing homes.

How is State Responsibility Area determined?

The Board of Forestry and Fire Protection (Board) classifies land as State Responsibility Area. The legal definition of SRA is found in the Public Resources Code Section 4125. The Board has developed detailed procedures to classify lands as State Responsibility Area. Lands are removed from SRA when they become incorporated by a city, change in ownership to the federal government, become more densely populated, or are converted to intensive agriculture that minimizes the risk of wildfire. While some lands are removed from SRA automatically, the Board typically reviews changes every five years.

What Fire Hazard Severity Zones are in State Responsibility Area?

All of the State Responsibility Area is in a Fire Hazard Severity Zone. Lands are either ranked as Moderate, High or Very High Fire Hazard Severity Zones.

What are the wildland urban interface (WUI) building codes in State Responsibility Area?

The WUI building codes (California Building Code (CBC) Chapter 7A) reduce the risk of embers fanned by wind-blown wildfires from igniting buildings. The codes for roofing, siding, decking, windows, and vents apply throughout all State Responsibility Area regardless of the fire hazard severity ranking. Ember-resistant building materials can be found at: https://osfm.fire.ca.gov/divisions/fire-engineering-and-investigations/building-materials-listing/

FHSZ Frequently Asked Questions

SRA Questions

Why is my property in a different zone than the adjacent area, which looks similar?

In wildland areas, zone edges are a result of the way zones are delineated. Specifically, zones represent areas of similar slope and fuel potential. Zone boundaries divide zones based on geographic and vegetation features that align with fire hazard potential; although, at a local scale, it may appear that the immediate area is similar on both sides of the edge. The class value within a zone is based on the average hazard score across the whole zone, so areas that are in the same zone but not immediately adjacent to a local area can have an influence on the final zone classification.

What is the difference between the various Fire Hazard Severity Zones?

Classification of a wildland zone as Moderate, High or Very High Fire Hazard is based on the average hazard across the area included in the zone, which have a minimum size of 200 acres. In wildlands, hazard is a function of modeled flame length under the worst conditions and annual burn probability. Both these factors generally increase with increasing hazard level, but there may be instances where one value is Very High and the other is low, pushing the overall hazard into a more intermediate ranking. On average, both modeled flame length and burn probability increase by roughly 40-60% between hazard classes.

Is the GIS data for Fire Hazard Severity Zones available for download?

The data inputs used to develop the Fire Hazard Severity Zones are identified in the Initial Statement of Reasons (ISOR) Title 19 Development (ca.gov). CAL FIRE has developed an additional data package which consists of sequential modeling steps, including any data inputs that were not already publicly available and referenced in the ISOR. The data package encompasses 34 spatial datasets and 8 tables, provided in raster, polygon, and table format. These datasets are formatted for Esri ArcGIS software, except for four tables provided in Excel. Ten of the datasets are updated versions used to produce an edited SRA FHSZ map following the public comment period that ended April 4, 2023. Upon formal adoption of the FHSZ map, the final SRA FHSZ geospatial data file will become available. The data package is available on the FHSZ website Fire Hazard Severity Zones (ca.gov) under the science and methods banner.

FHSZ Frequently Asked Questions

LRA Questions

What is Local Responsibility Area or LRA?

Local Responsibility Areas (LRA) are incorporated cities, urban regions, agriculture lands, and portions of the desert where the local government is responsible for wildfire protection. This is typically provided by city fire departments, fire protection districts, counties, and by CAL FIRE under contract.

When did Fire Hazard Severity Zones begin in Local Responsibility Area?

Assembly Bill 337 (Bates, 1992) prompted by the devastating Oakland Hills Fire of 1991, calls for CAL FIRE to evaluate fire hazard severity in Local Responsibility Area and to make a recommendation to the local jurisdiction where Very High FHSZ exist. Government Code 51175 then provides direction for the local jurisdiction to take appropriate action.

How are Fire Hazard Severity Zones determined in Local Responsibility Areas?

CAL FIRE uses an extension of the State Responsibility Area Fire Hazard Severity Zone model as the basis for evaluating fire hazard in Local Responsibility Area. The Local Responsibility Area hazard rating reflects flame and ember intrusion from adjacent wildlands and from flammable vegetation in the urban area.

What are the requirements for landowners in Fire Hazard Severity Zones in Local Responsibility Areas?

California's WUI building codes (CBC Chapter 7A) apply to the design and construction of new buildings located in High and Very High FHSZs in Local Responsibility Areas. Local ordinances may require ignition resistant construction for remodel projects. Check with your local building department to determine which ignition resistant building codes apply to your project. In addition, Government Code Section 51182 calls for defensible space clearance and other wildland fire safety practices for buildings. Owners are also required to make a natural hazard disclosure as part of a real estate transfer. For information regarding home hardening and defensible space clearance, visit www.readyforwildfire.org.

Does the designation of Very High Fire Hazard Severity Zones in the Local Responsibility Area trigger the 100-foot clearance requirement?

Yes, per Government Code 51182 unless a local government has passed a more stringent requirement, the 100-foot defensible space clearance applies. For information regarding home hardening and defensible space clearance, visit www.readyforwildfire.org.

FHSZ Frequently Asked Questions

LRA Questions

What is the process for developing Fire Hazard Severity Zones in the Local Responsibility Area?

CAL FIRE uses the same modeling data that is used to map the State Responsibility Area. The department works with local jurisdictions for validation of the mapping. The map, along with a model ordinance, are then sent to the governing body for adoption.

How are the new Fire Hazard Severity Zones impacting development?

Many of the changes expanding Fire Hazard Severity Zones in Local Responsibility Areas have been supported by the building industry. CAL FIRE works closely with the building industry when setting various building codes and defensible space requirements, so we are working together to not affect development itself but to make sure development matches the hazards of that area.

When will the Local Responsibility Area Map be released?

The Local Responsibility Area map process will happen after the State Responsibility Area process has been completed, which is estimated to occur in winter of 2024/25.

Why haven't Moderate and High Fire Hazard Severity Zone classes been classified before in the Local Responsibility Area?

New legislation, Senate Bill 63 (Stern, 2021), now requires the adoption of all three Fire Hazard Severity Zone classes in the Local Responsibility Area. Previously only Very High Fire Hazard Severity Zones were required for adoption in Local Responsibility Areas.

What is the difference between the various Fire Hazard Severity Zones?

Classification outside of wildland areas is based on the fire hazard of the adjacent wildland and the probability of flames and embers threatening buildings.

Why is my property in a different zone than the adjacent area, which looks similar?

In non-wildland areas, zone edges occur based on distance to the wildland edge. Because hazard in these areas is largely determined by incoming embers from adjacent wildland, urban areas that are similar in vegetation type and housing density may have a change in FHSZ class as the distance to the wildland edge increases. Areas immediately adjacent to wildland receive the same FHSZ score as that wildland where fire originates, and the model then produces lower scores as the distance to wildland edge increases.

LRA Legislation Factsheet

Assembly Bill No.337

An act to add Chapter 6.8 (commencing with Section 51175) to Part 1 of Division 1 of Title 5 of the Government Code, and to amend Section 13108.5 of the Health and Safety Code, relating to fire protection.

[Enrolled, January 28, 1991]

AB 337, Bates. Very high fire hazard severity zones.

(1) Under existing law, the State Board of Forestry is required to classify all lands within the state, in accordance with prescribed criteria, for the purpose of determining areas in which the financial responsibility of preventing and suppressing fires is primarily the responsibility of the state.

This bill would declare that the prevention of fires is not a municipal affair but is instead, a matter of statewide concern, and would make a finding and declaration of the Legislature that its provisions apply to all local agencies, including, but not limited to, charter cities, charter counties, and charter cities and counties. The bill would prohibit that finding from limiting the authority of a local agency, as defined, from imposing more restrictive fire and panic safety requirements, as otherwise authorized by law.

The bill would state that it is not the intent of the Legislature to limit or restrict the authority of a local agency to impose more restrictive fire and panic safety requirements, as otherwise authorized by law.

This bill would require the Director of Forestry and Fire Protection to identify areas in the state as very high fire hazard severity zones within all counties pursuant to a prescribed schedule. The bill would require local agencies, as defined, to designate, by ordinance, very high fire hazard severity zones in their jurisdiction after receiving recommendations from the director, except as prescribed. The bill would authorize local agencies to include or exclude areas following certain findings and would require changes made by local agencies to be final and not rebuttable by the director. By requiring local agencies to designate very high fire hazard severity zones within their jurisdictions, this bill would impose a state-mandated local program. The bill would require the State Fire Marshal to prepare and adopt a model ordinance that provides for the establishment of any high fire hazard security zones.

Assembly Bill No.337 (Continued)

(2) Under existing law, any person who owns, leases, controls, operates, or maintains any building or structure in, upon, or adjoining any mountainous area or forest-covered lands, brush-covered lands, or grass-covered lands, or any land that is covered with flammable material, is required to undertake specified fire protection measures, including the maintenance of specified firebreaks.

The bill would enact requirements of this nature for any person who owns, leases, controls, operates, or maintains, any occupied dwelling or occupied structure in, upon, or adjoining any mountainous area, forest-covered land, brush-covered land, grass-covered land, or land covered with flammable material, which area or land is within a very high fire hazard severity zone, as described in (1).

The bill would authorize local agencies to exempt certain structures and would exempt certain land or water areas.

The bill would make violation of these requirements an infraction or misdemeanor, as specified, thereby imposing a state-mandated local program by creating a new crime, and would specify related matters.

This bill would require local agencies to notify owners of property of violation and would authorize local agencies to correct the conditions and make a lien upon the property, as prescribed. By creating these requirements, this bill would impose a state-mandated local program.

The bill would permit a violation of these requirements to be considered a public nuisance, as specified.

(3) Existing law requires the State Fire Marshal to adopt, amend, and repeal regulations for roof coverings and openings into the attic areas of buildings in those fire hazard severity zones in state responsibility lands as designated by the director. Existing law requires the director to classify lands within state responsibility areas into fire hazard severity zones.

This bill would instead require the State Fire Marshal to propose, and would require the State Building Standards Commission to adopt, amend, and repeal those regulations. The bill would also require the State Fire Marshal to propose, and would require the State Building Standards Commission to adopt, amend, and repeal, those regulations for buildings in very high fire hazard severity zones in state responsibility lands, designated by the director, and in very high fire hazard severity zones as described in (1). The bill would require roofs on all new buildings and certain existing buildings in both of those zones to be at least a class B roof that complies with Standard 32-7 of the Uniform Building Code, as adopted in the California Building Standards Code. The bill would impose requirements on installers and roofing materials and make other related changes. The bill would exempt historic buildings, as defined, from these provisions.

LRA Legislation Factsheet

Senate Bill No.63

CHAPTER 382

An act to amend Sections 51177, **51178, 51178.5,** 51182, and 51189 of the **Government Code**, to amend Section 13108.5 of the Health and Safety Code, and to amend Sections 4124.5 and 4291 of, and to add and repeal Sections 4123.8, 4291.5, and 4291.6 of, the Public Resources Code, relating to fire prevention.

[Approved by Governor September 28, 2021. Filed with Secretary of State September 28, 2021.]

SB 63, Stern. Fire prevention: vegetation management: public education: grants: defensible space: fire hazard severity zones.

(1) Existing law requires the Director of Forestry and Fire Protection to identify areas of the state as very high fire hazard severity zones based on specified criteria. Existing law requires a local agency, within 30 days after receiving a transmittal from the director that identifies very high fire hazard severity zones, to make the information available for public review, as provided. This bill, among other things, would also require the director to identify areas of the state as moderate and high fire hazard severity zones. The bill would modify the factors the director is required to use to identify areas into fire hazard severity zones, as provided. The bill would require a local agency to make this information available for public review and comment, as provided. By expanding the responsibility of a local agency, the bill would impose a state-mandated local program.

This bill would also make conforming changes.

(2) Existing law requires a person who owns, leases, controls, operates, or maintains an occupied dwelling or structure in, upon, or adjoining a mountainous area, forest-covered land, brush-covered land, grass-covered land, or land that is covered with flammable material that is within a very high fire hazard severity zone, as designated by a local agency, or a building or structure in, upon, or adjoining those areas or lands within a state responsibility area, to maintain a defensible space of 100 feet from each side and from the front and rear of the structure, as specified. Existing law authorizes a greater distance than specified above on the specified land in a very high fire hazard severity zone. Existing law specifies that clearance beyond the property line may only be required if state law, local ordinance, rule, or regulation includes certain findings and specifies that clearance on adjacent property shall only be conducted following written consent by the adjacent landowner.

LRA Legislation Factsheet

Amended by Senate Bill No.63

Government Code 51178

The State Fire Marshal shall identify areas in the state as moderate, high, and very high fire hazard severity zones based on consistent statewide criteria and based on the severity of fire hazard that is expected to prevail in those areas. Moderate, high, and very high fire hazard severity zones shall be based on fuel loading, slope, fire weather, and other relevant factors including areas where winds have been identified by the Office of the State Fire Marshal as a major cause of wildfire spread.

(Amended by Stats. 2021, Ch. 382, Sec. 2.5. (SB 63) Effective January 1, 2022.)

Government Code 51178.5

Within 30 days after receiving a transmittal from the State Fire Marshal that identifies fire hazard severity zones pursuant to Section 51178, a local agency shall make the information available for public review and comment. The information shall be presented in a format that is understandable and accessible to the general public, including, but not limited to, maps.

(Amended by Stats. 2021, Ch. 382, Sec. 3.5. (SB 63) Effective January 1, 2022.)

LRA Legislation Factsheet

Assembly Bill No. 211

CHAPTER 574

An act to amend Sections 11891, 11893, 12581, 12996, 12998, 12999.4, and 12999.5 of, and to add Sections 12999.6 and 13001 to, the Food and Agricultural Code, **to amend Section 51179 of the Government Code**, to amend Sections 44274.10, 44274.11, 44274.12, 44274.13, and 44274.14 of the Health and Safety Code, to amend Sections 3113, 4799.05, 14503.5.1, 14538, 14549.2, 14581, 42052, and 42060 of, to add Sections 14537.5, 14548, 14555, and 21166.3 to, to add Part 5 (commencing with Section 75250) to Division 44 of, and to repeal Section 75250.1 of, the Public Resources Code, to amend Section 43152.6 of, and to amend and repeal Section 43152.10 of, the Revenue and Taxation Code, to amend Section 13198 of the Water Code, to amend the Budget Act of 2021 (Chapters 21, 69, and 240 of the Statutes of 2021) by amending Item 8570-002-0001 of Section 2.00 of that act, and to amend the Budget Act of 2021 (Chapter 44 of the Statutes of 2022) by amending Items 3540-101-0001 of Section 2.00 of that act, relating to public resources, and making an appropriation therefor, to take effect immediately, bill related to the budget.

[Approved by Governor September 27, 2022. Filed with Secretary of State September 27, 2022.]

AB 211, Committee on Budget. Public resources trailer bill.

(2) Existing law requires the State Fire Marshal to identify areas of the state as moderate, high, and very high fire hazard severity zones based on specified criteria. Existing law requires a local agency to designate, by ordinance, very high fire hazard severity zones in its jurisdiction within 120 days of receiving recommendations from the State Fire Marshal. Existing law authorizes a local agency, at its discretion, to include areas within the jurisdiction of the local agency, not identified as very high fire hazard severity zones by the State Fire Marshal, as very high fire hazard severity zones following a finding supported by substantial evidence, as provided.

This bill would additionally require a local agency to designate, by ordinance, moderate and high fire hazard severity zones within 120 days of receiving recommendations from the State Fire Marshal. By expanding the responsibility of a local agency, the bill would impose a state-mandated local program. The bill would additionally authorize a local agency, at its discretion, to include areas within the jurisdiction of the local agency, not identified as moderate and high fire hazard severity zones by the State Fire Marshal, as moderate and high fire hazard severity zones, respectively. The bill would prohibit the local agency from decreasing the level of fire hazard severity zone as identified by the State Fire Marshal for any area within the jurisdiction of the local agency, as provided.

LRA Legislation Factsheet

Amended by Assembly Bill No. 211

Government Code 51179

(a) A local agency shall designate, by ordinance, moderate, high, and very high fire hazard severity zones in its jurisdiction within 120 days of receiving recommendations from the State Fire Marshal pursuant to Section 51178.

(b) (1) A local agency may, at its discretion, include areas within the jurisdiction of the local agency, not identified as very high fire hazard severity zones by the State Fire Marshal, as very high fire hazard severity zones following a finding supported by substantial evidence in the record that the requirements of Section 51182 are necessary for effective fire protection within the area.

(2) A local agency may, at its discretion, include areas within the jurisdiction of the local agency, not identified as moderate and high fire hazard severity zones by the State Fire Marshal, as moderate and high fire hazard severity zones, respectively.

(3) A local agency shall not decrease the level of fire hazard severity zone as identified by the State Fire Marshal for any area within the jurisdiction of the local agency, and, in exercising its discretion pursuant to paragraph (2), may only increase the level of fire hazard severity zone as identified by the State Fire Marshal for any area within the jurisdiction of the local agency.

(c) The local agency shall transmit a copy of an ordinance adopted pursuant to subdivision (a) to the State Board of Forestry and Fire Protection within 30 days of adoption.

(d) Changes made by a local agency to the recommendations made by the State Fire Marshal shall be final and shall not be rebuttable by the State Fire Marshal.

(e) The State Fire Marshal shall prepare and adopt a model ordinance that provides for the establishment of very high fire hazard severity zones.

(f) Any ordinance adopted by a local agency pursuant to this section that substantially conforms to the model ordinance of the State Fire Marshal shall be presumed to be in compliance with the requirements of this section.

(g) A local agency shall post a notice at the office of the county recorder, county assessor, and county planning agency identifying the location of the map provided by the State Fire Marshal pursuant to Section 51178. If the agency amends the map, pursuant to subdivision (b) or (c) of this section, the notice shall instead identify the location of the amended map.

(Amended by Stats. 2022, Ch. 574, Sec. 10. (AB 211) Effective September 27, 2022.)

LRA Legislation Factsheet

Increasing Fire Hazard Severity Zone (FHSZ) Area and Designation

Government Code section 51179 requires a local agency to designate, by ordinance, moderate, high, and very high FHSZ within 120 days of receiving the identified FHSZ's from the State Fire Marshal pursuant to Section 51178.

The law does not allow for a local jurisdiction to request changes or provide comments to the State Fire Marshal on the FHSZ designations. However, a local agency may choose to increase the designation of a FHSZ from the FHSZ identified by the State Fire Marshal, or designate areas as having a FHSZ that were not designated in a FHSZ by the State Fire Marshal. This may occur because FHSZ zone edges in the maps and data from the State Fire Marshal are not aligned with parcel boundaries or roads that some may consider for lines of convenance when adopting ordinances. A local agency is not allowed to reduce the designation of a FHSZ classification from the State Fire Marshal (i.e. a local agency cannot make an area designated as High by the State Fire Marshal, Moderate in its adopted ordinance).

However, a local jurisdiction can increase the designation from the one identified by the State Fire Marshal. If a local agency decides to increase the designation of a FHSZ, it may do so if it does the following:
1. If increasing the designation to Very High, a local agency must make a finding supported by substantial evidence in the record that the requirements of Government Code section 51182 are necessary for effective fire protection.
2. If increasing the designation to Moderate or High, a local agency may do this at its discretion.

If a local agency decides to include areas in its FHSZ adopted ordinance not identified as being in a FHSZ by the State Fire Marshal, it may include those areas if it does the following:
1. If including areas not identified as being in a FHSZ and designating it as Very High, a local agency must make a finding supported by substantial evidence in the record that the requirements of Government Code section 51182 are necessary for effective fire protection.
2. If including areas not identified as being in a FHSZ and designating it as Moderate or High, a local agency may do this at its discretion.

Land Use Planning Program

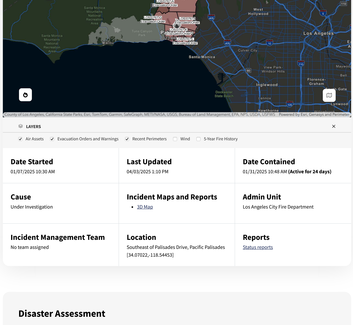
CAL FIRE's Land Use Planning Program is a specialized unit that provides support to local governments by providing fire safety expertise on the State's wildland urban interface building codes, as well as collaborating in the development of Safety Elements in General Plans.

For More Information

osfm.fire.ca.gov/fhsz

Palisades Fire

100% Contained 23,448 Acres 1 County: Los Angeles



LAYERS

Air Assets Evacuation Orders and Warnings Recent Perimeters Wind 5-Year Fire History

Date Started	Last Updated	Date Contained
01/07/2025 10:30 AM	04/03/2025 1:10 PM	01/31/2025 10:48 AM (Active for 24 days)
Cause	**Incident Maps and Reports**	**Admin Unit**
Under Investigation	• 2D Map	Los Angeles City Fire Department
Incident Management Team	**Location**	**Reports**
No team assigned	Southeast of Palisades Drive, Pacific Palisades [34.07022, -118.54453]	Status reports

Disaster Assessment

Palisades Fire Disaster Assessment

Damage inspection teams have completed inspections for 100% of all structures within the fire footprint.

Evacuation Orders

Immediate threat to life. This is a lawful order to LEAVE NOW. The area is lawfully closed to public access.

Some evacuations remain in place to residents only and entry passes are required. As of February 3, there are two locations to obtain **access passes** ☑ for residents and authorized contractors to enter the Palisades. Passes can be obtained daily from 10:00 AM - 5:00 PM. Inclement weather conditions may cause access to be suspended.

- To identify your evacuation zone please visit CAL FIRE's 3D map and search for your address.
- To receive updates for your evacuation zones, please visit Genasys Project

Before law enforcement officials can re-open evacuation zones, it's crucial to ensure that hazards are mitigated in the fire area. Even in evacuation zones where homes may not have been damaged, many cooperators are working to mitigate hazards like fallen power lines, burned out guard rails, and clearing significant wind damaged trees and other debris. Wait for official clearance before heading back and follow officials' safety precautions once allowed in.

Residents seeking re-entry will be required to provide proof of residency when approaching roadblocks. Acceptable forms of identification include a government-issued photo ID that clearly displays the resident's name, photo, and physical address. These measures are in place to facilitate a safe and organized re-entry process.

Evacuation Shelters

Westwood Recreation Center
1350 South Sepulveda Boulevard
Los Angeles, CA 90025

Road Closures

Road closures may still exist within the fire perimeter. Check for updated road closures **here**.

Animal Evacuation Shelters

Missing Pets Line: (213) 270-8155

Small Animals:

- American Red Cross Sheltering Site with mobile animal shelter (small animals only)
- Lancaster Animal Care Center, 5210 W Ave I, Lancaster
- Palmdale Animal Care Center, 38500 Sierra Hwy, Palmdale
- North Central Animal Service Center, 3201 Lacy St, Los Angeles (LA City residents only)

Large Animals:

- LA Equestrian, 480 Riverside Dr, Burbank (**At Capacity as of 1.13.25**) Please go to Hansen Dam Horse Park, 11127 Orcas Ave, Hansen Dam
- Pierce College, 6201 Winnetka Avenue, Woodland Hills (LA County residents only)
- Ventura County Fairgrounds, 10 e Harbor Blvd, Ventura (Ventura County residents only)

Status Update

Situation Summary

CAL FIRE Incident Management Team 2 has transitioned command of the incident back to the Los Angeles City Fire Department. Cal OES will be overseeing the recovery effort of affected communities and restoration of services. For up-to-date Public Health Information and restoration of public utilities, please utilize the links and contacts below. Responsibility Area: LRA - 15,531 acres. SRA - 7,718 acres. FRA - 199 acres.

Initial Protective Actions

Visit **Palisades Fire Information Linktree** for Initial Protective Actions.

Additional Resources

- Governors News Room
- Repopulation Video
- Video De Repoblación

Incident Demographics

Palisades Fire Demographics

Federal Assistance

Disaster Recovery Centers are open to the public from 9:00 AM to 8:00 PM. Residents affected by the wildfires can apply to receive assistance by submitting applications for disaster relief.

- UCLA Research Park West
  10850 West Pico Blvd.
  Los Angeles, CA 90064

- Altadena Disaster Recovery Center
  5401 W. Woodbury Road
  Altadena, CA 91001

- California secures federal assistance to support response to Palisades Fire in Los Angeles County - FMAG Press Release
- President Joseph R. Biden, Jr. Approves California Major Disaster Declaration- Major Disaster Declaration

Family Assistance Center

If you are looking for someone impacted by the January 2025 fires in Los Angeles County, or you want to inform your family of your safety wellness. Please, contact the Red Cross at (800) 675-5799 or visit American Red Cross.

- Donations ARE NOT being accepted at Family Assistance Centers.

Missing Persons Hotline: (213) 996-1800

Incident Photos and Videos

Palisades Fire Flickr

Palisades Fire CAL FIRE INT 2 YouTube

State Park Closures

Due to the recent impacts suffered by the current Palisades Fire, the following locations are closed to the public effective immediately and will remain closed until further notice: Department of Parks Recreation - Angeles District

Resources Assigned

800	22	1	9	1
Personnel	Engines	Water Tenders	Crews	Other Assigned

Numerous firefighting air tankers from throughout the State are flying fire suppression missions as conditions allow.

Damage Assessment

Confirmed Damage to Property, Injuries, and Fatalities.

973	6,837	12	3	1
Structures Damaged Residential, Commercial and Other	Structures Destroyed Residential, Commercial and Other	Confirmed Civilian Fatalities	Confirmed Civilian Injuries	Confirmed Firefighter Injuries

Palisades Fire Structure Status

Field damage inspection is ongoing and subject to change. The icons on the map indicate the known status of the structure. By entering this site, you are making a public record request pursuant to Government Code Section 6254 et seq. for the information contained herein.

I agree to the above terms and conditions

Contact Information

Palisades Fire Public Information Line
(213) 484-5604

Palisades Fire Media Line
(323) 379-3841

Online Fire Information
https://www.fire.ca.gov/

Agency Information

City of Los Angeles, Los Angeles Department of Water & Power, Los Angeles Department of Transportation, Los Angeles City Emergency Management Department, Los Angeles County Office of Emergency Management, Los Angeles County Department of Animal Control, Los Angeles Community Brigade, Los Angeles County Department of Public Works, Los Angeles County Department of Public Health, City of Malibu, California State Parks, Los Virgenes Municipal Water District, Southern California Edison, Pepperdine University, California Highway Patrol, American Red Cross, National Park Service, Gabrieleno Band of Mission Indians-Kizh-Nation.

Social Media

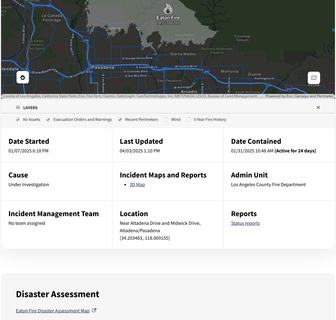
LosAngelesFireDepartment
LAFD
Cal-OES
Cal_OES

The map layers provided are powered by Esri, Genasys, Perimeter and other potential resources, and are based on their respective data sources. The accuracy and reliability of the information are subject to the data provided by these platforms.

Copyright © 2025 State of California

Eaton Fire

100% Contained | 14,021 Acres | 1 County: Los Angeles



LAYERS

Air Assets | Evacuation Orders and Warnings | Recent Perimeters | Wind | 5-Year Fire History

Date Started	Last Updated	Date Contained
01/07/2025 6:18 PM	04/03/2025 1:10 PM	01/31/2025 10:48 AM **(Active for 34 days)**

Cause	Incident Maps and Reports	Admin Unit
Under Investigation	• 3D Map	Los Angeles County Fire Department

Incident Management Team	Location	Reports
No team assigned	Near Altadena Drive and Midwick Drive, Altadena/Pasadena [34.203483, -118.069155]	Status reports

Disaster Assessment

Eaton Fire Disaster Assessment Map

Damage inspection teams have completed inspections for 100% of all structures within the fire footprint. Damage inspections are ongoing. The recovery effort is being led by Cal OES. Inquiries relating to the watershed taskforce can be directected to media@caloes.ca.gov.

Evacuation Shelters

Pasadena Convention Center
300 East Green St
Pasadena, CA 91101

Parking is available at the parking structure across the street from the Convention Center, located at 155 E. Green St. Please enter from Marengo Ave. The Humane Society is on-site to accept small pets for boarding. Service animals will be allowed inside the Convention Center.

Road Closures

Local Road Closures: https://pw.lacounty.gov/roadclosures/
State Road Closures: https://quickmap.dot.ca.gov/

Animal Evacuation Shelters

Small Animals:

- Pasadena Humane : 361 S. Raymond Ave, Pasadena, CA 91103

Large Animals:

- Industry Hills Expo Center : 16200 Temple, City of Industry, CA 91744

Status Update

Situation Summary

CAL FIRE Incident Management Team 3 has transitioned command of the incident back to Los Angeles County Fire. Cal OES will be overseeing the recovery effort of affected communities and restoration of services. For up-to-date Public Health Information and restoration of public utilities, please utilize the links and contacts below. Responsibility Area: LRA - 3,074 acres. SRA - 2,279 acres. FRA - 7,768 acres.

*Fatalities and Damage inspection numbers may change.

Initial Protective Actions

For initial protective actions visit: **Eaton Fire Information Linktree**

Additional Resources

- Governors News Room
- How to sign up for real time evacuation and repopulation notifications
- Repopulation Video
- Video De Repoblación
- Disaster Assistance

Federal Assistance

- California secures federal assistance to support response to Palisades Fire in Los Angeles County - FMAG Press Release
- President Joseph R. Biden, Jr. Approves California Major Disaster Declaration - Major Disaster Declaration

A new Disaster Recovery Center will be opening in Altadena on Monday, Jan. 27, 2025, from **9 AM to 8 PM** and will be available to residents **seven days a week**. The new center will be located at **540 West Woodbury Road, Altadena, CA 91001**.

Both the Pasadena and Altadena locations will be open through the end of January. However, beginning Saturday, Feb. 1, 2025, the Pasadena location will be **closed**, and all services will be shifted to Altadena.

Disaster Resource Center
The Disaster Resource Center is open to the public from 9:00 a.m. to 8:00 p.m., daily. Residents affected by the wildfires can apply to receive assistance by submitting applications for disaster relief.

Westside Location
UCLA Research Park West
10850 West Pico Blvd.
Los Angeles, CA 90064

Eastside Location
Pasadena City College
Community Education Center
3035 E. Foothill Blvd.
Pasadena, CA 91107

Family Assistance Center

If you are looking for someone impacted by the January 2025 fires in Los Angeles County, or you want to inform your family of your safety wellness. Please, contact the Red Cross at (800) 675-3788 or visit American Red Cross.

Donations ARE NOT being accepted at Family Assistance Centers.

Public Health Information

- Unsafe Drinking Water Notice Pasadena: Unsafe Drinking Water in Evacuation Zones
- Unsafe Drinking Water Notice Foothill: Unsafe Drinking Water in Evacuation Zones
- LA County Public Health: Fire Safety and Health
- Protecting yourself from Wildfire Smoke: Air Resources Board Information
- Wildfire Recovery and Resiliancy - Ways to Stay Safe/Ways to Help

Forest Closures

The entire Angeles National Forest is temporarily closed for public safety and the protection of natural resources.

For more information please visit: https://www.fs.usda.gov/angeles

Pasadena Unified School District

- Please check Pasadena Unified School District website for the most recent information regarding school closures: https://www.pusd.us/

Incident Photos and Videos

Eaton Fire Flickr

Incident Demographics

Eaton Fire Demographics

Damage Assessment

Confirmed Damage to Property, Injuries, and Fatalities.

1,074	9,414	18	9
Structures Damaged Residential, Commercial and Other	Structures Destroyed Residential, Commercial and Other	Confirmed Civilian Fatalities	Confirmed Firefighter Injuries

Eaton Fire Structure Status

Field damage inspection has concluded. The icons on the map indicate the known status of the structure. By entering this site, you are making a public record request pursuant to Government Code Section 6254 et seq. for the information contained herein.

I agree to the above terms and conditions

Contact Information

Public Information Line
626-662-0120

Media Line
626-629-8266

Online incident information
https://www.fire.ca.gov/

Agency Information

LA County Mental Health
(800)854-7771
https://dmh.lacounty.gov/

LA County Dept. Public Works
(626)458-5100
https://pw.lacounty.gov/epd/pw-public-works/contact-public-works/

Pasadena Water and Power
(626) 744-4005
https://pwp.cityofpasadena.net/

LA County Medical Examiner
(323) 343-0512
https://me.lacounty.gov/

LA County Public Health
(833)540-0473
http://publichealth.lacounty.gov/

Southern California Edison
1 800 655-4555
https://www.sce.com/helpcenter/contact-us

Sierra Madre Fire Department
(626) 355-3611
https://www.sierramadreca.gov/cityhall/departments/fire_department

Gabrieleno Band of Mission Indians - Kizh Nation
626-286-1632
https://www.gabrieleno-nsn.us/

Arcadia Fire Department
(626) 574-5400
https://www.arcadiaca.gov/protect/fire_department/index.php

Southern California Gas
1 877 238-0092
https://www.socalgas.com/about-us

California National Guard
(916) 854-3000
https://calguard.ca.gov/

Social Media

LACoFD
LACOFD
CalFireSocialMedia
CalFireSocialMedia
cal_oes
cal_oes

The map layers provided are powered by Esri, Garmap, Perimeter and other potential resources, and are based on their respective data sources. The accuracy and reliability of the information are subject to the data provided by these platforms.

Copyright © 2025 State of California



Preserve Wild Santee

July 24, 2022

Chris Jacobs, Principal Planner
City of Santee Department of Developers
10601 Magnolia Avenue
Santee, CA 92071
cjacobs@cityofsantee.ca.gov

RE: Fanita Ranch Final Revised EIR (SCH# 2005061118)

Dear Mr. Jacobs,

Please include the following comments in the Administrative Record.

Notice of Availability & Project Description Section 3.0

Why did the city wait to Recirculate the Revised EIR / open the public comment period until one day after the Santee City Council voted to rescind its decision to place the Fanita Ranch Project Referendum on the November 8, 2022 ballot?

Why has the required "Concurrent Preparation of the Administrative Record" lacked and still lack **public notice** for consideration of:

1. Notice Of Exemption (NOE) for Fanita Ranch…EHP2021-1 received by the State Clearinghouse 12/28/21 ?
2. Fanita Ranch…EHP2021 Essential Housing Program Application December __ 2021 [3-85] ?
3. Urgency Ordinance 592 ?

Preserve Wild Santee strenuously objects to the Fanita project NOE and Urgency Ordinance 592 as unethical and illegal. We request revision and recirculation of the EIR consistent with the law. The above elaborate scheme to deprive Santee residents of their authority to vote on the project must fail.

City of Santee's illegal attempt to disenfranchise resident voters utilizing Ordinance 592 / Notice of Exemption (NOE) Fanita Ranch…EHP2021-1

The intent to approve the 2,949-3,008-unit Fanita Ranch subdivision by a unilateral ministerial act is blatantly unconstitutional and illegal.

Upon what authority does the city intend to preempt the Measure N voting requirement and the Santee General Plan with a ministerial approval of the project?

Constitution of the State of California, Article II, Section 1.
All political power is inherent in the people. *Government is instituted for their protection, security, and benefit, and they have the right to alter or reform it when the public good may require.*

The people of Santee overwhelmingly rejected a 3,000-unit project on Fanita Ranch by a 2/3 landslide. The people qualified a second Referendum on the current 3,000-unit project. The people passed initiative to provide voters the ultimate authority on similar sized projects in violation of the Santee General Plan without the need to qualify future Referendums.

The Constitution of the State of California vests land use authority in the people. It is insidious and illegal to willfully seek means to evade the people's authority on the Fanita Ranch development proposal utilizing Ordinance 592 and Notice of Exemption (NOE) EHP2021-1.

Urgency Ordinance 592 & Discretionary Actions 3.12:

Ordinance 592 is not needed and is insidious. It's sole impact and primary purpose is the ability to approve a 3,000-unit luxury subdivision in a Very High Fire Hazard Severity Zone by usurping the authority of the people vested within them by the

constitutions of the State of California and United States. The ordinance is a reckless attack on democracy.

The residents of Santee incorporated in 1980 primarily to provide local regulative authority of land use and development. **The history of land use and development decisions in Santee illustrates the lack of necessity for an urgency declaration by the current developer-corrupted city council.**

Incorporation and engagement of Santee residents in a local CEQA process has made Santee one of the most affordable and highly desirable places to live in San Diego County. Since incorporation in 1980, with the exception of Fanita Ranch and Rattlesnake Mountain Specific Plan Areas (SPAs), every housing application in Santee, both in and out of Very High Fire Hazard Severity Zones (VHFHSZs) has been approved without a CEQA challenge court hearing. Only Fanita Ranch has been subjected to successful referendums and CEQA challenges.

There is no legitimate rationale for usurping the land use power vested in the people.

Rebuttal to Ordinance 592 findings:

- With the exception of Fanita Ranch, there has not been any "delay" of housing production executed by the power vested in the people of Santee.
- City housing is diverse and among the most affordable and desirable of jurisdictions within San Diego County. [Table 17: Medium Home Sales Prices 2015 and 2020, Santee Housing Element 2021-2029, p. 24]
- "Cost burdens" are ubiquitous nationwide and are locally undefined by the Ordinance in Santee. Nationwide marginalization of living wages exacerbated by corrupted and inflationary monetary policies are the true sources of household "cost burden." Approval of a massive luxury subdivision does not address the needs of marginalized citizens. The "urgency" argument diverts from and exacerbates marginalized citizens' plight by further eroding democratic process and institutional trust.
- Housing prices rise inordinately due to the over production and concentration of luxury housing which in itself perpetuates higher prices. Developers and

home owners will charge as much as the market will pay for their product/ property regardless of any subsidies that may reduce their costs.

- All housing requires reinvestment and maintenance as governed by the laws of physics/thermodynamics. Stripping citizens of their authority to defend their quality-of-life from significant adverse environmental impacts removes citizen incentive to maintain and reinvest in existing housing stock. Age of housing is not consequential in a homes adequacy.
- Building new housing does not generate maintenance improvements to existing housing. The two classes are distinct. A homeowners newfound ability to abandon existing housing can actually discourage reinvestment in their existing homes/neighborhoods.
- Santee civil servants are paid well enough to locate in more expensive locations outside of Santee if they so choose and many have done so. Santee is one of the most affordable jurisdictions in San Diego County. [Table 17] Numerous subdivisions were built over the past two decades and more are currently under construction.
- City bureaucracy has become addicted to short-term infusions of developer fees despite the cost burden of providing essential services to residential units over the long-term. It is commercial development that provides revenue stability to a General Fund.

Rational for adoption of Ordinance 592 is inadequately supported. Evidence contradicts 592 as being political theater.

Ordinance 592 **falsely cites a Regional Housing Needs Assessment (RHNA) assignment of 3,660-units.** The Santee Housing Element correctly contradicts Ordinance 592 in Table 34: RHNA Housing Needs for 2021-2029, p. 65, with an RHNA allocation of only 1,219 units. “Affordable” Low Income categories total 603 of those 1,219-units and would not be built by the Fanita Ranch luxury subdivision. [Table 35: RHNA Credits and Remaining Need]

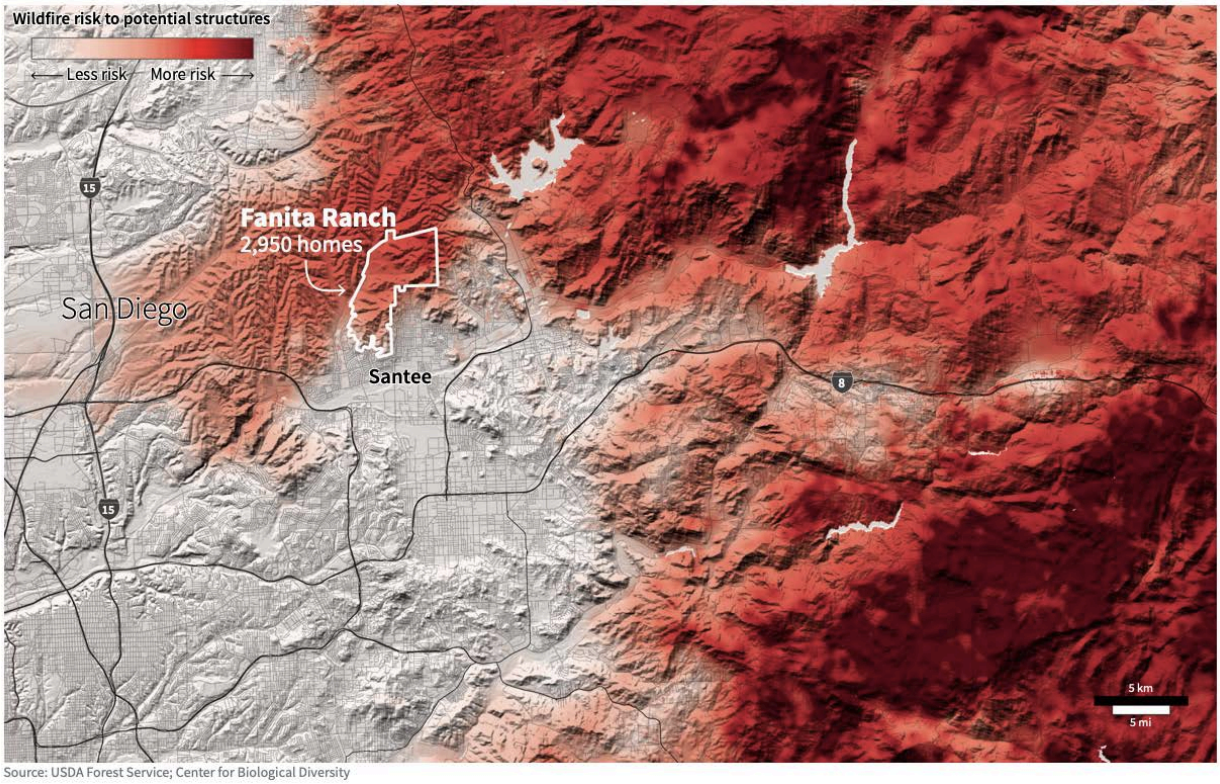
The Santee fair share of regional housing need has fallen - not risen - directly contradicting the false flag arguments of Ordinance 592 used to justify usurping the people’s land use authority.

The City was aware of the correct RHNA calculation when the Ordinance was drafted, yet chose to utilize an outdated higher regional needs allocation to weakly support its unconstitutional Ordinance 592 and Fanita Ranch NOE **EHP2021-1.**

The Final REIR fails to, but must, disclose the Fanita project's inconsistencies with the Land Use Element of the Santee General Plan. The REIR must fully disclose all approvals required for the project including the voting requirement of Measure N.

Considering the voting requirement of Measure N, why does the Project Description, p. 3-82 anticipate beginning construction in 2023? How is a 2023 construction date substantiated? Unsubstantiated projections should be stricken.

Construction of luxury housing in a severe fire hazard zone is not essential nor urgent. Public safety and respect for land use law is essential. Section 3.12 Discretionary Actions must be revised to meet legal standards.

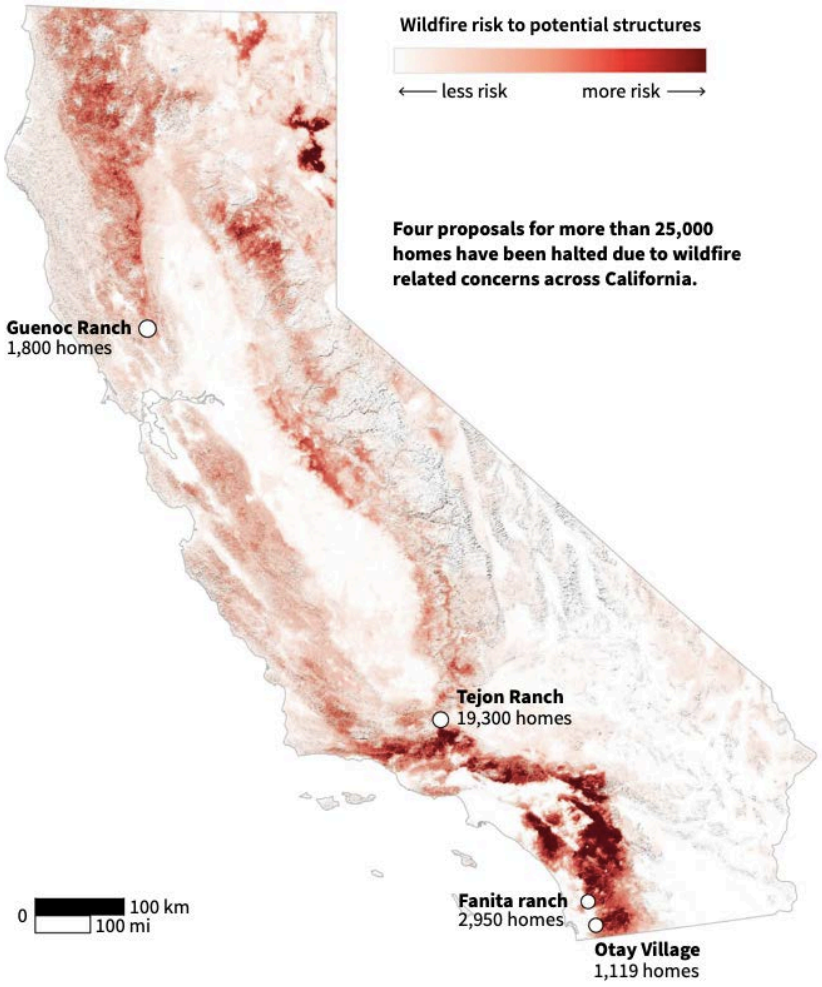


Source: USDA Forest Service; Center for Biological Diversity

The real emergency is one the REIR and Santee City Council refuse to recognize. It is the economic dependence upon fossil fuels responsible for the rapidly increasing trend of fire severity. The REIR is inadequate without considering how climate breakdown / increasing fire severity is likely to impact the project site.

4.18 Wildfire

"Since 2016, more than 50,000 structures in California have been destroyed by wildfire…Eighteen of the 20 largest wildfires in California history have happened since the turn of the millennium - 12 of them since 2016."[1]



[1] Exhibit 1. Emma Marris, People Deserve to Know if their Houses are Going to Burn. March 15, 2022, The Atlantic. https://www.theatlantic.com/science/archive/2022/03/wildfire-insurance-california-fair-plan/627065/ Reuters Graphics.

Severe recent fire losses in California and their impact upon potential retention of fire insurance coverage in California are not disclosed.

The REIR is deficient because it fails to remedy deficiencies identified by the court and because it omits relevant disclosure of increasing fire severity.

REIR 4.8-2. "Extreme conditions, used in worst-case fire modeling for the project site, include 92ºF temperatures…"

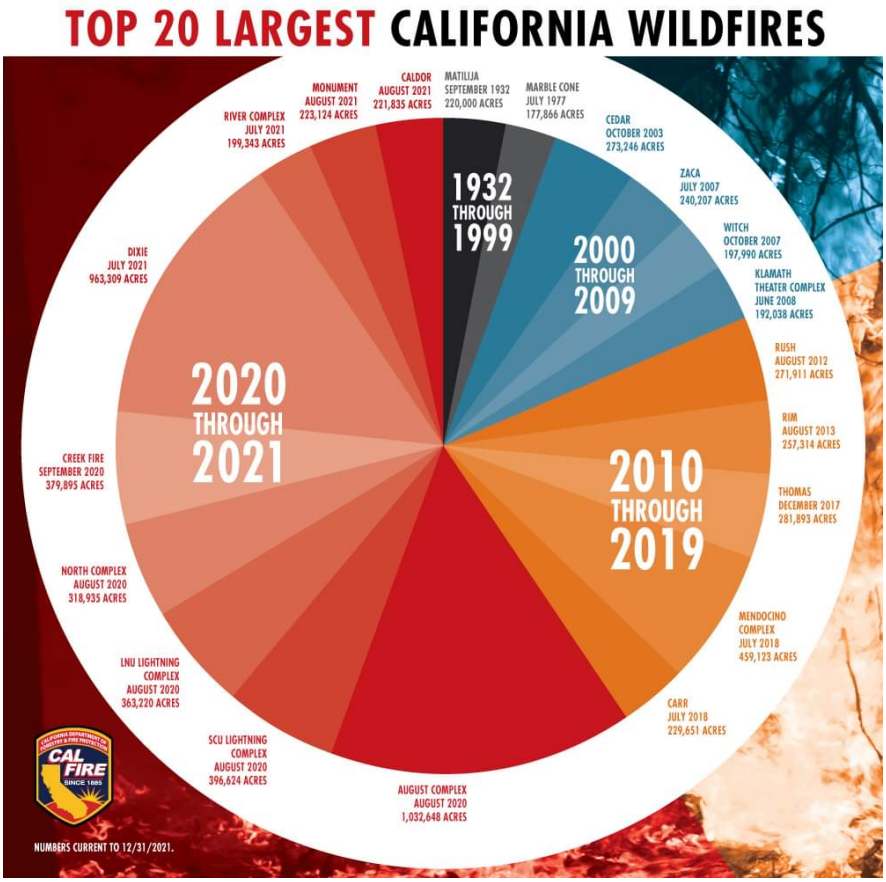
Fanita project fire modeling underestimates worst-case temperatures, winds and humidity levels.

Temperatures in Santee now exceed 92ºF during any season, commonly exceed 100ºF and approach 120ºF during extreme heat waves. [50+ years of experience as a resident]

Pro-Development bias in the data presented above becomes more readily apparent by comparing Santee's own Ordinance 570, which documents significantly hotter weather than the 92ºF temperatures utilized in "worst-case fire modeling." "Temperatures ranging between 75- and 100- degrees F are common throughout the year." [Exhibit 10. Ordinance 570, Climatic Conditions: p. 2]

So "worst-case temperatures" are underestimated by a minimum of 8ºF in REIR fire-modeling.

The last seven years have been the warmest years on record worldwide. All indications are for continued temperature rise due to global dependence upon fossil fuel consumption that disrupts atmospheric energy circulation and prior rates of energy release back into space.



Project fire modeling and planning should reflect the reality of increasing temperatures and resulting insurance company coverage withdrawals[2] from severe hazard zone homes, but the REIR ignores the issue and fails to disclose, avoid, or mitigate for the significant impacts to future project residents.

Local Regulatory Ordinance & CA Public Resource Code - PRC

"The amount of fuel modification necessary shall take into account the flammability of the structure as affected by building material, building standards, location and type of vegetation. Fuels shall be maintained in a condition so that a wildfire burning under ***average*** weather conditions would be unlikely to ignite the structure." PRC 4291(a) (emphasis added)

[2] Exhibit 25. Camille von Kaenel. 09/03/2021. Insurance Companies Increasingly Drop Homes Throughout San Diego County As Fire Risks Rise. inewsource. https://www.kpbs.org/news/2021/09/03/insurance-companies-increasingly-drop-homes-throug

The building and defensible space enforcement standards applied to the project are designed to prevent ignition under average weather conditions and consider if ignition is likely or not. Building standards and defensible space enforcement do not consider the increasing frequency of severe weather extremes. The REIR's failure to disclose and distinguish between fires impacting the project during average weather conditions and fire impacts under severe weather conditions cripple the document.

Defensible Space Inspections are conducted primarily to prevent transition of fire from vegetation to structures and/or from structures to adjacent vegetation, but enforcement is limited by professional judgement that considers site variables under "average weather conditions."

Please disclose to the public how California PRC 4291, more restrictive County of San Diego Defensible Space Ordinance, and City of Santee Ordinance 570 relate and derive enforcement authority for the project?

What are the consequences for not meeting the standards of the governing codes relative to notices, citations and forced abatement?

How many Defensible Space Inspectors does Santee currently employ relative to the number of structure occupied parcels in the city?

How many Defensible Space Inspections does Santee complete in a year and how are those inspections documented?

How many notices, citations and enforcement actions has Santee made since 2007? Please disclose by year to compare relative to increasing wildland-urban-interface.

How many Defensible space inspector will be assigned to the project and how will they be funded? What will be their enforcement process?

A secondary (and usually undiscussed) purpose of a Defensible Space Inspection is to assist homeowners to adapt to a "new normal" of increasingly extreme fire behavior, but there are limitations to adaptive ability. What are these limitations and how will they effect the project?

REIR 4.18.2.2 discusses agencies responsible for Defensible Space Inspection and enforcement. Notably absent from the discussion is the City of Santee where properties on the WUI and elsewhere would fail inspections if they were conducted.

The REIR further states:

"If violations of the program requirements are noted, inspectors list the required corrective measures and provide a reasonable time frame in which to complete the task. If violations still exist upon re-inspection, the local fire inspector will forward a complaint to the County for further enforcement action." [4.18-7]
How many violations in Santee have been identified and sent to the County? What has been the result? Has the county enforced violations in Santee? If so, please provide documentation, because the REIR is like errant on this assertion.

Since I posses substantial experience performing Defensible Space Inspections as assigned to the Cal Fire Prevention / County of San Diego Community Risk Reduction Units, I am aware of flaws the REIR statement relies upon.

While Cal Fire / County Fire will respond to public complaints, the complaint response is secondary to progress prioritized for annual inspection plan areas. Because engine crews, which may be absent on strike team assignments, etc. are relied upon for a substantial percentage of annual inspections and because the crew of DSI inspectors is insufficient for the vast number of parcels in the county, annual inspection plans are regularly not completed.[3]

Furthermore, failing secondary inspections, when completed, may not result in an actual citation or forced abatement. There are very few citations issued for failing homeowners both county and statewide, with those few citations focused upon

---

[3] Exhibit 30. Joshua Emerson Smith. Reporter notebook: Cal Fire San Diego cracks down on flammable vegetation around homes. April 30, 2021. San Diego Union-Tribune. https://www.sandiegouniontribune.com/news/environment/story/2021-04-30/cal-fire-san-diego-flammable-vegetation?fbclid=IwAR1GjIuNWegcGiXD9MeJsa_YQ3Yyegq__T0IHB98gVphlHTJH7vQT1Z4tSs

worst offenders and no current program for abatement in existence.[4] How does Santee's record differ and suggest we will see something different over the long-term for the project?

Inspections conducted by an HOA or third party on Fanita Ranch are likely to have similar limitations. In some HOA governed area I inspect, it is actually HOAs that are deficient in Zone 2, impacting concerned/threatened residents.
How will Santee enforce action from reluctant HOAs?

Since Santee does not routinely conduct Defensible Space Inspections and notice violations, Fanita Ranch cannot rely upon a non-existent program within its jurisdiction or rely upon partially completed programs in other jurisdictions to prevent transfer of structure fires to open space during periods of extreme fire weather.

Reliance upon fire inspection and suppression departments in other jurisdictions as partial rationale for locating residents within a severe fire hazard zone is inappropriate.

REIR 4.18-2 acknowledges Santa Ana winds are not limited to Fall seasons. Santa Ana winds are also occurring in late Spring and have potential wind "speeds of up to 50 miles per hour or higher." However, the REIR underestimates potential high temperatures, relative humidity, fuel moisture levels. Temperatures above 115 F and Relative Humidity under 10 percent have occurred outside of Fall and are likely to continue to occur with greater frequency.

What are the levels of service for SR-52, SR-67, Mast Boulevard, Cuyamaca Street, Fanita Parkway and Magnolia avenue during morning and afternoon commute hours?

---

[4] Exhibit 31. Joshua Emerson Smith. California's not enforcing wildfire-prevention rules for homeowners, leaving tens of thousands of properties vulnerable to big blazes. July 7, 2019. San Diego Union-Tribune.
https://www.sandiegouniontribune.com/news/environment/story/2019-06-11/californias-not-enforcing-wildfire-prevention-rules-for-homeowners-leaving-tens-of-thousands-of-properties-vulnerable-to-big-blazes

What are the differences in evacuation times during commute hours for existing residents north of Mast Boulevard (residents between Mast Boulevard and the project site) and proposed residents during significant evacuation scenarios and a worst case scenario?

REIR 4.18-8 "…the Community Emergency Response Team, which educates community members about disaster preparedness and trains them in basic response skills, such as fire safety, light search and rescue, and disaster medical operations. The City is 1 of 20 jurisdictions that support and participate in the team."

I am unaware of the existence of or opportunity to participate in any such training in Santee as either a resident or fire professional. Who, what, when and where when does the Community Emergency Response Team operate?

REIR 4.18-8 significantly over-estimates the capability of the San Diego County Emergency Operations Center. The EOC cannot "ensure an effective, coordinated evacuation." Evacuations in San Diego County have been chaotic and deadly, despite outstanding work by the professional resources activated.

REIR 4.18-8. The utility of safety grid maps is over stated when evacuation required is immediate or imminent. Grids are relatively large and may contain substantial population densities. Population within a grid can easily gridlock ingress/egress at the project and/or adjacent infrastructure.

REIR 4.18-10
4.18.3 Thresholds of Significance
The project would significantly exceed thresholds 2, 3, 4, 6, 8 and requires avoidance, additional mitigation or full disclosure with a statement of overriding considerations.

REIR 4-18-12 cites an incorrect address for Fire Station 5 which may alter the anticipated response time estimate calculation.

REIR 4.18-13 "50-feet of modified fuel areas along both sides of the road." 50-feet of fuel modifications are insufficient for gridlocked traffic experiencing an over burn adjacent to mature chaparral capable of flame generation exceeding 100 feet.

What are the flame lengths estimated on either side of the unmanaged areas these routes traverse?

How many residential streets within the project site are oriented north, northeast and east forcing potential driving toward the fire without an alternative? What are the distances for each of these street segments?

REIR 4.18-13 over-states the utility of the Fanita Ranch Wildland Fire Evacuation Plan by calling it a "sophisticated evacuation modeling approach" without providing substantial data to support the claim.

REIR 4.18-13 makes a false assurance that "Wildfire evacuations from the site would be focused on early relocation from the project site long before a fire would threaten the project or its access routes." Since data documents the opposite, the REIR does not provide data to support the false claim the project can be evacuated prior to wind driven wildfires. This is a fatal flaw in the REIR.

REIR 4.18-13 inappropriately places heavy reliance upon utilization of Temporary Refuge Areas (TRAs). TRAs are survival measures to be used by over-extended firefighters when an escape route to an appropriately sized safety zone has been compromised. TRAs are not appropriate for civilians to rely upon as dependable evacuation tools. Survival in a TRA may not be tenable as fire behavior intensifies. As conditions deteriorate at a TRA, a secondary action is required to prevent injury or death. The ability to asses these changing circumstances is challenging for professional firefighters and would be significantly lacking in the resident population. Furthermore, TRAs are not substitutes for identifying and utilizing viable escape routes and safety zones. [Cal Fire. 2014. Wildland Urban Interface Operating Principles, p. 244-255. Exhibit 2]

Even if new residents were to read and understand the "Ready, Set, Go!" brochure, executing the directions during emergency is tenuous. I have provided Ready, Set, Go! brochures to thousands of residents in San Diego County and discussed the concepts with interested residents. The REIR relies too heavily upon the public's limited ability to execute evacuation-specific actions during significant wildfires.

REIR 4.18-14. Threshold 2 conclusion of less than significant impacts is not supported.

REIR 4.18.21. The REIR anticipates completion of FMZ vegetation management twice per year. [4.18-29] Zone 2 is proposed to eliminate 70% of native shrub vegetation. The REIR acknowledges disturbance introduces "highly flammable exotic grasses" of greater susceptibility to ignitions, which can then ignite more fire resistant native shrubs [4.18-25]. Leaving just 30% of native vegetation in Zone 2 creates an unrealistic and likely unattainable goal for control of flash fuels in FMZs. The result is likely to be the conversion of natural lands into a more ignition vulnerable landscape, especially over the longer-term.

The REIR misrepresents the potential for multi-directional evacuation on the project site. In fact, at least half of the Vineyard Village development island must evacuate into the direction of Santa Ana wind driven fires.

REIR 4.18.21-25
The REIR fails to disclose and discuss the trade-off made by designing high density, close proximity structures inconsistent with the lot space requirements adopted by Land Use Element Fanita Ranch Guiding Principle 3 of the Santee General Plan:

3. The plan shall contain a mix of house sizes on lot sizes distributed as follows:
6,000 sq. ft. lots – 20 percent of total lots
10,000 sq. ft. lots – 20 percent of total lots
20,000 sq. ft. lots – 60 percent of total lots or greater
LAND USE ELEMENT
Santee General Plan
Santee, California - 1-29 - 1-30

Violation of GP3 is a significant un-avoided, inadequately mitigated and undisclosed impact to public safety because design of structures in close proximity within a severe fire hazard zone significantly increases the potential for massive losses from structures to structure direct flame impingement cluster burns.



“The Santa Ana winds with wind gusts of up to 60 mph blowing from northeast/ east pose a significant threat from wind-blown embers to all structures within this project.” [Fanita Ranch Fire Protection Plan 2007. p 14. AR 028606]

IIBHS Major Finding: “While homes adjacent to wildland are most vulnerable to wildfires, homes in the interior areas of housing developments that were located less than 15 feet apart, were much more likely to burn in clusters - in other words, multiple homes right next to each other tended to burn…Cluster burning was not witnessed in homes located more than 45 feet apart from each other.” [Exhibit 3. Insurance Institute for Business & Home Safety. Mega Fires: The Case for Mitigation. p. 8, 26.]

Violation of GP3 is also significant because the project is not capable of being fully evacuated during firestorm event ignitions within 16-miles aligned with the project. Occupied and cluster burning structures have significant potential to become a mass casualty event.

Furthermore, consistency violation of GP3 requires a public vote for project approval subject to Santee General Plan Protection Measure N and other State law.

Will the project be placed on the ballot for consideration by Santee voters as required by Measure N passed in 2020?

With regard to a public vote, the REIR information is contradictory to the statement made by Mayor John Minto to the press after the opening of the REIR public comment period.
"Minto… noted that because the project would need an amendment to the city's General Plan it would require a public vote. That was mandated in 2020 when Santee voters passed Measure N, which would put any project that needs an amendment to the existing General Plan on the public ballot for approval."[5]

If there will not be a public vote, how do you explain the Mayor's statement?

What are the range of separation distances between structures?

Where, by distance between structures/proximity range, are those structures arranged on the project's developed site landscape?

Once ignited, what is the minimum distance required between structures to prevent a likely transfer of a structure fire to an adjacent structure? What data supports a minimum separation between structures?

What is the range of inadequate spacing for project structures vulnerable to structure to structure direct flame impingement?

Furthermore, the need for primary booster pump and backup power sources (subject to failure) to maintain water pressure significantly increases the potential for a cluster burn failure.

---

[5] Mike Allen. Santee Council Removes Fanita Ranch From November Ballot.. June 13, 2022. East County Magazine. Exhibit 3. https://www.eastcountymagazine.org/print/37950?fbclid=IwAR0bu8JR6GGiwGs9n7Qh6zjLuwWInCSOFZwoVhC1rM58dYu96bqQW8uILjQ

"A private booster pump and secondary power source would be installed for approximately 21 single-family residences in Vineyard Village where the area experiences residual pressures of less than 40 pounds per square inch during peak hour demand conditions."
[REIR 4.18.23]

What are the power sources for the pumps and where are the power sources and pumps located?

The REIR fails to disclose and discuss the significant adverse impacts of choosing to locate residential development above steep slopes, chutes and fire chimneys with Fuel Model 4 Chaparral in direct path of the prior Cedar Fire corridor. [II: 101:29204-5]

REIR 4.18.37 Ignition Resistant Structures

The REIR attempts an apples to oranges inaccurate comparison of fire activity and structural design in Rancho Santa Fe. My prior comments already in the Administrative Record detail how the wind and fire activity diminished significantly prior to the 2007 Witch Creek fire threatening the Rancho Santa Fe development. Structures built after 2007 continue to be damaged or destroyed in wildfires. Despite available research, the REIR does not disclose the conclusions and implications for the Fanita Ranch project.

Discussion of significant fires that did not sustain structure loss without disclosing and discussing recent fires with modern structure loss displays pro-development bias and reduces the credibility of the REIR.

What California fires and developments since 2007 have sustained structure losses in wildfires and why?

> *"Almost no one expected it. After all, the homes were brand new. They were surrounded by dozens of other homes. And most importantly, they met the state's building codes for areas at heightened risk of wildfires.*

> *"Ventura City Fire Marshal Joe Morelli thinks topography played a role…And even with the fire-resistant construction standards you can still have loss. They're not fireproof standards."*
>
> *"According to Cal Fire data, 80 percent of houses destroyed in the Thomas Fire had fire-resistant exteriors and 90 percent had fire-resistant roofs."*[6]

So why the determination to build on Fanita despite the hazards?[7]

The answer in Santee, documented in my prior letters is mirrored elsewhere and specifically in Orange County. Financial reasons there include:

* $50,000 to incumbent campaigns of the decision makers
* > $1,000,000 annually to the local fire department with the bill for actual fire suppression going to state and federal governments as a subsidy
* $8.25 million local annual property tax revenue
* Substantial $ to the growth machine: Business / real estate / development consultant industries

[Emily Guerin. 09/24/2018. Why Do We Keep Building Houses In Places That Burn Down?][8]

Appendix P2. Wildfire Evacuation Plan

The "Wildland Fire Evacuation Plan for the Fanita Ranch Community" (plan) is inadequate to mitigate public safety impacts below a level of significance. The plan lacks substantial evidence to support its conclusions and is contradictory.

About 8,000 new residents are proposed to be concentrated on Public Safety Map Grid page 224… in the highest of fire hazard severity zones.

---

[6] Exhibit 5. Emily Guerin. December 9, 2018. Fire-Resitant is not Fire-Proof, California Homeowners Discover,, NPR. https://www.kunc.org/2018-12-09/fire-resistant-is-not-fire-proof-california-homeowners-discover

[7] Exhibit 33. Anna Huntsman and Jake Steinberg. Developments in disaster-prone areas mean big bucks for builders, but can leave communities at risk. August 13, 2019. News21. https://stateofemergency.news21.com/developments-in-disaster-prone-areas-means-big-bucks-for-builders-but-can-leave-communities-at-risk/

[8] Exhibit 6. Emily Guerin. 09/24/2018. Why Do We Keep Building Houses In Places That Burn Down? LAist. https://laist.com/news/why-do-we-keep-building-houses-in-places-that-burn-down

The plan contradicts the Ready, Set, Go!" (RSG) model it proposes for public distribution by directing residents to "make sure to secure your home by locking all doors and windows…" [Wildfire Evacuation Plan for the Fanita Ranch Community, p. 10]

Cal Fire Evacuation Tips and RSG under "Set" directs evacuees to leave doors **unlocked**.[9] This is a significant contradiction and exhibits how if fire planners are confused - significant segments of the the public are likely to be confused when events occur also, significantly compromising safety.

The Directive to lock all doors is alarmingly significant because during events when the project cannot be evacuated prior to the arrival of the fire front, the plan relies upon the availability of "Temporary Refuge Areas" (TRAs). If doors are expected to be open by evacuees or firefighters and they are not, severe injuries could occur.

Even if the public becomes aware of the correct directive to leave doors unlocked to facilitate TRAs and structure protection, many residents will not do so because of un-locked doors vulnerability to looting.

Furthermore, the Evacuation Plan places inappropriately heavy weight on the public's ability to timely read, understand, remember and then execute during an emergency by utilizing RSG and the 5 additionally listed preparedness reference tools residents might be introduced to.

Without disclosing, supporting and defining the "highest probability wildfire", the Plan makes an outrageously unsupportable assertion; "targeted areas of Fanita Ranch and the existing community can be evacuated within 19 minutes." [plan p. 15].

The plan does not consider the vast majority of residents are unlikely to be in the model state of Ready, Set before they decide to Go! **There will be significant lag times between the fire size-up, the Evacuation Order and actual execution of**

[9] Exhibit 7. Ready Set, Go! Get Set, p 9. Exhibit 10 Evacuation Tips, PDF page 45.

the order after it is received, even if the directive is heard, understood and acted upon.

For example, the 2007 Harris Fire ignited at 9:23 am, but it wasn't until 10:30 am until the first Reverse 911 evacuation calls were made.[10] (Sorenson and Vogt. p. 2).

This was a lag of 37 minutes from ignition to public alert experienced even after post 2003 Cedar Fire upgrades to communications. Add additional time for the public to digest the information and act.

Furthermore, the new communications system did not reach all residents targeted. For the 2007 fires, **37% of respondents surveyed indicated they did not receive the evacuation alert.** (Sorenson and Vogt. p. 8).

Significantly, of the survey respondents who acknowledged receipt of evacuation directives, 41% did not evacuate. (Sorenson and Vogt. p. 12). If a similar percentage ignores directives on Fanita Ranch, the close proximity of structures with cluster burn vulnerability results in significant mass casualty risk potential the plan does not analyze or disclose.

"Warnings by themselves do not motivate evacuation, people must perceive risk."[11] (Dash and Gladwin 2007 Abstract)

"As we see time and time again, for as much research as has been conducted on the issue of evacuation, our understanding of evacuation is extremely limited. Those expected to evacuate often do not, and those who should not evacuate at least in the estimation of emergency managers often do." (Dash and Gladwin. p. 3. Exhibit 9)

Furthermore, the modern phenomenon of misinformation permeating social media can disrupt what are intended to be "phased evacuations."

---

[10] Exhibit 8. Sorenson and Vogt, Results of An Investigation of the Effectiveness of Using Reverse Telephone Emergency Warning Systems in the October 2007 San Diego Wildfires, June 2009, p. 2.

[11] Exhibit 9. Nicole Dash and Hugh Gladwin. 2007. Evacuation Decision Making and Behavioral Responses.

The plan acknowledges, "Many civilian deaths have occurred when residents evacuated late and were exposed to wildfire on unprotected roadways." [plan p. 23]

Surviving 2007 fire evacuees surveyed reported obstacles of traffic congestion, smoke impairing visibility, road debris, road closures, vehicle problems and health effects. (Sorenson and Vogt, June 2009. P 14, 15. Exhibit 8).

The plan does not offer any range of time to reflect differences in commute hour traffic flows or (as during the 2003 Cedar Fire) a before sunrise emergency when the public is sleeping and is even more slow to react. It would be difficult to execute the times projected under best case scenarios, but the plan should be evaluating opposite worst case scenarios. Especially since the plan reluctantly admits, "…evacuation…may not be feasible." [plan p. 20]

The plan does not recognize SR-67, SR-125 and SR-52 are often gridlocked backing up traffic on Santee streets. Nor does it recognize regional traffic growth is expected to increase the congestion and disrupt emergency service response and ability to evacuate.

In contrast to the REIR / Evacuation Plan, Santee Ordinance 570 does raise this issue.
"The amount of traffic will continue to grow with regional population growth, creating an artificial obstructive topographical condition…these conditions may negatively affect access and the Fire Department's ability to deliver service."[12]

The same undisclosed issues discussed above will significantly impact the 1hour, 57 minutes projected evacuation time for all vehicles to exit the project site.

The plan is significantly flawed because it does not consider worst-case scenario rates of spread from close proximity ignition points and compare a few representative scenarios with best and worst-case evacuation times.

---

[12] Exhibit 10. City of Santee Ordinance 570. Topographical Conditions, p. 3

Furthermore, the plan asserts there will be the luxury of phased evacuations without considering potential rates of spread from highly probable ignition sources such as SR-67.

An extreme weather fire spreading from SR-67 at 1,966.5 feet/minute (Fanita Ranch Fire Protection Plan BehavePlus calculation) could strike the project in less than 10 minutes.

"The Highway 67 corridor presents a serious threat as a ready source of potential ignitions resulting from vehicle accidents, over-heated vehicles and burning material thrown from vehicles during extreme fire weather conditions brought about by drought and drying seasonal Santa Ana winds. During the October 2003 wildfires, Incident Reports noted wind gusts of up to 75 MPH from the northeast at higher elevations." Fanita Ranch Fire Protection Plan. 2007, p. 3. AR 018469]

[Vineyard Village]"Rock Point is vulnerable to ignitions at the SR-67 corridor within ten minutes or less under high velocity Santa Ana winds. Evacuation routes are vulnerable to direct flame impingement, radiant heat, and smoke. City reference to 'safe routes' for evacuation is unsupported and incorrect." Cleveland National Forest Supervisor - Retired, Anne S. Fege, Ph.D., M.B.A.

The plan makes distorted assertions about the extent of evacuations, suggesting the project site will not require complete evacuation because "mass evacuations" will no longer occur.

"This type of evacuation, called a mass evacuation, is not used in Santee or San Diego County." [plan p. 10] The statement is not accurate. The Incident Commander size-up attempts to determine the rate-of-spread and path of the fire. This estimate (subject to changing fire weather/behavior) determines the extent of the evacuation, not some pre-determined phasing plan.

The plan fails to understand or disclose that the Incident Commander (IC) evaluates current and expected fire behavior and then issues evacuation directives based upon what is actually in the expected fire path. The IC uses Public Safety Grid Maps to identify at risk populations and communicate directives. The size of the evacuation is primarily determined by the expected rate-of-spread from the

fires active fronts and flanks during size-up, not by utilizing a planners idea of what may constitute most efficient evacuation phasing.

It is both plausible, and highly likely that evacuation orders could be issued for the entire project site (Public Safety Grid & Evacuation Planning Map Book page 224)[13] and for offsite populations on adjacent page grids simultaneously during a Santa Ana wind driven firestorm when evacuation needs are immediate or imminent.

Because the bias of the plan is to support development, the plan wishes to relegate ignition points and rate-of-spread to secondary considerations. Consultant planners refused to even calculate basic evacuation timing without a court order.

The plan does not even disclose the existence of Public Safety Grid & Evacuation Planning Map Book page 224 and invents an entirely new phasing proposal that is unlikely to be reviewed or available to emergency responders prior to or during the next wind driven firestorm.

It is also distorted to cite (Sorensen and Vogt) for support, when Fanita planners have resisted our requests to estimate evacuation times and compare those to expected rates of spread. Sorenson and Vogt support the issue we brought to court, "accuracy of evacuation time estimates should be established."

"Our research identified ten major issues in evacuation planning that cut across hazards. Planning for large-scale evacuations requires improvement. **A better understanding of special evacuation planning needs for fast-moving events is needed. Evacuation planning for concurrent hazardous events is lacking.** A better understanding of human behavior in evacuations is desirable. The **accuracy of evacuation time estimates should be established.** Guidelines on reentry after an evacuation should be improved. Special populations planning requires further investigation. Liability for evacuation decisions should be resolved. Uncertainties

[13] Exhibit 11. Public Safety Grid Map page 224. PDF page 18.

and problems in evacuation decision-making need greater attention. Adoption and implementation of integrated evacuation plans should be investigated."[14]
(John Sorenson, Barbara Vogt and Dennis Mileti)

Sorenson confirms the importance of **"evacuation time estimates"** in later research. (Sorenson 2002)

Fanita planners have resisted analysis of the issues Sorenson and Vogt conclude deserve attention and this plan does little to address those issues identified.

Plan section 3.3.1 Evacuation Points and Shelters is generic word soup that does not offer any specific locations on or off of the project site expected to function as evacuation points or shelters. This is a significant deficiency in the plan which fails to establish if suitable evacuation points or shelters exist for the populace during events of magnitude. Specifically, where are these suitable points or shelters and what facts establish them as suitable functionality for large evacuation events?

The plan acknowledges that shelter-in-place is not preferred for residents that would be "directly impacted or in the direct path of a hazard." [plan p. 22] Yet, all of the project site could be impacted within a short interval of minutes during a wind driven fire with a rapid rate-of-spread or with simultaneous area ignitions. The plan labels structures as "ignition resistant," not ignition proof, which places the resident population in significant danger. The REIR use the term "minimize ignitions." [REIR 4.18-42, Fanita Ranch Fire Protection Plan May 2022 p. 38]

The plan downplays and deflects from the significant risk of shelter-in-place strategy by pointing to three large fires without resident injuries or structure loss, and by failing to disclose the destruction of other large fires with structures built to fire resistant standards.

The 2018 Camp Fire burned 18,804 structures in Paradise. Post fire analysis concluded 56% of the structures built to 2008 Chapter 7A standards were

[14] Exhibit 12. John Sorenson, Barbara Vogt and Dennis Mileti. Evacuation: An Assessment of Planning and Research. 1987. Abstract.

destroyed.[15] https://wildfiretoday.com/2021/10/11/characteristics-of-structures-that-burned-in-the-2018-camp-fire/

Home proximity to each other was a key factor. Homes with > 18 meters of separation survived at substantially higher rates than those in close proximity to another burning structure.[16] [Exhibit 14]

The Evacuation Plan / Final REIR ignores the Marshal Fire that burned about 1,000 structures within hours on December 30, 2021. The Marshal Fire demonstrates the potential for rapid destruction of fire resistant homes placed in close proximity. Drone video aftermath reveals the destructive potential for homes in close proximity with little adjacent vegetation fuels. Homes became the fuel. Video documents homes that survived had fewer homes in close proximity.

The community impacted by the Marshal Fire had more numerous points of ingress/egress differentiating it from the constrictive congestion of Fanta Ranch dependency upon Mast Boulevard. Shelter-in-place strategy is a recipe for failure in densely configured sites in severely vulnerable topography such as Fanita "Vineyard Village."

Denser development, such as what is proposed for Fanita, built to Chapter 7A standards, may protect the structures from direct flame impingement of a vegetation fire burning under moderate weather conditions, but density design becomes a detriment once buildings ignite and cluster burn.

The plan fails to disclose destruction of 20 mansions by a 200-acre fire in Laguna Niguel, May 11, 2022. The spring wildfire burned adjacent to the ocean during onshore flow wind gusts of 20-25 mph. This was not a Santa Ana condition. Homes were immaculate and compliant with PRC Section 4291 defensible space code. Proximity of structures doomed them once the initial home ignited from the

---

[15] Exhibit 13. Bill Gabbert Characteristics of structures that burned in the 2018 Camp Fire. October 11, 2021. Wildfire Today. https://wildfiretoday.com/2021/10/11/characteristics-of-structures-that-burned-in-the-2018-camp-fire/

[16] Exhibit 14. Knapp, E.E., Valachovic, Y.S., Quarles, S.L. *et al.* Housing arrangement and vegetation factors associated with single-family home survival in the 2018 Camp Fire, California. *fire ecol* **17,** 25 (2021). https://doi.org/10.1186/s42408-021-00117-0





downslope generation of firebrands. There is significant similarity in vulnerability from downslope vegetation on Fanita Ranch to close proximity home clusters above.

Fire resistant homes with PRC 4291 compliant defensible space ignited during a spring onshore wind driven fire. Coastal Fire, Laguna Niguel, 05/11/2022. https://www.ocregister.com/2022/05/11/fire-prompts-evacuation-at-laguna-beach-resort/

The weather was not extreme. The winds were under 25 mph and relative humidity was 52%.

'The big difference is, and were seeing it again, y'know, with the climate change," Fennessy said. "The fuel beds in this county, throughout Southern California, throughout the West are so dry that fire like this is going to be more commonplace. Five years ago, 10 years ago, a fire like this would likely have been stopped very small."[17]



[17] Eric Licas. Coastal fire burns 20 homes, forces evacuations in Laguna Niguel. May 11, 2022. The Orange County Register. https://www.ocregister.com/2022/05/11/fire-prompts-evacuation-at-laguna-beach-resort/

“With the climate change. The fuel beds are so dry that fire like this is going to be more common place. [Orange County Fire Chief Brian Fennessey, ABC News.] During unexpected ignition with rapid fire spread, it takes only one absent resident on Fanita who leaves a window open for fresh air to create vulnerability for an entire cluster of homes.



See Exhibit 16 before and after Tubbs Fire aerials of high density cluster burns at Coffey Park and high-density destruction in the City of Ventura during the Thomas Fire.

Significant cluster burn risk can be reduced by three modifications:

- **Eliminate all windows and garage doors on the north, northeast, east and southeast sides of structures / require air tight garage door seals**

- **Require a minimum of 50 feet between each structure (keep other structures out of Zone 1)**
- **Limit the number of windows on southern to northwest sides of structures to 1 per room, with an area limit of 9 square feet, constructed in a permanently closed design.**

Evacuation Plan Section 4 - Wildfire Scenarios

Without supporting data analysis and disclosure, the "Wildfire Scenarios" section of the plan excludes actual worst-case scenarios from consideration. Scenarios where ignition points are in close proximity to the project with spread rates at a magnitude to impact the developed site during a time period insufficient to evacuate the entire site are not adequately considered.

"If a fire starts in the backcountry (East San Diego County) and is fanned by these fire weather conditions, an early evacuation of the area may occur several or more hours prior to actual threatening conditions. Such an evacuation may include the **entire project site**." [plan p. 25.]

I've provided data in prior comment letters documenting large-area/short-time-period scenarios are both plausible and likely. **The plan is significantly deficient because it refuses to do calculated ignition point / rate-of spread analysis with distressed fuels during extreme weather conditions and then avoid or mitigate for such a scenario's significant adverse impacts.**

I've asked for this analysis repeatedly. The court acknowledged in its ruling the EIR was inadequate because of the failure to respond adequately to public comments. The plan repeats this failure by the denial bias embedded in this section.

The plan then generally admits:

"If a wildfire ignited close to the Fanita Ranch community during weather that facilitates fire spread (i.e., low humidity and high winds facilitate fire spread), multiple hours would likely not be available for evacuation and a different approach would need to be explored."

What are the critical distances and time periods during worst case fire spread scenarios?

The plan fails to consider and then avoid or mitigate for these circumstances. Furthermore - under the above scenario, there is not time to explore a "different evacuation approach." The time for exploration is now while significant deficiencies may still be addressed, not during the event when failures have real life consequences.

The 3 "contingency options" mentioned are to generalized. Please "explore" 1 - 2 - 3 specifics: [Evacuation Plan p. 25.]
"(1) partial relocation, where residents in perimeter homes on the north/west/east edges are temporarily relocated to internal areas or to the Fanita Commons Village Center;"

How long would it take to relocate "residents in perimeter homes on the north/west/east edges" to "internal areas of the Fanita Commons Village Center"?

What is the capacity of the Center?

Under what conditions is the Center at risk of significant failure?

What is the contingency for failures at the Center after a partial evacuation there?

Is the Center designed with characteristics of a safety zone under a specified stress point or is the Center sufficient to be a Temporary Refuge Area up to a specified stress point?

Considering the Incident Commander uses a much more generalized Public Safety Grid Map system, specifically, how will evacuation of "residents in perimeter homes on the north/west/east edges" be timely and accurately communicated from the IC to the EOC, then law enforcement and to the targeted residents?

How will confusing messaging permeating through other neighborhoods whose actions could adversely impact the targeted evacuation be avoided?

If the IC chooses to request more specific areas for evacuation orders, what is the average amount of time it takes for the specific order to be prepared by the IC, communicated by the IC to the EOC and then translated digitally and distributed through WEA or AlertSanDiego systems to the public?

"2) individual neighborhood relocations, where residents of certain neighborhoods are temporarily relocated to the Fanita Commons Village Center or south to the Cities of Lakeside or El Cajon;"

Considering the Incident Commander uses a much more generalized Public Safety Grid Map system, specifically, how will evacuation of "certain neighborhoods" be timely and accurately communicated from the IC to the EOC, then law enforcement and to the targeted residents?

How will confusing messaging permeating through other neighborhoods whose actions could adversely impact the targeted evacuation be avoided?
How long will it take to evacuate "certain neighborhoods" to "Lakeside or El Cajon."

How much delay time will be added to the evacuation of a vulnerable existing WUI from the evacuation of "certain neighborhoods"?

In what scenarios would existing Santee neighborhoods north of Mast Boulevard be evacuated prior to "certain neighborhoods" on the Fanita ranch project site?

If the IC chooses to request more specific areas for evacuation orders, what is the average amount of time it takes for the specific order to be prepared by the IC, communicated by the IC to the EOC and then translated digitally and distributed through WEA or AlertSanDiego systems to the public?

"(3) temporary refuge, where residents are instructed to remain in their homes while firefighters perform their structure protection function."

What are the contingency options if/when structures fail and begin to cluster burn?

What are the thresholds and contingencies when firefighters cannot remain outside to perform structure protection functions?

Specifically, where are firefighter safety zones and for fires of what specific threshold would the safety zones remain sufficient?

What are the contingency options when residential doors are locked and radiant heat precludes outside operations and/or direct flame impingement from cluster burning structures precludes indoor shelter?

What are the contingency options when residential vehicles and/or fire engines begin to melt?

The plan exaggerates the utility of the internal road network. Significant numbers of residents would be forced to evacuate in the direction of a Santa Ana firestorm before connecting to the Fanita/Cuyamaca horseshoe connection to an overburdened Mast Boulevard.

The plan acknowledges reliance upon emergency responders to control intersections and traffic flow, but does not disclose that responders required may be limited or absent due to concurrent incidents.

What is the contingency plan for concurrent incidents when law enforcement / emergency responders are unavailable?

The plan overstates EOC capability and over relies upon it. “Fire and law enforcement officials **will** identify evacuation points before evacuation routes are announced to the public.” [plan p. 27]

There are scenarios where the EOC will not be able to accomplish the above, including scenarios when phone lines and cell towers may not function. It is also unknown if it will be feasible to monitor traffic conditions which “**must** be monitored along evacuation routes…” [plan p. 27]

Evacuation Plan Section 5 - Fanita Ranch Resident Fire/Evacuation Awareness

"There are aspects of fire safety and evacuation that **require** a significant level of awareness by the residents and emergency services to reduce/or avoid problems with an effective evacuation." [plan p. 29]

Ready, Set, Go! (RSG) brochures/procedures are useful tools, however their utility is overstated. RSG does not provide the required significant level of awareness.

I have distributed RSG brochures to thousands of residents in San Diego County while performing Defensible Space Inspections. Without engaging in question/ answer discussions during and after distribution of RSG, an assessment of residents comprehension of RSG and their ability to execute upon it or fulfill the **"required"** "significant level of awareness" is absent.

Experience has demonstrated to me that redundancy of concept and repeated exercise of it (practice) is necessary to achieve a "significant level of awareness." There is not any evidence the Fanita plan will achieve either.

The redundancy of concept measures described in the plan are infrequent, voluntary and inadequate to achieve a "significant level of awareness" for the bulk of the resident population.

Registration for the "AlertSanDiego" emergency notification is a primary talking point during my public contact inspections. Out of thousands of public contacts, many have stated they would register, but a relative few requested or accepted offers to be walked through the short registration process (Most people can register in two to three minutes). Therefore, it is unknown how much redundancy is required to gain registration action from a public contact. Especially since much of the public in San Diego County remains unregistered.

Furthermore, existing Santee residents are unaware of or participating in the type of educational activities promised for future Fanita Ranch residents, which puts in question the feasibility of those promises in the plan.

Evacuation Plan Section 6 - Fanita Ranch Evacuation Procedures

Conclusions about plan effectiveness are optimistic and negated by development sited on inappropriate topography within a severe hazard zone.

What are the trigger points that constitute a "conservative threshold" for evacuation of Fanita Ranch?

The plan's conclusion regarding Fanita Ranch non-consideration as a "vulnerable community" is errant. Close proximity between structures and the inclusion of windows/vents leaves the development vulnerable to cluster burns. [Exhibit 16]

6.1 Fanita Ranch Evacuation Summary

"…it is **imperative** that each household develop a plan that is clearly understood by all family members and **participates** in the educational and training programs sponsored by the Fanita Ranch HOA and the SFD. In addition, it is **imperative** that the "READY! SET! GO!" information be **reviewed on a routine basis** along with the accompanying maps illustrating evacuation routes, temporary evacuation points and pre-identified safety zones. It **must** be kept in mind that conditions may arise that will dictate a different evacuation route than the roads used on a daily basis." [plan p. 32]

It is more imperative that decision-makers understand the 6.1 introductory paragraph is unrealistic and there are significant real world safety impacts associated with these unreal expectations.

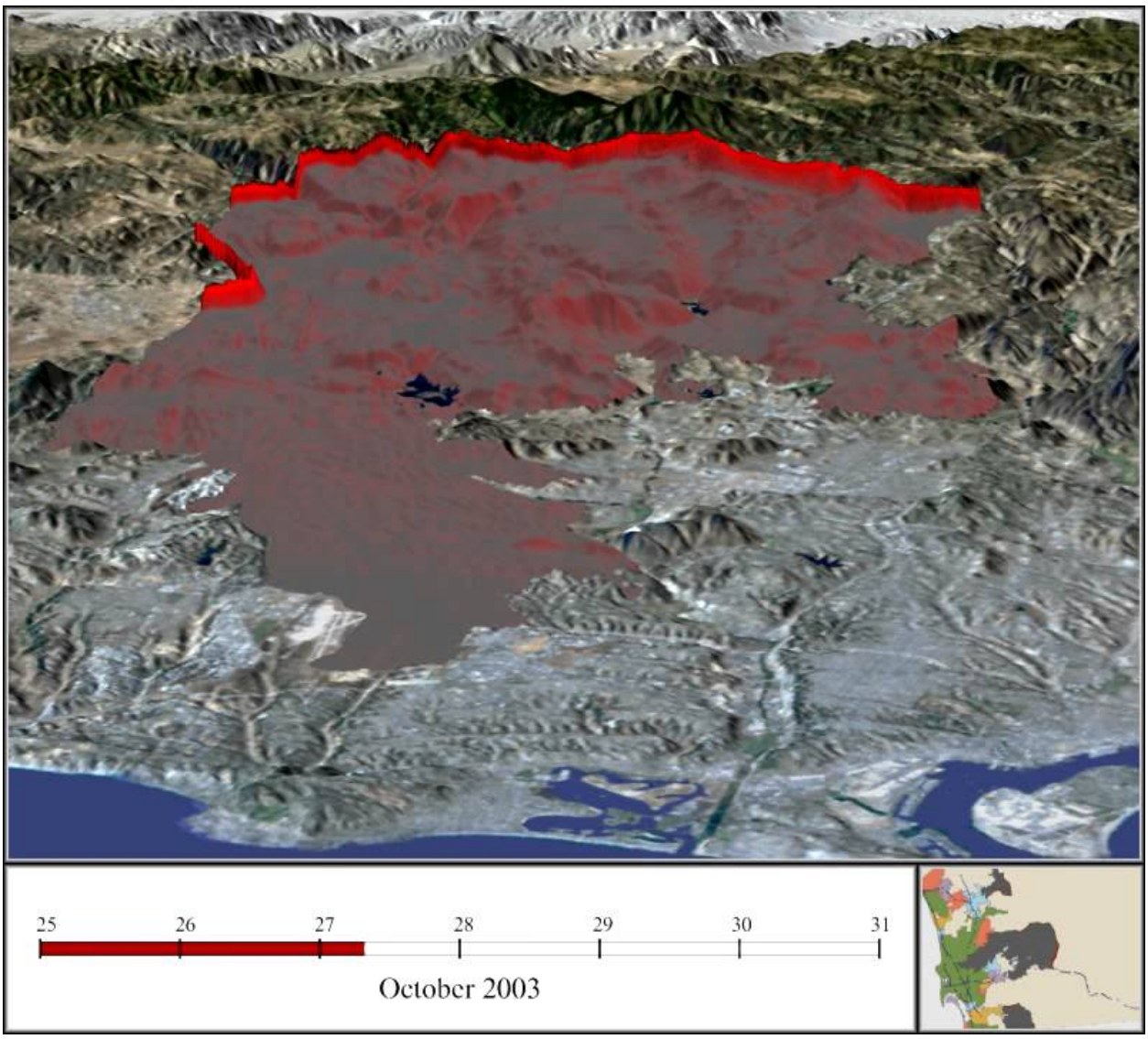
The significant adverse impacts to public safety of residing in fire vulnerable topography and continuous east-west aligned vegetation corridor have not been disclosed, avoided or adequately mitigated.

6.2 Fanita Ranch Road Evacuation Capacity Analysis

"In an actual emergency, unified command…**will** consider…**will** issue specific evacuation or shelter-in-place directives…"

<u>The language above creates a false narrative that in itself is a significant impact to public safety.</u>

There can be no guarantee that there WILL be enough trained/experienced personal or enough time to effectively consider “numerous factors including wind speeds and direction, humidity, topography, fuel loading, emergency access routes, evacuation routes, shelter-in-place options, time needed to evacuate, and other variables.” [plan p. 11]



Note the Cedar Fire rate of spread was underestimated by law enforcement and experienced fire officials in both premiere wildand firefighting agencies.

"Fire and law enforcement personnel underestimated the potential size and rate of spread of the Cedar Fire."[18] [Exhibit 17. United States Forest Service, California Department of Forestry and Fire Protection]

Underestimation should be expected because of the human brain's inability to comprehend exponential growth/fire spread. Yet, the plan inappropriately forecasts expert precision.

"…exponential growth is beyond our natural intuition and comprehension. That's why any phenomenon involving exponential growth is potentially dangerous, why mathematics provides the only tool we have to handle it, and why leaders and societies can do themselves and us possibly irreparable harm…if they ignore what the math tells them."[19] [Exhibit 18. Mathematics Association of America]

Leading the public to believe and **rely upon** a false narrative of reliably accurate dispersal of directives has been deadly and can be again in high risk settings as the frequency of extreme weather events increase.

For example, during the 2018 Camp Fire, a mother and daughter had divergent positions on the issue of waiting for official direction. The mother chose to wait for specific directive and without any, chose to shelter-in-place until getting direction. The daughter felt uncomfortable, but lost time trying to persuade her mother to evacuate with her. The mother perished in her home waiting for direction that never came. The daughter survived a harrowing evacuation, where others did not.

---

[18] Exhibit 17. United States Forest Service, California Department of Forestry and Fire Protection. 2003 San Diego County Fire Siege Fire Safety Review, p. 15 https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5297020.pdf

[19] Exhibit 18. Keith Devlin. Can We Really Understand Exponential Growth? June 1, 2020. Mathematics Association of America. https://www.mathvalues.org/masterblog/can-we-really-understand-exponential-growth

“Christina and her mother argued on whether to evacuate and ultimately her mother decided to stay put because she had not heard evacuation orders from officials.”[20]

“They argued about the neighbor, showering, paying the phone bill, packing the safe, talking to a woman named Mary, the bumper-to-bumper traffic outside, the severity of the fire and God. They argued over evacuating.”[21] [22]

Furthermore, as residents experience the dynamics of one or more fires, the basic experience can lead to a false sense of security that disarms residents to more serious dynamics in subsequent events. Emergency fatigue is an unconsidered significant adverse impact.

“"She didn't expect it to be that bad. She expected someone would be calling, or something, if it got bad. But they didn’t.”[23] [Exhibit 22. NBC News]

Note that law enforcement reported mass alerts were sent: “5,227 by email, 25,643 via phone (to both land lines and cellular devices) and 5,445 by text message… Like other counties, Butte has a system that allows residents to sign up for “reverse 911” telephone alerts in times of emergency.” [Exhibit 22. NBC News]

Law enforcement after the fact statements support the significance of emergency fatigue upon the population and public safety officials themselves.

---

[20] Exhibit 19. Yaritza Avon. Chico State student loses mother and Paradise home during the Camp Fire. December 5, 2018. The Orion. https://theorion.com/77084/news/chico-state-student-loses-mother-and-paradise-home-during-the-camp-fire/

[21] Exhibit 20. Bianca Quilantan. December 19, 2018. “I want my mom back” Camp Fire survivor recounts final moments with her mother. San Jose Mercury News. https://www.mercurynews.com/2018/12/19/i-want-my-mom-back-camp-fire-survivor-recounts-final-moments-with-mother/

[22] Exhibit 21. Briar Stewart. ‘This is where they must have found her:' Women who refused flee California fire is one of the dead. November 22, 2018. CBC News. https://www.cbc.ca/news/world/california-paradise-wildfires-1.4915372

[23] Exhibit 22. James Rainey. Paradise Fire survivors say warning were too little, too late. November 14, 2018. NBC News. https://www.nbcnews.com/news/us-news/paradise-fire-survivors-say-warnings-were-too-little-too-late-n935846

"You have to keep in mind that this was an extraordinarily chaotic and rapidly moving situation. The fire started in a remote area. It takes awhile for our fire resources to get there and from that point, trying to determine the path of travel and whether or not that's going to effect populated areas, that takes time," Honea said.

He added that it's possible some people were warned and didn't immediately act to get out of harm's way. "We were trying to move tens of thousands of people out of an area very rapidly with the fire coming very rapidly. And no matter what your plan is to do that, no plan will ever work 100 percent when you are dealing with that much chaos."

Honea, who took office four years ago, also suggested that emergency officials have to be concerned not to over-burden people with excessive or unneeded evacuation orders. He said the region had already lived through evacuations from earlier fires and last year's threatened collapse of the Oroville Dam, which caused nearly 200,000 people to flee.

"So that takes a toll on people," Honea said. "I don't want to ever get into situation where people begin to stop paying attention because they feel like we are ordering evacuations for no cause or for very little cause." [Exhibit 22. NBC News]

As an experienced wildland firefighter and currently as a Cal Fire Defensible Space Inspector performing public outreach, when I discuss emergency alerts with the public and request registration with the AlertSanDiego system, I let individuals know that an alert may not be issued. And when an alert is issued, they will only receive the alert if they have service at their present location at that time. It is up to individuals to grasp the vulnerabilities of their physical location, preplan evacuation routes and safety zones with representative scenarios, maintain situational awareness and act upon their own judgement if required by circumstances. Official alerts/directions are to be taken seriously to guide actions if issued and received. **The difficulty of evaluating physical settings in dynamic circumstances for both officials and residents is why it is gross negligence for land use officials to intentionally site new residents into increasingly severe hazard zones.**

The plan's false narrative of guaranteed expert direction from public safety agencies is a significant adverse impact to public safety.

For residents already residing in tenuous locations, LCES is not just for firefighters. LCES (Lookouts, Communications, Escape Routes, Safety Zones) should be practiced by the public. However, even firefighters have difficulty implementing the concept. Hence, firefighter injuries and deaths continue to occur in the effort to defend poorly sited people and properties.

Technical Memorandum Appendix D suggests: "Existing Land Uses" north of Mast Boulevard can be evacuated in 78 minutes. Partial evacuations can be accomplished in scenarios ranging from 19 minutes to 78 minutes. Full Project evacuation is estimated to take 53 - 92 minutes depending upon construction of the Magnolia Avenue escape route. A Full Project evacuation including Existing Land Uses is estimated to take 117 minutes. [plan p. 18] These estimates do not account for various degrees of readiness and mobilization by the public or lags in distribution of communications.

Without substantiating evidence, the plan labels the 19 minute scenario as the "Most Probable Evacuation." The label is misleading because the need for a full project evacuation may be just as probable as the "most probable" perimeter only evacuation scenario suggested as a 19 minute end point.

This "Most Probable" scenario should be re-designated as a "Priority Phase 1 Perimeter Evacuation" Scenario.

However, the "Most Probable" scenario does not reflect the reality of the San Diego County Evacuation Planning Map Book Public Safety Grid Index system most likely to be utilized for evacuation directives (Orders and Warnings) when the need for evacuation is immediate or imminent. The grids cover much larger areas than the meandering perimeters desired in "Most Probable." Half of the project or more exists on a single grid. For example, the bulk of the project, both "Orchard Village" and "Vineyard Village" exist on Grid 3333 of page 224.[24]

[24] Exhibit 11. Public Safety Grid Map

During a major Santa Ana wind driven event, even if an experienced Incident Commander is available, the IC is still unlikely to have time to be any more specific than to identify the Public Safety Grid numbers subject to a directive when the need for evacuation is immediate or imminent. Elaborate specific directives are unlikely to be effectively communicated.

If the IC chooses to request more specific areas for evacuation orders, what is the average amount of time it takes for the specific order to be prepared by the IC, communicated by the IC to the EOC and then translated digitally and distributed through WEA or AlertSanDiego systems to the public?

For instance, even if contemplated, a description of the "Most Probable" perimeter evacuation would require identification of four different grids and is complicated enough that it is unlikely to be completely understood and translated for implementation. This reality means that significantly larger populations are likely to be simultaneously evacuated than the Evacuation Plan alleges (without providing substantial evidence in support). The entire grids identified are most likely to be evacuated rather than elaborate subsets of those grids. The same issue exists for all of the partial evacuation scenarios the plan relies upon.

Hence, if the plan's other data input calculations are reliable, a more realistic evacuation time is a minimum of 120 minutes (two hours) plus additional time for readiness/mobilization variations, plus time for neighborhoods adjacent to Fanita outside of Santee, plus time from when the ignition report to when a size-up with an action plan is communicated to dispatch. These additional realities could require another 60-minutes or more.

A project evacuation time of two hour or more has a significant divergence from the FEMA guideline to be able to evacuate a community in 1.5 hours or better. [plan p. 34] **The additional time of 30 minutes or more is a significant adverse impact to public safety.**

The plan analysis suggests that a typical Santa Ana wind-driven fire with ignition 16 miles northeast of the project might leave SR-52 westbound "available for a period of time" because of the 14 hours between the reported Cedar Fire ignition and approximate arrival to SR-52. [plan p. 35]

The period from fire ignition to front arrival referenced does not recognize the 2003 Cedar Fire did not ignite during Santa winds.

The Cedar Fire (reported to dispatch at 1737, October 25, 2003) spread relatively slowly for about 8 hours until early morning when Santa Ana winds over 15 mph then drove the fire rapidly toward the coast.[25] [Exhibit 17. USFS, p. 13]

The period of time before SR-52 is impacted will be heavily dependent upon wind speed and distance. Ignitions within 16 miles of the project site fanned by 40 mph winds or greater, could impact SR-52 and the project site well under the 2 hours estimated for evacuation of the site vicinity. The plan fails to disclose or adequately consider the ramifications of ignitions relatively close to the project site. Instead, the plan largely ignores or downplays the significance of firestorm ignitions near the project rationalizing with a misplaced reliance upon TRAs or shelter-in-place contingencies. Public safety risk is significant.

Furthermore, none of the Evacuation Scenarios consider existing populations directly adjacent to Fanita Ranch on Grids 3334 and 3234 of page 224 on Eucalyptus Hills in Lakeside.[26] What are the time impacts associated with evacuation of Eucalyptus Hills, 1/4 mile from Fanita Ranch open space?

Plan analysis conclusion of only 6 minutes difference in evacuation time for residents by building the project are flawed (1.3 versus 1.2 hours). (p. 34)

The project would not build new ingress/egress for Santee, nor significant upgrades to Santee's currently congested boulevards. Project evacuation would add 7,042 vehicles to the currently congested road network [Appendix D p. 13].[27] How does the plan support a 6 minute difference conclusion with an addition of 3,000 homes?

---

[25] Exhibit 17. United States Forest Service, California Department of Forestry and Fire Protection. 2003 San Diego County Fire Siege Fire Safety Review, p. 13 https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5297020.pdf

[26] Exhibit 11. Public Safety Grid Map

[27] Fanita Ranch Fire Evacuation Analysis Technical Memorandum, Appendix D, page 13

The plan introduces further bias towards development by referencing approval by the County of San Diego Board of Supervisors for subdivisions with 60-120 minute evacuation timeframes. The plan fails to disclose the referenced projects were successfully challenged by either the California Attorney General, environmental organizations and/or successful referendums because of adverse impacts prioritizing fire safety.[28] [plan p. 35]

What is the current status for all of the subdivision projects referenced on page 35?

The plan wrongly asserts without support, "additional [evacuation] time does not necessarily generate a greater safety risk." Where are the specific TRAs and what are their contingencies? Under what conditions will specific TRAs fail or be insufficient to prevent injury? Without detailed answers to these two questions a plan conclusion that available evacuation time is unnecessary is unsupported.

6.2 Phased vs. Mass Evacuation - Evolution of Wildfire Evacuation Implementation

The plan errantly suggests high risk Red Flag days will occur "fewer than 20 days per year." [plan p. 35]

The conclusion is unsupported. Extreme weather records are now a common occurrence that will continue as long as the economy remains dependent upon burning large quantities of fossil fuels. Extreme fire behavior is increasingly correlated to human intransigence and ineffectiveness to resolve a destructive fossil fuel addition with transition to cleaner alternatives.

The plan fails to recognize that it is the rate-of-fire-spread and distance from directly aligned populations that determines the size of areas targeted for evacuation directives. Phased evacuations may or may not be an option. Recognition of facts above is what is "most realistic."

---

[28] Camille von Kaenel. San Diego officials said rural homes were safe from fires. They were listening to developers. June 15, 2022. Inewsource. https://inewsource.org/2022/06/15/rural-homes-fire-risk/?fbclid=IwAR2uSYjVdR0Fmx8Ofn40qd07ALRRKGonGtuwHxoAjpdYBieJgAV5CE51nXY

The plan recognizes "phased evacuation effort **will** need to be enforced by law enforcement agencies and coordinated with the OA EOC and affected jurisdictions." [plan p. 36] However, the plan fails to recognized law enforcement does not have the authority to force evacuations or prevent evacuations divergent from a target phase plan that could disrupt the directed evacuation. Nor does the plan adequately address or recognize that law enforcement may be unavailable to perform the required enforcement and coordination.

The plan fails to disclose that a lucky "break in severe winds" was a primary factor in limiting injuries during the 2017 Lilac Fire.[29] [County of San Diego] By this omission, the plan misrepresents the potential feasibility of future required evacuations.

6.2 Evacuation Modeling: Planning Uses and Limitations

"Emergency responders **will** coordinate the safest possible evacuation based on the dynamic circumstances of the actual event, including the appropriate phasing of the evacuation, and utilization of the most appropriate ingress and egress routes for area residents and emergency responders." [plan p. 37]

Once again, the plan inappropriately and significantly overstates the capability and availability of emergency response.

6.4 Civilian and Firefighter Evacuation Contingency

The plan admits that "no community in San Diego County has been directed to shelter in place during a wildland fire." [plan p. 38] Yet, the plan relies on TRAs and shelter-in-place for aligned firestorm ignitions within 16 mile of the project site. This reliance places people and property in significant risk of injury during a wildfire.

---

[29] Exhibit 24. County of San Diego. Lilac Fire After Action Report. December 2017. Executive Summary page 5. https://www.sandiegocounty.gov/dmpr/docs/LilacFireAAR.pdf

The plan recommends “concerted pre-planning” to determine when it is safe for civilian populations to “temporary seek refuge than evacuate.” [plan p. 38] Failure to complete this analysis now is a significant impact to public safety by plan deficiency.

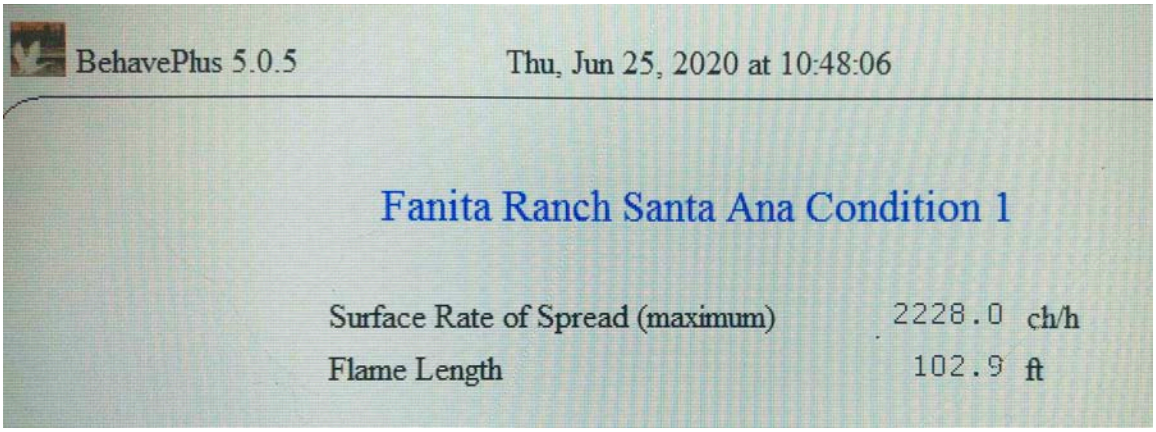
The plan admits evacuations may be disrupted or precluded by factors that include: “Fires that prevent safe passage along planned evacuation routes; inadequate time to safely evacuate; Fire evacuations during peak traffic conditions or when large events are occurring; Blocked traffic due to accidents or fallen tree(s) or power pole(s); The need to move individuals who are unable to evacuate.” [plan p. 38] Yet, the plan fails to disclose the potential consequences of the listed risk factors occurrence. What are those significant potential consequences?

6.4.1 Safety Zones

Vineyard Village/Rock Point “will eventually be surrounded by southern mixed chaparral vegetation more than six feet in height…best described as Fuel Model 4 (FM-4). An FM-4, chaparral vegetation greater than 6-feet in height, provides the greatest rates of spread and energy release with flame length usually exceeding 100 feet.” [Fanita Ranch Fire Protection Plan 2007. 1:192:15843]

The current evacuation plan significantly underestimates potential flame lengths, fire intensity and the size of safety zones required to reduce potential burn injuries.

The Fanita project’s own 2007 Fire Protection Plan (prepared by actual firefighters without manipulating data inputs to get a diminished results) used the BehavePlus model to calculate flame lengths of 100 feet. I confirmed the 2007 FPP, 100 feet flame length calculation using BehavePlus 5.0 calculating a result of **102.9 feet.**



The 34 feet+ underestimation of flame length/fire intensity is significant. Another 136 feet of fuel separation is necessary. The actual safety zone requirement is 400 feet in all directions.

Furthermore, a safety zone of appropriate size for flame length size does not assure protection from convective activity, such as fire whorls that may impact the center location point.

"…potentially greater distance if there were site-specific features that would result in more aggressive fire behavior.." [plan p. 39]

Fanita Ranch has features that would result in more aggressive fire behavior. The project locates development at the top of numerous fire chimneys and chutes. [II: 101:29204-5]

The plan suggests "some neighborhood interior roads would provide safety zones" but hedges by stating, "during a fire, the identified safety zones may not be feasible due to distance, location, fire behavior, etc." [plan p. 39] The "etc." fails to specifically disclose cluster burn risk for all neighborhoods due to the close proximity of structures relative to each other.

The plan defers its actual purpose by placing the responsibility upon fire and law enforcement agencies to identify potential safety zones with **required** focused study.

"…safety zones will require additional focused study." [plan p. 39]

Focused study should have shaped the design of the project to avoid steep topography, chutes, chimneys, saddles and Fuel Model 4 vegetation. [II: 101:29204-5]

Failure to design and designate adequate safety zones is a significant adverse impact to public safety that must be disclosed.

6.4.1 Temporary Firefighter Refuge Areas

The plan correctly discloses "TRAs are not a substitute for a safety zone." And "a TRA requires another planned tactical action, i.e., TRAs cannot be considered the final action. [plan p. 40.]

TRAs are not considered appropriate tactics for civilians because they require expertise and rely upon a series of actions that may be compromised or fail.[30] [Exhibit 2. Cal Fire. 2014. Wildland Urban Interface Operating Principles]

Yet, without disclosing the project's significant risk of cluster burn, the plan relies upon "interior areas of neighborhoods" to be used as TRAs "For the Fanita Ranch Community."

The plan identifies residences it previously directs to be "locked" as TRAs and touts fire resistant features, including ember resistant vents and a tempered pane of dual pane windows.

Wide FMZs do not stop airborne firebrands. Ember resistant vents aligned with a storm of firebrands can be breached to points of structure ignition.

Windows can be broken by convective action that lifts objects stored outside of a residence allowing ignition.

---

[30] Exhibit 26. Firefighter Nation Staff. 7/17/2012. Temporary Refuge Area Considerations and Options. Firefighter Nation. https://www.firefighternation.com/firerescue/temporary-refuge-area-considerations-and-options/#gref

Windows can be left open for ventilation by residents absent and unaware of fire ignitions or motivated to ventilate by hot weather increasing the probability of fire ignitions.

The plan infers the project may not be able to be evacuated "during a fast moving wind driven fire that ignites off of SR-52 or SR-67" and relies upon TRAs (sometimes appropriate for firefighters - not civilian tactics) without disclosing significant risk of cluster burns or any tactical contingency to deal with cluster burns. [plan p. 41]

The plan then once agains overstates the capability of fire and law enforcement resources by promising "The decision for evacuation or temporary refuging on site **will** be made by responding law enforcement and/or fire personnel."

Even if law enforcement is available, law enforcement officers are not trained to calculate wildland fire rate-of-spread over various fuel types and topographies in dynamic weather conditions. Nor are they trained to make a series of tactical decisions for civilian use of Temporary Refuge Areas. These tasks would be a challenge for trained veteran firefighters if they are available and not detained by concurrent fire activity elsewhere.

6.5 Social Aspects of Wildfire Evacuation

Fire: Plan consumption is largely limited to planners; Training is largely limited to professionals with redundancy and experience required for successful execution; Education is sparse; Awareness is motivated in the midst of an event.

To reduce the probability for chaos and panic, the plan places too much weight on public exposure to RSG, understanding of RSG, and ability to execute RSG concepts.

The plan once again over promises stating "movement… will occur according to a pre-planned and practiced protocol, reducing the potential for panic." [plan p. 41]

Who is pre-planning?

Where are examples of these pre-plans in Santee?

What are the protocols referenced?

Who is practicing the protocols referenced?

What documentation exists to demonstrate the protocols referenced have been and will be practiced in Santee?

The plan inadvertently admits there are circumstances when evacuees will not "receive information from credible sources," despite repeated contradictory use of the word "will."

The plan does emphasize a **requirement** for annual training without establishing a mechanism commitment for such essential training.

"The importance of training these personnel cannot be understated and annual education and training regarding fire safety and evacuation events **will** be essential for successful future evacuations." [plan p. 41]

Evacuation training at fire agencies is limited, if it occurs at all, and is secondary to the primary responsibility of fire suppression. I suspect the same is true for law enforcement where the primary responsibility is law enforcement.

6.6.1 Evacuation of Special Populations

The plan relies upon "Accessible AlertSanDiego, CERT programs, or other" to provide emergency evacuation transportation to special needs individuals anticipated as residents. [plan p. 42]

The Camp Fire (among others) where a Reverse 911 system was in place demonstrated that reaching all special needs individuals during a firestorm is not

feasible. Special needs individuals are also less likely to be willing to leave without simultaneous evacuation of their pets.

Placing special needs individuals in the Fanita Ranch severe fire hazard zone is a significant adverse impact to public safety.

7. Limitations

[My observations bracketed]. Again the plan over promises:

"The Fanita Ranch populace **will** be "Set"…officials **will** implement the plan and mandate [*without legal authority to do so*] that populations "Go"…evacuation **will** occur based upon conservative decision points…residents **will** be aware of this evacuation plan…educational outreach **would** result in a populace that understands [*without any way to measure understanding or compel educational participation*] the potential for evacuations and the routes and options that may be presented to them." [plan p. 46]

The plan correctly lists some of its contradictions, including:

- "…instances when evacuation is not possible"
- "During extreme fire weather conditions, there are no guarantees that a given structure will not burn or that evacuations will be successful…"
- "Fire can compromise procedures through various unpredictable ways"
- "Fire is a dynamic and somewhat unpredictable occurrence, and it is important for anyone living at the wildland-urban interface to educate themselves…"

These admitted limitations and contradictions, despite project mitigation measures, are why a decision to place new residents in harm's way significantly exposes people or structures to a significant risk of loss, injury or death involving wildland fires and requires either avoidance or a statement of overriding considerations for doing so.

The project should be denied. Placing thousands of new residents in a Cal Fire designated "Very High Fire Hazard Severity Zone" while the State is setting more records for climate exacerbated wildfires would be gross negligence.

Santee residents previously defeated a 3,000-unit project by a 2/3 landslide. The effort to force another 3,000-unit project upon Santee residents despite their clear direction reeks of corruption. [Reference Van Collinsworth letters dated 9/21/2020 documenting the flow of funds from Fanita Ranch proponents to elect Santee city council members.]

Specific evidence was provided in my prior comment letters as to why cluster burns on this project are of great concern. The specific evidence presented by my comments remain inadequately address by substantial evidence to the contrary. I carry forward my prior public safety objections to the project.

The project is based upon the false assumption that cluster burns will not occur. The site cannot be effectively evacuated so the design wagers heavily that design features will prevent cluster burns with mass fatalities. The REIR distorts reality by making "apple to orange" comparisons for Fanita with projects that survived wildfires, while failing to discuss recent subdivisions that have suffered losses. My previous comments explain in detail why those comparisons fail. I carry those comments forward.

What are the distances between structures and the flame impingement potential from structure-to-structure.

Who are the entities to be relied upon for transportation assistance? This should be answered by a project that proposes to place thousands in a severe fire hazard zone.

The project assumes without providing any evidence that law enforcement will be available during Santa Wind driven wildfires when emergency response teams are often overwhelmed by the pace and scale of multiple expanding events. The REIR does not adequately address the potential for gridlock along evacuation routes adjacent to wildland fuels capable of incinerating evacuees.

The REIR assumes incorrectly and without any evidence that a wildfire will not transition into the urban environment with older homes highly vulnerable to embers and that high-intensity urban fires would not impact gridlocked escape

routes. The REIR completely ignores recent fire history of urban environments in California and Oregon being wiped from the map by wind driven firestorms.

What is the total amount of wildlan-urban-interface area added by the project? How many miles of wildlland interface currently exist in Santee? What percentage increase does the project represent? How many brush engines and firefighters does Santee currently have to respond to emergencies and how many will be added?

What is the percentage change in resource availability versus wildlan-urban-interface?

The project site has had difficulty maintaining existing fire buffers taking well into June to cut tall dead flash fuel grasses. Creating more interface increases the burden of difficulty.

A buffer 4-times flame length rule of thumb to reduce the potential for burn injuries is standard for firefighters. The principle is the same if it is a firefighter deploying a fire shelter or an individual temporarily sheltered in a vehicle. Chaparral is capable of generating flame lengths in excess of 100-feet and the gridlock the inadequate circulation system provides potentially leaves people incinerating in their vehicles.

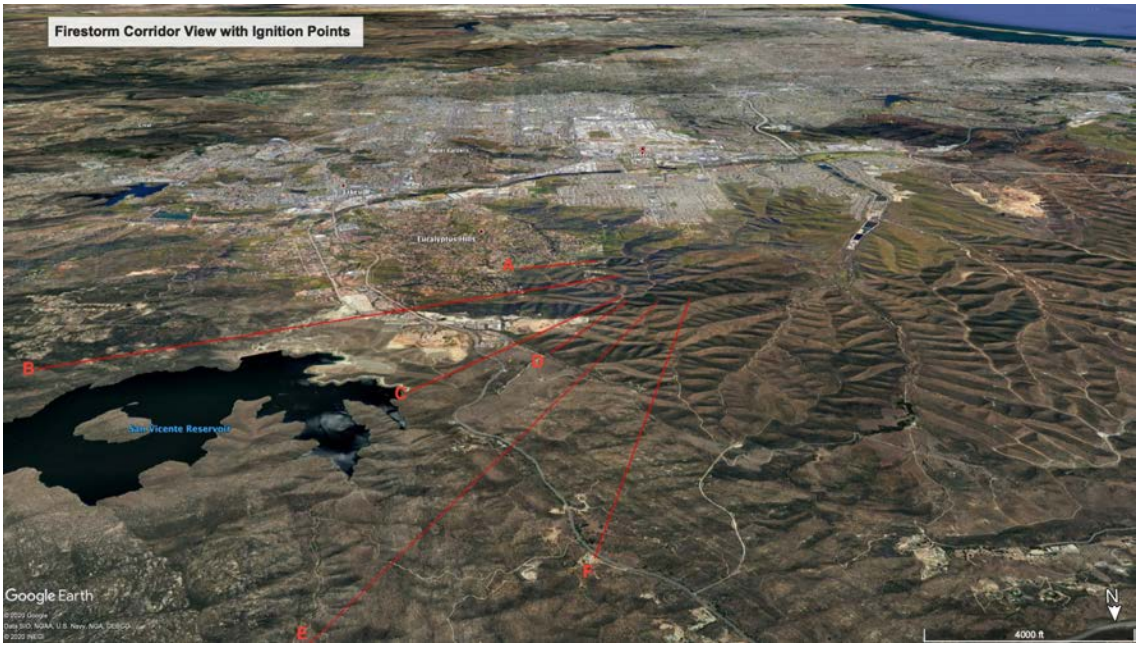
Fire code requires two access routes with at least 1.38 miles of separation. Cuyamaca Street and Fanita Parkway merge into a single horseshoe configuration dependent upon Mast Boulevard. The distance between the two roads is only **1.25 miles** at the exits from natural lands. Fire Code D107.2 Remoteness requires a minimum of 1.38 miles of road separation based upon a service area diagonal dimension of 2.75 miles. **The road design is not compliant and both of these routes could be heavily impacted by a firestorm simultaneously.**

There is a lack of public safety zones within the project site. Since the project relies upon the school as a Temporary refuge Area, what is the status of potential school construction? What is the impact of losing the school site as a TRA?

Why hasn't the highest risk topography on the northern part of the project site been avoided?

Points A- E are all plausible ignition points and plausible scenarios for Santa Ana wind driven fires, yet the EIR fails to plan for any of them or any other points of ignition. Not one single scenario is evaluated in the document for timing of evacuation or emergency response. The decision is negligent and a callous denial of the trends of growing mega-storm wildfires.

Point A is .6 miles from the project.
Point B is 3.75 miles from the project.
Point C is 1.9 miles from the project.
Point D is 1 mile from the project.
Point E is 3.75 miles from the project.
Point F is 3 miles from the project.
[1 mile = 5,280 feet]



The 2007 FPP disclosed a potential rate of spread at **1,966.5 feet/minute**

Of the requested ignition point analysis, Points B and E are the greatest distance so the fire would impact the project site more rapidly in the other scenarios.

Points B & E = 19,800 feet / 1966.5 feet/minute = **10.06 minutes to the project site**.

Can the project site be evacuated in 10 minutes or less? The answer to this question the EIR refuses to analyze and disclose is that it is absolutely not feasible to evacuate the project site in 10 minutes or less. Under these scenarios with structural failure leading to cluster burns there would be a mass casualty incident.

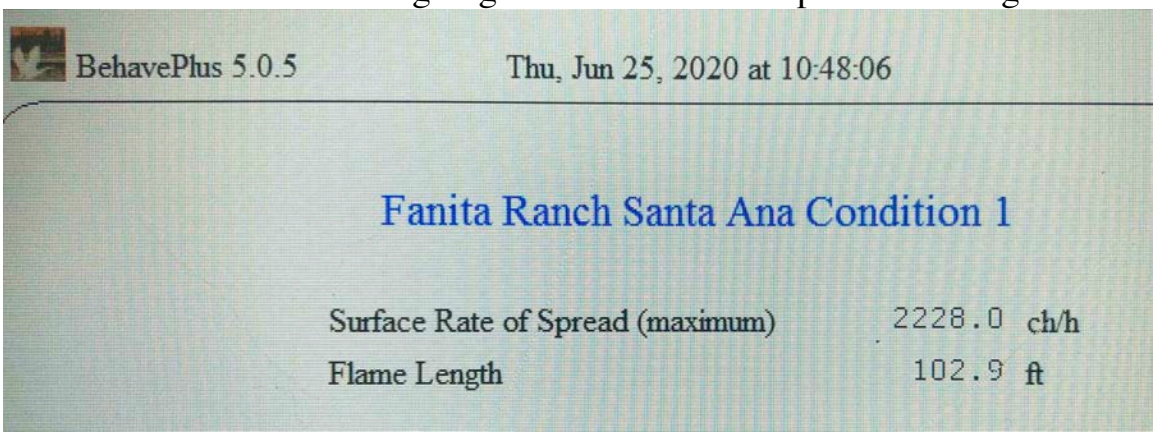
These calculations reveal a significant adverse impact with an answer of yes to the question: "***Would the project expose people or structures, either directly or indirectly, to a significant risk of loss, injury or death involving wildfires?"***

Again – the EIR does not adequately address this CEQA required significance threshold issue/question.

A Santa Ana wind driven fire igniting 17 miles downwind would impact the project site in 45 minutes.

89,760 feet / 1966.5 feet/minute = **45 minutes to the project site.**

In 2007, at hearing, a project consultant estimated at least 1 hour and 45 minutes to evacuate a 1,395-unit project site. If the calculation for the 1,395-unit project is reliable, evacuation of the project site is clearly underestimated and infeasible for a 3,000-unit project. The project wagers heavily upon shelter-in-place without being honest about the bet or designing a feasible fall back plan if the wager fails.



A project infeasible to evacuate provides incentive for project proponent consultants to diminish former FPP flame length calculations by utilizing different inputs. I have performed a calculation yielding 102.9 ft. flame lengths using reasonable input variables.

The Evacuation Plan is Inadequate

The Evacuation Plan needs to address the additional significant deficiencies.

What data addresses the deficiencies identified below?

An Evacuation Plan summary should be part of a Tactical Suppression plan summary that describes the specific area of coverage by geographic name/s, Public Safety grid map pages / grid numbers & Thomas Guide grid pages.
The tactical suppression summary cover should prepare a Risk Assessment Summary with a Risk Assessment Matrix and Critical Information chart including: Firefighter Safety, Civilian Safety, Air Safety (recognizing MCAS Miramar and Gillespie Field flight paths), Hazmat, Fuels, Topography, Clearance, Construction, Structural Spacing, Access, Water, Communications, Tac Air support.

Critical Information should include response safety including access and communication frequencies.

Briefing Information should include fuels, expected fire behavior, topographic features, access, special hazards, specific safety zones, temporary refuge areas, limits of use for each, water supplies.

Command post, potential participants, staging areas should be identified.
Large fire weather development factors should be addressed.
WUI arrangements should be identified.
All of the items above should encapsulated on the cover page summary.

A second summary page should be developed for a Tactical Plan that includes the Evacuation Plan Summary. The EP summary should include a description of targeted populations, including critical/notable sites and communication methods. Evacuation trigger points should be identified. Temporary assembly sites and safety zones should be identified.

The larger tactical plan summary should include a primary plan, alternate plan, contingency plan, emergency plan and perimeter control plan.

Develop an assessment of population and structures at risk for the planning area that considers structural triage.

Emergency resource needs for the first six hours should be identified, including law enforcement, logistics and other organizational response.

A tactical map should be prepared that includes information from the critical information summary page.
Area map page summaries to clearly portray evacuation routes and other critical data should be included.

Scenario maps should be prepared that include critical ignition points, major paths, and projected arrival times with common and extreme weather variables.

Have the Tactical / Evacuation Plan Summaries described above been prepared similar to what already exists (as described above) for another location in the county? If not, will they be prepared and when?

The project has significant adverse impacts to public safety and should be denied.

Sincerely,
/s/
Van Collinsworth
Geographer/Fire Expert/Director

Attachments: Exhibits 1-34

Exhibit Index

1 People deserve to know their houses are going to burn
2 CAL FIRE Wildland-Urban-Interface Safety
3 MEGA FIRES- The Case for Mitigation
4 Santee Council Removes Fanita Ranch from November Ballot
5 Fire Resistant is not Fire-proof California Homeowners Discover
6 Why do we keep building houses in places that burn down
7 Ready-Set-Go! CAL FIRE
8 Sorenson and Vogt, Results .. Using Reverse
9 Evacuation Decision Making and Behavioral Responses
10 City of Santee - Ordinance No. 570 p 3
11 Evacuation Checklist Grid Maps Plan Tactics B
12 Evacuation An Assessment of Planning and Research
13 Characteristics of structures that burned in the 2018 Camp Fire
14 Housing Arrangement...Camp Fire
15 Coastal fire burns 20 homes, forces evacuations in Laguna Niguel
16 High Density Development Damage Comparisons
17 Cedar Fire Report
18 Can We Really Understand Exponential Growth?
19 Chico State student loses mother and paradise home
20 'I want my mom back'- Survivor recounts final moments with mother
21 Woman who refused to flee is one of the dead
22 Paradise fire survivors say warnings were too little too late
23 Courts block San Diego housing projects over wildfire risks
24 Lilac Fire After Action Report
25 Insurance Companies Increasingly Drop Homes Throughout San Diego
26 Temporary Refuge Area Considerations and Options
27 Reuters Graphics California fires threaten unbuilt housing
28 National Bureau of Economic Research
29 Referendum Item 10 Statements
30 Reporter notebook/ Cal Fire San Diego…
31 California's not enforcing wildfire-prevention rules for homeowners
32 Santee DraftHousingElement 2021-2029
33 Developments in disaster-prone areas means big bucks for builders, but can leave communities at risk
34 CAL FIRE Wildland-Urban-Interface Book

References & Links:

Anna Huntsman and Jake Steinberg. Developments in disaster-prone areas mean big bucks for builders, but can leave communities at risk. August 13, 2019. News21.
https://stateofemergency.news21.com/developments-in-disaster-prone-areas-means-big-bucks-for-builders-but-can-leave-communities-at-risk/

Briar Stewart. 11/22/2018. 'This is where they must have found her': Woman who refused to flee California fire is one of the dead. CBC News
https://www.cbc.ca/news/world/california-paradise-wildfires-1.4915372

Bianca Quilantan. 12/19/2018. 'I want my mom back': Survivor recounts final moments with mother. San Jose Mercury News
https://www.mercurynews.com/2018/12/19/i-want-my-mom-back-camp-fire-survivor-recounts-final-moments-with-mother/

Cal Fire. 2014. Wildland Urban Interface Operating Principles
https://www.iaff.org/wp-content/uploads/2019/05/CAL-FIRE-Wildland-Urban-Interface-Book.pdf

Camille von Kaenel. 06/15/2022. San Diego officials said rural homes were safe from fires. They were listening to developers. inewsource.
https://inewsource.org/2022/06/15/rural-homes-fire-risk/?fbclid=IwAR2uSYjVdR0Fmx8Ofn40qd07ALRRKGonGtuwHxoAjpdYBieJgAV5CE51nXY

Camille von Kaenel. 09/03/2021. Insurance Companies Increasingly Drop Homes Throughout San Diego County As Fire Risks Rise. inewsource.
https://www.kpbs.org/news/2021/09/03/insurance-companies-increasingly-drop-homes-throug

County of San Diego. 2017. Lilac Fire After Action Report
https://www.sandiegocounty.gov/dmpr/docs/LilacFireAAR.pdf

Daniel Trotta. May 4, 2022. As California burns, environmentalists find new tactic to halt development. Reuters.
https://www.reuters.com/world/us/california-burns-environmentalists-find-new-tactic-halt-development-2022-05-03/?fbclid=IwAR0w1RCG7MAoIPX7dPC_1xxEUOrLIGX2u5ykZ9iJBVIAjra5GDRoNwNDvbI

Emma Marris. 03/15/2022. People Deserve to Know their Houses Are Going to Burn. The Atlantic.
https://www.theatlantic.com/science/archive/2022/03/wildfire-insurance-california-fair-plan/627065/

Emily Guerin. 12/09/2018. Fire-Resistant Is Not Fire-Proof, California Homeowners Discover. KPCC Southern California Public Radio
https://www.kunc.org/2018-12-09/fire-resistant-is-not-fire-proof-california-homeowners-discover

Emily Guerin. 09/24/2018. Why Do We Keep Building Houses In Places That Burn Down? LAist
https://laist.com/news/why-do-we-keep-building-houses-in-places-that-burn-down

Eric E. Knapp, Yana S. Valachovic, Stephen L. Quarles and Nels G. Johnson. 2021. Housing arrangement and vegetation factors associated with single-family home survival in the 2018 Camp Fire, California

Firefighter Nation Staff. 7/17/2012. Temporary Refuge Area Considerations and Options
https://www.firefighternation.com/firerescue/temporary-refuge-area-considerations-and-options/#gref

James Rainey. 11/14/2018. Paradise Fire survivors say warnings were too little, too late. NBC News
https://www.nbcnews.com/news/us-news/paradise-fire-survivors-say-warnings-were-too-little-too-late-n935846

Joshua Emerson Smith. Reporter notebook: Cal Fire San Diego cracks down on flammable vegetation around homes. April 30, 2021. San Diego Union-Tribune.
https://www.sandiegouniontribune.com/news/environment/story/2021-04-30/cal-fire-san-diego-flammable-vegetation?fbclid=IwAR1GjIuNWegcGiXD9MeJsa_YQ3Yyegq__T0IHB98gVphlHTJH7vQT1Z4tSs

Joshua Emerson Smith. California's not enforcing wildfire-prevention rules for homeowners, leaving tens of thousands of properties vulnerable to big blazes. July 7, 2019. San Diego Union-Tribune.
https://www.sandiegouniontribune.com/news/environment/story/2019-06-11/californias-not-enforcing-wildfire-prevention-rules-for-homeowners-leaving-tens-of-thousands-of-properties-vulnerable-to-big-blazes

Mike Allen. 06/12/2022. Santee Council Removes Fanita Ranch From November Ballot. East County Magazine.
https://www.eastcountymagazine.org/print/37950?fbclid=IwAR0bu8JR6GGiwGs9n7Qh6zjLuwWInCSOFZwoVhC1rM58dYu96bqQW8uILjQ

Patrick W. Baylis & Jason Boomhower. Monitored vs. Voluntary Adaptation to Natural Disasters: The Case of U.S. Wildfires. December 2021. National Bureau of Economic Research. http://www.nber.org/papers/w29621

Sorenson, J. A. 08/30/2002. Planning Protective Action Decision-Making: Evacuate or Shelter-in-Place. Oak Ridge National Lab. FEMA.
https://www.osti.gov/biblio/814651-planning-protective-action-decision-making-evacuate-shelter-place

Travis Hartman & Daniel Trotta, May 2, 2022. California fires threaten unbuilt housing. Reuters.
https://graphics.reuters.com/CLIMATE-CHANGE/USA-WILDFIRES/zgvomlymnvd/index.html?fbclid=IwAR1XIf6qPrwGJIrLSnAP6J3e5YUIFn94w1fbK9O2k7klKz4t2Gt73RveLek

United States Forest Service, California Department of Forestry & Fire Protection. 2003. The 2003 San Diego County Fire Siege Fire Safety Review
https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5297020.pdf

Yaritza Avon. 12/5/2018. Chico State student loses mother and Paradise home during the Camp Fire. The Orion
https://theorion.com/77084/news/chico-state-student-loses-mother-and-paradise-home-during-the-camp-fire/

8/26/2021 Urgency Ordinance adopting an Essential Housing Program
https://ceqanet.opr.ca.gov/2021080506

City of Santee. 2021. Draft Housing Element 2021-2029
https://www.cityofsanteeca.gov/Home/Components/News/News/3890/9

12/28/21 Fanita Ranch Essential Housing Project (EHP2021-1)
https://ceqanet.opr.ca.gov/2021120599

Notice of Exemption
https://www.cityofsanteeca.gov/home/showpublisheddocument/21743/637768993340730000

City of Santee Regular Meeting Agenda. June 08, 2022. Item 10 - Resolution Repealing Resolution No. 006-2021

Collinsworth. 6/08/2022. Statement Item 10 - Resolution Repealing Resolution No. 006-2021

Peter J. Broderick. 6/08/2022. Letter Item 10 - Resolution Repealing Resolution No. 006-2021. Center for Biological Diversity

Recirculated Sections of Final Revised Environmental Impact Report Fanita Ranch Project
https://www.cityofsanteeca.gov/services/project-environmental-review

Van K. Collinsworth

9222 Lake Canyon Road, Santee, CA 92071
Phone: 619-777-8268

Defensible Space Inspector

Wildland Fire & Natural Resource Management Experience

Fire Inspector – California Department of Forestry & Fire Protection / Cal Fire **2016-2022**

- Performed over 5,000 defensible space inspections focused on wildland-urban-interface, primarily in the Witch Creek Fire and Cedar Fire corridors. Achieved > 90% average annual compliance. Explained & distributed Ready, Set, Go! Performed public registration of AlertSanDiego. Trained firefighters for digital DSI. Updated DINS and ICS qualifications. Provided initial size-up reports of lightning fires on Mt. Palomar, Hot Springs Mtn. and other incidents. Performed traffic control. Evacuated trail/trailhead. Directed engine resources to special needs residents during Battalion 8 incidents. Made public presentations. Introduced engine crews to Electrical Vehicle TC response/fire suppression tactics.

Wildland Firefighter - Forestry Technician, USDA Forest Service **1980-1993**

- Responded to fire emergencies in the Western US including major Santa Ana wind driven. Performed in supervisory positions: Incident Commander, Assistant Operations Chief, Assistant Air Operations Chief, Fire Engine Operator, AFEO, Squad Supervisor. Performed backfire and burnout operations with drip torches and fusees. Coordinated with a heli-torch to backfire in chaparral. Participated in search & rescue operations. Completed/taught fire training courses/exercises. Planned/executed prescription burns without escapes.

Natural Resource Geographer **1994-2015**

- Shape community development and policy through analysis of and contribution to environmental documents, planning efforts and public relations. Review legal notices, hearing notices, staff reports, conditional use permits, general plans, zoning overlays, grading ordinances, fire protection plans, aerial photographs and other planning documents. Provide expert testimony on fire and natural resource issues.
- Performed site field evaluations. Identified and documented resources with high-resolution images and GPS. Created maps, spreadsheets, films and web content.
- Organized and participated in public forums. Delivered television, radio and telephone press interviews.
- Provided oversight for construction mitigation & monitoring agreements, including the application of storm water regulations; development and implementation of landscaping plans for the SR-125 Tollway. Coordinated with Caltrans, CA Regional Water Quality Control Board, County of San Diego, City of San Diego, City of Chula Visa staff, elected officials, planning group representatives and community members to resolve transportation, land use and various community environmental issues. Served as a founding member of the Policy Committee for the San Diego Fire Recovery Network. Authored "Preventing Firestorm Disaster" PPT, November 2003.

Academic Qualifications

Master of Arts, Geography/Political Science emphasis, Humboldt State University **1986**

Teaching Credential, Social Science, Humboldt State University **1983**

Bachelor of Arts, Geography, Humboldt State University **1982**

125-quarter units of Environmental Resource and Biological Sciences.



Preserve Wild Santee

September 23, 2020

Mr. Chris Jacobs
Santee City Council
City of Santee
10601 Magnolia Avenue
Santee, CA 92071

RE: Fanita Ranch Draft Environmental Impact Report

Dear Mr. Jacobs and City Council,

The project should be denied. Placing thousands of new residents in a Cal Fire designated "Very High Fire Hazard Severity Zone" while the State is setting more records for climate wildfires would be gross negligence. Magnifying the potential negligence, the applicant has now proposed elimination of the Magnolia Avenue escape route.

The applicant's decision to cancel the noticed August 26 hearing to eliminate the Magnolia Avenue escape route in an attempt to allow a conflicted councilmember to vote on the project fails for many reasons.

The significant adverse impacts to public safety, noise and traffic impacts of the revision have not been disclosed, avoided or adequately mitigated. Elimination of the Magnolia Avenue escape route from a Cal Fire designated "Very High Fire Hazard Severity Zone" is a significant change to the project that requires real analysis, full disclosure and recirculation of the EIR with an adequate public review period.

The idea that a Cuyamaca Street southbound left turn prohibition can mitigate the significant adverse impacts to neighborhood streets is baseless. Even if the prohibition was respected and enforced (which it won't be) it does nothing to prevent cut through traffic westbound from existing Magnolia Avenue to Cuyamaca Street. This alone, is a significant adverse impact to neighborhood health and safety that is undisclosed. Furthermore, the adverse impacts from the mitigation measure itself have not been considered, such as the safety conflicts from non-compliant drivers.

Secondarily, any discussion of the project with or without the Magnolia Avenue escape route conflicts Council member McNelis because the route is still part of the discussion as an alternative. Rob McNelis needs to recuse himself from the hearing for this conflict. Attachment 1 Magnolia Extension Evacuation Route Map clearly shows Magnolia Avenue extension as a "Potential Road Alternative."

9222 Lake Canyon Road, Santee, CA 92071 Tel/Fax (619) 258-7929 SaveFanita@cox.net I.D.#980429
PreserveWildSantee.org

1.3 Section 1.3 fails to acknowledge or even discuss the significance of eliminating the Magnolia Avenue escape route undermining the credibility of the entire document. Unfortunately, this action continues a theme of denial evident by turning away from the conclusions of the prior Fire Protection Plan in favor of hiring a new consulting firm that was previously fined by the FPPC for laundering funds to pro-Fanita project council members.

Santee residents previously defeated a 3,000-unit project by a 2/3 landslide. The effort to force another 3,000-unit project upon Santee residents despite their clear direction reeks of corruption. [Reference Van Collinsworth letters dated 9/21/2020 documenting the flow of funds from Fanita Ranch participants to elect Santee city council members.]

In regard, to responses to our July 13, 2020 comment letter. We find the responses inadequate and stand by the objections raised.

Thematic Responses with general rationalizations to the specific evidence provided in comments are inadequate. For instance, specific evidence was provided as to why cluster burns on this project are of great concern. None of the specific details were addressed with substantial evidence to the contrary.

Furthermore, false information is provided with a suggestion cluster burns don't occur in new developments, 0-7-22. When asked for distances between structures and the flame impingement potential from structure-to-structure, the response was to pivot rather than answer with factual data.

At 07-23, the response fails to calculate or even estimate the time it would take to evacuate the project site. If consultants can't venture an estimate now, how can public officials be expected to figure that out in the heat of the moment when lives are on the line? What is likely, yet undisclosed is that the site cannot be effectively evacuated and the design wagers heavily that design features will prevent cluster burns with mass fatalities.

07-27: Specific questions regarding change to total WUI and firefighter staffing are ignored and unanswered.

07-29: The response repeats claims about specific developments that have already been refuted with specific evidence in prior PWS comments.

07-30: The response attempt to shift responsibility for inadequate FMZ maintenance from the current Fanita Ranch owner to individual homeowners. The photos were taken on land that is the applicant's responsibility. Similar issues can be expected over time with new ownership.

07-31: There is no confusion about a 4-times flame length rule of thumb to reduce the potential for burn injuries. The principle is the same if it is a firefighter deploying a fire shelter or an individual temporarily sheltered in a vehicle. Chaparral is capable of generating flame lengths in excess of 100-feet and the gridlock the inadequate circulation system provides potentially leaves people incinerating in their vehicles. The FPP has not even bothered to calculate the time it takes to evacuate any portions of the project site.

7-38: The response mentions temporary shelter in a village core without any specifics. If the project is counting on a school, at over $70 million that structure is unlikely to be built as part of the project.

9222 Lake Canyon Road, Santee, CA 92071 Tel/Fax (619) 258-7929 SaveFanita@cox.net I.D.#980429
PreserveWildSantee.org

07-40: The response shirks the responsibility of locating thousands of people in a fire corridor by claiming there is not a requirement to provide an evacuation plan.

The Response represents the resistance and failure of the EIR to answer the basic CEQA threshold of significance question:

"***Would the project expose people or structures, either directly or indirectly, to a significant risk of loss, injury or death involving wildfires***?

The detailed questions asked in comments with regard to the project, it's "Fire Protection Plan" and "Evacuation Plan" are attempts to get the consultant team to address the basic CEQA threshold of significance issue.

A computer search of the FEIR does not locate the basic threshold question. It is no wonder the responses avoids or refuses to answer the questions specific to this CEQA issue. This failure leaves a gaping hole in the document regardless of whether a case can me made that an "evacuation plan" is not required or would not be utilized by emergency response if it were thoughtfully prepared. A significant portion of firefighters time is spent in training and preparation.

For instance, for my crews, that training included learning the geography of the district/unit and field-tested size-ups of potential ignition points with theoretical emergency response. In too many cases it also included harsh criticism of the situations land use authorities created on the ground with site-specific building approvals. Regardless, thoughtfully prepared plans, if prepared and made available would aid the training and preparation process described. This is especially true as the threat to development intensifies. The treat grows increasingly undeniable by the rapid pace of setting new records for wildfires.

For a stark taste of reality compare the list of California's Top 20 wildfires provided at the July 13, 2020 comment deadline and today. In less than a few months the list has been massively altered along with California's landscape by an astounding 3 million+ acres burned and still spreading. The record for the state's largest wildfire (the Mendocino Complex, 459,123 acres set in 2018) has been broken by a factor of two (August complex 878,368 acres and still burning). The state's record for the largest fire and all 20 of California's most destructive fires, have now occurred since 1990. Two of the fires – The North Complex and LNU Lightning Complex are now on the list for the Top 20 Deadliest California Wildfires. The deadliest California wildfire – the Camp Fire – a megafire of 153,336 acres destroying 18,804 structures, killing 85) has actually been knocked of the list of the Top 20 Largest fires. All 20 of the state's largest fire are now megafires exceeding 160,000 acres. At our July comment deadline, there were still 5 fires on the list of largest fires between 140,000 and 153,000 acres. The trends are an ominous warning to those that would still approve developments in high-risk topography.

07-43: The Response fails to answer the question. Who is or are the appropriate entities for transportation assistance? This should be answered by a project that proposes to place thousands in a severe fire hazard zone.

07-44, 45, 46, 47: The Responses shirk responsibility for emergency planning and preparation and fail to answer the valid questions raised.

9222 Lake Canyon Road, Santee, CA 92071 Tel/Fax (619) 258-7929 SaveFanita@cox.net I.D.#980429
PreserveWildSantee.org

07:49: The Response assumes without providing any evidence that law enforcement will be available during Santa Wind driven wildfires when emergency response teams are often overwhelmed by the pace and scale of multiple expanding events. The response is a continuation throughout the document of discounting the potential for gridlock along evacuation routes adjacent to wildland fuels capable of incinerating evacuees.

07-51: The Response again fails to answer the basic question of how long it will take to evacuate the project site. The response assumes incorrectly and without any evidence that a wildfire will not transition into the urban environment with older homes highly vulnerable to embers and that high-intensity urban fires would not impact gridlocked escape routes. The response completely ignores recent fire history of urban environments in California and Oregon being wiped from the map by wind driven firestorms.

07-52: The Response shirks responsibility for emergency planning and preparation and fails to answer the valid questions raised. The Response assumes without providing any evidence that law enforcement will be available during Santa Wind driven wildfires when emergency response teams are often overwhelmed by the pace and scale of multiple expanding events.

07-54: The Response shirks responsibility for emergency planning and preparation and fails to answer the valid questions raised.

07-55: The Response shirks responsibility for emergency planning and preparation and fails to answer the valid questions raised. The **Figure 2 Evacuation Plan Map is not accurate as it shows a Mast Boulevard connection to Lakeside and SR-67**. This is a fatal flaw as Mast Boulevard is identified as a "Primary Evacuation Route." The failure to correct this issue after requesting a correct map is glaring. Now the Magnolia Avenue escape route identified on Figure 2 has been removed from the project preferred alternative as well so a council member can vote. Neither of these issues are accounted for because the need for evacuation and preparation is not taken seriously by the flawed assumptions built into the limited analysis.

Attachment 1 Magnolia Extension Evacuation Route Map in the second errata has clearly failed to correct the errant map depicting Mast Boulevard connected to Lakeside and SR-67. **Attachment 2 No Magnolia Extension Evacuation Route Map** still depends on the non-existent Mast Boulevard connection to Lakeside/SR-67.

Will **all** dwelling units contain an approved automatic sprinkler system? If not the code relevant to the two required access routes for the site is ignored. Cuyamaca Street and Fanita Parkway merge into a single horseshoe configuration dependent upon Mast Boulevard. The distance between the two roads is only **1.25 miles** at the exits from natural lands. Fire Code D107.2 Remoteness requires a minimum of 1.38 miles of road separation based upon a service area diagonal dimension of 2.75 miles. **The road design is not compliant and both of these routes could be heavily impacted by a firestorm simultaneously.**

07-56: The Response concludes without evidence there is not a lack of safety zones within the project site and ignores comments demonstrating how rapidly the project site can change with cluster burns.

07-58: The Response fails to answer the question of why the riskiest topography on the project site was not avoided.

9222 Lake Canyon Road, Santee, CA 92071 Tel/Fax (619) 258-7929 SaveFanita@cox.net I.D.#980429
PreserveWildSantee.org

07-58-62: The Response discounts readily available data that demonstrates worst-case scenarios are plausible and should be considered.

07:63-74, 08-1-8-6: The Responses shirk responsibility for emergency planning and preparation and fail to answer the valid questions raised.

Points A- E are all plausible ignition points and plausible scenarios for Santa Ana wind driven fires, yet the EIR fails to plan for any of them or any other points of ignition. Not one single scenario is evaluated in the document for timing of evacuation or emergency response. The decision is negligent and a callous denial of the trends of growing mega-storm wildfires.

Point A is .6 miles from the project.
Point B is 3.75 miles from the project.
Point C is 1.9 miles from the project.
Point D is 1 mile from the project.
Point E is 3.75 miles from the project.
Point F is 3 miles from the project.
[1 mile = 5,280 feet]

The 2007 FPP disclosed a potential rate of spread at **1,966.5 feet/minute**

Of the requested ignition point analysis, Points B and E are the greatest distance so the fire would impact the project site more rapidly in the other scenarios.

Points A & E = 19,800 feet / 1966.5 feet/minute = **10.06 minutes to the project site**.

Can the project site be evacuated in 10 minutes or less? The answer to this question the EIR refuses to analyze and disclose is that it is absolutely not feasible to evacuate the project site in 10 minutes or less. Under these scenarios with structural failure leading to cluster burns there would be a mass casualty incident.

These calculations reveal a significant adverse impact with an answer of yes to the question: "***Would the project expose people or structures, either directly or indirectly, to a significant risk of loss, injury or death involving wildfires?"***

Again – the EIR does not directly address this CEQA required significance threshold issue/question.

A Santa Ana wind driven fire igniting 17 miles downwind would impact the project site in 45 minutes.

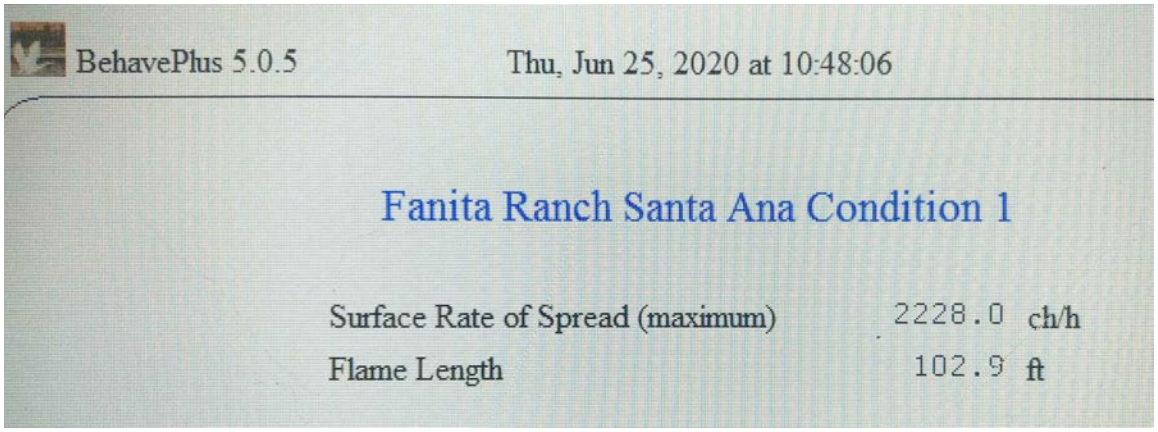
89,760 feet / 1966.5 feet/minute = **45 minutes to the project site.**

The 2007 FPP estimated at least 1 hour and 45 minutes to evacuate a 1,395-unit project site. If the calculation for the 1,395-unit project is reliable, evacuation of the project site is clearly infeasible for a 3,000-unit project.

The consultant team is aware of the 2007 FPP conclusions, so it is no wonder the issue has been buried by an unsupportable mix of assertions the project can withstand firestorms with some mix of temporary refuge areas for evacuees. The project wagers heavily upon shelter-in-place without being honest about the bet or designing a feasible fall back plan if the wager fails.

9222 Lake Canyon Road, Santee, CA 92071 Tel/Fax (619) 258-7929 SaveFanita@cox.net I.D.#980429
PreserveWildSantee.org

A project infeasible to evacuate provides incentive to diminish 2007 FPP flame length calculations by utilizing different inputs. I have performed a calculation yielding 102.9 ft. flame lengths using reasonable input variables.



Responses to Aesthetics, Alternatives, Biology, Cultural, Energy and Climate

The responses to issues raised in these sections are also inadequate and our objections are carried forward along with our prior comment letters.

Finally, we object to the brief time period provided to review the substantial changes to the document and request Recirculation for public review.

Sincerely,

/s/
Van K. Collinsworth
Geographer/Fire Expert/Director

Attachments:
Recent wild fire data and press
Credentials

9222 Lake Canyon Road, Santee, CA 92071 Tel/Fax (619) 258-7929 SaveFanita@cox.net I.D.#980429
PreserveWildSantee.org

Van K. Collinsworth

9222 Lake Canyon Road, Santee, CA 92071
Phone: (619) 258-7929, E-Mail: Van27@cox.net

Wildland Fire and Natural Resource Qualifications

Experience

Fire Inspector – California Department of Forestry & Fire Protection / Cal Fire **2016-2019**

- Performed thousands of defensible space inspections focused on wildland-urban-interface in Battalions 5 & 8 Witch Creek & Cedar Fire corridors. Performed other fire prevention actions. Achieved > 90% average compliance/season. Trained firefighters for digital DSI. Lightning patrols provided initial size up reports of lightning fires on Mt. Palomar, Hot Springs Mtn. and other incidents. Made public presentations. Updated Damage Inspection Certification. Updated Cal Fire Certifications include: Incident Command System for Initial Response: IS-100100, IS-100700.b, IS-00200.c. Wildland Fire Behavior S-190. Damage Inspection (DINS).

Wildland Firefighter - Forestry Technician, USDA Forest Service **1980-1993**

- Responded to fire emergencies in the Western US including major Sana Ana wind driven. Performed in supervisory positions: Incident Commander, Assistant Operations Chief, Assistant Air Operations Chief, Fire Engine Operator, AFEO, Squad Supervisor. Performed backfire and burnout operations with drip torches and fusees. Coordinated with a heli-torch to backfire in chaparral. Participated in search & rescue operations. Completed/taught fire training courses/exercises. Planned/executed prescription burns without escapes.

Natural Resource Geographer / Resource Analyst **1994-2019**

- Shape community development and policy through analysis of and contribution to environmental documents, planning efforts and public relations. Review legal notices, hearing notices, staff reports, conditional use permits, general plans, zoning overlays, grading ordinances, fire protection plans, aerial photographs and other planning documents. Provide expert testimony on fire and natural resource issues.
- Performed site field evaluations. Identified and documented resources with high-resolution images and GPS. Created maps, spreadsheets, films and web content for negotiation and public distribution.
- Organized and participated in public forums. Delivered television, radio and telephone press interviews.
- Provided oversight for construction mitigation & monitoring agreements, including the application of storm water regulations; development and implementation of landscaping plans for the SR-125 Tollway. Coordinated with Caltrans, CA Regional Water Quality Control Board, County of San Diego, City of San Diego, City of Chula Visa staff, elected officials, planning group representatives and community members to resolve transportation, land use and various community environmental issues. Served as a founding member of the Policy Committee for the San Diego Fire Recovery Network. Authored "Preventing Firestorm Disaster" PPT, November 2003.

Education

Master of Arts, Geography/Political Science emphasis, Humboldt State University **1986**

Teaching Credential, Humboldt State University **1983**

Bachelor of Arts, Geography, Humboldt State University **1982**

Includes 125-quarter units of Environmental Resource and Biological Sciences.

Top 20 Largest California Wildfires

	FIRE NAME (CAUSE)	DATE	COUNTY	ACRES	STRUCTURES	DEATHS
1	**AUGUST COMPLEX** *(Under Investigation)**	August 2020	Tehama	**878,368**	86	1
2	**MENDOCINO COMPLEX** *(Under Investigation)*	July 2018	Colusa, Lake, Mendocino & Glenn	**459,123**	280	1
3	**SCU LIGHTNING COMPLEX** *(Under Investigation)**	August 2020	Stanislaus, Santa Clara, Alameda, Contra Costa, & San Joaquin	**396,624**	222	0
4	**LNU LIGHTNING COMPLEX** *(Under Investigation)**	August 2020	Sonoma, Lake, Napa, Yolo & Solano	**363,220**	1,491	5
5	**NORTH COMPLEX** *(Under Investigation)**	August 2020	Butte, Plumas & Yuba	**299,723**	1,784	15
6	**CREEK FIRE** *(Under Investigation)**	September 2020	Fresno & Madera	**283,724**	855	0
7	**THOMAS** *(Powerlines)*	December 2017	Ventura & Santa Barbara	**281,893**	1,063	2
8	**CEDAR** *(Human Related)*	October 2003	San Diego	**273,246**	2,820	15
9	**RUSH** (*Lightning*)	August 2012	Lassen	**271,911 CA / 43,666 NV**	0	0
10	**RIM** *(Human Related)*	August 2013	Tuolumne	**257,314**	112	0
11	**ZACA** *(Human Related)*	July 2007	Santa Barbara	**240,207**	1	0
12	**CARR** *(Human Related)*	July 2018	Shasta County & Trinity	**229,651**	1,614	8
13	**MATILIJA** *(Undetermined)*	September 1932	Ventura	**220,000**	0	0
14	**WITCH** *(Powerlines)*	October 2007	San Diego	**197,990**	1,650	2
15	**KLAMATH THEATER COMPLEX** *(Lightning)*	June 2008	Siskiyou	**192,038**	0	2
16	**MARBLE CONE** *(Lightning)*	July 1977	Monterey	**177,866**	0	0
17	**LAGUNA** *(Powerlines)*	September 1970	San Diego	**175,425**	382	5
18	**BASIN COMPLEX** *(Lightning)*	June 2008	Monterey	**162,818**	58	0
19	**DAY FIRE** *(Human Related)*	September 2006	Ventura	**162,702**	11	0
20	**STATION** *(Human Related)*	August 2009	Los Angeles	**160,557**	209	2

There is no doubt that there were fires with significant acreage burned in years prior to 1932, but those records are less reliable, and this list is meant to give an overview of the large fires in more recent times.

This list does not include fire jurisdiction. These are the Top 20 regardless of whether they were state, federal, or local responsibility.

*Numbers not final.

9/22/2020

Top 20 Most Destructive California Wildfires

	FIRE NAME *(CAUSE)*	DATE	COUNTY	ACRES	*STRUCTURES*	DEATHS
1	**CAMP FIRE** *(Powerlines)*	November 2018	Butte	153,336	**18,804**	85
2	**TUBBS** *(Electrical)*	October 2017	Napa & Sonoma	36,807	**5,636**	22
3	**TUNNEL - Oakland Hills** *(Rekindle)*	October 1991	Alameda	1,600	**2,900**	25
4	**CEDAR** *(Human Related)*	October 2003	San Diego	273,246	**2,820**	15
5	**VALLEY** *(Electrical)*	September 2015	Lake, Napa & Sonoma	76,067	**1,955**	4
6	**NORTH COMPLEX** *(Under Investigation)**	August, 2020	Butte, Plumas, & Yuba	299,723	**1,784**	15
7	**WITCH** *(Powerlines)*	October 2007	San Diego	197,990	**1,650**	2
8	**WOOLSEY** *(Under Investigation)*	November 2018	Ventura	96,949	**1,643**	3
9	**CARR** *(Human Related)*	July 2018	Shasta County, Trinity	229,651	**1,614**	8
10	**LNU LIGHTNING COMPLEX** *(Under Investigation)**	August 2020	Lake, Napa, Sonoma, Yolo & Solano	363,220	**1,491**	5
11	**CZU LIGHTNING COMPLEX** *(Lightning)*	August 2020	Santa Cruz, San Mateo	86,509	**1,490**	1
12	**NUNS** *(Powerline)*	October 2017	Sonoma	54,382	**1,355**	3
13	**THOMAS** *(Powerline)*	December 2017	Ventura & Santa Barbara	281,893	**1,063**	2
14	**OLD** *(Human Related)*	October 2003	San Bernardino	91,281	**1,003**	6
15	**JONES** *(Undetermined)*	October 1999	Shasta	26,200	**954**	1
16	**BUTTE** *(Powerlines)*	September 2015	Amador & Calaveras	70,868	**921**	2
17	**CREEK FIRE** *(Under Investigation)**	September 2020	Fresno & Madera	283,724	**855**	0
18	**ATLAS** *(Powerline)*	October 2017	Napa & Solano	51,624	**783**	6
19	**PAINT** *(Arson)*	June 1990	Santa Barbara	4,900	**641**	1
20	**FOUNTAIN** *(Arson)*	August 1992	Shasta	63,960	**636**	0

"Structures" include homes, outbuildings (barns, garages, sheds, etc) and commercial properties destroyed.
This list does not include fire jurisdiction. These are the Top 20 regardless of whether they were state, federal, or local responsibility.
*Numbers not final

9/22/2020

Top 20 Deadliest California Wildfires

	FIRE NAME *(CAUSE)*	DATE	COUNTY	ACRES	*STRUCTURES*	DEATHS
1	**CAMP FIRE** *(Powerlines)*	November 2018	Butte	153,336	18,804	**85**
2	**GRIFFITH PARK** *(Unknown)*	October 1933	Los Angeles	47	0	**29**
3	**TUNNEL - Oakland Hills** *(Rekindle)*	October 1991	Alameda	1,600	2,900	**25**
4	**TUBBS** *(Electrical)*	October 2017	Napa & Sonoma	36,807	5,643	**22**
5	**NORTH COMPLEX** *(Under Investigation)**	August 2020	Butte, Plumas, & Yuba	299,723	1,784	**15**
6	**CEDAR** *(Human Related)*	October 2003	San Diego	273,246	2,820	**15**
7	**RATTLESNAKE** *(Arson)*	July 1953	Glenn	1,340	0	**15**
8	**LOOP** *(Unknown)*	November 1966	Los Angeles	2,028	0	**12**
9	**HAUSER CREEK** *(Human Related)*	October 1943	San Diego	13,145	0	**11**
10	**INAJA** *(Human Related)*	November 1956	San Diego	43,904	0	**11**
11	**IRON ALPS COMPLEX** *(Lightning)*	August 2008	Trinity	105,855	10	**10**
12	**REDWOOD VALLEY** *(Power Lines)*	October 2017	Mendocino	36,523	544	**9**
13	**HARRIS** *(Undetermined)*	October 2007	San Diego	90,440	548	**8**
14	**CANYON** *(Unknown)*	August 1968	Los Angeles	22,197	0	**8**
15	**CARR** *(Human Related)*	July 2018	Shasta County, Trinity	229,651	1,614	**8**
16	**ATLAS** *(Powerline)*	October 2017	Napa & Solano	51,624	781	**6**
17	**OLD** *(Human Related)*	October 2003	San Bernardino	91,281	1,003	**6**
18	**DECKER** *(Vehicle)*	August 1959	Riverside	1,425	1	**6**
19	**HACIENDA** *(Unknown)*	September 1955	Los Angeles	1,150	0	**6**
20	**LNU Lightning Complex** *(Under Investiagation)**	August 2020	Napa/Sonoma/Yolo/Stanislaus/ Lake	363,220	1,491	**5**

** Fires with the same death count are listed my most recent. Several fires have had 4 fatalties, but only the most recent are listed.
***This list does not include fire jurisdiction. These are the Top 20 regardless of whether they were state, federal, or local responsibility.
* Numbers not final

9/22/2020


Vancouver
Seattle
Montana
North Dako
Idaho
Oregon
South Dako
Wyoming
Nebrask
Denver
Nevada
Utah
San Francisco
Kans
California
Okl
Los Angeles
New Mexico
Texas
CURRENT
WILDFIRES
ESRI

Couple who died in California fire were ready to evacuate but reconsidered after 'erroneous information'

By Nelly Yaa, Hollie Silverman, Sarah Moon and Chert Mossburg, CNN
Updated 3:40 AM ET, Mon September 16, 2020

More from CNN

Jake Lloyd-Zhihao details what Pelosi should've said after impeachment

Dwayne Johnson rips down palm after getting trapped in driveway

Ad Feedback

The Best Sofa Beds & Sleepers

The Best Sleeper Sofa Brands, Prices & Where to See The Top Chairs Online Now

Open

Ad Choices

Related Articles

Fire Claims Homes as Calif. Battles Blazes

Evacuation Orders Issued as Calif. Fires Grow

Couple Who Died in Fire Had Fled Home Twice

Couple Who Died in Fire Had Fled Home Twice

Couple Who Died in Fire Had Fled Home Twice

Couple Who Died in Fire Had Fled Home Twice

[CNN] — Two people found dead near their destroyed home were packed and ready to evacuate the North Complex Fire in Northern California last week but changed their minds based on erroneous information, Butte County Sheriff Kory Honea said Tuesday.

Six days ago, Philip Rubke, 66, was found inside of burned-out Toyota pickup in the Concow area of Butte County, CA, authorities said Tuesday afternoon, according to the sheriff.

"After speaking to family members, it is believed the pair was aware of the fire in the area," Honea said. "They had packed their belongings in preparation to evacuate but later decided not to evacuate based on erroneous information they received from a concerned citizen."

The pair lived in Berry Creek, which is the area bordered by the Bear Fire, part of the North Complex.

Content by CNN Underscored

Never forget your password again with this award-winning app

CNN Underscored partners with companies that, in our opinion, can help you make a purchase. CNN receives revenue.

Berry Creek was under an evacuation order as of 3:22 p.m. PT on Tuesday. The evacuation was posted on social media sites and on the fire information line, and transmitted to cell phones. Deputies also went through the area with evacuation plans in case they were unable to reach anyone.

It is unknown where the couple saw or heard the information regarding the fire, Honea said. The sheriff's office is conducting an active investigation into the deaths. The area is still under the evacuation order.

Related Article Kamala Harris makes trip to California as wildfires rage

Man survives flames but loses farm

Eddie Campos watched helplessly as flames raced toward his family farm in Jamul, California.

"We called for an update. It just happened. Our property. We called for chopper support. And we couldn't get no help at all," Campos said.

Photos: Wildfires burning in the West

Wildfire smoke is seen in Medicine Bow National Forest, in southeastern Wyoming, on Monday, September 21.

1 of 40

Hide Captions

"We tried to get all our personal belongings. And I lost our kids, 11's time, and our bee are in danger now. It's just a horrible experience, seeing this fireplace headed toward us a few minutes."

Wildfires burn in the Western US

Note: Data as of 12:24 a.m. ET Friday.
Source: National Interagency Coordination Center, Pacific Northwest Region

Soon, his farm was engulfed in flames. But his family was lucky. At least 24 people have died in the Western wildfires, which have burned more than 4.7 million acres. That's more land than six states.

The National Interagency Fire Center said at least 87 wildfires are burning in 11 states.

Many of the fires are still raging, and pushing firefighters beyond exhaustion.

"We have so many brave firefighters who are working unending hours to try to contain these fires," Sacramento Mayor Darrell Steinberg said Tuesday.

"We are living through an unprecedented situation here on the West Coast and in California."

Before Campos and his family fled, "we went down the street to help a neighbor who was trapped," Campos said.

"We grabbed one dog. We helped get some chickens out — I think there were about nine or 10 chickens," he said. "It's a real tight community, and we worked together to rescue animals before we left here."

Related Article Wildfires are ravaging the West. Here's how you can help

this place."

16 people are missing in Oregon

Near the Beachie Creek fire east of Salem, Oregon, Scott Fogarty has no idea what happened to his longtime friend George Aleph. But he knows what happened to Aleph's property.

"His home was completely lost, and his shop," Fogarty said, holding photos of his friend.

Aleph is among at least 16 people missing in the Oregon wildfires, which have already killed eight people in the state.

Officials have said 20 people died, but two sets of recovered remains turned out to be those of relatives, according to Marcus Pridgeon of the state's Office of Emergency Management.

Authorities fear more deaths. A mobile medical examiner facility has been set up in Linn County, a southern area of the fires, said Timothy Fox, a spokesman for the Oregon Police Chiefs.

He said this is the first time a mobile morgue of that kind has ever been needed.

A nurse packs for evacuation, then goes back to work

Sherry Bell and Fred Andrews packed in the dark as the fire approached their home near Medford, Oregon. They weren't quite sure whether they should leave, but a police car went down the street urging people over the the loudspeaker to leave.

They did, but Sherwin went back to work at a hospital where she is a respiratory therapist in the neonatal intensive care unit. She helped evacuate young patients.

"It was the hardest sitting in my friend's home and thinking about what could be happening," she told CNN's Brooke Baldwin. Sherwin was extremely concerned that the fire obviously would come to the hospital and that set issued at refusing to move after it was released, police say.

Related Article Oregon wins praised for evacuating residents in time, but fear and confusion at setting as more after he was released, police say

The next day, Sherwin went by the neighborhood. The homes were gone. She went to her friend's home and it was the backyard was dried up.

"Nothing was really recognizable," she said. "It didn't feel like my home. It just felt like just pain. It was just really surreal to see."

The 36 victims include a boy and his grandmother

At least 21 people have died in the California wildfires. The Butte County Sheriff's Office has identified seven victims of the North Complex fire, who ranged in age from 35 to 70 and died in Berry Creek.

The eight people killed in Oregon included 13-year-old Hyatt Toffe and his grandmother, Peggy Wood.

And in Washington state, one child was killed, Gov. Jay Inslee said.

Oregon Emergency Management Director Andrew Phelps urged those who are evacuating to register with the American Red Cross so officials and loved ones will know they're safe.

"If you're concerned for missing family, please report that concern to the local law enforcement entity," he said.

Washington air quality is 'oppressive'

In Washington, the air quality is more than uncomfortable. Inslee called it "oppressive."

"It remains unhealthy at best, and hazardous at worst," Inslee added.

In fact, parts of the West Coast now have the worst air quality in the world, according to a study monitoring group IQAir.

Inslee said the wildfires, which have burned 620,000 acres (almost 970 square miles) in the state, have destroyed 600 homes.

Related Article The Western US has the worst air quality in the world, monitoring group says

CNN's Andy Rose, Steve Almasy, Martin Savidge, Michael Guy, Konstantin Toropin, Carma Hassan, Jennifer Sosa, Artemis Moshtaghian and Joe Sutton contributed to this report.

Paid Content

Smartfeed

[Photos] Octomom's Kids Are All Grown Up. Here's How...
Cotter

The Best Song Of All Time Is Mostly Forgotten Today
The Guide

Milwaukee students attending online class heard fatal shots and their teacher called 911

Read More

This Is The Most Beautiful Oscar Dress Of All Time
It's Easy

If Your Dog Eats Grass (Do This Every Day)
Ultimate Pet Nutrition

Unsold 2018 SUVs Going for Pennies on the Dollar
SUV | Sponsored Listings

Content by CompareCards

Spend $500, Get $200 with 1 of these cards

4 cards charging 0% interest until 2022

Results are in: Best credit cards of 2020

Don't Ignore These Offers if you have Excellent Credit

Conquer your debt with one of these cards

Content by LendingTree

Refi rates at 2.40% APR (0% DC pre-qualify)

Experts urge Americans to refinance in 2020

Skip this month's payment if you refinance today

Your best refinance rates for September 2020

Hack your mortgage by refinancing for a dip! Fees!

[Photos] Kim Kardashian's Ex Has Totally Changed. Now Fans Can't Even Recognize Him
Stars Cellular | Sponsored

Ad Choices

Paid Content

Historian: I watched 'Mulan' so you don't have to
Fandom

Oregon officials preparing for 'mass fatality incident' as...
CNN

Paid Links

Cell Phone Plans for Seniors in 2020

Mini Central Implants

Luxury Patio Furniture

Mortgage Interest Rates Today

10 Best Retirement Plans

Powered by Outbrain

More from CNN

An Oklahoma State University nurse died days from injuries.

University of Wisconsin-Madison grad student admits pretending...

An Idaho pastor skeptical of masks lands in the ICU for Covid-19

Scientists win award for giving an alligator helium and making...

California 'Gay Sex To Superstar Solar Panels If You Own A Home...
Energy Bill Cruncher

California Women Who Used Tatcum Powder May Be Eligible For A...
Talcum Powder Lawsuit

The Stunning Volkswagen Atlas Is Turning Heads In 2020
2020 Volkswagen Atlas | Sponsored Listings

Ad Choices

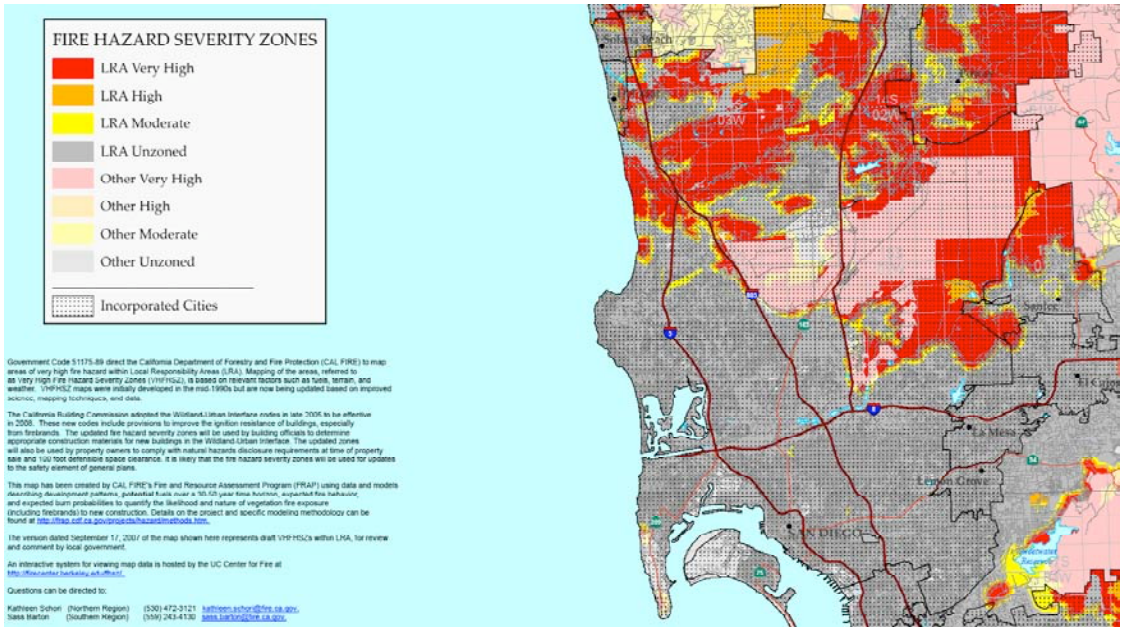
Mr. Kevin Mallory
City of Santee
10601 Magnolia Avenue
Santee, CA 92071

June 26, 2009

RE: Fanita Ranch REIR, Public Safety – Wildland Fire

Dear Mr. Mallory,

The City's new "Revised EIR" regarding fire safety does not take seriously the issues raised by public interest groups or the court's direction to reconsider its determination that fire safety impacts are less than significant. Instead, the City obtained expert testimony that attempts to disavow the conclusions and requirements plainly laid out in its own previous fire protection plan. Hence, the City does not impose any actual changes or meaningful mitigation requirements that would improve public safety within a State designated "Very High Fire Hazard Severity Zone." In its intransigence, the City would lose an opportunity to eliminate or mitigate significant fire risk to the public.[1]



*Once again the City attempts to downplay the severity of the Fanita Ranch fire hazard zone designation. Neither the REIR, nor the prior FEIR present the State of California Fire Hazard Severity Zone Map that includes Fanita Ranch within its most severe designation at "very high." The REIR refers instead to a "high" fire hazard zone twice at page 2, while making no reference to the State Fire Hazard Severity Zone Maps despite our previous comment letter pointing out the discrepancy. The State makes a clear distinction showing "Very High" fire severity in red and "**High**" severity zones in **orange**. Only Sycamore Creek riparian area is orange (High Severity) while the vast remainder of the Ranch is red (Very High Severity).*

The significant and severe fire risk at Fanita is exacerbated by the "mixed interface" embedding of the project within twenty miles of wildland fuel edge rather than the traditional replacement of the existing urban edge.[2]

"Required" Age Class Management

In regard to the "large open space area," the Fanita Fire Protection Plan (FFPP) warns "***without management, the probability is very high that the entire area will burn in a severe stand replacement wildfire***." The high probability of such a severe burn is why there is significant risk to *people* and property and why the FFPP has listed fuel modification for all open space as a "Required Treatment."[3]

The organization of the FFPP clearly designates Fuel modification of the open space habitat within Section 5.2 " **Required** Treatments and Actions." Section "5.2.11 **Required** Maintenance of Habitats," Section 5.2.12a **Required** Age Class management," both fall within Section 5.0 "Fuel Modification Descriptions & **Required** Treatments, And Conceptual Fuel Modification Location Map. The FFPP calls for and requires broad open space fuel modification clearly and repeatedly. Adoption however, would require additional off site mitigation for biological impacts.

So the City now wishes to isolate one variable (the risk to structures) and hence, misapply the research of fire scientist Jack Cohen that focuses primarily on the threat to structures from flame impingement and radiant heat. Although it would be advisable to increase the defensible space on Rock Point's northeast interface to 150 feet to protect from radiant heat, plaintiffs have not argued that direct flame impingement from fuel modification zones 1 and 2 (if strictly maintained)[4] would strike structures. Still, even Mr. Cohen acknowledges that a threat to structures remains from embers when he states in regard to Fanita: "*those that do [*ignite*] can be readily protected by limited resources*."

The unaddressed vulnerability here is that our experience in San Diego County under severe firestorms is the significant probability that absolutely no resources are available when individual structures ignite from embers and those residential ignitions readily spread to adjacent structures.[5] The REIR acknowledges this reality on page 7, "…City engine companies may not be readily available due to incidents in other areas due to wildland fire emergencies."

Cohen further notes the danger of embers/firebrands:

> *"Extreme Wildfires can produce firebrand spot-ignitions at distances of a mile or more; however* ***intense firebrand exposures within one-half to one-quarter mile*** *often ignite numerous surface fires within a residential area that spread to contact and ignite homes and/****or firebrands directly ignite homes****."* Jack Cohen 4/23/2009

The age class management required by the FFPP all falls within the one-half to one-quarter mile zone capable of producing intense firebrands and home ignitions ahead of the flame front and after the fire head passes.

Of the 1,125 homes destroyed in the Witch Fire of 2007, the majority had fire resistant features and still succumbed to ignitions by embers.[6] Hence, significant threat to public safety remains for structures placed in very high fire hazard severity zones. Furthermore, **the myopic focus on structures vulnerability to flame impingement misses or dismisses project critics relevant issues and the ability to mitigate their significant fire threat**.

Those unaddressed fire safety issues that remain are:

9222 Lake Canyon Road, Santee, CA 92071 Tel/Fax (619) 258-7929 SaveFanita@cox.net I.D.#980429
PreserveWildSantee.org

- Vulnerability of structures to embers/firebrands due to extreme events, human error, or inadequate maintenance (ie., fire tornados or fire whirls,[7] broken windows from flying debris, drapes left over windows, open windows, open doors and garage doors, settlement cracks of structures built in landslide areas, wood piles, gas barbeques and motor-homes and other flammables stored too close to structures, delinquent or inadequate fuel treatments). Are rain gutters proposed? If so, how will they be kept clear of embers and combustible material?

- Vulnerability of adjacent homes and the entire development from flame impingement and radiant heat once one or more homes are ignited from embers/extreme events or human error. There remains significant fire risk of structures within 100-feet of each other to cluster burn (especially those with north to east wildland interfaces).[8]

- Vulnerability of people outside of structures to flame impingement, radiant heat and smoke. (Individuals on foot, on motorized and un-motorized vehicles, hikers and other individuals in the preserve, individuals attempting to evacuate or reach and secure their homes, or individuals simply locked out of vacant structures because they reside in another neighborhood or are children without keys; individuals at inadequate fuel buffers on sloped sections of emergency access routes; firefighters defending structures without adequate safety zones or escape routes).

- Vulnerability of elderly and weak individuals within structures to smoke, stress, or loss of power.

- Vulnerability of **established homes along the current Fanita Ranch WUI** caused by accumulating fuel loads if age class management of the preserve is rejected.

- Vulnerability of established homes along the current Fanita Ranch WUI caused by new development islands **that eliminate or reduce the ability to backfire from the older WUI in defense of higher intensity fires.** (Increased intensity created by accumulated fuel loads combusting during eventual stand replacement events).



Multiple large attic vents on this typical older Santee home are vulnerable to penetration and ignition from firebrands.

9222 Lake Canyon Road, Santee, CA 92071 Tel/Fax (619) 258-7929 SaveFanita@cox.net I.D.#980429
PreserveWildSantee.org





"Closed" doors that exhibit openings for firebrand ignitions typical of Santee homes.





Multiple attic vents, exposed wood eves and chimneys are vulnerable to penetration and ignition of the structure from firebrands.





9222 Lake Canyon Road, Santee, CA 92071 Tel/Fax (619) 258-7929 SaveFanita@cox.net I.D.#980429
PreserveWildSantee.org

Hearing and recognizing the validity of these significant fire threats leaves the City with primarily two options for mitigation:[9]

1. Follow through on the requirements of the original FFPP by performing age class management over the entire open space areas "that must be purposefully managed"; then mitigating for the additional significant adverse biological impacts off site; and preparing a statement of overriding considerations for the remaining significant adverse fire safety impacts.[10] (The City understands the additional cost of additional biological impacts as would be required by the Wildlife Agencies and thus, previously decided to simply dismiss the FFPP's age class management requirement).

Or

2. Reconfigure the project to reduce or eliminate significant fire risk to people and structures within the proposed project area.[11] **This is the most sensible option**.

Mitigation Measures that warrant implementation include:

1. Increased fuel buffers around roads and evacuation routes to reduce vulnerability from direct flame impingement, from radiant heat, and vulnerability to vision and breath impairing smoke/heat. (*Increased buffers require increased biological mitigation*).
2. Redesign of subdivision circulation to open cul-de-sacs that could now force individuals and firefighters to evacuate into the headwind of a Santa Ana wind driven firestorm.
3. Relocation of streets and developed green spaces to the wildland interface to act as a buffer for structures and as critical anchor points for firefighting operations.[12]
4. Relocation of structures and private lots away from topographic chimneys that can focus firestorm velocity by funneling wind gusts of embers, debris and radiant heat.[13]
5. Increase lot sizes to minimum one-acre for all lots with a northeast wildland interface to reduce the significant threat of cluster burning.
6. Consolidation of development with adjacent existing development and overall reduction of the extremely lengthy and vulnerable wildland-urban interface.[14]
7. Retrofit of established homes along the Fanita WUI if age class management of the adjacent preserve is rejected to thereby mitigate the significant impact created by project design.
8. Elimination of northern most "villages" that are in the severest hazard zone.[15]
9. Prohibition of RV motorhome storage on properties and roads with a wildland interface.

Any of the fire consultants retained by the City and developer, if given the leeway, could find ways to reduce the significant vulnerability of the project subdivision footprint. The reality is that fire consultants were apparently hired and restricted to the task of defending a poor project footprint. This means that the first and most critical factor for reducing fire risk; ***location,*** appears entirely ignored. Such limits have led to a philosophy and approach of - *we can build anywhere and defend it*. That is their real message with Fanita. If such a philosophy could be and was actually implemented safely, we would not continue to shoulder the massive losses of life and property from wildfire in subdivisions previously reviewed and authorized by fire authorities and land use officials. In essence, if their approach had been credible, wildfire would not be the significant public safety issue that it remains. Fire planners should be called into the engineering and design process early to integrate their expertise rather than later as is obvious with Fanita.

9222 Lake Canyon Road, Santee, CA 92071 Tel/Fax (619) 258-7929 SaveFanita@cox.net I.D.#980429
PreserveWildSantee.org

Fire risk associated with climate change has become too severe to continue the business as usual approach of "we can build anywhere and defend it." Reality requires implementing the feasible mitigation that can reduce or eliminate significant fire threat even if it means additional costs of subdivision redesign or expensive mitigation for additional biological impacts at an off site location.

Comments related to Specific portions of the Revised EIR:

REIR at p. 16:
"The project may have a significant adverse impact if it would expose people or structures to a significant risk of loss, injury, or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands."



Cedar Fire victim perished in area of wide clearance at fuels similar to and northeast of Fanita's proposed "Rock Point."

Note that in addition to structures, the CEQA standard is a significant adverse impact from the project if **people** are exposed to **injury**, death or loss[16] from wildland fires. The REIR neglects and dismisses the significant risk of injury to people by focusing its attention primarily upon structures. There is little or no comment from the REIR or any hired consultant regarding the significant risk of injury or death to people caught outside of structures during a severe firestorm. The significant risk to individuals in vehicles attempting to evacuate or reach and secure their homes and to any individual on foot in the project vicinity must be addressed.[17]

REIR at pages 3-6:
The City relies upon an elaborate set of code requirements to mitigate risk to structures. Some of these are readily incorporated, but others are complicated, difficult to enforce, difficult to implement and are subject to unaware people mistakenly letting down their guard. Examples of problematic sections are: 4707.1 & 2 Fuel modified defensible space Zones One & Two; 4707.3 Defensible space adjacent to roadways; 4712.1 Decking, appendages and projections; 4713 Ancillary buildings and structures; 4714 Windows; 4715 Exterior doors; 4716.1 Combustible fencing; 4716.2 Permanent Outdoor fireplaces, permanent barbecues and grills; 4716.3 Spark arresters; 4716.4 Storage of firewood and combustible materials. All of these sections represent areas of fire risk vulnerable to breach by lack of maintenance, complacency or thoughtlessness by private parties. Even structures built and maintained to the highest most recent fire standards are

9222 Lake Canyon Road, Santee, CA 92071 Tel/Fax (619) 258-7929 SaveFanita@cox.net I.D.#980429
PreserveWildSantee.org

subject to ignition.[18]

Simply the idea of code reliance in a very high fire hazard zone is problematic. For example, the law against cell phone use while driving is regularly un-enforced and frequently ignored despite the knowledge that the distraction created by use may be catastrophic at any wrong time. Elements of the City fire code cited above are similar. The weakness and limitations of the code approach should be acknowledged. Recognition would allow consideration and implementation of additional mitigation strategies.

City code presently requires unimproved parcels to be mowed and/or cleared one hundred feet from any structure and up to thirty feet from established roadways, yet a status check of Santee's Wildland–Urban-Interface demonstrates serious breach of this ordinance.[19] **See photo Exhibit A: State of Santee's Fanita Wildland-Urban Interface** that documents extended and typical failed maintenance within the 100-foot fuel modification zone in Santee. As time passes it becomes increasingly difficult to rely on un-enforced codes for fire protection. Because the complacency exhibited in this photo documented situation is typical of the last Fanita Ranch development, then it is reasonable to expect a similar breach at the proposed development as similar time passes and attentions are diverted. If the City cannot gain compliance with its Wildland-Urban-Interface (WUI) fire code now along miles of its extensive interface, why would we expect compliance when the interface is more than doubled to a total 38 miles by the project? It is more reasonable to expect weaknesses that create critical wildfire vulnerabilities at the project site and throughout the city.

Santee's existing un-enforced code from Title 8 Health And Safety:

> ***"8.48.160 Maintenance standards.***
> *All parcels **shall** be mowed and/or cleared a distance of **one hundred feet from any structure or adjacent structure if the parcel is unimproved** and up to thirty feet along each side of established regularly traveled roadways or driveways. Clearance of property shall be accomplished by methods that will not disturb native soil or root stock. The required width will be at the discretion of the fire chief or his or her authorized representative. (Ord. 443 § 1 (part), 2004)"*



Inadequate clearance, vulnerable vents, eves, and wood fences at northeast WUI.

9222 Lake Canyon Road, Santee, CA 92071 Tel/Fax (619) 258-7929 SaveFanita@cox.net I.D.#980429
PreserveWildSantee.org



Typical un-cleared Fanita Ranch WUI northeast exposure, May 13, 2009

REIR p. 7:
"In a letter dated April 2, 2009, Firewise 2000, Inc. reconfirmed that the conclusions of the Fanita Fire Protection Plan ('FFPP") are based on the following:
1. That the habitat open space (ie., Preserve is not a required component of the FFPP and it is not needed to support the conclusion in the FFPP."

The statement above is clearly contrary to the "**requirements"** listed in the FFPP. A change of heart after litigation is not credible. Furthermore, Mr. Rogers hedges when discussing embers by stating "***When used as designed*** *the ignition resistant features will prevent loss of these homes due to wind blown embers*." The public has very wide latitude for using their homes "as designed" that creates vulnerability. An example of which is simply opening their windows. The Ventura County Fire Department has a substantial list of 15 items requested to secure a home structure prior to evacuation and another 12 items for survival in case of entrapment.[20] Just the single list item of sealing vents is likely to be infeasible or overwhelming to the occupant.

Furthermore, the City's own expert, Don Oaks considers the FFPP Section "5.3 **Recommendations** for Inclusion in the CCR's" to be "**requirements**."[21] So it follows that if "recommendations" are FFPP requirements, then the more stringently stated requirements are FFPP "requirements."

REIR errant conclusions at pages 10-11, and references to the Don Oaks expert letter:
Contrary to the REIR's errant unsupported statement about homes lost on the Witch Fire, findings show that the majority of homes lost *had* fire resistant features.

> *"An analysis of the Witch fire's pattern of destruction points to deficiencies in long-held beliefs about building in fire-prone areas. Fire-resistant walls and roofs are helpful, and brush clearance is essential. But alone they are insufficient in the face of*

9222 Lake Canyon Road, Santee, CA 92071 Tel/Fax (619) 258-7929 SaveFanita@cox.net I.D.#980429
PreserveWildSantee.org

> *millions of burning embers flying horizontally more than a mile ahead of the flames. Of 497 structures that burned in unincorporated areas of San Diego County during the Witch fire, more than half had fire-resistant walls and roofs, a Times analysis of government data showed. Information on construction materials has not been compiled for neighborhoods inside the cities of San Diego and Poway, but senior fire officials estimate that well over 75% of the destroyed homes had fire-resistant exteriors."*[22]

When evaluating the Witch Creek Fire losses and comparing Fanita Ranch, the City (again and without presenting any expert data to the contrary) ignores a significant decrease in fire spread and intensity prior to reaching Rancho Santa Fe area developments that was documented prior to litigation, yet concludes that meeting Rancho Santa Fe building standards at Cielo/Crosby/Bridges is conclusively sufficient (REIR p. 10-11). The City and Mr. Oaks also ignore significant geographical differences with Fanita previously documented. (See PWS letters 12/5/2007 & 12/4/2007).

Mr. Oakes bias toward a "stay-in-place" strategy is a significantly serious conflict with the Santee' Fire Department's evacuation policy that may jeopardize a confused public. None of the residential properties along the established Fanita WUI are suitable for a "stay-in-place strategy," so a mixed official message leaves the public at new and established portions of the Fanita WUI with confusion and with the potential to evacuate in a panic at the worst possible time.[23] The contradiction is a significant adverse impact created by the project that must be addressed for both older residences on the already established Fanita WUI and future residences within the project site.

With regard to age class management of the project open space immediately adjacent to fuel modification zones 1 & 2, there are numerous examples/opinions in favor of the practice (**of *establishing a community fuel break***) to further reduce significant risk even if the risk reduction is incremental relative to a zone 1 and zone 2 focus. The fuel load reduction program administered by the County and referenced by the City of Santee in the REIR is one such example.[24]

Immediately west of Fanita, fuel loads are in fact managed at MCAS-Miramar. These operations could be expected to reduce fire threat at the very northwest portion of Fanita Ranch for ignitions at the base under moderate on shore conditions where winds would move the fire toward Santee.[25] The most recent prescribed burn was implemented May 15, 2009 as "part of the MCAS Miramar Fire Department's annual vegetation management program to reduce wildfire risk at the air station."[26]

REIR pages 11-12, fuel management of open space:

*"That is**, fuel management of open space may be important when home sites are not designated with 100-foot fire buffers and are not constructed with materials designed to prevent ignition from wildland fire or wind-blown embers and are located next to a wildland open space fuel source**." Fanita REIR*

Impacts from wind-blown embers are an expected product of fire consumed vegetation and are a significant risk reality for **all** residential properties downwind.[27] Age class management practices for fire risk reduction are attempts to reduce the volume of embers, the total intensity of the fire and hence the rate of fire spread. Age class management efforts have the greatest effectiveness

9222 Lake Canyon Road, Santee, CA 92071 Tel/Fax (619) 258-7929 SaveFanita@cox.net I.D.#980429
PreserveWildSantee.org

the closer they are employed to the actual WUI. Effectiveness of age class management for reducing fire risk diminishes when practiced in the remote backcountry, yet can be significant for reducing ember ignitions when applied within 1,200-feet.[28] Age-class management on Fanita Ranch, because of the immediate proximity to the development's fuel modification zones 1 & 2, would have greater significance for reducing fire risk relative to many of the more distant efforts suggested by County or other agency plans. This is especially so for homes already established along the Fanita Ranch WUI. Younger less fuel loaded stands of vegetation can assist firefighters to halt fire spread at the flanks and even at the fire head upon a favorable weather change.[29] Spot fires ignited from embers well ahead of the main fire are more readily contained upon initial attack in younger age class fuel loads as well.

Furthermore, there is clearly a significant reduction in fire risk by age class management for any individual traveling within the project site and for **established homes** along the Fanita Ranch WUI that would be **negatively impacted by unlimited or unnatural fuel accumulation**. The REIR acknowledges this reality by pointing out,

> *"That is, fuel management of open space may be important when home sites are **not designated with 100-foot fire buffers and are not constructed with materials designed to prevent ignition from wildland fire or wind-blown embers** and are located next to a wildland open space fuel source*."

This condition is typical of Santee's existing homes along the Fanita Ranch WUI.[30] Again, the FFPP "required" age class management. Allowing unlimited or unnaturally heavy fuel loads on Fanita Ranch open space would create an unintended **significant fire risk/adverse impact** to currently established older style homes along the Fanita Ranch WUI. **A "fire resistant construction" retrofit of older homes along the entire Fanita Ranch interface should be required if age class management is rejected**.

The REIR's less than significant impact finding **relies upon** and ***"requires fuel modification zones and structures to be built with fire resistant materials,"*** (REIR p. 14). Again, older structures along the Fanita WUI lack both of these attributes and would be subject to accumulating fuel loads of the unmanaged open space as a result of the project.

Both the FFPP and the REIR document a recent history of frequent fires on Fanita since the construction of existing WUI homes. Favorable weather and low fuel load conditions during these recent burn events prevented home loss, however fuel loads would accumulate with exclusion of fires of moderate intensity by the project. Don Oaks conclusions regarding management of the open space do not consider negative impacts from the project to the established WUI due to accumulating fuel loads. The "stay-in-place" strategy appropriate to Mr. Oaks has never been utilized for the existing WUI and has not been adopted by the Santee Fire Department for even the proposed project structures that Mr. Oaks attention was focused upon.

Furthermore, the reason that Fanita Ranch did not appear within "9 priority areas" referenced by the REIR is because Fanita recently experienced a severe burn reducing fuel loads (Cedar Fire in 2003). The "9 priority areas" in San Diego County have fuel loads that have not burned for decades. Again, Fanita is within a State designated very high fire risk zone.

9222 Lake Canyon Road, Santee, CA 92071 Tel/Fax (619) 258-7929 SaveFanita@cox.net I.D.#980429
PreserveWildSantee.org

"Preventing homes from being built in rugged fire prone zones should be a priority. Right now, the focus has been on clearing a defensible space around homes. It's becoming real clear that that's not going to solve our problem." Dr. Jon Keeley[31]

Structures Resistance to Firebrands/Embers:



Attic vent vulnerable to embers within a fire tornado.

How will ventilation of proposed structures be designed to prevent infiltration from firebrands/embers? The City does not address the significant vulnerability of home ventilation, despite acknowledging vegetation management and design may be important to prevent ignition from wind-blown embers (REIR p. 11).

At the "Trails" development NIST data indicates 70% of the homes destroyed went undefended and that only 60% of the homes where a defensive action was taken were successful. (p. 19) Homes possessed fire resistant features such as tile roofs, yet were vulnerable to embers or other ignition. About 2/3 of homes were ignited directly or indirectly by embers. One-third were directly ignited by embers. (p. 26) The example of the Trails, where about 1/3 of total homes were defended and 1/3 were lost should be an indication of the significant fire risk that remains at Fanita.

NIST researcher Alex Maranghides explained the importance of the ember ignition data: *"This is an important finding because current guidelines to make structures more fire resistant offer little guidance on how to make structures more resistant to an ember attack."*[32]

While the City provides no indication of the ventilation size or filtration to be employed on Fanita structures, impartial research data has been gathered regarding the ineffectiveness of current ventilation standards for preventing ember penetration. BFRL/NIST researchers tested ¼-inch or 6 mm (the recently adopted California WUI standard) 3 mm and 1.5 mm screens. "*For all screen sizes tested, the firebrands were observed to penetrate the screen and produce a self-sustaining smoldering ignition inside the paper beds inside the structure*."[33]

9222 Lake Canyon Road, Santee, CA 92071 Tel/Fax (619) 258-7929 SaveFanita@cox.net I.D.#980429
PreserveWildSantee.org

The Ventura County Fire Department[34] and The Deer Springs Fire Safety Council have published warnings and requested action against ember risk.[35]



Wind-blown embers

Vulnerability to embers is another significant reason why location matters and must be taken into account during subdivision footprint design.

Recent research calls out the narrow focus on fuel loads for reduction of fire hazard and suggests greater spatial considerations for management actions and location of development.[36]

Mitigation Figures 1, 2 & 3 below are illustrations of modified subdivision designs that attempt to account and mitigate for the biophysical variables that are basic elements influencing fire frequency and fire intensity on and near Fanita Ranch.

9222 Lake Canyon Road, Santee, CA 92071 Tel/Fax (619) 258-7929 SaveFanita@cox.net I.D.#980429
PreserveWildSantee.org

Applicable Illustrations of Specific Feasible Fire Mitigation Measures:



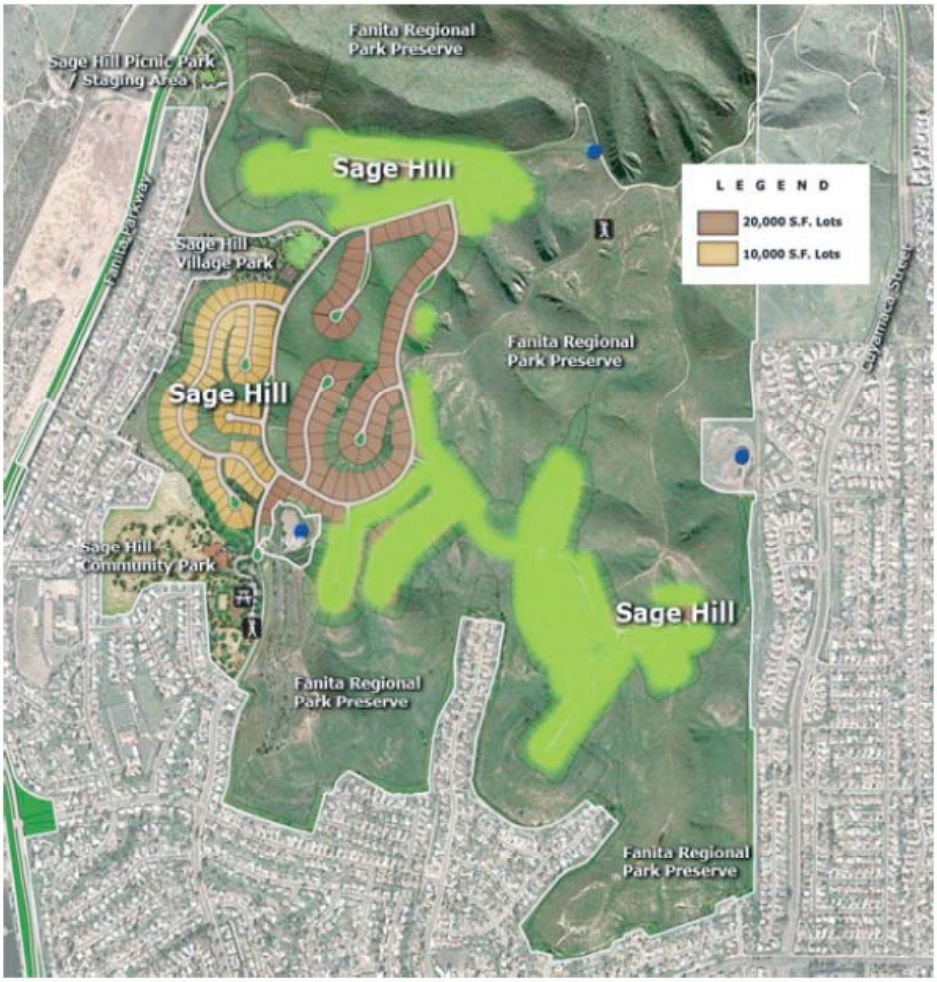
Removal of housing-wildland-interfaces creates backfiring anchor points from exterior roads. Eliminating soley northeast evacuation creates southwesterly escape routes.

Mitigation Figure 1 - Backfiring Anchor Points & Circulation:

The light green shading of Mitigation Figure 1 represents the elimination of extremely vulnerable lots, many of which are placed at the top of topographical fire chimneys. The road becomes exterior to the remaining lots creating clear areas for suppression efforts (hose lays or backfiring operations) with improved escape routes and potentially wider safety zones.[37] The black lines are proposed extensions/connections of the circulation system to provide both the public and firefighters escape routes opposite a Santa Ana wind driven fire. The "Oak View" northeast oriented cul-de-sac peninsula is eliminated.

9222 Lake Canyon Road, Santee, CA 92071 Tel/Fax (619) 258-7929 SaveFanita@cox.net I.D.#980429
PreserveWildSantee.org

Anchor Creating Consolidation of Sage Hill



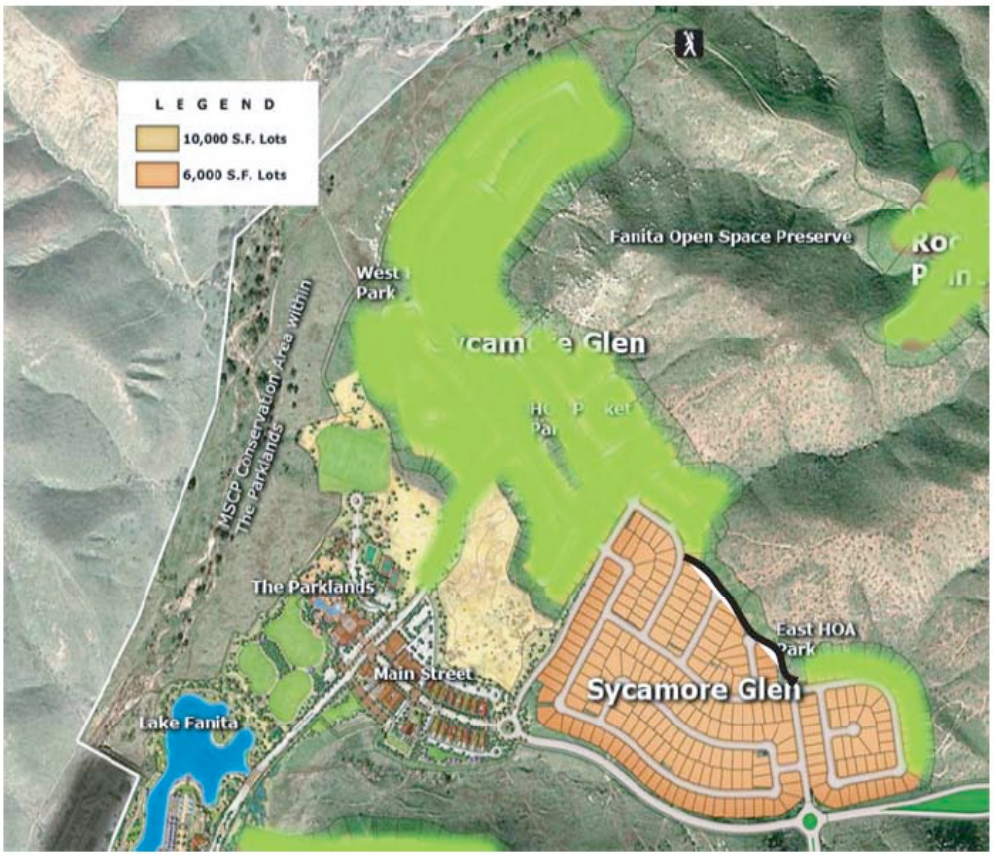
Consolidating development southwest of an exteror road creates fire suppression anchors, eliminates northeast evacuations and an island of houses in a sea of vegetation. Ability to backfire upslope from the older WUI is retained.

Mitigation Figure 2 - Anchor Creating Consolidation of Sage Hill:

Consolidating development southwest of an exterior road at "Sage Hill" creates opportunities for fire suppression anchors, eliminates segments of required northeast evacuation and eliminates an island of houses in a sea of vegetation. Removing "Sage Hill's proposed southeast island retains the option of backfiring upslope from the older WUI peninsulas at Fanita's southern boundary. Total WUI perimeter is greatly reduced, thereby reducing fire resource demand. All development is effectively consolidated by one exterior road with a northeast interface from Fanita Parkway to Carlton Hills Boulevard. The ability to backfire upslope toward the **heavy accumulating fuel load of the landslide remediation area** from Carlton Hills Boulevard's older WUI is retained.

9222 Lake Canyon Road, Santee, CA 92071 Tel/Fax (619) 258-7929 SaveFanita@cox.net I.D.#980429
PreserveWildSantee.org

Anchor Creating Consolidation of Sycamore Glen



Exensions into the high velocity northern fire corridor are eliminated at "Sycamore Glen" and all of "Rock Point." A road connection (black) creates a firefighting anchor on the northeast WUI.

Mitigation Figure 3 - Anchor Creating Consolidation of Sycamore Glen:

Northern development extensions into the high velocity firestorm corridor of the Cedar Fire are eliminated from "Sycamore Glen" and the entire "Rock Point" by this mitigation measure (denoted in light green). A northeast shielding road connection (shown in black) creates an anchor point and escape route for firefighters. The "Oak View" northeast oriented cul-de-sac peninsula is eliminated.

Significant Adverse Impact to Firing Operations Tactics that Defend the Existing WUI:

Implementation of the site reconfiguration shown in Figures 2 & 3 can mitigate for the significant adverse impact to firing operations tactics created by new development islands that lie in the path of potential firing operations.

Under severe weather conditions and with only limited resources, backfiring operations from the older urban edge may be the most effective tool to defend structures from a rapidly advancing wildfire. In fact, I witnessed effective firing operations in Sycamore Canyon during the Cedar Fire. Effective firing operations that I witnessed on the northeast interface of Sycamore Canyon

9222 Lake Canyon Road, Santee, CA 92071 Tel/Fax (619) 258-7929 SaveFanita@cox.net I.D.#980429
PreserveWildSantee.org

would be precluded by development on Sage Hill because it would risk burning over emergency access routes and new development incompletely evacuated.

Elimination of one of the few effective suppression tactics (backfire) that can be utilized to defend the long exposed interface from a large rapidly advancing wildfire creates a significant adverse impact upon older less fire resistant structures that remain upon the WUI. Project reconfiguration and/or retrofits to existing structures are needed mitigation.

"Stay-in-place" versus Evacuation:

The decision to locate families within a severe fire hazard zone should be just as sobering as locating families within a flood plain.[38] Firefighters forced into action in either situation must determine when lives or property can be saved - in essence, where to risk their own lives and make a stand. Fire behavior is subject to rapid intensification. Too many experienced professionals have lost their lives in miscalculations where there wasn't time to evacuate to a well-anchored flank or safety zone. Firefighter fatalities on the Cedar and Esperanza fires came while attempting to defend structures built on high-risk topography.[39] Between the two fires, six firefighters died, three others suffered burns and both homes were destroyed. The decision a firefighter makes on the fire line is similar to the assessment the general public is required to make when confronted with a wildfire that threatens their homes. In general, those that choose to stay and in fact survive have little idea of the gamble they've made in terms of the direction and intensity of the fire head. While there cannot be an accounting from those who have perished in a wildfire, the footnoted experience from a survivor of a stay-in-place strategy gone wrong is worthy of consideration because it is analogous to many of the decisions future residents of Fanita are likely to be confronted with. [40] Those that would place a home in the likely path of a firestorm should gain their understanding of the word firestorm.

Significant Adverse Impact to Firefighter and Resident Safety – Rock Point Peninsula:

The most egregious example of disregard for safety is the northeast Rock Point peninsula, which multiplies the excessive risk throughout Rock Point. Flame lengths of nearly 100 feet are modeled for surrounding vegetation. Considering that the standard safety zone for firefighters is flame length by a multiple of four, or a 400 feet radius, **what is the escape route and where is the safety zone for any firefighter defending a peninsula home under a blow-up burn of the peninsula's wildland interface? Are these homes expected to be defended under severe Santa Ana fire behavior or not?** The biophysical characteristics of this location make a high intensity blow-up probable over time. **What is the longest and shortest distance across the penninsula between wildland fuels? What temperatures or radiant heat range would be expected in the center with both interfaces burning simultaneously? And would a resident or firefighter forced from a burning structure be expected to survive?**

Consider also, that standard procedure for wildland structure protection requires "*No plan to protect a structure be based on the anticipated need to seek refuge in the engine, **structure** or in a fire shelter when the flame front passes*."[41] **Structures are not to be planned safety zones**. **Will firefighters at Rock Point experiencing intense fire behavior be expected to open homes to seek refuge as a flame front passes?**

If, as a desperate measure a firefighter took shelter in a peninsula structure, and was then forced from it if it caught fire, where would the next shelter be and how would he reach it without exposure to deadly radiant heat?

9222 Lake Canyon Road, Santee, CA 92071 Tel/Fax (619) 258-7929 SaveFanita@cox.net I.D.#980429
PreserveWildSantee.org

Conclusion:

The City has based its approval upon a false premise – that Rancho Santa Fe "shelter-in-place" communities "survived the full force of 60 mph, very dry, Santa Ana winds under the very worst burning conditions San Diego County has ever experienced" and that nothing more needs to be done besides build consistent to those standards. The REIR does not correct the City's inaccurate assumption about fire weather for Rancho Santa Fe developments and hence does not reconsider the implications of the error (Collinsworth to Mallory, 12/05/2007). The City would like to believe that the anecdotal (Cielo/Rancho Santa Fe survival) allows disregard of location – that homes can now be sited anywhere. The false assumption regarding fire weather/behavior and the conclusions derived from it provide a weak foundation for project approval in its present design with potentially fatal consequences.

Impartial study just released from NIST has confirmed my report on "Witch/Guejito Fire" weather and recognized the limitations on knowledge of fire spread on the urban interface.[42] The initial flame front reached the "Trails" development just prior to 4 AM with a Rate of Spread at 5.6 MPH. Without a change in fire weather and corresponding rate of spread, the flame front would have reached Cielo/Rancho Santa Fe (6.7 miles west) before 7 AM. In fact, the fire did not arrive at Cielo until afternoon and wind shifts prevented the fire from burning to the Ocean as projected that morning by authorities. Fire intensity at Cielo was nothing like what developments east of I-15 experienced in early morning. Weather data for the entire incident records speeds substantially below the City's 60 mph expectation.[43] It would be a monumental error to base policy on a "survival test" that never occurred.

Please address, consider and mitigate the significant adverse impacts to public safety created by location of the project in a severe fire hazard zone as detailed above.

Sincerely,
/s/

Van K. Collinsworth, M.A.
Resource Analyst/Executive Director
Former Wildland Firefighter USDA-Forest Service[44]

Attached Exhibit List:

Exhibit A: State of Santee's Fanita Wildland-Urban Interface

Exhibit B: Agenda Item 1B **AUTHORIZATION TO ACCEPT $7 MILLION IN FEDERAL GRANTS FOR HAZARDOUS FUELS REDUCTION ACTIVITIES (District 1, 2, 5)**

Exhibit C: "Lack of Resources, outside support plague fire department, chief says" Mark Sauer and Tony Manalatos, San Diego Union-Tribune, December 1, 2007.

Exhibit D: "**Lessons From the Fire"** Joe Mozingo, Ted Rohrlich and Rong-gong Lin li, Los Angeles Times, December 23, 2007

9222 Lake Canyon Road, Santee, CA 92071 Tel/Fax (619) 258-7929 SaveFanita@cox.net I.D.#980429
PreserveWildSantee.org

Exhibit E: Southern California Firestorm 2003, Mission Centered Solutions Report for the Wildland Fire Lessons Learned Center, December 8, 2003.

Exhibit F: Integrated Natural Resources Management Plan for Marine Corps Air Station Miramar, Section 7.2.4 Wildland Fire Management, pages 7.7 – 7.10.

Exhibit G: MCAS Miramar press release, May 14, 2009, Cpl. Derek Carlson.

Exhibit H: Ready, Set, Go! Wildfire Action Plan, Ventura County Fire Chief Bob Roper, Ventura County Fire Department, 2009, pages 8-10.

Exhibit I: "Is It Safe?" Deer Springs Fire Safe Council, Fire Safety News, Volume 6, No. 1, Winter 2009.

Exhibit J: NIST Technical Note 1635 A Case Study of a Community Affected by the Witch and Guejito Fires, Alexander Maranghides & William Mell, NIST National Institute of Standards and Technology, U.S. Department of Commerce, June 2009

Exhibit K: On the Use of a Firebrand Generator to Investigate the Ignition of Structures in Wildland-Urban Interface (WUI) Fires, Samuel L. Manzello, John R Shields, and Jiann C. Yang, Building and Fire Research Laboratory (BFRL), National Institute of Standards and Technology (NIST), 2007

Exhibit L: "Predicting Spatial Patterns of fire on a Southern California Landscape" Alexandra Syphard et al., International Journal of Wildland Fire 2008.

Exhibit M: Esperanza Fire Accident Investigation Factual Report, USDA-Forest Service, October 26, 2006, excerpt.

Exhibit N: Novato Fire Protection District Cedar Fire Incident Recovery Report, May 26, 2004, Wildland Structure Protection Standard Operating Procedures Section.

Exhibit 0: Firefighter Safety Zones: A Theoretical Model Based on Radiative Heating, Bret W. Butler and Jack D. Cohen, USDA-Forest Service 1998.

Exhibit P: PWS Prior Fire Comments 12/4/2007 & 12/5/2007

---

[1] The REIR further downplays the severity of the hazard zone by pointing to Fanita's absence from a County program to reduce fuel loads on lands that have not burned for decades. Since Fanita burned almost entirely in 2003, the absence reflects only the current status of the fuel load on Fanita, not the severity of the land's fire hazard zone.

[2] "*Of particular concern is the increasing pattern of the classic urban-wildland interface being replaced by the "mixed interface," where development is embedded in a wildland matrix (Davis 1989). In this regard, education of homeowners, and local politicians, to the potential "costs" associated with residence at the urban/wildland interface is essential; 'fire suppression is no more capable of preventing all catastrophic fires at this interface, than flood control can prevent disaster for those living in flood plains' (Frank Davis personal communication, 1999). Unfortunately, adequate planning is not the whole*

9222 Lake Canyon Road, Santee, CA 92071 Tel/Fax (619) 258-7929 SaveFanita@cox.net I.D.#980429
PreserveWildSantee.org

answer since development plans are often altered due to political pressure, and commonly in manners that enhance fire risk (Miller 1998)." "**Fire Management of California Shrubland Landscapes**" "Environmental Management" Vol. 29, No. 3, page 401. Dr. Jon E. Keeley, 2002.

[3] It is also notable that the San Diego County Board of Supervisors voted unanimously on May 13, 2009 to accept federal grants to fund fuel load reduction projects beyond the 100 foot standard for structures. The treatments specified will also allow thirty feet of clearance for evacuation roads which is twenty feet over the ten feet required in Section "4707.3 Defensible space adjacent to roadways" in Santee wildland code. The County will now perform strategic fuel treatments "*pursuant to National Fire Protection Association Standard 1144 (which specifies **up to 200 feet**) when determined necessary by a registered forester and wildfire authority that it is necessary to support the defensible space in order to prevent impacts to evacuation corridors and structures during fires*." The BOS approved treatments to **500 feet** of structures and evacuation corridors of "dead, dying and diseased trees." May 13, 2009, Agenda Item 1B AUTHORIZATION TO ACCEPT $7 MILLION IN FEDERAL GRANTS FOR HAZARDOUS FUELS REDUCTION ACTIVITIES (District 1, 2, 5)

[4] The FFPP itself points out serious compromise of a "Firewise" community in Santee where homes on the WUI are planted with prohibited vegetation. How will these common, but serious vulnerabilities be prevented on Fanita if they aren't preventable here already? (FFPP, Photo: 13, page 14).

[5] The thousands of homes lost to wildfire since 2003 exemplify the absence of fire resources during extreme wind driven events. San Diego Fire Chief Tracy Jarman acknowledged this occurrence in 2007. *"Jarman described in vivid detail the moment on Oct. 22, the second day of the fires, when she realized her department was on its own. A separate blaze, the Guejito fire, had crossed into Rancho Bernardo and merged with the Witch Creek fire. So Jarman made a desperate call to Cal Fire: The city immediately needed air support and 150 strike teams – that's 750 fire engines and 3,000 firefighters. Cal Fire's response: **Nothing was available**."* **"Lack of Resources, outside support plague fire department, chief says"** Mark Sauer and Tony Manalatos, San Diego Union-Tribune, December 1, 2007.

San Diego Fire Recovery Network (SDFRN) member Patricia Akers validates the relevant dynamics for the County in her post, *"On the issue of defensible space, I am hearing from people from Jamul during the 2007 fires, who had 300 feet plus cleared to sterile top soil who lost their homes, when the firefighters who were at the properties were called off elsewhere. Their water tanks were untouched, still full with ash from the home that they once served. It looks like the county has really fallen back on the defensible space alone, rather than working out who and how to protect the homes. And the defensible space is only PART of the picture. Remember Crest had an intact fire break 1,000 feet wide before Cedar. The fuel fed tornado went across that break leaving a white path 25 feet wide into the community. People from both 2003 and 2007 are talking about their windows and how heavier embers from the house next door, or even down the street, broke them when its eaves blew up from a heat and fire tornado. Vinyl windows fell out the frames. Vents dropped hot ash into the crawl space. A Juniper next to the house wicked flame through the vent of a two story house. Eaves were uncovered*

9222 Lake Canyon Road, Santee, CA 92071 Tel/Fax (619) 258-7929 SaveFanita@cox.net I.D.#980429
PreserveWildSantee.org

framing with plywood for the sub roof. The embers gathered on top of the end caps. The fence caught on fire and it set off a window frame. Or and this is where it is really heartrending, 'we left our windows and (or) doors open, we were too intent on leaving to think about closing them...'" Patricia J. Akers, SDFRN BBD, May 15, 2009.

[6] "*Fire officials believe that embers driven by raging winds through small openings or against exposed wood were responsible for igniting a majority of the 1,125 homes leveled by the Witch fire, the most destructive in California this year…An analysis of the Witch fire's pattern of destruction points to deficiencies in long-held beliefs about building in fire-prone areas. Fire-resistant walls and roofs are helpful, and brush clearance is essential. But alone they are insufficient in the face of millions of burning embers flying horizontally more than a mile ahead of the flames. Of 497 structures that burned in unincorporated areas of San Diego County during the Witch fire, more than half had fire- resistant walls and roofs, a Times analysis of government data showed. Information on construction materials has not been compiled for neighborhoods inside the cities of San Diego and Poway, but senior fire officials estimate that well over 75% of the destroyed homes had fire-resistant exteriors."* "**Lessons From the Fire"** Joe Mozingo, Ted Rohrlich and Rong-gong Lin li, Los Angeles Times, December 23, 2007.

[7] "*Observed fire whirl behavior was both unexpected and extreme in these fires, catching many firefighters by surprise and significantly contributing to spotting up to 3/4 mile. 180-degree wind shifts proceeded fire whirls by 45 seconds to a minute."* [Firefighter] *"Respondents reported unusual numbers of fire whirls that ranged from several yards wide up to a 1/2 mile wide. Destructive fire whirls, those causing structural damage unrelated to fire, also were reported. In addition to appearing suddenly, large fire whirls, characterized by a jet engine noise, took in debris such as large tumbleweeds and bushes from the bottom and ejected flaming debris from top—raining embers and violently showering sparks as much as 3/4 of a mile beyond the head of the fire. In one reported case, a fire whirl entered an area that had already burned clean down to three-inch stubble and whirled across several hundred feet of burned area into unburned fuel, carrying fire the whole way and igniting the unburned fuel. Another fire whirl crossed an eight-lane freeway. Small fire whirls merged into larger ones. Some reported fire whirls moving downhill." "What we were expecting to see were fire whirls (4' to 6' tall), what we actually saw were true fire tornadoes. The fire researchers kept telling us what we were seeing was impossible and never seen before. After three days of discussion, the fire researchers started to understand that what they were expecting and what was happening was not jiving. -Division Supervisor"* **Southern California Firestorm 2003 Report for the Wildland Fire Lessons Learned Center**, Mission Centered Solutions, December 8, 2003, page 6.

[8] "*As a type of fuel, involved structures emanated intense radiant heat. Heat levels in the street were unusually high*." **Southern California Firestorm 2003 Report for the Wildland Fire Lessons Learned Center**, Mission Centered Solutions, December 8, 2003, page 7.

9222 Lake Canyon Road, Santee, CA 92071 Tel/Fax (619) 258-7929 SaveFanita@cox.net I.D.#980429
PreserveWildSantee.org



Cluster burn example from Cedar fire. Photo by John Gibbins, SDUT.

[9] A third option would be for the City is to prepare a defensible statement of overriding consideration that explains why the dollars they hope to gain from taxing the development outweigh adoption of feasible mitigation measures that can further reduce significant fire risk of the project.

[10] The FFPP discusses methods for age class management by grazing, mowing, weed whacking and prescription burns (pages 32-36 and the REIR at pages 13-14). As noted by Jon Keeley (a critic of too frequent and poorly placed prescription burns in remote locations) prescription burns or other methods of age class management can be effective at controlling fires under moderate weather conditions. *"Prescription burning is effective at controlling fires that burn under moderate weather conditions and ineffective at controlling fires that ignite under severe weather conditions…Fire management should focus on strategic placement of prescription burns both to insure the most efficient fire hazard reduction and to minimize the amount of landscape exposed to unnaturally high fire frequency."* "**Prescription Burning in Chaparral Shrublands**" USGS Western Ecological Research Center Publication Brief for Resource Managers, Dr. Jon Keeley, March 2002.

[11] Unfortunately, since none of these options are palatable to the City/developer, experts have been hired to try and talk a way out of considering feasible meaningful actions that can improve public safety. Is the City paying for these experts on behalf of the bankrupt developer? If so, why and how does that affect the City's ability to carry out CEQA mandates without undue bias? Considering that the developer is delinquent on tax payments, delinquent on water bills, delinquent on property maintenance, delinquent on payments to other contractors and is in bankruptcy court, how is it that the staff time and expert time required to prepare material in the REIR document is being paid for?

[12] "Greenbelts and open spaces where fuels had been treated or abated or both were effective as control points in the WUI. Native, fire resistant plants were effective in creating defensible space that was effective and still natural looking." **Southern California Firestorm 2003 Report for the Wildland Fire Lessons Learned Center**, Mission Centered Solutions, December 8, 2003, page 9.

9222 Lake Canyon Road, Santee, CA 92071 Tel/Fax (619) 258-7929 SaveFanita@cox.net I.D.#980429
PreserveWildSantee.org

[13] The experience of Skip and Linda Miller is a case in point. The Miller's lost their home in the 2003 Cedar Fire, rebuilt it with "shelter in place" fire resistant features and then lost their home to wildfire again in 2007. Neither their new home's fire resistant features, nor reduced fuels could prevent a Santa Anta wind driven fire from consuming their home. "*When the Millers rebuilt their house after the Cedar fire, they appeared to have done everything right. With family and friends doing much of the work, they cleared vegetation on their property, used a concrete-based material for the siding, and installed indoor sprinklers and vents…Skip Miller said firefighters were in tears as they apologized for not saving his home. He's more stoic. He accepts that fire is one of the dangers of living where he does. "If I'm stupid enough to build in chaparral, then I'm responsible for it," said the 61-year-old retired teacher…Jamie Miller said the Santa Ana winds were so strong that there was little she and other firefighters could have done to save the house. 'It's better to just evacuate,' she said. 'My parents are smart. They know the material things aren't worth trying to save…Linda Miller has returned to work while Skip begins the lengthy process of rebuilding. He's not kidding when he says they're thinking about constructing their house underground this time*.'" "**Unhappy history repeats** - Couple rebuilt after Cedar fire only to lose their home again," Anne Krueger, San Diego Union-Tribune, November 11, 2007.

[14] It will be extremely difficult, expensive and likely infeasible to adequately maintain the 20 miles of interface with hazardous fuels created by the project. If building of new more fire resistant development relative to older houses was sited directly adjacent to existing WUI homes, and thus, removed those older homes from the WUI, then the project would actually reduce fire risk for the older homes by shielding. However the opposite is true, the project leaves the entire older fire vulnerable WUI in place and rejects age class management. This will increase adjacent fuel loads above what would likely be loaded otherwise and creates a **significant unmitigated impact** to public safety from the project.

[15] "*A major contributor to increased fire suppression costs and increased loss of property and lives is the continued urban sprawl into wildlands naturally subjected to high-intensity crown fires*." "**Prescription Burning in Chaparral Shrublands**" USGS Western Ecological Research Center Publication Brief for Resource Managers, Dr. Jon Keeley, March 2002. *"Another obvious approach would be better land planning that manages for limited human use in high-risk areas and reduces risky urban/wildland interface configurations."* "**Fire Management of California Shrubland Landscapes**" "Environmental Management" Vol. 29, No. 3, page 399. Dr. Jon E. Keeley, 2002.

[16] At the very minimum, there is a significant risk of loss of property from smoke damage and ash (clothing, furniture, vehicles; Any combustible property left outdoors such as wood patio furniture, play equipment, wooden sheds, wood fences are all at significant risk of loss).

[17] Clearance should be increased for evacuation roads over the current 30 feet (especially for sections on slopes) and the preserve's extensive trail system should be posted closed to all activities under "Red Flag" extreme weather condition warnings. Biological impacts of increased clearance should be mitigated.

[18] *"Before dawn on Oct. 22, the Witch fire stormed through the chaparral-covered hills of north San Diego County toward Ron and Carol Bedell's home. As they fled through*

9222 Lake Canyon Road, Santee, CA 92071 Tel/Fax (619) 258-7929 SaveFanita@cox.net I.D.#980429
PreserveWildSantee.org

smoke and ash to escape the flames, the couple from Poway were optimistic that their new multimillion-dollar home would survive. It had been built to the highest fire standards, with a slate roof and tempered windows. And the Bedells were careful to keep brush cleared to 150 feet. About 5 a.m., the fire roared up to their property, blew past and moved on, leaving the home intact. But eight hours later, with the wildfire burning miles away, their house caught fire -- the victim of smoldering embers that wafted through the dog door. ." "**Lessons From the Fire**" Joe Mozingo, Ted Rohrlich and Rong-gong Lin li, Los Angeles Times, December 23, 2007.

[19] The FFPP itself points out serious compromise of a "Firewise" community in Santee where homes on the WUI are planted with prohibited vegetation. How will these common, but serious vulnerabilities be prevented on Fanita if they aren't preventable here now? (FFPP, Photo: 13, page 14).

[20] "Ready, Set, Go! Wildfire Action Plan" Ventura County Fire Chief Bob Roper, Ventura County Fire Department, 2009 pages 8 & 9.

[21] "*Further, The FFPP **requires** extraordinary deed encumbrances, and describes in detail, individual home owner and Fanita Home Owner Association responsibilities for maintenance in perpetuity.*" Don Oakes Letter, May 7, 2009.

[22] "**Lessons From the Fire"** Joe Mozingo, Ted Rohrlich and Rong-gong Lin li, Los Angeles Times, December 23, 2007.

[23] "The defensive strategy is often misunderstood by fire authorities and the public, said Dave Bacon, a retired Cleveland National Forest fire chief. He heads Firewise 2000 Inc., a fire-protection consulting firm in Escondido. Shelter in place "doesn't mean you always stay at home," Bacon said. "It means you can stay at home because you have done advance preparation. You need to know when to evacuate and when evacuation is too late." "**Shelter in Place kept flames at bay**" Lori Weisberg and Emmet Pierce, San Diego Union-Tribune, December 2, 2007.

[24] *"Using existing community fuel breaks and planned points (often old burn projects) worked effectively to keep fire out of the mountain communities… In wildland areas, the quality and placement of fuel treatments—not gross acres treated—mattered most. In some cases, five acres treated in the right spot saved a community."* **Southern California Firestorm 2003 Report for the Wildland Fire Lessons Learned Center**, Mission Centered Solutions, December 8, 2003, page 9.

[25] Integrated Natural Resources Management Plan for Marine Corps Air Station Miramar, Section 7.2.4 Wildland Fire Management, pages 7.7 – 7.10.

[26] MCAS Miramar press release, May 14, 2009, Cpl. Derek Carlson contact.

[27] A survivor of the 2009 Australian firestorm description of embers: *"They call it "ember attack". Those words don't do it justice. It is a fiery hailstorm from Hell driving relentlessly at you. The wind and flying embers explore, like claws of a predator, every tiny gap in the house. Embers are blowing through the cracks around the closed doors and windows."* California Fire News, February 10 2009.

[28] *"… the buffer zone often needs to be wide enough (100 to 400 m) to reduce the chances for airborne fire brands from the unmanaged shrubland zone."* "**Fire Management of California Shrubland Landscapes**" "Environmental Management" Vol. 29, No. 3, page 401. Dr. Jon E. Keeley, 2002.

[29] "Young stands of vegetation may assist fire crews in preventing lateral spread, but

9222 Lake Canyon Road, Santee, CA 92071 Tel/Fax (619) 258-7929 SaveFanita@cox.net I.D.#980429
PreserveWildSantee.org

generally only assist in stopping the advancing front of large fires when coincident with a significant change in weather (Rogers 1982, Dunn and Piirto 1987)." "**Fire Management of California Shrubland Landscapes**" "Environmental Management" Vol. 29, No. 3, page 399. Dr. Jon E. Keeley, 2002.

[30] "In addition, existing homes surrounding the Fanita Development were built in the 50's and 60's and are mostly wood structures with no fire protective WUI requirements." REIR page 16.

[31] "**San Diego's Fire Readiness Called into Question**" Fox 6 News fire forum coverage, November 27, 2007.

[32] "NIST Study Offers First Detailed Look at the Progress of a Wildlan-Urban Fire" http://www.physorg.com/news164454924.html June 17, 2009.

[33] Samuel L. Manzello, John R Shields, and Jiann C. Yang, **On the Use of a Firebrand Generator to Investigate the Ignition of Structures in Wildland-Urban Interface (WUI) Fires,** Building and Fire Research Laboratory (BFRL), National Institute of Standards and Technology (NIST), 2007, p. 11.

[34] *"Vents: Vents on homes are particularly vulnerable to flying embers. All vent openings should be covered with 1/8-inch or smaller metal mesh. Do not use fiberglass or plastic mesh because they can melt and burn. Attic vents in eaves or cornices should be baffled or otherwise protected to prevent ember intrusion (mesh is not enough)."*
Ventura County Fire Chief Bob Roper. "Ready, Set, Go! Wildfire Action Plan" Ventura County Fire Department, 2009.

[35] "*Make certain embers can't enter through the attic vents, whether they're under your eaves, on your roof, or on the side of your home at the gables. Apply special baffled vent covers or stainless steel screening that stops the embers from entering your attic while still allowing for adequate ventilation to prevent the formation of mold. The NIST found that 1/16" screening still allows some ember intrusion. Check to see if there are combustible materials on the inside of your attic vents and attempt mitigation."*
"Is It Safe?" Deer Springs Fire Safe Council, Fire Safety News, Volume 6, No. 1, Winter 2009.

[36] "**Predicting Spatial Patterns of Fire on a Southern California Landscape**" Alexandra D. Syphard, et al. International Journal of Wildland Fire 2008, 17, 602-613.

[37] "Determine SAFETY ZONES and ESCAPE ROUTES," USFS Standard Fire Fighting Order. Safety Zones should be four times maximum flame length (a 400 foot radius at Rock Point that does exist on the northeast peninsula).

[38] LIFE photos of wounded Cedar Fire survivor Rudy Reyes should be sobering to those that would locate development in harm's way:

9222 Lake Canyon Road, Santee, CA 92071 Tel/Fax (619) 258-7929 SaveFanita@cox.net I.D.#980429
PreserveWildSantee.org







[39] The Esperanza report identified "Causal" and "Contributing" factors for the firefighter fatalities. The report overlooked a root cause of the deaths, which was the decision to approve and build the home in a location destined to burn. While some consider this incident an accident, it may more readily be considered a high-risk gamble that was lost. The report identified these top factors:

"Contributing Factor 1. Organizational culture - The public (social and political) and firefighting communities expect and tolerate firefighters accepting a notably higher risk for structure protection on wildland fires, than when other resources/values are threatened by wildfire."

"Causal Factor 2. The decision by command officers and engine supervisors to attempt structure protection at the head of a rapidly developing fire either underestimated, accepted, and/or misjudged the risk to firefighter safety."

9222 Lake Canyon Road, Santee, CA 92071 Tel/Fax (619) 258-7929 SaveFanita@cox.net I.D.#980429
PreserveWildSantee.org

Esperanza Fire Accident Investigation Factual Report, USDA-Forest Service, October 26, 2006, page 43.

[40] Relevant excerpts from "**I now understand the word 'firestorm'**" Luke van den Berk, February 10, 2009. Luke van den Berk … was trapped in the house with his children — sons Aaron, 13, and Khyle, 12, and daughter Brodee, 16 — and his girlfriend, Lois MacDonald, 42. This is their story.
http://www.theage.com.au/opinion/i-now-understand-the-word-firestorm-20090209-8288.html?page=-1

THERE wasn't much warning…the fires were 700 metres away. He said: "You can leave now if you want to. If you want to stay we will help you out if we can." We decided to stay in the house. Within three minutes the flames were 30 to 40 metres high. There were horizontal sparks and embers — the wind was just incredible. The word "firestorm" — I have a clear understanding of it now. We were inside the house and the noise outside was incredible. Sparks and embers were bashing up against the roof and the windows, the fence had caught fire, the woodpile against the house caught fire. Then the windows started exploding — it sounded like a 747 taking off. It was broad daylight but it went dark because there was so much smoke and stuff — it just went dark. The house was on fire. I had three attempts at getting everyone out safely — they were all in the lounge room. I kept going outside to see if we could get a decent path out, but the radiant heat was the killer. The first two times I went out, the radiant heat just forced me back in the house. At that point I knew I had to wait for that initial part of the storm to pass over. Unfortunately, it consumed the house while we were in it. I shut all the bedroom doors. We lost two cats and five kittens — I had to shut the bedroom door and we listened to them die. We saved our little dog, Cougar. It was traumatic for the kids. I had to shut the door because the windows had exploded and the bedrooms were on fire. I made my third attempt at going outside. The radiant heat had passed a little, and I just thought, "We have to get out." I had buckets of water outside. I took them in and got sheets and towels, dipped them into the water and wrapped everyone up over their heads and their faces and told them we had to go. When we were 100 metres from the house, the roof collapsed. That was one or two minutes after we got out. We ran out into the street. There were flames everywhere. You just looked down the street and there was devastation. It was like the army came in and bombed the whole thing with napalm. We were running down the street. Gas cylinders were exploding. A lot of the cylinders had safety features on them … apparently when a gas cylinder heats up, a valve releases and all the gas comes out of the cylinder, so there was lots of shhhh noises. A lot of cars were exploding — it was like a war zone. We had to step over power lines, go under power lines, there were power poles falling over in front of us, trees coming down everywhere. And the noise — all I can compare it to is the sound of a 747 taking off. We were running down the street and the radiant heat was getting at us. We had to keep moving. If you stood still you would have shrivelled. We ran down the street for about a kilometre — there was just no one, no one to help. My girlfriend was going, "Where the hell are the fire brigade?" I said, "We are on our own, we have got to go." I just had to keep them going, I said, "Keep going, keep going, faster." We got to one house about a kilometre away and there was someone there spraying water on it. We took refuge in their house. There was a lady

9222 Lake Canyon Road, Santee, CA 92071 Tel/Fax (619) 258-7929 SaveFanita@cox.net I.D.#980429
PreserveWildSantee.org

inside. We were probably there for about 10 minutes. I was popping in and out of the house because I was paranoid about what was going to happen. His pump stopped working and then his balcony caught fire and I just went back in and said, "We gotta go." My girlfriend didn't want to leave. I started swearing: "We have got to go f---ing now." We got the kids and the dog and we left … we left those people there. Fortunately we caught up with them at the third house we got to — our final refuge. We went to another house where a man was watering down his house. He had his son with him. He told us to get inside and we felt quite safe. He was outside running round, wetting it all down. Then another 10 minutes went past and he said, "I can't save it — we've got to go." We had to go only 50 metres over the road to the third house… She was really well set up. She had fire pumps. The kids sheltered in the basement part of the house — they were very traumatised. My daughter was having an asthma attack at that point. We had no medication and we had to get her down low on the floor because it was all full of smoke under the house as well. I just had to talk her through it, telling her, "You have just got to calm down, you have to breathe through it slowly, just relax, we are safe now."

[41] **Novato Fire Protection District Cedar Fire Incident Recovery Report**, May 26, 2004, pages 76 & 77. The death of firefighter Steve Rucker and burn injuries of three crew members during the attempted defense of a home is the report's focus. Developed and published in the report are standard operating procedures for wildland structure protection; pages 73-82.

[42] The City does not provide any measure of the effectiveness of WUI fire prevention measures because few measurements have been taken. In the desire to develop, the City places its hopes on the inaccurate story of Cielo.

Alexander Maranghides & William Mell, **NIST Technical Note 1635 A Case Study of a Community Affected by the Witch and Guejito Fires**, NIST National Institute of Standards and Technology, U.S. Department of Commerce, June 2009, pages 7, 13 & 17.

*"Despite the increasing frequency and losses from WUI fires, there has been **relatively little research**, compared to fires within structures, **on WUI fire spread**. This is due, in part, to the fact that the subject of WUI fire research falls between traditional studies of building fires and forest fires, non-overlapping areas that in the past have been the responsibility of different branches of the government. **Advances in measurement science are needed to effectively characterize and identify the conditions and mechanisms that result in a high risk of structure ignition across a range of WUI community types and conditions. Also, to date, no study that measures the effectivenes of current risk mitigation practices, whether through wildland fuel treatments or modification of residential fuels, has been conducted**. In this paper, the term WUI refers to locations where topographical features, vegetation types, local weather conditions and prevailing winds result in potential for ignition of structures from flames and embers of a wildland fire. The WUI fire problem is gaining momentum across the Southern continental US and is particularly severe across southern California. Between October 2003 and October 2007, seven California WUI fires destroyed a total of 8877 structures, on average over 2200 structures per year. These seven fires resulted in 29 deaths, and over 317 000 hectares (783 000 acres) burned. The 2003 Cedar fire and the 2007 California Firestorm are among the top four fire incidents for the number of structures destroyed and acres burned. The Witch fire, the largest of the fires that occurred during*

9222 Lake Canyon Road, Santee, CA 92071 Tel/Fax (619) 258-7929 SaveFanita@cox.net I.D.#980429
PreserveWildSantee.org

the 2007 California firestorm, burned 80 124 hectares (197 990 acres) and destroyed 1125 residential structures, 509 outbuildings and 239 vehicles. Additionally, 77 residential structures and 25 outbuildings were damaged. Suppression costs were $18 million. The property damages for the 2007 California Fire Storm, dominated by the Witch fire, are estimated at $1.8 billion. The Witch Fire resulted in 45 firefighter injuries and two civilian fatalities. The Witch Fire started on October 21, 2007 at 12:35 pm at the Witch Creek area, east of Ramona in San Diego County." p.7

*"By 3:50 am, the fire front had reached the intersection of Highland Valley road and Sycamore Creek, covering a distance of 4.5 km (2.8 miles) in a little over 30 minutes at a rate of 9.0 km/h (**5.6 mph**). **At that time the fire had reached the perimeter of The Trails**…The Trails was assaulted by both the Guejito and the Witch fires. The main front of the Guejito Fire reached The Trails at approximately 3:45 am Monday morning October 22nd and came from the Highland Valley. It is estimated that the Witch Fire arrived at the southeastern part of The Trails sometime around 6:00am."* P. 13

*Reports of embers on the Sycamore Creek side (eastern side) were provided at 3:50 am, the same time the main fire front reached The Trails. The fire line then progressed in the community by moving further on the eastern and western sides where wildland fuel is present and almost reaches its **final configuration by 5:30 am**. Based on first responder accounts, **the wind veered from the northeast to the east shortly before 6:00 am. This wind shift arrived at the Trails, shortly before the Witch fire. It is likely that the shift in wind direction, slowed and eventually stopped the fire spread within the Trails**, however, given the data available, this cannot be confirmed."* P. 17.

[43] Alexander Maranghides & William Mell, **NIST Technical Note 1635 A Case Study of a Community Affected by the Witch and Guejito Fires**, NIST National Institute of Standards and Technology, U.S. Department of Commerce, June 2009, pages 11, 12 & 33. Wind speeds recorded during the incident were primarily between 21-36 mph. Corresponding wind gusts recorded were 24-56 mph. Winds the "Trails" development faced were expected to be at least as severe as Poway (speed 21mph, gusts to 26 mph) or Ramona (speed 26 mph, gusts to 38 mph).

[44] Van K. Collinsworth obtained a Master's degree with Geographic emphasis in 1986 from Humboldt State University, a Bachelor's in Geography in 1982 and teaching credential in 1983, HSU. Natural Resource and Geographic studies include: Biology, Botany, Zoology, Ecology, Geology, Soil Science, Hydrology, Range Management, Environmental Impact Report Writing, Natural Resource Economics, Economic Geography, Physical Geography, Urban Geography, Mountain Geography, Cartography, Air Photo Interpretation, Resource Planning & Environmental Design, Environmental Policy, Conservation Geography, Environmental Engineering. Completion of various fire behavior and suppression courses with the US Forest Service. Related professional experience includes resource interpretation, land management and fire suppression assignments with the USDA-Forest Service between 1980 and 1992. Founded Preserve Wild Santee in 1994. Voluntarily analyzed numerous CEQA and NEPA documents submitting comments that helped to improve development projects within the San Diego County. Monitored compliance with mitigation requirements, ordinances and plans.

9222 Lake Canyon Road, Santee, CA 92071 Tel/Fax (619) 258-7929 SaveFanita@cox.net I.D.#980429
PreserveWildSantee.org

Provided a region-wide source of environmental education. In 2003, participated in the founding and on-going educational activities of the San Diego Fire Recovery Network. Produced "Preventing Firestorm Disaster" powerpoint utilized as the basis of educational exhibits in public buildings.

Specific fire suppression experience that is relevant to comments submitted in this letter includes: Participation in the planning and execution of sage land and pine forest control burns. Drove and operated fire engines. Engine assignments included everything from small initial response to engine strike teams dispatched to large wildland fires throughout the western United States. Large fire response was also often as a member of a hand crew actively building fireline, backfiring and burning out. I was also transported on initial attack by helicopter and worked with helicopters on water drops, or when equipped with a helitorch. Guided from the ground safe landings and take-offs at high altitudes. Knew and utilized the Incident Command System. Performed as Incident commander on initial attack and transitioned to other roles as warranted including assisting Operations and Air Operations Officers. Sized-up fires upon initial attack and ordered other resources from dispatch necessary to suppress fires. Briefed superior officers/ICS Teams to the location of all incident resources upon transition.

The fire example most similar to the Cedar and Witch Fires was the 133,000-acre Wheeler Fire on the Los Padres National Forest. I performed as a Squad Supervisor on a twenty-person crew that doused structure ignitions fueled by "Sundowner" Santa Ana winds throughout the night of our initial 24-hour shift. The total nine-shift campaign included extensive line building in steep chaparral topography that included backfiring operations where I used a drip-torch in coordination with a helitorch above to successfully ignite fires that ran into and contained the main fire. I voluntarily used this experience to assist structure protection when the Cedar Fire burned to Santee's wildland/urban interface in 2003.

Total professional fire assignments ranged diversely from coastal to alpine environments that included natural and human ignitions under various climatic conditions within diverse plant communities. The most difficult and dangerous assignments were usually attempts to protect structures found within wildlands. On my initial fire (the "Swall Fire" in 1981) we experienced a 180 degree reversal in wind direction that forced us to immediately abandon flanking line construction to defend homes on the down-slope fire head of a steep sage scrub and pine forest mountain. As the most experienced members of our crew completed backfiring ignitions at the closest structure, I was instructed to initiate the crew's decent down the escape route and into the safety zone. The wind and heat from the fire became so intense that it blew the hardhats off of some of the firefighters as we ran down the escape route. While this particular home was saved, other homes on the slope were destroyed. A fire engine was destroyed and others were damaged on the same slope. Fortunately, there were no casualties and after the fire head blew by us we returned to protecting structures throughout the night. The loss of structures on this fire was my first experience with members of the public blaming government firefighters for the loss of homes. The reality is that the homes placed within

9222 Lake Canyon Road, Santee, CA 92071 Tel/Fax (619) 258-7929 SaveFanita@cox.net I.D.#980429
PreserveWildSantee.org

the unfavorable circumstances of topography, weather and fuel exceeded our ability to save more structures that day. This dangerous situation on the wildland/urban interface continues to multiply with predictably disastrous results throughout the western United States.

9222 Lake Canyon Road, Santee, CA 92071 Tel/Fax (619) 258-7929 SaveFanita@cox.net I.D.#980429
PreserveWildSantee.org



Preserve Wild Santee

December 15, 2018

John O'Donnell, Principal Planner
Santee City Council
10601 Magnolia Avenue
Santee, CA 92071
jodonnell@cityofsanteeca.gov

RE: Notice of Preparation (NOP) of a Draft Revised Environmental Impact Report for the Fanita Ranch Project (SCH# 2005061118)

Dear Mr. O'Donnell and Santee City Councilmembers,

I'm providing additional references in support of our request for a conservation alternative and minimum development alternative.

- Cal Fire Chief Ken Pimlott states that a ban should be considered on building in high fire hazard areas (such as Fanita Ranch) as climate continues to breakdown.

- Chaparral on Fanita Ranch can be a significant contributor to carbon sequestration needed to fight climate breakdown. This should also be an important consideration for the climate action plan.

Thank you for considering these comments.

Van K. Collinsworth
Geographer/ Director
Preserve Wild Santee

Attachments:
- Cal Fire chief: State must consider ban on homes in fire-prone areas
- Official: California Must Mull Home Ban In Fire-Prone Areas
- Mature semiarid chaparral ecosystems can be a significant sink for atmospheric carbon dioxide

Lahaina Fire Forward-Looking Report

Steve Kerber
Derek Alkonis

This publication is available free of charge from:
https://doi.org/10.60752/102376.28074944



Photo Credit: Dahlquist Photography

January 14, 2025
Columbia, MD

Fire Safety Research Institute

© 2025 Underwriters Laboratories Inc.

Acknowledgments

The authors express sincere gratitude to the people of Maui for their willingness to share information and personal stories about this incident. The authors also acknowledge the steadfast commitment of the Hawai‘i Attorney General Anne E. Lopez and the Hawai‘i Department of the Attorney General to complete this independent research and analysis.

The authors also thank the County of Maui and the following individuals for their invaluable contributions: Clay Trauernicht from the University of Hawai‘i, John Bravender and Derek Wroe from the National Weather Service, Elizabeth Pickett from the Hawai‘i Wildfire Management Organization, Michael Walker from the State of Hawai‘i Division of Forestry and Wildlife, former Hawai‘i County Mayor and Civil Defense Agency Administrator Harry Kim, Karl Fippinger from the International Code Council, and Darus Ane, Jim Barnes, Leonard Casson, Alysa Finlayson, Tim Hagel, Todd Harms, Garrett Kim, T J Martin, Jessica Pickett, Kevin Roche, and Adam Thiel from FACETS. Their insights and data have been instrumental in the compilation of this report.

Special thanks also go to FSRI’s Gavin Horn and Daniel Gorham for their contributions to the analysis, as well as Charley Fleischmann, Dan Madrzykowski, and Dawn Ey for their supporting efforts.

Disclaimer
In no event shall UL Research Institutes (ULRI) be responsible to anyone for whatever use or non-use is made of the information contained in this report and in no event shall ULRI, its employees, or its agents incur any obligation or liability for damages, including, but not limited to, consequential damage arising out of or in connection with the use or inability to use the information contained in this report.

TABLE OF CONTENTS

02 ACKNOWLEDGMENTS

02 DISCLAIMER

03 TABLE OF CONTENTS

05 LIST OF TABLES

06 **1.0 Executive Summary**

08 **2.0 State of Hawai‘i Priorities and Recommendations**

09 Priority 1. Action Planning and Accountability

09 Priority 2. State Fire Marshal

10 Priority 3. Wildfire Education Programming

11 Priority 4. Communication Systems

11 Priority 5. Utilities Risk Reduction and Planning

12 Priority 6. Fire Weather

12 Priority 7. Evacuation

13 Priority 8. Codes and Standards

13 Priority 9. Wildfire Response Preparedness

14 Priority 10. Vegetation and Land Management

15 **3.0 County Priorities and Recommendations**

16 Priority 1. Coordinated Action Planning and Accountability

18 Priority 2. Risk Assessment and Data Driven Investment

19 Priority 3. Wildfire Response Preparedness

22 Priority 4. Incident Management

22 Priority 5. Wildfire and Wildland Urban Interface (WUI) Education Programming

23 Priority 6. Communication Systems and Planning

24 Priority 7. Evacuation

24 Priority 8. Codes and Standards

25 Priority 9. Utilities Risk Reduction and Planning

25 Priority 10. Vegetation and Land Management

27 **4.0 Fire Code and Building Code Review**

28 4.1 Building and Fire Codes in the State of Hawai‘i

28 4.1.1 Hawai‘i State Building Code Council

TABLE OF CONTENTS

29 4.1.2 Hawai‘i State Fire Council

29 4.1.3 Hawai‘i State Fire Codes

29 4.1.4 Governor’s Affordable Housing Initiative and the State Building Codes

31 4.2 Building Codes in County of Maui

31 4.2.1 County of Maui Building Code Discussion

31 4.2.2 County of Maui Building Code - 2023 Updates

32 4.2.3 County of Maui Building Code Administration

35 4.3 Fire Codes in County of Maui

35 4.3.1 County of Maui Fire Code Administration

35 4.3.2 Organization of the County of Maui Department of Fire & Public Safety

35 4.3.3 Fire Prevention Bureau and Personnel

38 4.4 Maui Recovery Permitting Center

39 **5.0 State Fire Marshal Review**

40 **6.0 Summary**

41 **7.0 Appendix**

41 7.1 Lahaina Fire Incident Analysis Report (Phase Two) Findings and Recommendations

56 **8.0 Acronyms and Meanings**

LIST OF TABLES

8	Table 1	The 10 highest priorities for enhancing wildfire readiness at the state level.
16	Table 2	The 10 highest priorities for enhancing wildfire readiness at the county level.
33	Table 3	Developmental Services Administration Program Staffing.
34	Table 4	Developmental Services Administration Building Program Staffing.
36	Table 5	Maui Fire Department Fire Prevention Program Staffing.
37	Table 6	Maui Fire Department Plan Review, Processing, and Inspection Revolving Fund Program Staffing.

EXECUTIVE SUMMARY

On August 8, 2023, Hurricane Dora, spinning south of the Hawaiian Islands added unprecedented winds to a landscape that was already susceptible to fire. By the end of the day, multiple wildfires moved across the island of Maui. The Lahaina Fire, sparked by downed powerlines and whipped by winds gusting over 80 miles per hour, quickly grew into an urban conflagration that would eventually overtake and destroy most of Lahaina Town. Burning over 2,000 structures and resulting in the loss of 102 lives, the Lahaina Fire became the most deadly wildfire in the United States in the last 100 years. The State of Hawai'i (the State), through Attorney General Anne Lopez, determined to understand this tragic event in all its complexities so that every effort could be made to prevent similar catastrophes from happening again. The Fire Safety Research Institute (FSRI) was contracted to complete three reports in an independent, comprehensive analysis of the Lahaina Fire and provide suggestions for a path to a safer Hawai'i.

The Lahaina Fire Comprehensive Timeline Report[1] (Phase One) presents a chronology of the events captured from an extensive data collection effort, resulting in more than 12,000 timeline entries. This report focuses on the time period beginning at 14:55 on August 8, 2023, and concludes at 08:30 on August 9, 2023, and includes the relevant events that occurred prior to, and during, this time, such as preparedness efforts, weather and its impact to infrastructure, and other fires occurring on Maui. Phase One includes hundreds of data points used to create a fire progression map showing the path the fire took as it impacted the built environment mauka (toward the mountain) to makai (toward the ocean), and to the south and to the north. Phase One was published April 17, 2024, with the comprehensive timeline.[2]

The Lahaina Fire Incident Analysis Report[3] (Phase Two) presents relevant background information; discusses weather, fuel, and infrastructure conditions; describes communication, incident management, fire suppression, and evacuation efforts; and details the impact of the fire on Lahaina's built environment. It also considers these factors in the context of the National Cohesive Wildland Fire Management Strategy[4] (Cohesive Strategy). The analysis of the nearly two terabytes of data collected for Phase One includes detailed explanations of how the fire impacted zones where there was a collection of destroyed, damaged, and undamaged structures. Analyzing each system component against organizational policies and procedures and evidence-based research resulted in 84 Findings and 140 Recommendations (see Appendix 7.1). The Findings and Recommendations highlight areas demanding attention to improve fire safety. This report does not include an analysis of recovery efforts or the fire's cause and origin, which was investigated by the County of Maui with assistance from the United States Bureau of Alcohol, Tobacco, Firearms, and Explosives (ATF). Phase Two was initially published September 13, 2024, with revision one published October 2, 2024.

A portion of this Lahaina Fire Forward-Looking Report (Phase Three) organizes these findings. A prioritized list of action items is provided to the State and all counties so that changes can be made that improve Hawaii's response to wildfires. Phase Three includes a Community Risk Assessment (CRA), Community Risk Reduction (CRR) plan, a Standards of Cover (SOC) analysis, and a review of the codes and standards adoption and use processes for the County of Maui. Each of these components are in progress.

FSRI has provided the State and counties with their own guidance documents, identifying the 10 highest priorities for enhancing wildfire readiness. In addition, FSRI has also engaged with the

EXECUTIVE SUMMARY

Department of the Attorney General (DOAG) and Hawai‘i Wildfire Management Organization (HWMO) to address the preparations needed for the Office of the State Fire Mashall (OSFM) to be effective as soon as possible.

Currently, the CRA, CRR, and SOC for the County of Maui are underway. The Maui Fire Department (MFD) has been provided with the resource demands for each analysis and the data needs for the SOC. FSRI has also identified data sources via public websites that the MFD will validate and review for accuracy. Timeline for completion of these analyses for the County of Maui is expected to take several months due to anticipated challenges validating data, and ultimately, completing the final report.

Section 3.0 of Phase Three outlines the 10 highest priorities for enhancing wildfire readiness in each county within the State of Hawai‘i and recommends that all counties complete a CRA, CRR, and SOC. To date, each county fire chief has received the County Priorities and Recommendations and personal briefings have been completed. The briefings served to ensure the 10 priorities are actionable and modified for each specific county’s circumstance, where needed.

Section 2.0 of Phase Three highlights the 10 highest priorities for enhancing wildfire readiness in Hawai‘i and was prepared at the request of Governor Josh Green and delivered in October 2024. Like Section 3.0, this distills Phase Two’s 84 Findings and 140 Recommendations into 10 areas of focus concentrated on the most urgent needs. A high-priority item for the State is staffing the OSFM and engaging state agencies in addressing Phase Two Findings and Recommendations.

Building codes and standards play a critical role in public safety by providing standardized requirements for building construction. Phase Three reviews the adoption process, and the versions of the codes that were in effect at the time of the August 8, 2023, fires. The adoption of contemporary codes and standards, and the use of advancements in building materials and construction techniques, are crucial components of a community’s resilience in the face of wildfire.

The Phase Three building codes and standards section complements the Federal Emergency Management Agency’s (FEMA), Maui Wildfire Mitigation Assessment Team’s (MAT) Recovery Advisories 1 through 4, and Codes, Standards, and Permitting Summary and Recommendations Report (90% Draft as of December 22, 2024).[5]

Just prior to publishing this report, the County of Maui released the Lahaina Long-term Recovery Plan.[6] The plan includes several “Priority Projects” within Section 7 that align with the Lahaina Fire Incident Analysis Report[7] (Phase Two) Findings and Recommendations, which are also included within the State and County Priorities of this report.



2.0 State of Hawaiʻi Priorities and Recommendations

The Lahaina Fire Incident Analysis Report (Phase Two) was released on September 13, 2024. In a briefing, Governor Green asked FSRI to identify the 10 key priorities for the State of Hawaiʻi to address to enhance wildfire safety statewide. By distilling the report's 140 Recommendations into these 10 areas of focus, the State (See Table 1) can create an immediately actionable plan concentrated on the most urgent and impactful areas. This streamlined approach provides a clear roadmap for the State to initiate progress and take the critical first steps necessary to establish a solid foundation that supports future meaningful improvements. While these 10 priorities are crucial for immediate action, the remaining recommendations are also vital and should be urgently addressed to ensure comprehensive wildfire system improvement across the state. This document includes recommendations for "how" to address each priority. These recommendations are limited by FSRI's understanding of the State of Hawaii's organizational structures but bolstered by FSRI's experience within each of the priority areas. We realize there may be different approaches that better align with state, county, and non-profit organizational processes.

Table 1. The 10 highest priorities for enhancing wildfire readiness at the state level.

10 Highest Priorities for Enhancing Wildfire Readiness at the State Level

Ensures an organizational structure that supports a coordinated process

Priority 1
Action Planning & Accountability
Facilitation of process to plan and implement subsequent priorities

Priority 2
Office of the State Fire Marshal
Complete process to hire SFM and OSFM staff;
Identify and hire an interim leader to facilitate action planning toward system components (below)

Lead agency assigned to develop & implement action plan

Priority 3 Wildfire Education Programming	**Priority 4** Communication Systems	**Priority 5** Utilities Risk Reduction & Planning	**Priority 6** Fire Weather
Priority 7 Evacuation	**Priority 8** Codes & Standards	**Priority 9** Wildfire Response Preparedness	**Priority 10** Vegetation & Land Management

2.0 STATE OF HAWAIʻI PRIORITIES AND RECOMMENDATIONS

Priority 1. Action Planning and Accountability

Require Department of Land and Natural Resources, Division of Forestry and Wildlife (DLNR-DOFAW), Hawaiʻi Building Code Council (HBCC), Hawaiʻi Public Utilities Commission (HPUC), State Fire Council (SFC), Office of Planning Sustainable Development (OPSD), Hawaiʻi Emergency Management Agency (HI-EMA), Hawaiʻi Department of Law Enforcement (DLE), Hawaiʻi Department of Transportation (DOT), and Commission on Water Resource Management (CWRM) to prepare a preliminary action plan for addressing Phase Two Findings and Recommendations pertaining to their areas of responsibility.

Findings and Recommendations Addressed:*

- Finding 1 (page 303) - Recommendations 1 and 2

Recommendations for how to address Priority 1

Select a Priority 1 task owner from a state government organization.

This priority could benefit from leadership from an individual or organization having the most knowledge of the wildfire system components addressed in Phase Two. In many states, this would be the State Fire Marshal (SFM). However, because there is no currently appointed fire marshal in Hawaiʻi, an alternative should be identified. Consider contracting with the non-profit HWMO to share a leadership role with a leader from a state organization having current wildfire responsibilities. The HWMO has knowledge and experience in wildfire prevention, preparedness, multi-partner coordination, and project management, and was also an excellent resource to FSRI throughout Phase One and Phase Two. They also work closely with all county, state, and federal fire agencies, public utilities, community groups, the National Weather Service (NWS), and code and standards organizations such as the National Fire Protection Association (NFPA), International Code Council (ICC), and Underwriter's Laboratories Standards and Engagement (ULSE).

The leader of this priority could be responsible for scheduling and facilitating meetings with the group of state organizations listed, sharing work product examples, preparing a timeline, using a project planning tool to document progress toward completion, and providing status reports to Priority 1 owner, while ensuring all tasks are completed, as per the timeline.

This priority sets the table for the subsequent priorities. Each state organization leading the development of their action plan should avoid working in isolation or reinventing existing processes, as this can lead to inefficiencies and fragmentation. Collaboration with other agencies and stakeholders is encouraged and essential to avoid duplication, competition, and potential harm. Achieving more cohesive and effective outcomes requires building on existing data, programs, and knowledge.

Priority 2. Office of the State Fire Marshal

State agency selected to oversee the OSFM to recruit and hire the SFM and individuals required to fill critical roles within the OSFM. The SFM (or interim leader) to work closely with SFC and other state agencies to prepare an action plan for addressing Phase Two Findings and Recommendations related to codes, standards, zoning, vegetation management, wildfire data collection, mutual aid response, and firefighter training and operations standards (including private contractors).

**Page numbers referenced correspond to the Lahaina Fire Incident Analysis Report (Phase Two).*

Findings and Recommendations Addressed:*

- Finding 3 (page 303) - Recommendations 1 and 2
- Finding 9 (page 304) - Recommendations 1, 2, 3, and 4
- **Note: Priority 2 is already in progress from the last legislative session. FSRI provided input to the job description to support the effort; however, the status of the hiring process is unknown.**

Recommendations for how to address Priority 2

This is a two-part project where both are completed concurrently. One project is to hire individuals needed to establish an OSFM, and the second is to identify an interim SFM who can work on the tasks that will ultimately be managed by the SFM once hired.

The first task is to select a Priority 2 owner. This could be the leader of the organization most responsible for managing the recruitment and hiring of the SFM and staff, which may come from the state agency the OSFM will report to, Department of Human Resources Development (DHRD), State Personnel Office, and/or a member of the SFC. Each one of these organizations has been, or will likely be, involved in the hiring process.

The organizations listed above should finalize the class specification and associated job duties to ensure it includes, but not be limited to, wildfire (including wildland urban interface - WUI) prevention, preparedness, response, and recovery, as well as multi-agency and multi-sector coordination and strategy.

The recruitment and hiring of the SFM should include a project plan with tasks, task owners, completion timelines, and other components of a well-developed work plan that ensures efficiency and accountability.

The second part of this project includes identifying an interim leader to address the system components of Phase Two that will ultimately be the responsibility of the SFM. This is another area where the HWMO may be able to assist as a contractor. As mentioned in Priority 1, they have knowledge, experience, and the professional network to develop a project plan to address each of the items listed in Priority 2, and several of the subsequent priorities where the SFM is listed.

Priority 3. Wildfire Education Programming

Provide educational programming for the diversity of audiences across the state regarding wildfire preparedness. Programming should include mitigation best practices, defensible space and vegetation management, fire weather, and fire behavior. Develop and implement a plan for ongoing financial support for this programming.

Findings and Recommendations Addressed:*

- Finding 11 (page 305) - Recommendation 1
- Finding 13 (page 305) - Recommendation 1
- Finding 18 (page 306) - Recommendation 4
- Finding 37 (page 309) - Recommendation 1
- Finding 39 (page 309) - Recommendation 1
- Finding 75 (page 316) - Recommendations 2 and 3

Recommendations for how to address Priority 3

This is another two-part project where both tasks are completed concurrently. One task is to identify a state government organization that will be responsible for ensuring wildfire-related educational programming is prioritized and supported at the state-level (accountability). The second is to fund and support the ongoing work to be adequately carried out (implementation).

The first task is to select a Priority 3 owner from a state government organization. Ensuring ongoing state-level accountability and support for this priority may eventually fall under the SFM's purview, or potentially DLNR-DOFAW's, should their responsibilities expand beyond conservation areas. In the meantime, the interim SFM, as identified in Priority 2, could take on this responsibility.

The second task is to ensure existing programming is supported and implemented. Currently, the HWMO serves as the lead coordinating entity for wildfire outreach campaigns, educational resources, and training programs, collaborating with the DLNR-DOFAW, county fire departments, emergency management agencies, and communities to deliver statewide, multi-sector wildfire preparedness and mitigation programs. However, with minimal to no state funding at present, securing financial support will be crucial for the sustained implementation of this priority.

Priority 4. Communication Systems

HI-EMA and SFM to assess the resiliency and functionality of communication systems and the All-Hazard Outdoor Warning Siren System (OWSS), and establish redundant public alerting and warning processes, including best practice messaging guidance.

Findings and Recommendations Addressed:*

- Finding 36 (page 309) - Recommendation 1
- Finding 37 (page 309) - Recommendation 1
- Finding 75 (page 316) - Recommendations 1 and 2

Recommendations for how to address Priority 4

Select a Priority 4 task owner from a state government organization.

Due to HI-EMA having responsibility for the OWSS they may be best positioned to own and lead this priority. Other organizations that can assist include county emergency management agencies, DLNR-DOFAW (could provide wildfire input on behalf of the SFM until one is selected, or have the interim SFM from Priority 2 engage), NWS, telecommunications providers, and Hawaiian Electric (may be able to help with addressing resilient electrical power options).

Priority 5. Utilities Risk Reduction and Planning

HPUC and SFM to work with public utilities (electric and water) to identify immediate improvements to vegetation management programs to protect infrastructure from wildfire and enhance resiliency, and to provide guidelines for supporting incident management and operations.

Findings and Recommendations Addressed:*

- Finding 29 (page 308) - Recommendation 1
- Finding 31 (page 308) - Recommendation 1
- Finding 56 (page 311) - Recommendation 1

**Page numbers referenced correspond to the Lahaina Fire Incident Analysis Report (Phase Two)*

2.0 STATE OF HAWAIʻI PRIORITIES AND RECOMMENDATIONS

Recommendations for how to address Priority 5

Select a Priority 5 owner from a state government organization.

Since the HPUC falls under the Department of Commerce and Consumer Affairs (DCCA), DCCA may be best positioned to own and lead this priority with assistance from the interim SFM identified in Priority 2. DLNR-DOFAW, DLNR-Land Division, land owners, Hawaiian Electric, and CWRM can also contribute to this effort.

To address guidelines for incident management and operations, the interim SFM mentioned in Priority 2 can work closely with the SFC to develop expectations/guidelines for cooperators supporting incident commanders.

It should be recognized that this priority is in-progress. Hawaiian Electric has developed Interim Wildfire Safety Measures[8] to reduce the risk of wildfires associated with utility infrastructure and continues to work closely with government agencies to make improvements to their wildfire preparedness and prevention efforts.

Priority 6. Fire Weather

DLNR-DOFAW, SFC, and SFM to support NWS in improving weather forecasting and historical record keeping by ensuring Remote Automatic Weather Stations (RAWS) are positioned in high wildfire danger areas statewide. Also, engage other stakeholders, such as Hawaiian Electric and University of Hawaiʻi, who are currently installing weather stations that may provide additional fire weather information.

Findings and Recommendations Addressed:*

- Finding 5 (page 303) - Recommendation 2
- Finding 6 (page 303) - Recommendation 1
  - Note: This can be expanded to installing more RAWS in West Maui and other wildfire prone areas since two (2) RAWS have been positioned in Lahaina.
- Finding 7 (page 303) - Recommendation 1
- Finding 8 (page 304) - Recommendation 1

Recommendations for how to address Priority 6

Select a Priority 6 task owner from a state government organization.

The DLNR-DOFAW is the only state organization with wildland firefighters possessing national qualifications and having extensive knowledge of weather and other factors influencing wildland fire behavior. The DLNR-DOFAW could work closely with the interim SFM mentioned in Priority 2 and the SFC to complete this priority.

Priority 7. Evacuation

HI-EMA, DLE, DOT, and OPSD to coordinate with county law enforcement, fire, emergency management, and planning agencies in preparing a standardized format for documenting and executing evacuation plans for high wildfire risk areas.

Findings and Recommendations Addressed:*

- Finding 16 (page 306) - Recommendation 1
- Finding 17 (page 306) - Recommendation 1
- Finding 18 (page 306) - Recommendations 1 and 3
- Finding 19 (page 306) - Recommendations 1 and 2
- Finding 71 (page 314) - Recommendations 1 and 2
- Finding 72 (page 315) - Recommendations 1, 2, 3, 4, 5, and 6
- Finding 76 (page 316) - Recommendations 1, 2, and 3

**Page numbers referenced correspond to the Lahaina Fire Incident Analysis Report (Phase Two)*

Recommendations for how to address Priority 7

Select a Priority 7 task owner from a state government organization.

The DLE is the state law enforcement agency responsible for collaborating with federal, state, county, and private sector stakeholders. In addition to working closely with the organizations identified in the priority, the DLE should also work with the HWMO to learn where the wildfire risk areas are located throughout the state, where these risks are expanding to, and which communities currently have neighborhood evacuation plans and safe refuge locations already identified and/or developed.

Priority 8. Codes and Standards

SFM, HBCC, and SFC collaboratively evaluate and enhance the review and adoption processes for codes and standards, ensuring they effectively address wildfire risks, particularly in the WUI. Continued work is needed to align and coordinate codes to reduce fire risks to the built environment. Jointly ensuring organizational structures are prioritized and appropriately staffed to efficiently adopt and implement updated codes that reflect the state's wildfire threat will help provide a unified approach to wildfire resilience.

Findings and Recommendations Addressed:*

- Finding 14 (page 305) - Recommendation 3
- Finding 15 (page 306) - Recommendation 1
- Finding 77 (page 316) - Recommendation 2
- Finding 78 (page 316) - Recommendation 1
- Finding 80 (page 316) - Recommendation 2

Recommendations for how to address Priority 8

Select a Priority 8 task owner from a state government organization.

Until an SFM is appointed, and if the HBCC does not have full-time administrative staff, a member of the Department of Accounting and General Services (DAGS) could be designated as the owner. DAGS and the interim SFM identified in Priority 2 could work closely with the HBCC, SFC, ICC, NFPA and other code and standards stakeholders to complete this priority.

Priority 9. Wildfire Response Preparedness

SFM, SFC, HI-EMA, and DLNR-DOFAW to improve the coordination of wildfire preparedness and response of emergency responders across all agencies and private contractors to ensure the effective and efficient use of shared resources and to provide expectations for incident management organization.

Findings and Recommendations Addressed:*

- Finding 40 (page 309) - Recommendation 2
- Finding 41 (page 310) - Recommendation 1
- Finding 42 (page 310) - Recommendation 1
- Finding 43 (page 310) - Recommendation 1

Recommendations for how to address Priority 9

Select a Priority 9 task owner from a state government organization.

The DLNR-DOFAW may be best positioned to be the owner and leader of this priority due to their specialized wildland firefighting training and operational expertise. The other organizations identified in the priority, including the interim SFM identified in Priority 2, can assist by expanding response to the WUI and other types of emergencies.

Priority 10. Vegetation and Land Management

Identify the state agency responsible for vegetation management of non-conservation areas and establish a framework for land owners to follow for responsible land management. Appropriate agencies to lead this effort include those with experience in natural resource and land management, zoning, education, and enforcement.

Findings and Recommendations Addressed:*

- Finding 9 (page 304) - Recommendations 1, 2, 3, 4, and 5
- Finding 10 (page 305) - Recommendations 1, 2, and 3
- Finding 11 (page 305) - Recommendation 1
- Finding 12 (page 305) - Recommendations 1 and 2
- Finding 13 (page 305) - Recommendations 1, 2, and 3
- Finding 78 (page 316) - Recommendation 1

Recommendations for how to address Priority 10

Select a Priority 10 task owner from a state government organization.

Currently, there is no state organization tasked with developing or enforcing vegetation management guidelines, directives, or laws, and there is no framework governing responsible land management or related codes and policies that ensure public safety is prioritized in such land management practices. In other states, this is often the responsibility of the SFM, state forestry, and/or land management agency.

For this priority, the DLNR-DOFAW may have the most state agency experience in the design and implementation of vegetative fuels management for fire risk reduction, even though its efforts are restricted to conservation areas.

The HWMO currently provides training, best practice information, and mitigation planning support for vegetation management. They have also developed statewide vegetation management maps and reports, and collaborated with communities, land stewards, and agencies on small defensible space and fuel break projects.

Perhaps the owner of this priority is the DLNR-DOFAW with assistance from the interim SFM identified within Priority 2. Other relevant partners, such as the HWMO (described above) and UH Economic Research Organization (UHERO), who have initiated a study about the economics related to this issue, could also be engaged for an informed and collaborative approach to developing the action plan and framework.

**Page numbers referenced correspond to the Lahaina Fire Incident Analysis Report (Phase Two)*

3.0 County Priorities And Recommendations

The Lahaina Fire Incident Analysis Report (Phase Two) was released September 13, 2024. The report includes 84 Findings and 140 Recommendations. At the request of Governor Green, FSRI identified 10 key priorities for the State of Hawai‘i to address to enhance wildfire safety statewide. The document was released September 30, 2024.

The follow-up to the state priority list is the county list. This list includes what the counties should focus on immediately to address the increasing threat of wildfire and urban conflagration (See Table 2). The 10 priorities draw on the recommendations from Phase Two that pertain to all Hawai‘i counties and other published reports that include references to the Lahaina Fire Findings and Recommendations.[9] Some of the priorities are consistent with the 10 priorities FSRI identified for the State.

This streamlined approach provides a clear roadmap for the counties to initiate progress and take the critical first steps necessary to establish a solid foundation that supports future meaningful improvements. While these 10 priorities are crucial for immediate action, the remaining recommendations are also vital and should be urgently addressed to ensure comprehensive wildfire system improvements across each county.

The priorities were reviewed with each county fire chief. The chiefs provided valuable input that was incorporated within the document to make the “how” to implement more actionable and achievable for all counties.



3.0 COUNTY PRIORITIES AND RECOMMENDATIONS

Table 2. The 10 highest priorities for enhancing wildfire readiness at the county level.



Priority 1. Coordinated Action Planning and Accountability

Assign county-based organizations — including fire, law enforcement, emergency management, the mayor's office, county corporation counsel, water department, planning department, and public works — to prepare a preliminary action plan for addressing Phase Two Findings and Recommendations pertaining to their areas of responsibility. County-based representatives from the electrical utility provider, emergency medical services contractors, and state and federal agencies, such as DLNR-DOFAW, National Park Service, and Airport Rescue Fire Fighters (ARFF) and other relevant government and non-governmental organizations (NGOs) involved in wildfire/WUI prevention, preparedness, and response should also engage in this exercise. Together, these entities can conduct the learning and research necessary to begin planning and taking action, and coordinate their work plans to best address the recommendations applicable to their organization.

Findings and Recommendations Addressed:*

- Finding 1 (page 303) - Recommendations 1 and 2

**Page numbers referenced correspond to the Lahaina Fire Incident Analysis Report (Phase Two)*

3.0 COUNTY PRIORITIES AND RECOMMENDATIONS

Recommendations for how to address Priority 1

Assemble a Leadership Team to facilitate and oversee this coordinated multi-partner effort. The team should include experts in pre-suppression, suppression, and collaborative multi-system wildfire mitigation to guide effective wildfire planning across county agencies. This team will ensure stakeholder collaboration and alignment, while safeguarding the accuracy and adherence of technical components to best practices.

The Leadership Team could be responsible for the following:

- Scheduling and facilitating meetings with federal, state, inter-county, and NGO partners to foster a collaborative and unified approach to wildfire/WUI prevention, preparedness, and response

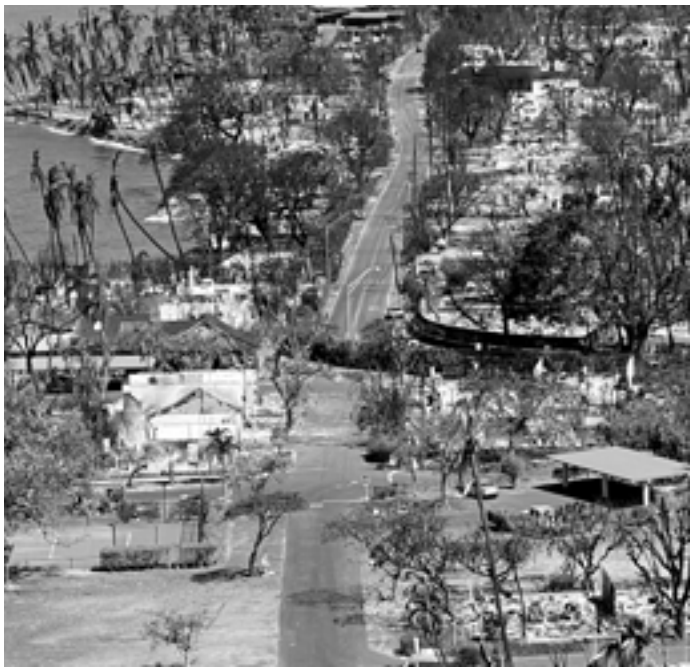
Each organization listed above should designate an internal lead and point of contact to serve as the Priority 1 Task Owner. This individual will be responsible for ensuring that the work remains on track and is effectively prioritized within their organization.

As the plans are being developed, a strategy for ensuring wildfire/WUI topics are appropriately prioritized is to include them within upper-, mid-, and lower-management meeting agendas. This can ensure the county's wildfire threat is given the consistent organizational attention required.

Each organization's Priority 1 Task Owner could be responsible within their organization for:

- Selecting wildfire/WUI agenda topics relevant to their organization
- Developing work plans to address these priority topics effectively
- Facilitating internal and external meetings to coordinate efforts and address organizational priorities

This priority sets the table for the subsequent priorities.The Leadership Team can encourage or ensure that as each county organization leads the development of their specific action plan, they should avoid working in isolation or reinventing existing processes, as this can lead to inefficiencies and fragmentation. Collaboration with other agencies and stakeholders is encouraged and essential to avoid duplication, competition, and potential harm. Achieving more cohesive and effective outcomes requires building on existing data, programs, and knowledge.



Priority 2. Risk Assessment and Data Driven Investment

Each county fire department should complete a CRA and CRR plan according to NFPA 1300. All fire departments should also complete an SOC analysis. These analyses provide the data needed to identify the investment in fire department resources to comprehensively address fire risk, as well as all the other hazards that exist throughout each county.

Phase Two Findings and Recommendations Addressed:*

- Mentioned on page 302 of Summary

Other sources of information that also address the need for the MFD to complete a risk assessment and SOC. These recommendations extend to all counties within the state.[10 11 12]

Recommendations for how to address Priority 2

Currently, the State contract with FSRI includes a CRA, CRR, and SOC for the MFD. Because wildfire and urban conflagration hazards exist within all four counties, it is highly recommended all four county fire departments conduct these critically important analyses if they have not been completed in the past five years. The analyses includes the following:

Community Risk Analysis

The CRA evaluates and enumerates natural, technological, and societal contributors to the health and safety of county residents, businesses, and visitors. This assessment benefits from the active involvement of county residents and local businesses in community-centered discussions of risk perception, societal and cultural contributors to risk, and the impact of multiple factors in the county's risk profile.[13]

Data needed for this work primarily consists of emergency incident, planning, and building information. Data should be de-identified (if needed), aggregated, and combined with data from other public and private sources, such as Census data, to characterize risk from all hazards across each county.

Community Risk Reduction Plan

Based on the CRA, and in concert with community groups/partners, the comprehensive CRR is designed to provide realistic strategies to increase the resiliency of the county's residents, infrastructure, and environment. The plan describes actions that can be taken by individuals, community organizations, government agencies, and others to mitigate risks, prepare to actively address risks, and make long-term progress on addressing risk in the community.

The CRR planning process should recognize the vital cultural and historical attributes of each county community by including residents and local businesses at every stage.

Data for this work will include information from county fire department staff on past risk-reduction efforts and the viability of proposed risk-reduction strategies; ideally, fire department and emergency management staff should be directly involved with all facets of the CRR planning effort.

Standards of Cover Analysis

An independent, comprehensive SOC analysis of the deployment and performance of a county fire department is required to objectively identify areas where additional resources are needed to help protect the community from all hazards.

This analysis will quantify the fire department's ability to deliver the capabilities described in NFPA 1710—Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments.

**Page numbers referenced correspond to the Lahaina Fire Incident Analysis Report (Phase Two)*

3.0 COUNTY PRIORITIES AND RECOMMENDATIONS

The SOC analysis is best conducted utilizing dynamic deployment modeling that considers the activity level of MFD response units and the interaction of these units with the County's EMS provider and mutual-aid resources (e.g., AMR, ARFF, DOFAW, etc.).

Data needed will primarily include computer aided dispatch (CAD) and fire department records management system (RMS) emergency incident information that is de-identified (if needed), aggregated, and analyzed without any personally identifiable information.

Funding and Getting Started

Completion of the same analyses for Kauaʻi, Hawaiʻi, and Honolulu county fire departments requires additional funding. Contracting for the same services for the three counties can be efficiently executed using the same request for proposal and statement of work that is agreed upon by the three counties.

Prior to securing funding, fire departments can begin gathering the data necessary for the three different analyses. The data elements are identified in NFPA 1300 and the FSRI SOC list (provided to each county fire department Priority 1 Task Owner upon request).

The HWMO can also be contracted to assist with assembling and analyzing the data needed for the CRA and CRR. The previous and current work performed by the HWMO, fire departments, and others will help inform the new CRA and CRR.

Priority 3. Wildfire Response Preparedness

County fire departments, police departments, emergency management agencies, county-based DLNR-DOFAW, electrical utility providers, and water companies to improve the coordination of wildfire preparedness and response of emergency responders across all agencies and private contractors to ensure the effective and efficient use of shared resources and to provide expectations for incident management organization.

Findings and Recommendations Addressed:*

- Finding 5 (page 303) - Recommendations 1 and 2
- Finding 6 (page 303) - Recommendation 1
- Finding 7 (page 303) - Recommendation 1
- Finding 8 (page 304) - Recommendation 1
- Finding 27 (page 308) - Recommendation 1
- Finding 28 (page 308) - Recommendation 1
- Finding 34 (page 309) - Recommendation 1
- Finding 35 (page 309) - Recommendation 1
- Finding 40 (page 309) - Recommendation 2
- Finding 46 (page 310) - Recommendation 1
- Finding 55 (page 311) - Recommendations 1 and 2
- Finding 59 (page 312) - Recommendations 1, 2, 3, 4, and 5
- Finding 60 (page 312) - Recommendations 1, 2, 3, and 4
- Finding 61 (page 313) - Recommendation 1
- Finding 62 (page 313) - Recommendations 1 and 2
- Finding 64 (page 313) - Recommendation 1
- Finding 65 (page 313) - Recommendation 1
- Finding 67 (page 313) - Recommendations 1 and 2
- Finding 68 (page 314) - Recommendations 1, 2, 3, 4, 5, and 6
- Finding 69 (page 314) - Recommendation 1
- Finding 70 (page 314) - Recommendation 1
- Finding 83 (page 317) - Recommendation 1

3.0 COUNTY PRIORITIES AND RECOMMENDATIONS

Recommendations for how to address Priority 3

This priority requires the following steps to ensure assisting and cooperating agencies are prepared for wildfire/WUI response.

Pre-incident Planning, Training, and Readiness

Task 1 - Above listed organizations become familiar with existing Community Wildfire Protection Plans (CWPP). The objective of the review is for organizational leaders through local responders to become aware of wildfire hazards, built environment vulnerabilities, and where evacuation challenges exist. The CWPP serves as an introduction to learning about the level of wildfire risk in communities and where urban conflagration is a threat to life safety and property conservation. It also identifies community- and agency-identified priorities for wildfire protection and action.

Task 2 - Fire departments enhance training to strengthen operational readiness during forecasted extreme conditions. Focus areas include initial attack strategies, structure defense tactics, utilizing alternative water sources, safely navigating electrical hazards, and effectively managing mop-up operations for wind-driven wildland and WUI fires.

Task 3 - Fire departments and the DLNR-DOFAW use the CWPPs to develop electronic wildland pre-attack plans / structure defense maps. The maps serve as a reference tool for responders before and during an incident. Maps can include locations for incident command posts, incident base, helispots, public temporary refuge areas, public safe refuge areas, safety zones, staging areas, pools, reservoirs, gates, evacuation routes, structure defense groups, and hydrant locations with connection sizes and municipal vs private identification. The maps should be accessible during incidents to all responders and updated annually or when changes occur. The process of creating and maintaining the maps can be codified in policy and procedure to ensure they are available and kept current.

Task 4 - Initiate automatic / mutual aid agreement between county fire department and county-based DLNR-DOFAW for joint response to all vegetation fires. This allows for more wildland capable resources on scene for initial attack, and for incidents requiring significant mop-up.

Task 5 - Fire departments and the DLNR-DOFAW establish a system to track fleet readiness to ensure preparedness of reserve/relief emergency apparatus prior to forecasted weather events. The report should be available via a web based platform so officers know the real time status of vehicles as listed by apparatus identification, type, and location. This can be codified in policy and procedure to ensure it is adhered to.

Task 6 - Fire departments and county-based DLNR-DOFAW work with private heavy equipment companies (and operators) to establish wildland firefighting expectations/standards addressing training, equipment, personal protective equipment, and operational performance.



3.0 COUNTY PRIORITIES AND RECOMMENDATIONS

Weather Tracking and Response

Task 7 - Fire and emergency departments should assign a dedicated individual or team responsible for tracking and consistently monitoring NWS fire weather forecasts, fire weather products, drought monitors, real-time conditions, and fuel conditions. This critical information should be regularly communicated to leadership and operational staff on a daily basis or as updates occur to support informed decision making and operational readiness.

Task 8 - During wildfire season (as per county incident data), fire departments and county based DLNR-DOFAW should consider having operational conference calls with officers to share weather and fuels information, reserve/relief unit status, augmented staffing plan, and other operational preparedness issues. This can be codified in policy and procedure to ensure it is adhered to.

Task 9 - When fire weather, or other significant weather events, are forecasted it is recommended the NWS brief fire departments, police departments, county-based DLNR-DOFAW, county-based National Park Service, electrical utility provider, public works, water department, and other cooperating agencies on expected severity of conditions and provide preparedness recommendations.

Task 10 - Fire departments, county-based DLNR-DOFAW, and electrical utility providers should consider establishing an augmented staffing plan triggered when fire weather and/or other severe weather conditions are forecasted. The parameters for augmented staffing should be related to fire history, weather, and fuel. Analyzing when, where, and how big fires burn in relation to weather and fuels data can land decision makers on a probability of large growth where augmented staffing could make a difference in controlling the fire when it is small. Augmented staffing can also be implemented at different levels.

A basic augmented staffing plan may consist of staffing the water tenders/tankers with an additional firefighter. A more robust plan could include wildland apparatus staffed with two to four personnel, a select number of relief apparatus being positioned and staffed in high risk areas, a chief officer assigned to dispatch, and a Type 3 incident management team on call status. The augmented staffing process should be codified in policy and procedure so it is clear what weather and fuel parameters are being evaluated to trigger staffing, and to identify the individual (role/rank) responsible for making the decision.



Priority 4. Incident Management

County emergency management agency, fire department, and law enforcement work with HI-EMA and SFM to develop and implement a statewide incident management training, qualification, and response framework consistent with the National Incident Management System (NIMS[14]) and in alignment with Homeland Security Presidential Directive 5.[16]

Findings and Recommendations Addressed:*

- Finding 40 (page 309) - Recommendations 2 and 3
- Finding 41 (page 310) - Recommendation 1
- Finding 44 (page 310) - Recommendations 1 and 2
- Finding 46 (page 310) - Recommendation 1
- Finding 47 (page 310) - Recommendation 1
- Finding 50 (page 311) - Recommendation 1
- Finding 51 (page 311) - Recommendation 1
- Finding 52 (page 311) - Recommendations 1 and 2
- Finding 55 (page 311) - Recommendations 1 and 2
- Finding 56 (page 311) - Recommendation 1
- Finding 57 (page 312) - Recommendations 1 and 2
- Finding 59 (page 312) - Recommendation 3

Recommendations for how to address Priority 4

Although individuals from state and county emergency management and response agencies complete some NIMS courses, currently there is no standardized incident management framework for the State of Hawai‘i. Establishing a NIMS framework for all county emergency management agencies, fire departments, police departments, and cooperating support agencies ensures consistent incident management preparation and operations. The NIMS framework and associated National Wildfire Coordinating Group (NWCG) training and qualification standards provide structure that can be adapted and scaled to organizational size and response demands. Additionally, standardized training and a unified incident management framework enable reliable personnel sharing and seamless support across agencies.

This commitment to a standard should be codified in state and county regulations.

Priority 5. Wildfire and Wildland Urban Interface (WUI) Education Programming

Provide educational programming and risk reduction support for the diversity of audiences across the county regarding wildfire preparedness. Programming to include mitigation best practices, defensible space and vegetation management, fire weather, and fire behavior. Develop and implement a plan for ongoing financial support for this programming.

Findings and Recommendations Addressed:*

- Finding 11 (page 305) - Recommendation 1
- Finding 13 (page 305) - Recommendation 1
- Finding 18 (page 306) - Recommendation 4
- Finding 37 (page 309) - Recommendation 1
- Finding 39 (page 309) - Recommendation 1
- Finding 75 (page 316) - Recommendations 2 and 3

Recommendations for how to address Priority 5

The recommendations outlined in the State's list can also be applied at the county level.

Contract with the HWMO to prepare and implement wildfire education programming. This would help maintain consistent messaging statewide. These programs and resources, co-developed with county and state fire agencies, are already being collaboratively implemented. Ensuring financial investment in these programs is essential to their success, enabling them to function effectively, meet community needs, and drive the critical shift from community and land manager wildfire awareness to proactive mitigation action.

Priority 6. Communication Systems and Planning

County emergency management agency to coordinate with HI-EMA to assess the resiliency and functionality of public emergency communication systems and the OWSS, and establish redundant public alerting and warning processes, including best practice messaging guidance. This priority also extends to: preparing plans for how different forms of public emergency communications will be executed and ensuring interoperability of emergency responder communications.

Findings and Recommendations Addressed:*

- Finding 36 (page 309) - Recommendation 1
- Finding 37 (page 309) - Recommendation 1
- Finding 39 (page 309) - Recommendation 1
- Finding 75 (page 316) - Recommendations 1 and 2

Recommendations for how to address Priority 6

County emergency management, fire department, and law enforcement should work closely with telecommunications providers and the Hawai'i Association of Broadcasters (HAB) to assess the functionality and resilience of communications systems in each high-hazard area of the counties, and to develop plans for how each public emergency communications form will be used. These organizations can inform emergency managers and responders of the strength and vulnerabilities of the telecommunications infrastructure, and determine how radio can be used more effectively to communicate alerts and updates when electrical and telecommunications infrastructure is compromised.

County emergency management should also work closely with HI-EMA to understand the functionality and resilience of the OWSS in each high-hazard area. Other organizations that can assist include county-based DLNR-DOFAW (could provide wildfire input), NWS, and Hawaiian Electric (may be able to help with addressing resilient electrical power options).

County agencies follow best practices to ensure alerts include language that is clear, concise, and standardized. Achieving interoperability of emergency responder communications requires planning and investment. This should start with fire, law enforcement, and emergency management working together to ensure investment in infrastructure and radio equipment achieves reliable interoperability.

**Page numbers referenced correspond to the Lahaina Fire Incident Analysis Report (Phase Two)*

3.0 COUNTY PRIORITIES AND RECOMMENDATIONS

Priority 7. Evacuation

County law enforcement, fire, emergency management, and planning agencies should collaborate to prepare a standardized methodology and format for documenting and executing evacuation plans for high wildfire risk areas.

Findings and Recommendations Addressed:*

- Finding 16 (page 306) - Recommendation 1
- Finding 17 (page 306) - Recommendation 1
- Finding 18 (page 306) - Recommendations 1 and 3
- Finding 19 (page 306) - Recommendations 1 and 2
- Finding 71 (page 314) - Recommendations 1 and 2
- Finding 72 (page 315) - Recommendations 1, 2, 3, 4, 5, and 6
- Finding 76 (page 316) - Recommendations 1, 2, and 3

Recommendations for how to address Priority 7

County emergency management, police departments, and fire departments should develop evacuation plans based on known and anticipated evacuation needs. County emergency management and law enforcement agencies should coordinate with the state DLE to ensure consistency with the state evacuation planning format. Coordination with the HWMO is also helpful to learn where the wildfire risk areas are located throughout the state, where these risks are expanding to, and which communities currently have neighborhood evacuation plans and safe refuge locations already identified and/or developed. Coordinate local community efforts to develop neighborhood-specific evacuation plans that align seamlessly with broader agency evacuation strategies.

Priority 8. Codes and Standards

County fire departments (prevention chiefs) and county planning departments should evaluate and enhance the review and adoption processes for codes and standards, ensuring they are driven by public safety and effectively address wildfire risks, particularly in the WUI. Focus on aligning and coordinating codes to reduce fire risks to the built environment, while simultaneously building the capacity needed for plans review, permitting, inspection, and enforcement. Organizational structures should be prioritized and appropriately staffed to adopt and implement updated codes efficiently, reflecting the county's wildfire threat and fostering a unified approach to wildfire resilience.

Findings and Recommendations Addressed:*

- Finding 14 (page 305) - Recommendation 3
- Finding 15 (page 306) - Recommendation 1
- Finding 77 (page 316) - Recommendation 2
- Finding 78 (page 316) - Recommendation 1
- Finding 80 (page 316) - Recommendation 2

Recommendations for how to address Priority 8

County fire department prevention chief tracks SFM, SFC and HBCC code amendment and adoption progress. The chief can also review code adoptions and amendments of other states and counties with similar wildfire and built environment risk. The work other states are doing in this area can inform next steps for county codes adoption and amendment process. The county prevention chief should also work closely with the ICC, the NFPA, and other code and standards stakeholders to complete this priority.

**Page numbers referenced correspond to the Lahaina Fire Incident Analysis Report (Phase Two)*

3.0 COUNTY PRIORITIES AND RECOMMENDATIONS

Priority 9. Utilities Risk Reduction and Planning

County fire departments and public utilities (electric and water) should identify immediate improvements to vegetation management programs to harden and protect infrastructure from wildfire, prevent utility-ignited fires, and enhance overall resiliency. Additionally, they should develop guidelines to support incident management, operations, and responder safety.

Findings and Recommendations Addressed:*

- Finding 29 (page 308) - Recommendation 1
- Finding 31 (page 308) - Recommendation 1
- Finding 56 (page 311) - Recommendation 1

Recommendations for how to address Priority 9

While the State is working with the HPUC to develop vegetation management guidelines/ regulations for electrical installations, the county fire department should work with local electrical utilities in the same effort, while also developing incident management operations and a responder safety training program.

Responder safety training programs related to compromised electrical infrastructure should include evidence-based practices for firefighters and police officers. Programs should be codified in agency policies.

This priority should complement Hawaiian Electric's ongoing efforts toward wildfire prevention and preparedness.[16]

Priority 10. Vegetation and Land Management

Identify a county agency to work with the state agency responsible for vegetation management of non-conservation areas and establish a framework for land owners to follow for responsible land management. Appropriate agencies to lead this effort include those with experiences in natural resource and land management, zoning, education, and enforcement.

Findings and Recommendations Addressed:*

- Finding 9 (page 304) - Recommendations 1, 2, 3, 4, and 5
- Finding 10 (page 305) - Recommendations 1, 2 and 3
- Finding 11 (page 305) - Recommendation 1
- Finding 12 (page 305) - Recommendations 1 and 2
- Finding 13 (page 305) - Recommendations 1, 2, and 3
- Finding 78 (page 316) - Recommendation 1



**Page numbers referenced correspond to the Lahaina Fire Incident Analysis Report (Phase Two)*

3.0 COUNTY PRIORITIES AND RECOMMENDATIONS

Recommendations for how to address Priority 10

Currently, there is no state or county organization tasked with developing or enforcing vegetation management guidelines, directives, or laws, and there is no framework governing responsible land management or related codes and policies that ensure public safety is prioritized in such land management practices. In other states, this is often the responsibility of the SFM, or state/county forestry agency.

For this priority, the DLNR-DOFAW may have the most experience in the design and implementation of vegetative fuels management for fire risk reduction, even though its efforts are restricted to conservation areas.

The HWMO currently provides training, best practice information, and mitigation planning support for vegetation management. They have also developed statewide vegetation management maps and reports, and collaborated with communities, land stewards, and agencies on small defensible space and fuel break projects.

Perhaps the owner of this priority is the county-based DLNR-DOFAW unit, with assistance from individuals from the fire department and planning department.

Engagement of the departments with the capacity to inspect and enforce is necessary due to land owners receiving notification to maintain properties, in accordance with local codes and ordinances. Counties not having a local vegetation management policy should adopt one, following national best practices for clearance around structures and management of large parcels. How land owners comply with vegetation management mandates must adhere to best practices, evidence-based research, and following ecological and environmental preservation standards. Other relevant partners, such as the HWMO (described above) and UHERO, which has initiated a study about the economics related to this issue, could also be engaged for an informed and collaborative approach to developing the action plan and framework.

Owners and managers of large vegetated land parcels in wildland or unmaintained agricultural areas should be actively engaged to promote education and encourage voluntary compliance. Additionally, they should provide critical information to aid response efforts, including gate accessibility, points of contact, staging areas, access routes, and available water resources.





4.0 Fire Code and Building Code Review

A component of the Phase Three report is a comprehensive independent review of the efficacy of current building and fire codes in Maui, including the present status of code implementation, education, and enforcement in place at the time of the August 8, 2023, Maui wildfires.

Although the information available from public facing websites (see footnotes) captures the code and standards adoption elements and processes in place on and before August 8, 2023, evaluating the efficacy of the current system requires additional data. The Phase Three components of CRA and the CRR planning process will provide data needed to determine how the prevention resources and investment effectively address the risks in Maui Nui. Furthermore, understanding the efficacy of fire prevention efforts statewide requires CRAs and CRRs to be completed by the counties of Kaua‘i, Hawai‘i, and Honolulu, as recommended within Section 3.

FEMA’s Mitigation Assessment Team’s (MAT) Recovery Advisories and Report on Codes, Standards and Permitting[17] also includes a review of the code adoption process while also providing recommendations for addressing deficiencies.

4.1 Building and Fire Codes in the State of Hawaiʻi

This section presents an overview of the State of Hawaiʻi and County of Maui building and fire codes that were in place prior to the August 2023 Maui wildfires. Applicable codes and regulations are included along with a profile of the established code administration programs in place for building safety and fire prevention programs as they were prior to the Maui wildfires.

4.1.1 Hawaiʻi State Building Code Council

The State Building Code Council (SBCC), authorized by Hawaiʻi Revised Statutes (HRS) §107-22,[18] establishes state building codes through the adoption and amendment of nationally recognized model building codes on a three year cycle.[19] [20] The SBCC is comprised of 11 voting members and one non-voting member as described below:

- Four county building officials, one from each of the four counties, appointed by the mayor
- One member representing the SFC
- One member representing the Department of Labor and Industrial Relations who has significant experience in elevator safety
- One member representing the State Energy Office of the Department of Business, Economic Development, and Tourism
- One member representing the Structural Engineers Association of Hawaiʻi
- One member representing the American Institute of Architects, Hawaiʻi State Council
- One member representing the Building Industry Association of Hawaiʻi or the General Contractors Association of Hawaiʻi, who has significant experience with building codes, with alternating four-year terms between the two organizations and the first four-year term to be served by the Building Industry Association of Hawaiʻi
- One member representing the Subcontractors' Association of Hawaiʻi who has significant experience with building codes

HRS §107-23[21] directs the SBCC to appoint an executive director with administrative abilities and experience with the building industry. Separately, HRS §107-23 directs the SBCC to appoint an executive assistant with experience in statutory and administrative rulemaking processes to assist in carrying out the duties of the council. The salaries of the executive director, executive assistant, and other staff are to be included annually in the budget of DAGS. These positions have not been appointed or funded since their creation in 2007.

4.1.1.1 Hawaiʻi State Building Codes

The approved building codes adopted by the SBCC, referred to comprehensively as the *Hawaiʻi State Building Code Rules*, in effect at the time of the Maui wildfires were:

- The latest fire code adopted by the Hawaiʻi SFC (detailed in Section 4.1.2)
- The 2018 edition of the *International Building Code* (IBC)©[22] with state amendments[23]
- The 2018 edition of the *International Existing Building Code*©[24] with state amendments[25]
- The 2020 edition of the *National Electrical Code (NEC)*©[26] with state amendments[27]
- The *Hawaiʻi State Elevator Code*[28]
- The 2018 edition of the *International Energy Conservation Code (IECC)*©[29] with state amendments[30]
- The 2018 edition of the *Uniform Plumbing Code*©[31] with state amendments[32]

- The 2018 edition of the *International Residential Code (IRC)*©[33] with state amendments[34]
- Hawaiʻi design standards to implement Act 5, Special Session Laws, 2005[35] as applicable to emergency shelters and essential government facilities

4.1.2 Hawaiʻi State Fire Council

The Hawaiʻi SFC,[36] authorized under HRS §132-16,[37] is organized under the Department of Labor and Industrial Relations. Hawaiʻi does not currently have an appointed SFM or have a SFM's Office.

The SFC is comprised of the fire chiefs from Hawaii's four major counties - Hawaiʻi County, Honolulu County, Kauaʻi County, and County of Maui. With a population under 100 people,[38] Kalawao County and the Village of Kalawao on Molokaʻi are not represented on the SFC. The State Fire Council is supported by four staff[39] — two administrative specialists, a program specialist, and a secretary.

Under HRS §132-3,[40] the SFC is charged with adopting a state fire code that sets minimum requirements for the protection of persons and property from fire loss. This charge includes setting minimum requirements for the storage, handling, and use of hazardous materials and in controlling conditions considered hazardous to life or property in the design, use, or occupancy of buildings or premises.

While the Hawaiʻi SFC adopts the state fire code, the SBCC is the authorized body to develop and adopt a comprehensive building code package for the state. The SFC Representative to the SBCC carries the State Fire Code Council's position and any concerns to the SBCC. Ultimately, the SBCC develops, adopts, and promulgates a comprehensive building code package which includes the state fire code.

FSRI anticipates there will be legislation introduced in the Hawaiʻi Legislature's upcoming 2025 session that will create an attached agency for the SFM, which will alter some of the duties and responsibilities of the SFC, if passed.

4.1.3 Hawaiʻi State Fire Codes

The Hawaiʻi SFC adopted the *NFPA 1, Fire Code*©, 2018 Edition, as amended as the state fire code on September 10, 2020. The HBCC moved to adopt the *NFPA 1, Fire Code*© 2018 Edition,[41] as amended on January 19, 2021 as part of its comprehensive building code package (detailed above in Section 4.1.1.1).

4.1.4 Governor's Affordable Housing Initiative and the State Building Codes

On July 17, 2023, prior to the Maui wildfires, the Governor of Hawaiʻi issued an Emergency Proclamation[42] relating to housing that suspended the ability of the SBCC to amend or update state building codes. By statute, this also precludes both the SFC and the SBCC from amending or updating the state fire code. This action was taken as part of a broader effort by the Governor to control home prices and encourage construction of additional residential dwellings throughout the state.

On September 15, 2023, the Governor's Emergency Proclamation[43] was amended and renewed following the Maui wildfires. This version of the Emergency Proclamation continued the suspension of the SBCC's authorities to amend or update the *Hawaiʻi State Building Codes*. However, this version also included amended language allowing Hawaii's counties to update their county building codes as authorized by law.

4.1 BUILDING AND FIRE CODES IN THE STATE OF HAWAIʻI

Subsequent amendments to the Governor's Emergency Proclamation continue to uphold the suspension of the SBCC's authorities to amend or update the *Hawaiʻi State Building Codes*. Amended proclamations were published:

- October 24, 2023 - Second Proclamation.[44] Does not apply to the area affected by the Lahaina wildfire. Statement and map included within all subsequent Proclamations.
- December 22, 2023 - Third Proclamation[45]
- January 18, 2024 - Fourth Proclamation[46]
- February 20, 2024 - Fifth Proclamation[47]
- April 19, 2024 - Sixth Proclamation[8]
- June 18, 2024 - Seventh Proclamation[49]
- August 15, 2024 - Eighth Proclamation[50]
- October 10, 2024 - Ninth Proclamation[51] Places a pause on the automatic adoption of county building codes, giving the counties additional time to review, amend and adopt the latest state and national building codes to suit their particular safety and design standards and needs. Suspending the automatic adoption of the latest codes will allow the State and counties to leapfrog over amending the 2021 statewide and model codes and focus their review efforts on the 2024 codes. This will provide more consistency and stability in the construction of affordable housing.[52]

As per the SBCC website,[53] and as required by HRS§107-24(c),[54] the following building codes without amendments from HBCC, have automatically become part of the *Hawaiʻi State Building Code* package:

- State Building Code – 2021 IBC (Unamended)[55]
- State Residential Code – 2021 IRC (Unamended)[56]
- State Energy Code – 2021 IECC (Unamended)[57]
- State Fire Code – 2021 NFPA 1 (As amended by the SFC)[58]
- State Plumbing Code – 2021 UPC (Unamended)[59]
- State Electrical Code – 2023 NFPA 70 (Unamended)[60]



4.2 BUILDING CODES IN THE COUNTY OF MAUI

4.2 Building Codes in County of Maui

The general ordinances of the County of Maui, Hawai‘i, are codified and published as *The Code of the County of Maui, Hawai‘i.*[61] The County of Maui's building codes are published in *Title 16 - Buildings and Construction*[62] of The Code of Maui County, Hawai‘i. The approved building codes adopted and enforced by the County of Maui's at the time of the Maui wildfires were:

- Chapter 16.08A - Residential Code based on the *International Residential Code*©, 2006 edition as amended
- Chapter 16.16C - Energy Code based on the *International Energy Conservation Code*©, 2018 edition as amended, as adopted by the State Building Code Council on December 15, 2020
- Chapter 16.18B - Electrical Code based on the *NFPA 70, National Electrical Code*©, 2008 Edition as amended
- Chapter 16.20C - Plumbing Code based on the *Uniform Plumbing Code*©, 2018 Edition as amended
- Chapter 16.26B - Building Code based on the *International Building Code*©, 2006 Edition as amended

4.2.1 County of Maui Building Code Discussion

The County of Maui's promulgation and on-going use of both the *International Residential Code*© and the *International Building Code*©, 2006 editions, as amended, were, for several years, inconsistent with HRS §107-28. Hawai‘i statute prescribes that, "Each county shall amend and adopt the *Hawai‘i State Building Codes* and standards listed in section 107-25, as the referenced *Hawai‘i State Building Codes* and standards for its respective county building code ordinance, no later than two years after the adoption of the *Hawai‘i State Building Codes*."

4.2.2 County of Maui Building Code - 2023 Updates

In April 2023, prior to the wildfires, the County of Maui adopted revised ordinances[63] to update and amend the county's building codes. While not published in *The Code of the County of Maui, Hawai‘i* in its May 31, 2023, version, the April 2023 ordinance included updates to and adoption of:

- Chapter 16.08B - Residential Code based on the *International Residential Code*©, 2018 edition with state amendments (county amendments to be determined)
- Chapter 16.10 *New Code/New Chapter* - Existing Building Code based on the *International Existing Building Code*©, 2018 edition with state amendment (county amendments to be determined)
- Chapter 16.16C - Energy Code based on the *International Energy Conservation Code*©, 2018 edition as amended
- Chapter 16.25 *New Chapter* - Building Code Administrative and Supplemental Provisions
- Chapter 16.26C - Building Code based on the *International Building Code*©, 2018 edition as amended
- Chapter 16.18B - Electrical Code was not changed and remained on the NFPA 70, *National Electrical Code*©, 2008 Edition as amended
- Chapter 16.20C - Plumbing Code was not changed and remained on the *Uniform Plumbing Code*©, 2018 Edition as amended

The enabling ordinances took effect on approval. However, as specified within the ordinances, the County of Maui only began enforcing the updated editions of the codes on October 28, 2023, 180 days following their approval and after the August 2023 wildfires.

4.2 BUILDING CODES IN THE COUNTY OF MAUI

4.2.3 The County of Maui Building Code Administration

The County of Maui Development Services Administration (DSA) administers the County's subdivision, building, electrical, plumbing, grading, and other construction related ordinances.

4.2.3.1 Organization of the County of Maui DSA

At the time of the Maui wildfires, the County of Maui DSA was one of three organizational elements under the direction and oversight of the County of Maui Department of Public Works.[64] These included the DSA, the Engineering Division, and the Highways Division.

The County of Maui DSA was organized into seven sections:

- Building Plans Review Section
- Building Permit Section
- Building Inspection Section
- Civil Construction and Inspection Section
- Electrical Permit and Inspection Section
- Plumbing Permit and Inspection Section
- Subdivision Section

4.2.3.2 The County of Maui DSA Budget and Personnel

The County of Maui DSA operates under the *Maui County Council Adopted Budget*. The Fiscal Year 2024 adopted budget, which was in effect during the Maui wildfires, began July 1, 2023, and ended on June 30, 2024. The DSA is funded under two separate lines of effort:



4.2 BUILDING CODES IN THE COUNTY OF MAUI

The Development Services Administration Program,[65] funded by the Maui County General fund.

FY 2024 Adopted: $2,822,519

Personnel: 21

Description: The DSA Program is primarily responsible for the administration of subdivision, building, electrical, plumbing, grading, driveway, roadway, and other construction codes. It also provides staff support for the Public Works Commission and the Board of Variances and Appeals.

See Table 3



Table 3. Developmental Services Administration Program Staffing.

Position Title	2024 Adopted
Development Services Operation Clerk	1
Electrical Engineer III	1
Electrical Engineer IV	1
Electrical Engineer V	1
Electrical Inspector II	4
Engineering Support Technician I	1
Land Use & Building Plans Examiner	1
Land Use & Codes Building Permit Clerk	3
Plumbing Inspector II	4
Secretary II	1
Specialty Plan Examiner I	1
Specialty Plan Examiner II	1
Supervisor Land Use/Build Plans Examiner	1
Program Total	21

4.2 BUILDING CODES IN THE COUNTY OF MAUI

The DSA - Building Permit Program,[66] funded by the Maui County DSA Revolving Fund.

FY 2024 Adopted: $1,921,800

Personnel: 19

The DSA - Building Permit Program collects a plan review fee from each building permit applicant. The fees are deposited into a revolving fund for the purpose of facilitating the building permit process. The program performs plan check and inspection services, as well as permit clerk services, which include distribution, monitoring of permit status, and maintaining the permit tracking system.

See Table 4

Table 4. Developmental Services Administration Building Program Staffing.

Position Title	2024 Adopted
Chief Building Plans Examiner	1
Civil Engineer IV	1
Clerk III	1
Computer Applications Support Technician III	1
Computer Applications Support	0
Electrical Inspector II	1
Engineering Construction Clerk	1
Engineering Support Technician II	2
Land Use & Building Plans Examiner	3
Land Use & Building Plans Technician	1
Land Use & Codes Building Permit Technician	3
Land Use & Building Plans Technician	1
Specialty Plans Examiner III	1
Supervising Building Inspector	1
Supervising Plumbing Inspector	1
Program Total	**19**

4.3 Fire Codes in County of Maui

The Code of the County of Maui, Hawai'i, Chapter 16.04D[67] incorporates the *NFPA 1, Fire Code*©, 2018 Edition as amended.

The County of Maui passed Ordinance 5451 on November 23, 2022, which included amendments to *NFPA 1, Fire Code*, 2018 edition, specifically addressing vegetation management.[68] The amendment within Subsection 10.13.10 within Ordinance 5451 extends authority to the fire department to require property owners to mitigate the vegetation around structures and to establish and maintain fuel breaks when deemed necessary.



4.3.1 County of Maui Fire Code Administration

The County of Maui Department of Fire & Public Safety's (MFD) Fire Prevention Bureau administers the County of Maui Fire Code. The Fire Prevention Bureau provides services including plan review, permitting, code enforcement, fire education, and fire investigation.[69]

4.3.2 Organization of the County of Maui Department of Fire & Public Safety

At the time of the wildfires, the MFD[70] was organized across five verticals:

- Fire Administration
- Training/Health & Safety
- Fire/Rescue Operations
- Fire Prevention
- Ocean Safety

The Fire Prevention Bureau was led by two Captains who reported to the Assistant Fire Chief of Support Services. The Assistant Chief of Support Services reported to the Deputy Fire Chief, who in turn reported to the Fire Chief.

4.3.3 Fire Prevention Bureau and Personnel

The Fire Prevention Bureau operates under the *Maui County Council Adopted Budget*. The Fiscal Year 2024 adopted budget, which was in effect during the Maui wildfires, began July 1, 2023, and ended on June 30, 2024. The Fire Prevention Bureau is funded under three lines of effort:

4.3.3 FIRE PREVENTION BUREAU AND PERSONNEL

The Fire Prevention Program, funded by the Maui County General fund.

FY 2024 Adopted: $1,493,093

Personnel: 12

Description: The Fire Prevention Program[71] is comprised of two Captains, two Firefighter IVs, six Firefighter IIIs, an Account Clerk III, and an Office Operations Assistant II. Its primary function is to reduce the likelihood of fires and minimize their various impacts to life, property, and the environment. It accomplishes this primarily through plans review, inspections, permitting, fire investigation, and public education.

See Table 5

Table 5. Maui Fire Department Fire Prevention Program Staffing.

Position Title	2024 Adopted
Account Clerk III	1
Fire Captain	2
Firefighter III	6
Firefighter IV	2
Office Operations Assistant II	1
Program Total	**12**



4.3.3 FIRE PREVENTION BUREAU AND PERSONNEL

The Plan Review, Processing, and Inspection Revolving Fund; and The Fire Hazard Removal Revolving Fund[72]

FY 2024 Adopted: $474,289

Personnel: 2

Description: The Plan Review, Processing, and Inspection Revolving Fund was established for the collection of fees for the review of plans and specifications submitted under section 132-9, HRS. Funds are to be expended for the salaries of two Firefighter IVs (plan reviewers), contracts, materials, supplies, equipment, payment of overtime, travel expenses, and training that will facilitate plans review, public education, fire investigation, permit processing, and inspections.

The Fire Hazard Removal Revolving Fund provides for the clearing of brush and debris from parcels that have been deemed as a fire hazard. The costs are recoverable against the owner or occupant of the property.

See Table 6



Table 6. Maui Fire Department Plan Review, Processing, and Inspection Revolving Fund Program Staffing.

Position Title	2024 Adopted
Firefighter IV	2
Program Total	**2**

4.4 Maui Recovery Permitting Center

On April 29, 2024, the County of Maui opened a Recovery Permitting Center (RPC) in Kahului. The RPC is staffed with members from 4LEAF, Inc. the same company that led the recovery effort in Paradise, California, after the Camp Fire in 2018. Maui's RPC is expediting the processing of permits for alterations, repairs, reconstruction, and new construction of structures in areas affected by the August 2023 Maui wildfires. The Maui Recovers dashboard[73] shares permits issued to date.



5.0 State Fire Marshal Review

On July 5, 2024, Governor Green signed Senate Bill 2085,[74] establishing the OSFM and re-establishing the position of the SFM that had been abolished in 1979 and replaced with the SFC.

Staffing the OSFM is expected to take time. As recruitment, selection, and hiring takes place, the state will be required to engage in critical fire safety work.

Within FSRI's 10 Highest Priorities for Enhancing Wildfire Readiness in Hawai'i document (Section 2.0), Priority 2 includes recommendations for contracting with the HWMO to perform in a project management role to ensure the State's 10 priorities are addressed, while also serving as an interim leader to address the system components of Phase Two that will, ultimately, be the responsibility of the SFM.

Since October 2024, FSRI has met with state legislators, Office of the Attorney General staff, and members of the Governor's Climate Action Team to discuss the content of the State's 10 Highest Priority document (Section 2.0). Regarding the OSFM, FSRI has shared the following recommendations:

- Substantially increasing the budget from the $172,000 allotted within Act 209 for the staffing of the OSFM[75]
- Identification of sustainable funding sources to ensure a functional annual budget
- Bolstering statutory authority required to address the wide spectrum of fire safety issues and to delineate responsibilities and reporting structures between the SFM and SFC
- Creating an organizational structure required to immediately address the 10 State Priorities effectively and other fire safety priorities unrelated to those mentioned in Phase Two[76]

On November 25, 2024, the Director of Labor and Industrial Relations (DLIR) provided the SFC's, SFM report to the legislature as per Act 209. The report includes duties and responsibilities, organizational structure within DLIR, proposed operating budget, and staffing model options.[77]



6.0 Summary

In the United States of America, the destruction and loss of life caused by the Maui fires of August 8-9, 2023, are unprecedented in modern times. Recognizing the complexity of this incident, FSRI used a systems analysis methodology to comprehensively examine the many contributing factors to the August 2023 fire event in Lahaina. It is vital to reiterate, as demonstrated throughout this report, that no single factor is, or set of factors are, directly responsible for the tragic outcome. The pre-conditions for these fires have been in the making for decades, stemming from the changing landscape of Maui Nui, more frequent extreme weather events, and the increased frequency of vegetation-fueled fires. It is important to note these same conditions exist across the State of Hawai‘i, in numerous other locations throughout the United States, and around the globe.

This Lahaina Fire Forward-Looking Report (Phase Three) details priorities and recommendations that can begin to be implemented by state and county leaders today to prevent future tragedies like those that took place on August 8-9, 2023. Several of these recommendations will be challenging to implement, and will demand collaboration amongst local, county, state, and federal agencies and individuals. Additionally, the recommendations will likely need to be addressed on different timelines. For example, leaders have collaboratively developed and executed plans on several initiatives to improve coordination and wildfire preparedness, while hiring an SFM and completing an SOC, CRA, and CRR plan will take months to complete. FSRI remains committed to working through the priorities and recommendations with the Department of the Attorney General, Federal, State, and County leaders, community members, and other partners that can help improve fire safety across the State of Hawai‘i.



7.0 APPENDIX

7.1 Lahaina Fire Incident Analysis Report (Phase Two) Findings and Recommendations
(access the full spreadsheet)

7.1 Lahaina Fire Incident Analysis Report (Phase Two) Findings and Recommendations				
Reference Section (Phase Two Report)	**Relevant Department**	**Actionable Areas**	**Finding**	**Recommendations**
2.0 Analysis of Background	• State of HI	Policy, Organizational	**1. Lack of state policy-making and investment addressing Cohesive Strategy components.**	**1.** Pursue integrated solutions using a multidisciplinary team to address the entire system of factors that influence wildfire risk and outcomes, including land use and subdivision planning, agriculture, forestry and environmental protection, emergency response, economists and tax experts, and policy-makers. Use the existing and established plans and studies as starting points for discussion and action. **2.** Learn from states that already have existing advanced wild-fire-fighting policies and procedures in place that are more mature in their work on wildfire prevention, preparedness, and response.
2.0 Analysis of Background	• State of HI	Policy, Organizational	**2. Statewide wildfire prevention is led by the non-profit Hawaii Wildfire Management Organization (HWMO) without state funding.**	**1.** Establish dedicated and sustained funding for HWMO to support the coordination and implementation of wildfire prevention and preparedness efforts, especially for communities and land stewards.
2.0 Analysis of Background	• State of HI	Policy	**3. Lack of standardized and consistent wildfire data collection and report submissions to federal organizations.**	**1.** Standardize wildfire data collection process for all counties and require Incident Status Summary, Form 209 completion for wildfires meeting reporting criteria. **2.** Leverage the impending release of the National Emergency Response Information System (NERIS) to insti-tutionalize fire reporting while ample resources are available and focused to onboarding and supporting fire agencies in this new federal program.
2.0 Analysis of Background	• MFD • MPD	Policy, Organizational	**4. The MFD and MPD did not initiate an AAR for the 2018 Lahaina Fire. MEMA did not finalize an AAR for the same incident.**	**1.** MEMA, the MFD, and the MPD should create policies that include incident parameters requiring an AAR to ensure learnings are documented and changes required for improvement are implemented.
3.2 Weather	• MFD • MPD • NWS • MEMA	Policy, Organizational, Preparedness	**5. Actionable extreme weather forecasts were provided to fire chiefs and emergency managers prior to the August 2023 fires. However, adjusting staffing for extreme weather events and their resultant risk of extreme fire behavior was not standard.**	**1.** Assign a point of contact within the MFD who is tracking weather conditions, and is disseminating that information to the rest of the department and across partner agencies. **2.** Establish standard operating procedures for Red Flag and severe fire weather warning conditions, to include: preparing and pre-positioning supplies, equipment, vehicles, and personnel in high-risk areas; ensuring clear and open lines of communication within and among agencies to optimize for rapid and coordinated deployment of resources; and communicating with the public to aid residents in translating the forecasted conditions and risks into evacuation readiness. The California Fire Weather Annual Oper-ating Plan is a good place to start developing a Hawai'i plan.
3.2 Weather	• State of HI • NWS	Research, Policy, Preparedness	**6. There is little perceptible difference between Hawai'i Red Flag criteria and a typical summer day, which may have contributed to the emergency manager's response to the forecast.**	**1.** Engage federal partners to assist in refining Red Flag criteria to be commensurate with appropriate fire danger that is actionable by policymakers, emergency managers and responders, and the public.
3.2 Weather	• NWS • HI-EMA	Policy, Organizational, Preparedness	**7. NWS-Honolulu fire weather forecast briefings to fire and emergency managers should occur on a more frequent basis.**	**1.** Engage policymakers, emergency managers and responders, and the public with more frequent fire weather forecast briefings. This will elevate understanding of the weather, while informing the community of the risk.

7.1 APPENDIX

Reference Section (Phase Two Report)	Relevant Department	Actionable Areas	Finding	Recommendations
3.2 Weather	• State of HI • NWS	Equipment, Organizational, Preparedness	**8. A lack of RAWS in West Maui, and other high wildfire risk areas, limits the capability to determine where Red Flag conditions may locally exist. The lack of resolution of fire weather data and monitoring yields uncertainty at the local level due to fire weather forecasts and Red Flag Warnings being based on data collected at the Honolulu airport, which is on O'ahu (not Maui). It does not represent the conditions observed in the diverse and numerous microclimates across all high fire risk areas across the state, including Lahaina, and therefore, serves as a point of reference (or inference, at best) for other regions.**	**1.** Install and fund the maintenance for a strategic set of RAWS that can provide information with resolution across the microclimates of high fire risk locations in the state.
3.3 Vegetative Fuel	• State of HI	Policy, Organizational, Preparedness	**9. A lack of vegetation management programs, including policy, regulation development and enforcement, and funding support to address vegetation management needs across the variety of landowner types contributed to a prevalence of unmanaged vegetation on the wildland and urban areas impacted by the August 8, 2023, fire.**	**1.** Develop comprehensive vegetation management programs that address the many types of land ownership and risk-reduction needs, to include thinning vegetation, removing invasive species, and creating strategic fuel breaks: - On public lands, funding for vegetation management must be commensurate with the personnel, equipment, and maintenance costs needed to strategically and consistently reduce risk. - On private lands, a combination of tax incentives and penalties for active land management, as well as a robust and proactive defensible space code inspection and enforcement programs are needed. - Such programs must be funded and staffed at a level appropriate to adequately ensure risk-reduction measures are implemented and effectively mitigate the potential for fire ignition and rapid spread through unmanaged lands. **2.** Establish specific governmental authorities, responsibilities, and goals for the management of vegetative fuels. (Currently, authority to address vegetation hazards is covered by a vague responsibility by the mayor and fire chief to address any number of hazards). **3.** Establish a system of penalties to address owners of agricultural land who are not participating in active agriculture or vegetation management. **4.** Develop programs that support coordination and implementation of an "All Hands, All Lands" approach, where vegetation management strategies and projects reduce risk across land ownerships, according to topography and anticipated fire behavior, rather than in fragmented or siloed parcels. **5.** Implement and expand use of targeted grazing for non-native forage grass removal and fuels reduction at landscape scale.

7.1 APPENDIX

Reference Section (Phase Two Report)	Relevant Department	Actionable Areas	Finding	Recommendations
3.3 Vegetative Fuel	• State of HI	Policy, Organizational, Preparedness	**10. Fire risk and protective measures are not generally considered or integrated into land use planning, ordinances, or permitting processes to ensure adequate defensible space or consistent management of vegetative fuels in and around communities.**	**1.** Require integrated land use planning through zoning regulation that requires vegetation management in high-risk areas. **2.** Educate homeowners on how to create defensible space around their properties, and require them to maintain these spaces. **3.** Incorporate community-scale, maintained green spaces that are multi-use and could act as fuel breaks and public safe refuge areas.
3.3 Vegetative Fuel	• State of HI	Policy, Organizational, Preparedness	**11. The existing landowner and land steward risk-reduction programs, which include best practices for vegetative fuels management, have limited capacity and have not been invested in by the government at a level that meets the current need.**	**1.** Provide land steward and community education regarding vegetation management best practices. Invest in, and grow, the existing programs of Firewise USA(TM) and educational programs for land stewards offered by existing groups, such as those already led (but underfunded) by the HWMO, University of Hawai'i, and their established partners.
3.3 Vegetative Fuell	• State of HI	Policy, Organizational, Preparedness, Research	**12. There is no adequate system for monitoring fuel loads, fuel moisture, and other relevant characteristics.**	**1.** Improve monitoring of fuels and utilize drones, satellite imagery, and ground-based monitoring systems to detect and assess vegetative fuel loads, fuel moisture, and high fire risk conditions. **2.** Establish an information dissemination system to fire and emergency managers to communicate high-risk locations and periods.
3.3 Vegetative Fuel	• State of HI	Policy, Organizational, Preparedness, Research	**13. There is a need for additional public and private investment in long-term ecosystem restoration and sustainable land management practices that promote healthy ecosystems, maintain active agriculture, reduce fire risk, and control erosion.**	**1.** This investment can be accomplished as key components of integrated land use planning, financial incentive and assistance programs, and land steward education (all described above). **2.** Invest in watershed partnerships, conservation groups, and other existing ecosystem conservation and agricultural initiatives. **3.** Invest in and bolster plant material supply chain for bulk seed production to support adequate fuel conversion and post-fire mitigation. For example, these programs could include common native seed collection, plant propagation, and outplanting.
3.4.1 Planning, Zoning, and Codes	• County of Maui	Policy, Prevention, Organizational, Preparedness	**14. At the time of the fire, zoning in some areas of Lahaina was not commensurate with the modern built environment, environmental risks, and population growth.**	**1.** Review and adjust zoning laws to better reflect the actual occupancy levels in Lahaina. **2.** Implement stricter enforcement to ensure compliance with occupancy limits. **3.** Enforce building codes and zoning regulations that require sufficient road width and access points in new developments to ensure better planning for future developments. **4.** Increase the availability of off-street parking solutions to reduce the reliance on narrow streets for vehicle parking. **5.** Emergency responders should have pre-determined plans, as well as uniquely adapted equipment (if available), tactics, and strategies for specific areas with narrow streets, outlining alternative access points, water supply strategies, and evacuation procedures.

7.1 APPENDIX

Reference Section (Phase Two Report)	Relevant Department	Actionable Areas	Finding	Recommendations
3.4.1 Planning, Zoning, and Codes	• County of Maui	Policy, Prevention, Organizational	**15. At the time of the fire, the County of Maui was enforcing the 2006 edition of the International Residential Code and International Building Code.**	**1.** Review and ensure adoption process meets requirements of state statute (HRS 107-28).
3.4.2 Road Networks	• MFD • MPD	Preparedness, Training, Equipment, Operational	**16. Emergency responders did not have ready capability to unlock emergency gates at various locations, including schools, to facilitate evacuations. They were often forced to rely on a third-party response for such access.**	**1.** The MPD and MFD should develop an assessment of its ability to access local utilities (Hawaiian Electric), flood control, waterworks, farms, resorts and public facilities (ex. private and public schools), flood control roads and gates, agricultural roads and gates, harbor areas, etc.) for emergencies. Create a system of universal lock security access that is available to all emergency responders and landowners.
3.4.2 Road Networks	• MPD • County of Maui	Preparedness, Policy, Preparedness, Operational	**17. Severe congestion due to parked cars along neighborhood streets hindered evacuation and response efforts.**	**1.** The MPD and county authorities should assess the parking needs and challenges within neighborhoods. This may include evaluating factors, such as population density, housing types, availability of off-street parking, street width, proximity to commercial areas or public transportation, and existing parking issues.
3.4.2 Road Networks	• MPD • County of Maui • MEMA	Preparedness, Policy, Organizational, Operational	**18. Limited written traffic plans or guidelines for emergencies and escalating incidents.**	**1.** Develop a pre-incident plan for the MPD to manage traffic during a wildfire that involves coordinating efforts to ensure public safety, facilitate evacuation if necessary, and maintain traffic flow in affected areas. Update MPD G.O. 405.1 Traffic Section and G.O. 405.7 Traffic Direction and Control to include instruction on wildfire evacuation. **2.** Implement and enforce strict no-parking zones on critical streets and encourage the use of off-street parking solutions to reduce the number of vehicles parked on narrow streets. **3.** Where possible, redesign traffic flow in congested areas, including implementing one-way street systems, to optimize vehicle movement. **4.** Residents in areas with narrow streets should be educated on fire safety procedures, importance of clear buffer zones/ defensible spaces, and evacuation plans to ensure a more coordinated response.
3.4.2 Road Networks	• County of Maui • MPD • MFD	Preparedness, Operational	**19. Roadways and evacuation routes were not adequately maintained prior to August 8, 2023, to sustain effective evacuation efforts during the fire event.**	**1.** Identify, name, map, and provide signage on dirt roads that serve as alternate egress/evacuation routes so residents and emergency responders refer to them by the same name. **2.** Inspect and maintain dirt roads annually. Modernize, standardize, and maintain barriers on dirt roads to help ensure they can be used during emergencies. **3.** Where feasible, widen roads to accommodate more parking, traffic, and provide room for emergency vehicles.
3.4.3 Water	• State of HI • Maui Water	Operational	**20. The County of Maui Department of Water Supply was seemingly in compliance with the Water System Design Standards for the State of Hawai‘i in August 2023.**	**1.** Given the increasing threat of wildfires and wildfire-initiated urban conflagrations, it may be necessary for the State of Hawai'i to revisit its design standards and guidelines for storage and distribution systems that could be used for firefighting purposes.

7.1 APPENDIX

Reference Section (Phase Two Report)	Relevant Department	Actionable Areas	Finding	Recommendations
3.4.3 Water	• Maui Water	Operational, Equipment	**21. No pumps are used outside of the water production facilities to provide pressure in the system. Both systems had uninterrupted electrical power during the August 2023 fires and produced water at capacity for the duration of the fire.**	N/A
3.4.3 Water	• Maui Water	Operational, Equipment	**22. The amount of drinking water in storage tanks at the beginning of the August 2023 fires seemingly met standard design requirements as required by the Water System Design Standards for the State of Hawai'i.**	N/A
3.4.3 Water	• Maui Water	Operational, Equipment	**23. As per the Phase One report (pages 237-239), the water supply monitoring system failed at 15:30 (3:30 p.m.) on August 8, 2023, and no storage tank data was recorded for the duration of the fire event. Once this data connection was lost, the County of Maui Department of Water Supply did not know how much stored water was available for firefighting during the fire.**	**1.** Develop, install, and maintain a resilient drinking water tank level monitoring system for the Lahaina and Māhinahina storage and distribution systems that can be monitored from the County of Maui EOC and other locations.
3.4.3 Water	• Maui Water	Operational	**24. As homes and other structures were damaged and destroyed by fire, household plumbing (e.g., plastic and other piping) inside of the buildings failed, allowing unrestricted flow of water from one (1) or more locations in each home or structure, resulting in water freely flowing from more structures and diminishing the overall water pressure and flow in the fire area.**	N/A
3.4.3 Water	• Maui Water	Operational, Training, Equipment	**25. As per the Phase One report (page 239), County of Maui Department of Water Supply employees were unable to enter the fire area to assist firefighters due to multiple factors, including traffic congestion and the danger presented by the fire. Firefighters did not have the time, training, or tools to shut off water.**	**1.** Develop a plan to coordinate with the County of Maui Department of Water Supply to address water system needs at the incident command post (ICP).
3.4.3 Water	• Maui Water	Operational	**26. Due to the hydraulics of the drinking water storage and distribution system, and given the excessive demand caused by the flow from damaged/destroyed structures, water was not provided with sufficient volume and sufficient pressure (i.e., the system could not meet the required demand) for use in firefighting for the entire August 2023 fire event.**	**1.** Perform a hydraulic analysis of both the Lahaina and Māhinahina storage and distribution systems. Use the results of this analysis to design larger and/or multiple interconnected pipes between the two (2) drinking water storage and distribution systems. Consider the use of pumps, as appropriate, to supplement pressure and volume. Determine pressure and volume limits for a major fire event that stakeholders understand and can operate to.

7.1 APPENDIX

Reference Section (Phase Two Report)	Relevant Department	Actionable Areas	Finding	Recommendations
3.4.3 Water	• Maui Water	Operational	**27. Water quality and cost concerns make it impractical to size a drinking water treatment, storage, and distribution system to accommodate the firefighting demands for a urban conflagration event similar to the one that occurred in August 2023.**	**1.** Provide alternate means of firefighting water supply for extreme events. This may include portable pumps to draw water from public and private pools, ponds, and other bodies of water (including sea water), large diameter hose equipped apparatus, sites, or connections for marine vessels to draw water from the Pacific Ocean, and other means.
3.4.4 Electrical	• Hawaiian Electric	Organizational, Operational	**28. Hawaiian Electric (in partnership with the MFD and MPD) did not have an adequate staffing plan to prepare for the wildfire conditions of August 8, 2023.**	**1.** Hawaiian Electric should work closely with the MFD and MPD to develop a staffing plan in preparation for high fire danger days. The plan should include implementing spotters and an artificial intelligence-enabled camera network, which can assess vulnerable areas of the infrastructure so failure points can be addressed quickly; operating a dedicated phone line to the MFD and MPD to communicate power and repair status; and assigning a representative to the ICP.
3.4.4 Electrical	• Hawaiian Electric • MFD • State of HI	Prevention, Policy	**29. A lack of electrical utility vegetation abatement regulations and enforcement may have contributed to vegetation at the base of utility poles and near transmission lines, creating a receptive fuel source for arcing electrical wires.**	**1.** Hawaiian Electric should continue to work closely with the PUC to execute the Climate Adaptation Transmission and Resilience Program and develop a long-term investment plan to protect infrastructure from high wind events and wildfire. The plan should include immediate vegetation management and enforcement requirements, a phased approach for undergrounding transmission lines in vulnerable areas, strategic replacement of bare overhead wires with covered conductors, and a Public Safety Power Shut-off program.
3.4.4 Electrical	• Hawaiian Electric • County of Maui • State of HI	Prevention, Policy	**30. Hawaiian Electric did not have a Public Safety Power Shut-Off program in place at the time of the fire.**	**1.** Establish a Public Safety Power Shut-Off and communication protocol in collaboration with the community. Shutting off power to vulnerable areas of the grid reduces the chance of ignition due to electrical infrastructure failure.
3.4.4 Electrical	• Hawaiian Electric • Maui Water	Preparedness, Policy, Organizational, Operational	**31. The lack of execution of a Hawaiian Electric pre-event organizational plan led to having to staff more field positions during the event to address problems with electrical and water infrastructure.**	**1.** Hawaiian Electric to prepare a staffing plan that is coordinated with the pre-event incident action plan (IAP).
3.5 Communications	• MFD • MPD	Preparedness, Organizational, Operational	**32. Central Dispatch ("Central") was limited by the availability of equipment and personnel.**	**1.** Expand Central's surge capacity by increasing the terminals/necessary equipment for call taking and dispatching operations and consider training personnel (including members from the MFD or MPD) to serve as "call takers" capable of transferring emergency 911 calls, and managing the non-emergency/administrative calls. **2.** Complete a comprehensive study of Central Dispatch to assess staffing, workloads, and technology to identify any gaps or additional resource needs to help ensure resilient communication during major emergencies and disasters.
3.5 Communications	• MFD • MPD • County of Maui • MEMA	Organizational, Policy, Operational	**33. Central Dispatch, and many other responding personnel, were deeply affected by this incident.**	**1.** Continue providing opportunities for individuals and crews to meet for a "report back/debrief." Ensure members know warning signs for PTS, PTSD, depression, suicide, and related impacts on personnel mental health. Provide access to Employee Assistance Programs (EAP) and peer support networks—encourage use when warning signs are present.

7.1 APPENDIX

Reference Section (Phase Two Report)	Relevant Department	Actionable Areas	Finding	Recommendations
3.5 Communications	• MFD • MPD	Organizational, Operational	**34. Dispatchers were responsible for monitoring multiple large fires and other associated events. Most of the dispatchers were experienced, but all dispatchers were overwhelmed and some expressed lack of adequate knowledge, ready access to needed information, and concern about the safety of the instructions they were providing callers. There were persistent communication challenges between Central, the MPD's Department Operations Center (DOC), and the EOC.**	**1.** Staff a MFD fire officer and a MPD officer at the rank of lieutenant (or higher) in Central Dispatch to aid with operational monitoring, EOC/DOC coordinations, incident tracking, communications, and assistance with command decisions when the EOC is activated.
3.5 Communications	• MFD • County of Maui • State of HI Organizational, Operational	Equipment, Organizational, Operational	**35. Private equipment operators primarily communicate with response entities and field personnel using personal cell phones.**	**1.** Create a formal communication plan for private contractors to use during emergency situations that includes resilient hardware and appropriate training.
3.5 Communications	• County of Maui • State of HI	Preparedness, Organizational, Operational	**36. Many residents did NOT receive a text notification from the county regarding the high winds and high fire danger.**	**1.** Assess the resiliency of communication systems and establish redundant public alert program and warning processes, including best practice messaging guidance.
3.5 Communications	• Hawaiian Electric • County of Maui • State of HI	Preparedness, Organizational, Operational	**37. Only one (1) siren from the All-Hazard Outdoor Warning Siren System was operable within the burn perimeter of the Lahaina area on August 8, 2023.**	**1.** Implement a statewide sustainable program for the All-Hazard Outdoor Warning System, which includes functioning hardware resilient against mass communications failure, regular maintenance, public education, additional resources and staffing.
3.5 Communications	• County of Maui • State of HI • MEMA	Preparedness, Operational	**38. The All-Hazard Outdoor Warning Siren System had not been utilized for warning of WUI fires prior to August 8, 2023. As of the publication date of this report, MEMA has implemented a process for activating sirens for wildfires.**	N/A
3.5 Communications	• MFD • MPD • MEMA • County of Maui	Preparedness, Policy, Organizational, Operational	**39. Even when people were told to evacuate and conditions seemed obvious that evacuation was necessary, many refused because there did not appear to be official notification that danger was imminent.**	**1.** Engage the community to provide additional public education regarding the importance of what to do in an emergency and to heed all evacuation instructions.
3.6 Incident Management	• MFD	Policy, Organizational, Operational	**40. Although there were opportunities for the MFD to provide staff support for the battalion chief(s) managing the incident, a formal command team was not established. The ICs were overwhelmed with the demands of the event and possessed limited situational awareness during a rapidly expanding emergency, which included a mayday; these factors contributed to challenges with tactical decision-making throughout the Lahaina PM fire.**	**1.** Review and modify the dispatch algorithm to reflect the resource availability. **2.** Provide the resources and training necessary to establish and maintain effective support for the initial incident commander (IC). **3.** Within MFD Hazard Zone Command SOG, include requirements for all chief officer engagement within the incident command structure for large complex incidents.

7.1 APPENDIX

Reference Section (Phase Two Report)	Relevant Department	Actionable Areas	Finding	Recommendations
3.6 Incident Management	• MFD • MPD • Hawaiian Electric • Maui Water	Policy, Organizational, Operational	**41. The MFD and MPD never connected to establish a unified command.**	**1.** The MFD, MPD, and other assisting and cooperating agencies should include guidance within their respective incident management SOGs on when unified command should be considered and how it could be established.
3.6 Incident Management	• MFD • MPD	Organizational, Operational	**42. Available public safety resources were inefficiently utilized. This resulted in the failure to establish and scale an effective incident management organization during the first 24 hours of the incident.**	**1.** Provide sufficient staffing to establish and maintain an effective incident management organization, while maintaining the capacity to conduct unit-level tactical actions. Once established, develop a robust incident action plan (IAP). An IAP should outline objectives, strategies, and tactics for managing the incident, including evacuation procedures, traffic management, and resource allocation. Communicating the IAP to all responding personnel and stakeholders ensures a shared understanding of roles, responsibilities, and priorities.
3.6 Incident Management	• MFD • MPD	Policy, Organizational, Operational	**43. There was no comprehensive plan for the MPD's wildfire response.**	**1.** Develop a comprehensive plan in coordination with the MFD for MPD's response to a wildfire that prioritizes public safety, efficient evacuations, and effective traffic management.
3.6 Incident Management	• MPD	Policy, Organizational, Operational	**44. Limited sharing of critical information occurred between field operations units, the MPD Department Operations Center (DOC), and the EOC.**	**1.** Review and update policies and develop new processes for information flow between MPD Command Personnel on site, command staff, dispatch, and the EOC. **2.** All commanders, captains, and above should receive training on activation of the DOC and a Department Operations Center quick reference guide should be developed for commanders to be utilized for any crisis.
3.6 Incident Management	• MPD	Policy	**45. The MPD Natural and Man-Made Disaster Plan, G.O. 411.4, does not include wildfire incidents.**	**1.** Update policy to include plans specifically related to wildfires.
3.6 Incident Management	• MFD • MPD • MEMA	Preparedness, Policy	**46. There was limited pre-event incident action planning for anticipated events or incidents by the MFD, MPD, and MEMA.**	**1.** The MFD, MPD, and MEMA should update the current policies and procedures regarding pre-event planning (including preparing pre-event incident action plans), staffing, and equipment.
3.6 Incident Management	• MFD • MPD • MEMA	Policy, Preparedness, Organizational	**47. There were no written procedures or guidelines for Continuity of Operations (COOP).**	**1.** The County of Maui, MPD, and MFD to prepare Continuity of Operations Plans (COOP) that outline procedures to ensure essential functions can continue during and after various types of emergencies or disruptions.
3.6 Incident Management	• MEMA • HI-EMA	Preparedness, Organizational	**48. Communication was limited between MEMA and HI-EMA EOC.**	**1.** Additional resources are needed to have a persistent durable communication link prior to, and during, a major emergency or disaster event.
3.6 Incident Management	• MEMA	Preparedness, Operational	**49. Given the known conditions forecasted for the County of Maui on August 8, 2023, agency representatives self-reported to the EOC throughout the day, but full activation of the EOC did not occur until 16:30.**	**1.** Under similar conditions, and given appropriate resources, consider full activation earlier to aid collaboration between all relevant emergency support functions.

7.1 APPENDIX

Reference Section (Phase Two Report)	Relevant Department	Actionable Areas	Finding	Recommendations
3.6 Incident Management	• MEMA	Preparedness, Policy, Organizational, Operational	**50. MEMA does not have a sufficient budget/personnel allocation to effectively and sustainably perform the wide range of preparedness, response, and recovery missions assigned to it.**	**1.** EOCs fulfill essential functions during emergencies and must be properly staffed and operationalized with (A) qualified overhead personnel to perform emergency management-related functions and (B) designated representatives from all cooperating/involved agencies/organizations to provide subject matter expertise, resource coordination/tracking, and immediate information relays to ICs in the field.
3.6 Incident Management	• MEMA	Organizational, Training, Operational	**51. During the EOC activation on August 8, 2023, there was a lack of clarity regarding the roles and responsibilities among MEMA personnel.**	**1.** Provide clearly defined roles and responsibilities for each staff member during EOC activations. Staff members should be trained and fully competent to fulfill their designated role. MEMA should also ensure staff training for secondary roles and responsibilities for when personnel are expected to shift to a different position (e.g., when vacancies occur).
3.6 Incident Management	• MEMA	Training, Operational	**52. Some MEMA personnel were unfamiliar with the software platform used for documentation and incident tracking during EOC activations.**	**1.** Ensure all personnel are fully trained and proficient with use of the designated EOC software program (WebEOC or any other software program designated by the MEMA Administrator). **2.** Ensure all MEMA EOC personnel understand the NIMS-ICS requirements for documentation during EOC activations.
3.6 Incident Management	• MEMA	Operational	**53. The EOC was overcrowded and personnel had to find alternative work locations.**	**1.** MEMA should examine the needs for the physical location and expand the EOC.
3.6 Incident Management	• MFD • MPD	Policy, Operational, Equipment	**54. Both the MPD and MFD were unable to maintain personnel accountability for officers, firefighters, and crews during the Lahaina PM fire.**	**1.** MPD roll calls should be initiated by dispatch and/or command staff as needed to maintain accountability. A policy should be established with defined roll call procedures. **2.** Ensure sufficient resources are available to support MFD Cs and division/group/unit-level supervisors with all functions of command/management, including personnel accountability. **3.** Adoption and consistent use of a common and resilient AVL platform on all MPD, MFD, and cooperators' (e.g., DOFAW, ARFF, and EMS) vehicles would assist dispatchers and command officers with personnel accountability and incident management.
3.6 Incident Management	• MFD	Operational, Training	**55. The MFD sponsors a Type 3 IMT that was not used August 8-9, 2023.**	**1.** Consider pre-deploying the Type 3 IMT when severe weather and/or fire danger conditions are forecasted. **2.** Enhance training and expand participation to include personnel from multiple disciplines, reinforcing the value of an all-hazards IMT and fostering collaboration across agencies. Consider securing training and experiences for Ocean Safety personnel to be able to perform in specific IMT overhead roles.
3.6 Incident Management	• Hawaiian Electric	Policy, Operational	**56. Hawaiian Electric should be at the incident command post (ICP), or tied in closely with the incident commander if an ICP is not established, to inform command of safety issues, other coordination opportunities, and act as a liaison to their organization.**	**1.** Create and follow a protocol to embed Hawaiian Electric representatives in the incident command post (when established) as liaisons.

7.1 APPENDIX

Reference Section (Phase Two Report)	Relevant Department	Actionable Areas	Finding	Recommendations
3.6 Incident Management	• MFD • MPD	Operational, Equipment	**57. The MPD and MFD did not deploy or use the mobile command vehicle as per MPD G.O. 304.11. Deployment and use of the vehicle in Lahaina before the PM fire may have initiated the unified command organization that was absent throughout the PM fire.**	**1.** Follow G.O. 304.11 to ensure the mobile incident command vehicle is used for appropriately sized incidents, such as the Lahaina PM Fire. **2.** Deploy the mobile command vehicle at planned events to exercise the deployment process and equipment.
3.6 Incident Management	• MFD • MPD	Policy, Operational	**58. There were no established unit identifiers for off-duty MPD officers or supplemental MFD units.**	**1.** Create a call sign procedure for identification of off-duty MPD officers who self-deploy and MFD personnel assigned to supplemental MFD units. The existing MPD G.O. 301.5 policy should be revised regarding the establishment of call signs for incoming off-duty officers and self-deploying officers. The MFD should establish a policy to standardize identification of staffed supplemental resources.
3.7 Fire Supression	• MFD • MPD • MEMA • Maui Water • DLNR-DOFAW • Hawaiian Electric	Preparedness, Policy, Organizational	**59. The MFD did not have an organizational pre-plan for an anticipated high wind or extreme fire weather event.**	**1.** Ensure effective sensemaking of forecasts and real-time conditions through training and pre-planning. **2.** Implement organization-wide start-of-shift briefings to discuss extreme fire weather conditions. **3.** Ensure the ICS can scale up quickly, integrating additional support, including personnel normally serving in administrative roles or other functions (e.g., fire prevention, ocean safety, and training), as needed. Provide training and protocols for pre-deployment. **4.** Communicate anticipated environmental conditions, risks, and performance expectations across organizations. This includes the MPD, MEMA, County of Maui Department of Water Supply, DLNR-DOFAW, and Hawaiian Electric, who reacted to environmental conditions only after problems arose. **5.** Develop a system for ongoing situational awareness that includes continuous monitoring of weather forecasts, fuel moisture levels, and fire behavior through real-time data and predictive models.
3.7 Fire Supression	• MFD • MPD • DLNR-DOFAW • Hawaiian Electric • Maui Water	Preparedness, Policy, Operational, Equipment	**60. With the impending forecast of severe fire weather, there was limited pre-deployment of additional public safety resources prior to the first fire event.**	**1.** With the potential impact of hurricanes like Dora and Red Flag conditions, the MFD, MPD, DLNR-DOFAW, and their cooperators should consider deploying additional resources across Maui Nui. **2.** Identify fire apparatus, incident management, and law enforcement resources for upstaffing and pre-deployment when severe conditions are forecasted. **3.** Ensure sufficient fire apparatus, response vehicles, portable equipment, PPE, and radios are available to resource the pre-deployment of additional response units and overhead assets. Whenever possible, standardize the equipment loadout on similar apparatus/vehicles to facilitate use by callback personnel. **4.** Consider providing dedicated personnel and resources for staffing management and callback, on a daily basis and before/during major incidents, to make command-level resources readily available for strategic/tactical ICS roles.

7.1 APPENDIX

Reference Section (Phase Two Report)	Relevant Department	Actionable Areas	Finding	Recommendations
3.7 Fire Supression	• MFD • MPD • County of Maui • State of HI • HI-EMA • MEMA	Preparedness, Prevention, Policy, Organizational, Training, Operational	**61. There appears to be a statewide culture of dismissing and/or under-recognizing wildfire risk. The underfunding and under-addressing of preparedness, planning, and mitigation efforts significantly impacts all parts of the system and fire outcomes. This cannot be overstated.**	**1.** Establish a culture of respect for extreme conditions and the need for operational adjustment.
3.7 Fire Supression	• MFD • MPD • DLNR-DO-FAW	Preparedness, Policy, Organizational, Operational	**62. DLNR-DOFAW resources, specialized wildfire equipment, and trained personnel were underutilized due to restrictive fire response zone guidelines.**	**1.** Incorporate land ownership maps into incident reporting and tracking to ensure that state and federal agencies with response duties and wildland firefighting capacity are notified and activated. **2.** Review and revise master mutual aid agreements for all fire suppression resources on Maui Nui, including, but not limited to, the MFD, ARFF, DLNR-DOFAW, and National Park Services to ensure optimal readiness and response for multi-hazard disasters.
3.7 Fire Supression	• MFD • MPD • County of Maui	Preparedness, Policy, Operational	**63. Densely populated and narrow roadways hindered both MFD and MPD movement during suppression (as well as evacuation and rescue) efforts. Apparatus positioning was not always optimal, due in large part to an overall lack of situational awareness about the location, severity, and trajectory of the fire(s).**	**1.** Responding MFD units should have pre-determined plans and operating practices for specific areas with narrow streets, outlining alternative access points, water supply strategies, evacuation procedures, and addressing the needs of vulnerable members of the community. **2.** Place hardcopy maps, mapbooks, and pre-incident plans in all response vehicles to provide redundancy if cellular network communication is unavailable.
3.7 Fire Supression	• MFD • MPD • Hawaiian Electric	Policy, Operational	**64. The uncertainty around the status of power in the area created numerous impacts on MPD and MFD response to the incident.**	**1.** As previously mentioned, Hawaiian Electric should have a representative at the ICP (when established).
3.7 Fire Supression	• MFD • DLNR-DO-FAW	Policy, Operational, Equipment, Training	**65. Private heavy equipment contractors lacked appropriate training, PPE, equipment, and communications.**	**1.** Strengthen the coordination with private contractors and address limitations in training, equipment (including standardizing equipment to ensure compatibility with all fire suppression resources), PPE, and communication.
3.7 Fire Supression	• MFD • DLNR-DO-FAW	Policy, Operational, Training	**66. A portion of the mopup area was difficult to access and posed safety threats.**	**1.** Include DLNR-DOFAW resources on initial response to vegetation and WUI fires. **2.** Ensure all personnel have the training to identify and establish safety zones and escape routes, and have protocols in place for communicating this to crews. **3.** Communicate the wildfire risk to all department members to set and/or reinforce expectations related to fire mopup procedures.
3.7 Fire Supression	• MFD	Policy, Operational, Training	**67. MFD firefighters performed mopup as proven successful under typical weather conditions. However, under the severe weather conditions on August 8, 2023, this level of mopup appears to have been insufficient.**	**1.** Revise policies, procedures, and trainings (E.O. 302.14) that address wildland firefighting (specifically mopup operations) to be in alignment with NWCG guidelines. **2.** Implement schedules to manage responder fatigue, ensuring adequate rest periods and meals.

7.1 APPENDIX

Reference Section (Phase Two Report)	Relevant Department	Actionable Areas	Finding	Recommendations
3.7 Fire Supression	• MFD	Policy, Operational, Training	**68. MFD wildland firefighting training, equipment, and staffing should be commensurate with the level of wildfire risk faced by firefighters.**	**1.** Conduct a comprehensive audit and gap analysis of existing MFD operating procedures/practices against relevant Occupational Safety and Health Administration (OSHA) regulations, National Fire Protection Association (NFPA) standards, fire service best practices, and NWCG standards/guidelines to help ensure compliance with industry regulations and best practices. By conducting an audit and implementing recommended improvements, the MFD can create a safer working environment for its personnel and enhance the effectiveness of its firefighting and rescue efforts for all incident types. **2.** Review the implementation of the MFD's 36-hour rule for alignment with operational needs during disasters and major emergencies. **3.** Consider developing a WUI firefighting playbook to address the increasingly severe wildfire threat across Maui Nui. Look to departments that respond to WUI incidents for expertise and protocols, such as California. **4.** Deliver training on, and provide a copy in all response vehicles, the NWCG Incident Response Pocket Guide (IRPG), PMS 461. **5.** Provide additional wildfire and WUI firefighting training and experiences (such as shadowing incident management personnel in other areas) for MFD personnel. **6.** Continue providing medical monitoring and behavioral health support for responders and support personnel.
3.7 Fire Supression	• MFD	Policy, Training, Operational	**69. Many initial attack resources were burned over due to fighting fire from a downwind position.**	**1.** Train firefighters about the impact of wind on fire progression and fire suppression techniques as per evidence based information and best practices.
3.7 Fire Supression	• MFD • DLNR -DO-FAW	Policy, Training, Operational	**70. Standard wildland firefighting operating procedures for the DLNR-DOFAW and MFD are not in alignment.**	**1.** The DLNR-DOFAW and MFD should collaborate to update and integrate standard operating guidelines and training for wildland firefighting.
3.8 Evacuation	• MFD • MPD	Policy, Training, Operational	**71. Unified coordination of evacuation procedures among the MPD, MFD, and other agencies may have facilitated more efficient egress of residents.**	**1.** Create, review, and implement an interagency comprehensive evacuation plan based on risk and resources. Integrated emergency response plans involving local, state, and federal agencies, as well as non-governmental organizations, should be developed, with regular joint training exercises to ensure smooth coordination during actual emergencies. **2.** The MPD should regularly train for wildfire evacuations, familiarizing themselves with evacuation procedures and protocols. This training enhances response capabilities and ensures a swift and organized evacuation process when wildfires threaten communities.

7.1 APPENDIX

Reference Section (Phase Two Report)	Relevant Department	Actionable Areas	Finding	Recommendations
3.8 Evacuation	• MFD • MPD • County of Maui	Preparedness, Policy, Operational	**72. During the evacuations, there were lapses in coordination and communication that could have reduced efficiency.**	**1.** Pre-plan evacuation routes. Effective evacuations during a wildfire, such as the Lahaina PM fire, require planning, coordination, and adherence to best practices. A key aspect is comprehensive pre-event planning, which involves identifying evacuation routes (including unnamed dirt roads), establishing communication protocols, and conducting drills to ensure readiness. **2.** Sufficient personnel are needed to manage traffic, provide assistance to evacuees, and maintain public safety. Adequate staffing levels enable timely and orderly evacuations, reducing the risk of congestion and confusion. **3.** Create and implement comprehensive traffic management plans that account for limited access and egress routes, including pre-planned alternate routes and strategies to manage congestion. **4.** Ensuring gates blocking potential evacuation routes are equipped with standardized locks and that emergency responders have the necessary keys or access codes is also vital. **5.** Develop comprehensive support systems for residents who need to evacuate–especially those with access and functional needs–including temporary housing, transportation assistance, and access to essential services. By addressing these key areas, the Maui community can improve its preparedness for future wildfires and other emergencies, ensuring better protection of lives and property. **6.** Volunteer training programs, such as those for Community Emergency Response Teams (CERT), should be expanded to assist with evacuation efforts and provide support during emergencies. Additionally, specific evacuation plans for vulnerable populations, including the elderly, disabled, and those without transportation, should be created, with community support networks established to assist these individuals during evacuations. Engage community organizations and CERT teams to provide additional support in evacuation efforts.
3.8 Evacuation	• MPD	Policy, Operational, Equipment	**73. While some Body-Worn Cameras (BWC) were activated (in keeping with the current policy), several files provided by the County of Maui were unreadable.**	**1.** Update the MPD's G.O. 304.12 policy to have BWCs activated upon dispatch and include a quality-control program to ensure all equipment is functioning properly and producing usable audio visual assets. **2.** The MPD should follow G.O. 304.12.
3.8 Evacuation	• MPD	Equipment, Training	**74. MPD officers experienced difficulty hearing radio traffic due to the wind and noise from the fire.**	**1.** Issuing radio earpieces to all officers will enhance communication, allowing them to stay informed and coordinate effectively during incidents. Officers should receive training on the proper use and maintenance of these earpieces to maximize their benefits.

7.1 APPENDIX

Reference Section (Phase Two Report)	Relevant Department	Actionable Areas	Finding	Recommendations
3.8 Evacuation	• County of Maui • MEMA	Preparedness, Policy, Equipment, Operational	**75. The alert systems in place did not adequately inform residents of inherent dangers.**	**1.** Developing and implementing multiple alert systems, including sirens, radio broadcasts, and door-to-door notifications, can ensure that evacuation orders reach all residents, especially when cell service and electrical power are lost. **2.** Expand community engagement and preparedness efforts with public awareness campaigns that emphasize the importance of evacuation and the risks of staying behind during wildfires, encouraging residents to have a personal evacuation plan that includes considerations for pets and family members with special needs. **3.** Educate the public about evacuation procedures and safe routes, and the importance of establishing family evacuation plans and having prepared “go-bags.” Regular drills and informational sessions can reinforce this knowledge, while localized communication networks, such as neighborhood watch groups or community liaisons, can assist in disseminating information.
3.8 Evacuation	• MFD • MPD	Preparedness, Policy, Equipment, Operational	**76. MPD officers encountered barriers to roads that could have been (and eventually were) used as alternate egress routes and lacked equipment to navigate these barriers.**	**1.** Perform annual status checks of emergency gates throughout the community. **2.** Equip police vehicles with disaster response kits, including appropriate PPE, to be able to facilitate evacuations and remove barriers from potential escape exits, such as chain link fences, gates, and boulders. **3.** The MFD to establish new policy/General Order for the provision of fire- and disaster-related emergency tools for patrol, such as bolt cutters, tow straps, etc.
4.0 Built Environment	• MFD • County of Maui • State of HI	Prevention, Preparedness, Policy	**77. Numerous stakeholder organizations (state, county, community, and HWMO) have collaborated to evaluate wildfire risk per West Maui CWPP.**	**1.** Hold a statutory organization accountable for executing the preparedness plans commensurate with the risk identified through these efforts. **2.** Adopt and enforce contemporary codes and standards for building construction in wildfire prone areas.
4.0 Built Environment	• MFD • County of Maui • State of HI	Prevention, Preparedness, Policy	**78. Codes and standards exist for addressing fire hazards of exterior vegetation (16.04D Subsection 10.13.10), but they require enhancement based on risk and current guidelines.**	**1.** Update, implement, and enforce fuel management and defensible space around structures.
4.0 Built Environment	• MFD • County of Maui • State of HI	Research, Prevention, Policy	**79. Some vegetation adjacent to structures survived where the structure was not destroyed.**	**1.** Additional research is necessary to understand the potential for lush, well-watered, and well-mainted vegetation to provide benefits (e.g., radiation shielding) that is not outweighed by the hazard.
4.0 Built Environment	• MFD • County of Maui • State of HI	Prevention, Policy	**80. Ember penetration through building envelopes, including roofs, vents, and windows, is a common pathway for building ignition.**	**1.** Buildings should be constructed and maintained to resist ember intrusion. This will include construction features (vents, roofs, etc.). **2.** Adopt stronger WUI codes (e.g., ICC International Wildland-Urban Interface Code and NFPA 1140: Standard on Wildland Fire Protection) or WUI Structure/Parcel/Community Hazard Mitigation Methodology guidance.

7.1 APPENDIX

Reference Section (Phase Two Report)	Relevant Department	Actionable Areas	Finding	Recommendations
4.0 Built Environment	• MFD • County of Maui • State of HI	Prevention, Policy	**81. Window and doors were left open prior to evacuation.**	**1.** Residents and citizens should be educated on the importance of closing building openings as an important component of preparation for, and departure from, a home during an evacuation—part of a "Ready, Set, Go: Close Before You Go" campaign.
4.0 Built Environment	• MFD • County of Maui • State of HI	Prevention, Policy	**82. Age of construction is not a primary indicator of structure survival (correlation not causation).**	**1.** Ensure properties and areas around structures are well-maintained, despite the structures' age (i.e., newer structures are not exempt).
4.0 Built Environment	• MFD • County of Maui • State of HI	Prevention, Policy, Operational	**83. Defensive actions appear to have lessened fire impact in the built environment.**	**1.** Identify fire suppression strategies and tactics commensurate with resources and infrastructure capabilities and availability. Preplan based on these limitations and local conditions.
4.0 Built Environment	• MFD • County of Maui • State of HI	Prevention, Policy	**84. Fuel breaks, such as Kahoma Stream, Kaua'ula Stream, Keawe Street Apartments at the Villages of Leiali'i construction site, and grass athletic fields by the Boys and Girls Club/Lahaina Recreation Center, appear to have impacted fire progression.**	**1.** Investigate zoning changes to incorporate fuel breaks in areas within the community to slow fire progression and to act as safe refuge areas for evacuating residents.

8.0 ACRONYMS AND MEANINGS

Acronym	Meaning
AG	Hawai‘i Attorney General
ARFF	Aircraft Rescue and Firefighting
ATF	United States Bureau of Alcohol, Tobacco, Firearms, and Explosives
CAD	Computer Aided Design
CRA	Community Risk Assessment
CRR	Community Risk Reduction
CWRM	Commission on Water Resource Management
CWPP	Community Wildfire Protection Plan
DAGS	Department of Accounting and General Services
DCCA	Department of Commerce and Consumer Affairs
DHRD	Department of Human Resources Development
DLE	Hawai‘i Department of Law Enforcement
DLIR	Department of Labor and Industrial Relations
DLNR	Department of Land and Natural Resources
DOAG	Department of the Attorney General
DOFAW	Hawai‘i Division of Forestry and Wildlife
DOT	Hawai‘i Department of Transportation
DLIR	Director of Labor and Industrial Relations
EMS	Emergency Medical Services
FSRI	Fire Safety Research Institute
HAB	Hawai‘i Association of Broadcasters
HBBC	Hawai‘i Building Code Council
HI-EMA	Hawai‘i Emergency Management Agency
HPUC	Hawai‘i Public Utilities Commission
HRS	Hawai‘i Revised Statutes
HWMO	Hawai‘i Wildfire Management Organization
IECC	International Energy Conservation Code
IBC	International Building Code
ICC	International Code Council
IRC	International Residential Code
MAT	Maui Wildfire Mitigation Assessment Team
MFD	County of Maui Fire and Public Safety, aka Maui Fire Department

8.0 ACRONYMS AND MEANINGS

Acronym	Meaning
NFPA	National Fire Protection Association
NGO	Non-Governmental Organization
NIMS	National Incident Management System
NWCG	National Wildfire Coordinating Group
NWS	United States National Weather Service
OPSD	Office of Planning Sustainable Development
OSFM	Office of the State Fire Marshal
OWSS	All-Hazard Outdoor Warning Siren System
RAWS	Remote Automatic Weather Stations
RMS	Records Management System
RPC	Recovery Permitting Center
SFC	State Fire Council
SOC	Standards of Cover
SFM	State Fire Marshal
UHERO	UH Economic Research Organization
UL	Underwriters Laboratories
ULRI	UL Research Institutes
ULSE	UL Standards and Engagement
WUI	Wildland-Urban Interface

SOURCES

1. Phase One, Comprehensive Timeline Report, April 17, 2024, https://d1gi3fvbl0xj2a.cloudfront.net/2024-04/FSRI_Lahaina_Fire-Comprehensive_Timeline_Report_04_17_2024_Redacted_Final_0.pdf.

2. Phase One, Comprehensive Timeline, April 17, 2024, https://docs.google.com/spreadsheets/d/11cDTSsS3vpW53pO61Xnudt0ACuTBw9CN/edit?gid=1159299693#gid=1159299693.

3. Lahaina Fire Incident Analysis Report, October 2, 2024 (Revision 1), chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://d1gi3fvbl0xj2a.cloudfront.net/2024-10/FSRI_Lahaina_Report__Redactions_10022024_Rev1%20(1)_0.pdf.

4. The National Cohesive Wildland Fire Management Strategy and Risk Analysis - Phase III Report, April 2014, https://www.forestsandrangelands.gov/documents/strategy/strategy/CSPhaseIIINationalStrategyApr2014.pdf

5. FEMA Mitigation Assessment Team Report, accessed December 22, 2024, https://www.fema.gov/emergency-managers/risk-management/building-science/disaster-support.

6. Lahaina Long-term Recovery Plan, December 2024, https://www.mauirecovers.org/lahaina

7. Lahaina Fire Incident Analysis Report, October 2, 2024 (Revision 1), https://d1gi3fvbl0xj2a.cloudfront.net/2024-10/FSRI_Lahaina_Report__Redactions_10022024_Rev1%20(1)_0.pdf

8. Hawaiian Electric, Interim Wildfire Safety Measures, https://www.hawaiianelectric.com/documents/safety_and_outages/wildfire_safety/20240209_interim_wildfire_safety_measures.pdf

9. Hawai'i Attorney General-FSRI Phase II Analysis report; Western Fire Chiefs Association, Maui Fire Department After Action Report, Institute for Building Home and Safety (IBHS) Lahaina report; Maui Police Department After Action Report.
https://www.mauicounty.gov/DocumentCenter/View/146279/2023-Wildfire-After-Action-Report
https://ibhs1.wpenginepowered.com/wp-content/uploads/Lahaina-Full-Policy-Paper.pdf
https://www.mauipolice.com/uploads/1/3/1/2/131209824/pre_aar_master_copy_final_draft_1.23.24.pdf

10. MFD After-Action Report, Maui Wildfires, August 7-11, 2023. https://www.mauicounty.gov/DocumentCenter/View/146279/2023-Wildfire-After-Action-Report
    - Observation - Staffing (page 23) - Recommendation 1.22.
    - Observation - Fire Stations (page 23) - Recommendation 1.24.

11. MFD 2021-2025 Strategic Plan. https://www.mauicounty.gov/DocumentCenter/View/101890/MFD-Master-Strategic-Plan-2021---2025?bidId=
    - Goal 4 (page 14) - Identify community risk reduction (CRR) initiatives to foster safer neighborhoods and communities.

12. Lahaina Long-Term Recovery Plan, December 2024, pages 31 and 32, Sections 6.4 Hazard Mitigation and Response, & 6.5 Rebuilding with Resilence, https://drive.google.com/file/d/14LwN3BbhreeaJo46UzKMAFBTEqhh3RJ3/view

13. NFPA 1300 Standard on Community Risk Assessment and Community Risk Reduction Plan Development, https://www.nfpa.org/product/nfpa-1300-standard/p1300code

14. NIMS Implementation Objectives for Local Government, https://www.fema.gov/sites/default/files/2020-07/fema_nims_implementation-objectives-20180530.pdf.

15. Homeland Security Presidential Directive 5, https://www.dhs.gov/sites/default/files/publications/Homeland%20Security%20Presidential%20Directive%205.pdf.

16. 16 Hawaiian Electric, https://www.hawaiianelectric.com/safety-and-outages/wildfire-safety

17. FEMA Mitigation Assessment Team Report, accessed December 22, 2024, https://www.fema.gov/emergency-managers/risk-management/building-science/disaster-support.

18. Hawai'i Revised Statutes, Chapter 107, Section 22, State Building Code Council, accessed September 14, 2023, https://www.capitol.hawaii.gov/hrscurrent/Vol02_Ch0046-0115/HRS0107/HRS_0107-0022.htm.

19. Hawai'i Revised Statutes, Chapter 107, Section 24(c), State Building Code Council, accessed December 2, 2024, https://www.capitol.hawaii.gov/hrscurrent/Vol02_Ch0046-0115/HRS0107/HRS_0107-0024.htm.

20. Hawai'i Building Code Council website, Building Code Publication and Adoption Schedule, accessed December 2, 2024, https://ags.hawaii.gov/wp-content/uploads/2023/03/SBCC-Code-Cycle-Critical-Dates_2023-03-10_.pdf.

21. Hawai'i Revised Statutes, Chapter 107, Section 23, Executive director and executive assistant; council budget, accessed September 14, 2023, https://www.capitol.hawaii.gov/hrscurrent/Vol02_Ch0046-0115/HRS0107/HRS_0107-0023.htm.

22. International Building Code (IBC)©, International Code Council, 2018 Edition, https://codes.iccsafe.org/content/IBC2018P6.

23. Hawai'i State Building Code adoption with state amendments, April 20, 2021, https://ags.hawaii.gov/wp-content/uploads/2021/09/2018StateBuildingCode_20210817.pdf.

24. International Existing Building Code (IEBC)©, International Code Council, 2018 Edition, https://codes.iccsafe.org/content/IEBC2018P5.

25. Hawai'i State Existing Building Code adoption with state amendments, November 17, 2020, https://ags.hawaii.gov/wp-content/uploads/2021/09/2018StateExistingBuildingCode_20201117.pdf.

SOURCES

26. National Fire Protection Association (NFPA) 70: National Electrical Code (NEC), 2020 Edition, https://www.nfpa.org/codes-and-standards/all-codes-and-standards/list-of-codes-and-standards/detail?code=70&year=2020.

27. Hawai'i State Electrical Code adoption with state amendments, March 31, 2022, https://ags.hawaii.gov/wp-content/uploads/2021/12/StateElectricalCode_03152022.pdf.

28. Hawai'i State Elevator Code, June 19, 2000, https://labor.hawaii.gov/hiosh/standards/standards-adminrules-part-11/.

29. International Energy Conservation Code (IECC)©, International Code Council, 2018 Edition, https://codes.iccsafe.org/content/IECC2018P5.

30. Hawai'i State Energy Code adoption with state amendments, January 14, 2021, https://ags.hawaii.gov/wp-content/uploads/2021/01/soh_bcc_energycode_20201215.pdf.

31. Uniform Plumbing Code, International Association of Plumbing and Mechanical Officials, 2018 Edition, https://epubs.iapmo.org/2018/UPC/.

32. Hawai'i State Plumbing Code adoption with state amendments, May 19, 2020, https://ags.hawaii.gov/wp-content/uploads/2020/06/StatePlumbingCode_20200519.pdf.

33. International Residential Code (IRC)©, International Code Council, 2018 Edition, https://codes.iccsafe.org/content/IRC2018/index.

34. Hawai'i State Residential Code adoption with state amendments, November 17, 2020, https://ags.hawaii.gov/wp-content/uploads/2021/09/2018StateResidentialCode_20201117rev1.pdf.

35. Hawai'i State Building Codes Requirements, Hawai'i Revised Statutes, Volume 2, Ch. 107, Sec. 25, 2005, https://www.capitol.hawaii.gov/hrscurrent/Vol02_Ch0046-0115/HRS0107/HRS_0107-0025.htm.

36. State of Hawai'i, State Fire Council, accessed September 20, 2023, https://labor.hawaii.gov/sfc/.

37. Hawai'i Revised Statutes, Chapter 132, Section 16, State Fire Council; composition; functions, accessed September 20, 2023, https://www.capitol.hawaii.gov/hrscurrent/Vol03_Ch0121-0200D/HRS0132/HRS_0132-0016.htm.

38. United States Census Bureau, Kalawao County, Hawai'i, QuicFacts, accessed September 20, 2023, https://www.census.gov/quickfacts/kalawaocountyhawaii.

39. State of Hawai'i, State Fire Council, Contact, accessed September 20, 2023, https://labor.hawaii.gov/sfc/contact/.

40. Hawai'i Revised Statutes Chapter 132, Section 3, accessed December 5, 2024, https://www.capitol.hawaii.gov/hrscurrent/Vol03_Ch0121-0200D/HRS0132/HRS_0132-0003.htm.

41. Hawai'i State Department of Labor and Industrial Relations, 2018 NFPA 1 Fire Code with State Amendments, accessed September 20, 2023, https://labor.hawaii.gov/wp-content/uploads/2024/01/2018-NFPA-1-Fire-Code-State-Amendments-with-Justifications.p.

42. Governor of Hawai'i, Emergency Proclamation Relating to Housing, July 13, 2023, accessed September 14, 2023, https://governor.hawaii.gov/wp-content/uploads/2023/07/2307072-1.pdf.

43. Governor of Hawai'i, Emergency Proclamation Relating to Affordable Housing, September 15, 2023, accessed September 15, 2023, https://governor.hawaii.gov/wp-content/uploads/2023/09/2309120.pdf.

44. Governor of Hawai'i, Second Proclamation Relating to Affordable Housing, October 24, 2023, accessed October 24, 2023, https://governor.hawaii.gov/wp-content/uploads/2023/10/Second-Proclamation-Relating-to-Affordable-Housing.pdf.

45. Governor of Hawai'i, Third Proclamation Relating to Affordable Housing, December 22, 2023, accessed December 22, 2023, https://governor.hawaii.gov/wp-content/uploads/2023/12/2312099.pdf.

46. Governor of Hawai'i, Fourth Proclamation Relating to Affordable Housing, January 18, 2024, accessed January 18, 2024, https://governor.hawaii.gov/wp-content/uploads/2024/01/Fourth-Proclamation-Relating-to-Affordable-Housing.pdf.

47. Governor of Hawai'i, Fifth Proclamation Relating to Affordable Housing, February 20, 2024, accessed February 20, 2024, https://governor.hawaii.gov/wp-content/uploads/2024/02/2402076.pdf.

48. Governor of Hawai'i, Sixth Proclamation Relating to Affordable Housing, April 19, 2024, accessed April 19, 2024, https://governor.hawaii.gov/wp-content/uploads/2024/04/2404063.pdf.

49. Governor of Hawaii, Seventh Proclamation Relating to Affordable Housing, June 18, 2024, accessed June 18, 2024, https://governor.hawaii.gov/wp-content/uploads/2024/06/240606566.pdf.

50. Governor of Hawai'i, Eighth Proclamation Relating to Affordable Housing, August 15, 2024, accessed August 15, 2024, https://governor.hawaii.gov/wp-content/uploads/2024/08/2408068_Eighth-Proclamation-Relating-to-Affordable-Housing.pdf.

51. Governor of Hawai'i, Ninth Proclamation Relating to Affordable Housing, October 10, 2024, accessed October 10, 2024, https://governor.hawaii.gov/wp-content/uploads/2024/10/2410041.pdf.

SOURCES

52. “Office of the Governor’s Housing Team website. Frequently Asked Questions - What has been updated across different versions of the Proclamations Relating to Affordable Housing? https://hale.hawaii.gov/frequently-asked-questions/.

53. Hawai‘i Building Code Council Website, no post date, accessed December 3, 2024, https://ags.hawaii.gov/bcc/building-code-rules/.

54. Hawai‘i Revised Statutes, Chapter 104, Section 24(c), accessed December 3, 2024, https://www.capitol.hawaii.gov/hrscurrent/Vol02_Ch0046-0115/HRS0107/HRS_0107-0024.htm.

55. Hawai‘i State Building Code - 2021 IBC (unamended) https://codes.iccsafe.org/content/IBC2021P2/chapter-1-scope-and-administration.

56. Hawai‘i State Residential Code - 2021 IRC (unamended) https://codes.iccsafe.org/content/IRC2021P2/chapter-1-scope-and-administration.

57. State Energy Code - 2021 IECC (unamended) https://codes.iccsafe.org/content/IECC2021P2/chapter-1-ce-scope-and-administration.

58. State Fire Code - 2021 NFPA 1 (as amended by State Fire Council) https://labor.hawaii.gov/sfc/files/2024/06/NFPA-1-2021-Ed-Amendments-w-just-Jan-2023.pdf.

59. Hawai‘i State Plumbing Code - 2021 UPC (unamended) https://epubs.iapmo.org/2021/UPC/.

60. Hawai‘i State Electrical Code - 2023 NFPA 70 (unamended) https://link.nfpa.org/free-access/publications/70/2023.

61. Municode, County of Maui, Hawai‘i - Code of Ordinances, Version: May 31, 2023, accessed September 20, 2023, https://library.municode.com/hi/county_of_maui/codes/code_of_ordinances?nodeId=COCOMAHA.

62. Municode, County of Maui, Hawai‘i - Code of Ordinances - Title 16 - Buildings and Construction, Version: May 31, 2023, accessed September 20, 2023, https://library.municode.com/hi/county_of_maui/codes/code_of_ordinances?nodeId=TIT16BUCO.

63. County of Maui, Hawai‘i, Development Services Administration - What’s New, accessed December 22, 2023, https://www.mauicounty.gov/558/Development-Services-Administration.

64. County of Maui, Hawai‘i, Council Adopted Budget, Fiscal Year 2024, pp. 635-664, https://www.mauicounty.gov/DocumentCenter/View/143272/000-FY-2024-Council-Adopted-Combined.

65. County of Maui, Hawai‘i, Council Adopted Budget, Fiscal Year 2024, pp. 659-661, https://www.mauicounty.gov/DocumentCenter/View/143272/000-FY-2024-Council-Adopted-Combined.

66. County of Maui, Hawai‘i, Council Adopted Budget, Fiscal Year 2024, pp. 662-664, https://www.mauicounty.gov/DocumentCenter/View/143272/000-FY-2024-Council-Adopted-Combined.

67. Municode, County of Maui, Hawai‘i - Code of Ordinances - Title 16 - Buildings and Construction, Version: May 31, 2023, accessed September 20, 2023, https://library.municode.com/hi/county_of_maui/codes/code_of_ordinances?nodeId=TIT16BUCO.

68. Municode - Maui County Code of Ordinances. “16.04D.230 - Subsection 10.13.10 amended.,” August 9, 2024. Accessed December 4, 2024, https://library.municode.com/hi/county_of_maui/codes/code_of_ordinances?nodeId=TIT16BUCO_CH16.04DFICO_16.04D.230SU10.13.10AM.

69. County of Maui, Hawai‘i, Fire Prevention Bureau, accessed September 20, 2023, https://www.mauicounty.gov/1465/Fire-Prevention-Bureau.

70. County of Maui, Hawai‘i, Council Adopted Budget, Fiscal Year 2024, pp. 291-325, https://www.mauicounty.gov/DocumentCenter/View/143272/000-FY-2024-Council-Adopted-Combined.

71. County of Maui, Hawai‘i, Council Adopted Budget, Fiscal Year 2024, pp. 320-323, https://www.mauicounty.gov/DocumentCenter/View/143272/000-FY-2024-Council-Adopted-Combined.

72. County of Maui, Hawai‘i, Council Adopted Budget, Fiscal Year 2024, pp. 324-325, https://www.mauicounty.gov/DocumentCenter/View/143272/000-FY-2024-Council-Adopted-Combined.

73. Maui Recovers Dashboard, accessed December 6, 2024, https://www.mauirecovers.org/recoverydashboard.

74. Senate Bill 2085, State Fire Marshal. Accessed December 4, 2024, https://www.capitol.hawaii.gov/sessions/session2024/bills/SB2085_CD1_.pdf.

75. Act 209 Relating to the State Fire Marshal. Accessed December 4, 2024, https://www.capitol.hawaii.gov/sessions/session2024/bills/GM1310_.PDF.

76. FSRI Lahaina Fire Incident Analysis Report. Accessed December 4, 2024, https://d1gi3fvbl0xj2a.cloudfront.net/2024-10/FSRI_Lahaina_Report__Redactions_10022024_Rev1%20(1)_0.pdf.

77. Department of Labor and Industrial Relations, State Fire Marshal plan. Accessed December 4, 2024, https://labor.hawaii.gov/wp-content/uploads/2024/11/State-Fire-Marshal-Report-ACT209-part-1-signed.pdf.

As this report deals with topics related to Hawaiian culture, geography, environment, and language, FSRI chose to include Hawaiian diacritical marks, such as the ʻokina (ʻ) and kahakō (macron) over vowels, throughout this report when writing Hawaiian words. These markings are essential features of modern, written Hawaiian language, serving to represent the proper pronunciation and meaning.

While we have made our best effort to use these marks properly, we acknowledge there may be unintentional errors. We did not include diacritical markings where we were unable to identify the proper spelling of a particular Hawaiian word (eg., Aa Street) or in instances where the information is from a third party's direct record (e.g., social media posts).

By including these marks, we aim to honor the Hawaiian language and show respect for its linguistic traditions – and for the people of Maui.

Lahaina Fire
Forward-Looking Report



Steve Kerber, Ph.D., P.E.
Vice President and
Executive Director, FSRI

Derek Alkonis
Research Program Manager

Fire Safety
Research Institute

© 2025 Underwriters Laboratories Inc.

COUNTY OF SAN DIEGO
BOARD OF SUPERVISORS - LAND USE
WEDNESDAY, MAY 22, 2024

MINUTE ORDER NO. 8

SUBJECT: NOTICED PUBLIC HEARING:
UPDATES TO FIRE SAFETY GUIDELINES AND STANDARDS DURING ENVIRONMENTAL REVIEW IN THE UNINCORPORATED AREAS AND FINDING THESE UPDATES ARE NOT SUBJECT TO CEQA
(DISTRICTS: ALL)

OVERVIEW

The County of San Diego's Wildfire and Fire Protection Guidelines (Fire Guidelines) were originally adopted by Planning & Development Services (PDS) on March 19, 2007. They aid in the review of discretionary projects (projects that require a public agency to exercise judgment or deliberate before deciding if the project will be approved or a permit will be issued) and associated environmental documents to determine whether, based on substantial evidence as defined under the California Environmental Quality Act (CEQA) Guidelines, a project may have a significant effect related to wildland fire.

The update to the Fire Guidelines is part of a broader effort directed by the Board on September 28, 2022 (6) to develop Vehicle Miles Traveled (VMT) policy options and separately address wildfire issues and concerns related to development within fire hazard severity zones in the unincorporated areas of the county. For example, the VMT policy options may increase safety risks to new residents based on where they are located within high fire severity zones. Specific considerations should be placed to protect residents and the public. During this hearing, the Board adopted the revised Transportation Study Guide (TSG) directed staff to update the Fire Guidelines in three phases to ensure that new unincorporated area projects located in State-designated High and Very High Fire Hazard Severity Zones (fire zones) go through additional analysis and implement mitigation to reduce impacts from wildfire. For example, mitigation may include incorporating building separation or setback requirements to reduce structure-to-structure ignition. The County has no discretion in the approval of the adopted State fire zone maps.

Phase 1 was adopted by the Board on January 25, 2023 (7) and included the clarification that: (1) a Fire Protection Plan is required for projects located within High and Very High fire zones; (2) that any waivers of standards in the State Fire Code shall be replaced with an alternative measure that provides the same practical effect, and; (3) various editorial changes. Phase 2 involves a comprehensive update to the Fire Guidelines to update all the requirements of a Fire Protection Plan (FPP), including water supply, access, fuel modification, and building standards. A FPP is a document that an applicant (developer)prepares that describes the level of fire hazard that would affect or be caused by a proposed development and the methods proposed to minimize that hazard. The current Fire Guidelines do not reflect current State standards and have not been updated for many years. The comprehensive update would bring the Fire Guidelines up to current State standards and incorporate changes to the Fire Code and align it with current State fire zone maps. Evacuation requirements will be addressed in Phase 3 of the Fire Guidelines update. If adopted, the Updated Fire Guidelines would apply to all new development projects and in-process projects that have not yet been approved by the County. The action in front of the Board today is to approve the second phase of this Board directed effort.

The updated Fire Guidelines presented for adoption today will ensure that new development is safe and implements measures to minimize the risk and impacts of wildland fires by providing clarity and standardize the review process for developers. After the Board considers the updated Fire Guidelines, staff will move into Phase 3 to develop evacuation standards and criteria and return to the Board for consideration in 2025.

RECOMMENDATION(S)
PLANNING COMMISSION
On March 22, 2024, Planning Commission considered staff's recommendation to adopt the County's CEQA Wildfire and Fire Protection Guidelines (Fire Guidelines) and recommended approval of staff's recommendation to the Board.

DEPARTMENT OF PLANNING & DEVELOPMENT SERVICES
Planning & Development Services concurs with the Planning Commission's recommendations stated below.

1. Find that the proposed action is not a project as defined in Public Resources Code section 21065 and CEQA Guidelines section 15378, and is therefore not subject to CEQA pursuant to CEQA Guidelines section 15060(c)(3).

2. Adopt the County's CEQA Wildfire and Fire Protection Guidelines (Attachment B) and revisions included in Attachment C by the following Resolution:
RESOLUTION OF THE COUNTY OF SAN DIEGO BOARD OF SUPERVISORS ADOPTING THE COUNTY OF SAN DIEGO GUIDELINES FOR DETERMINING SIGNIFICANCE AND REPORT FORMAT AND CONTENT REQUIREMENTS FOR WILDLAND FIRE AND FIRE PROTECTION

EQUITY IMPACT STATEMENT
Planning & Development Services (PDS) is guided by several Regulatory Codes, Administrative Codes, Board Policies and Guidelines to serve the region and customers consistently and equitably. The updates to the County's CEQA Wildfire and Fire Protection Guidelines will ensure that new development in all communities within the unincorporated areas implements improved fire safety measures and minimizes impacts to existing residents and communities. The updates will enhance the County's evaluation of new development projects, ensuring they equitably address fire safety and mitigate wildfire impacts to the extent feasible.

SUSTAINABILITY IMPACT STATEMENT
The proposed action to update the County's CEQA Wildfire and Fire Protection Guidelines (Fire Guidelines) will contribute to the County of San Diego's Strategic Initiatives Sustainability Goal No. 4 to protect the health and wellbeing of everyone in the region by ensuring that new development addresses and mitigates impacts related to wildfire risk. The updated Fire Guidelines will require additional analysis be completed for projects located within high and very high fire risk areas to ensure they are safe, minimize impacts to existing residents and communities, and implement measures to reduce the risk of wildfire.

FISCAL IMPACT
There is no fiscal impact associated with these recommendations. The updates to County's CEQA Wildfire and Fire Protection Guidelines will be implemented through privately initiated projects which are privately funded. Private development costs will be paid for by the private sector through the entitlement and permit processes. There will be no change in net General Fund costs and no additional staff years.

BUSINESS IMPACT STATEMENT
N/A

ACTION:
ON MOTION of Supervisor Desmond, seconded by Supervisor Montgomery Steppe, the Board of Supervisors closed the Hearing and took action as recommended, and adopted Resolution No. 24-046, entitled: RESOLUTION OF THE COUNTY OF SAN DIEGO BOARD OF SUPERVISORS ADOPTING THE COUNTY OF SAN DIEGO GUIDELINES FOR DETERMINING SIGNIFICANCE AND REPORT FORMAT AND CONTENT REQUIREMENTS FOR WILDLAND FIRE AND FIRE PROTECTION.

AYES: Vargas, Anderson, Montgomery Steppe, Desmond
ABSENT: Lawson-Remer

State of California)
County of San Diego)

I hereby certify that the foregoing is a full, true and correct copy of the Original entered in the Minutes of the Board of Supervisors.

ANDREW POTTER
Clerk of the Board of Supervisors

Signed by Andrew Potter

Resolution No. 24-046
Meeting Date: 05/22/2024 (08)

RESOLUTION OF THE COUNTY OF SAN DIEGO BOARD OF SUPERVISORS ADOPTING THE COUNTY OF SAN DIEGO GUIDELINES FOR DETERMINING SIGNIFICANCE AND REPORT FORMAT AND CONTENT REQUIREMENTS FOR WILDLAND FIRE AND FIRE PROTECTION

WHEREAS, on May 22, 2024, the Board of Supervisors, held a duly advertised public hearing on the Updated California Environmental Quality Act Wildfire Guidelines and Fire Protection Guidelines; and

WHEREAS, on May 22, 2024, the Board of Supervisors found that this action complies with the California Environmental Quality Act (CEQA) and State and County Guidelines as set forth in Exhibit A because this resolution for adoption of the Wildfire Guidelines and Fire Protection Guidelines is: (1) not a project as defined in the Public Resources Code section 21065 and CEQA Guidelines section 15378, and is therefore not subject to CEQA pursuant to CEQA Guidelines Section 15060 (c); and (2) subject to the common sense exemption, because it can be seen with certainty that there is no possibility that it may have a significant effect on the environment (Section 15061(b)(3) of the CEQA Guidelines)

NOW THEREFORE BE IT RESOLVED that the Board of Supervisors takes the following action:

1. Adopt the County of San Diego Guidelines for Determining Significance and Report Format and Content Requirements for Wildfire and Fire Protection dated May 22, 2024 (Attachment B).

BE IT FURTHER RESOLVED that the Board of Supervisors finds that the County Wildfire Guidelines and Fire Protection Guidelines are consistent with the County of San Diego General Plan in that the goals, objectives, and policies of all the elements of the plan have been or will be met.

BE IT FURTHER RESOLVED that this Resolution shall take effect and be in force on May 22, 2024.

APPROVED AS TO FORM AND LEGALITY

Claudia G. Silva, COUNTY COUNSEL

By: Jerod Markley, Senior Deputy County Counsel

Resolution No. 24-046
Meeting Date: 05/22/2024 (08)

EXHIBIT A

The adoption of the resolution for the proposed Wildlife and Fire Protection Guidelines (Fire Guidelines) is not a "project" as defined in the Public Resources Code section 21065 and California Environmental Quality Act (CEQA) Guidelines section 15378 and is therefore not subject to CEQA pursuant to CEQA Guidelines section 15060(c)(3). A project, as defined by CEQA, is the whole of an action that has the potential to result in either a direct physical change or reasonably foreseeable indirect physical change to the environment. While the Fire Guidelines facilitate analysis of wildland fire risk under CEQA, they do not substitute for or diminish that analysis for any project. In addition, the Fire Guidelines do not authorize or ban any development or exempt any project from CEQA review, and therefore there is no possibility that their adoption may have a significant effect on the environment. The adoption of the Fire Guidelines is also subject to the commonsense exemption in CEQA Guidelines section 15061(b)(3) because it can be seen with certainty that there is no possibility that adopting the Fire Guidelines may have a significant effect on the environment. The Fire Guidelines do not authorize or prohibit any development and therefore will not cause environmental impacts. In accordance with CEQA Guideline section 15064.7, the Fire Guidelines have been circulated for public review and are proposed to be adopted by Resolution of the Board.

ON MOTION of Supervisor Vargas, seconded by Supervisor Montgomery Steppe, the above Resolution was passed and adopted by the Board of Supervisors, County of San Diego, State of California, on this 22nd day of May 2024, by the following vote:

AYES: Vargas, Anderson, Montgomery Steppe, Desmond
NOT PRESENT: Lawson-Remer

- - -

STATE OF CALIFORNIA)
County of San Diego) §

I hereby certify that the foregoing is a full, true and correct copy of the Original Resolution entered in the Minutes of the Board of Supervisors.

ANDREW POTTER
Clerk of the Board of Supervisors

By: _____
Janely Valdivia, Deputy

Resolution No. 24-046
Meeting Date: 05/22/2024 (08)

COUNTY OF SAN DIEGO

LAND USE AGENDA ITEM

BOARD OF SUPERVISORS

NORA VARGAS
First District

JOEL ANDERSON
Second District

TERRA LAWSON-REMER
Third District

MONICA MONTGOMERY STEPPE
Fourth District

JIM DESMOND
Fifth District

DATE: **May 22, 2024** **08**

TO: Board of Supervisors

SUBJECT

UPDATES TO FIRE SAFETY GUIDELINES AND STANDARDS DURING ENVIRONMENTAL REVIEW IN THE UNINCORPORATED AREAS AND FINDING THESE UPDATES ARE NOT SUBJECT TO CEQA (DISTRICTS: ALL)

OVERVIEW

The County of San Diego's Wildfire and Fire Protection Guidelines (Fire Guidelines) were originally adopted by Planning & Development Services (PDS) on March 19, 2007. They aid in the review of discretionary projects (projects that require a public agency to exercise judgment or deliberate before deciding if the project will be approved or a permit will be issued) and associated environmental documents to determine whether, based on substantial evidence as defined under the California Environmental Quality Act (CEQA) Guidelines, a project may have a significant effect related to wildland fire.

The update to the Fire Guidelines is part of a broader effort directed by the Board on September 28, 2022 (6) to develop Vehicle Miles Traveled (VMT) policy options and separately address wildfire issues and concerns related to development within fire hazard severity zones in the unincorporated areas of the county. For example, the VMT policy options may increase safety risks to new residents based on where they are located within high fire severity zones. Specific considerations should be placed to protect residents and the public. During this hearing, the Board adopted the revised Transportation Study Guide (TSG) directed staff to update the Fire Guidelines in three phases to ensure that new unincorporated area projects located in State-designated High and Very High Fire Hazard Severity Zones (fire zones) go through additional analysis and implement mitigation to reduce impacts from wildfire. For example, mitigation may include incorporating building separation or setback requirements to reduce structure-to-structure ignition. The County has no discretion in the approval of the adopted State fire zone maps.

Phase 1 was adopted by the Board on January 25, 2023 (7) and included the clarification that: (1) a Fire Protection Plan is required for projects located within High and Very High fire zones; (2) that any waivers of standards in the State Fire Code shall be replaced with an alternative measure that provides the same practical effect, and; (3) various editorial changes. Phase 2 involves a comprehensive update to the Fire Guidelines to update all the requirements of a Fire Protection Plan (FPP), including water supply, access, fuel modification, and building standards. A FPP is a document that an applicant (developer)prepares that describes the level of fire hazard that would

affect or be caused by a proposed development and the methods proposed to minimize that hazard. The current Fire Guidelines do not reflect current State standards and have not been updated for many years. The comprehensive update would bring the Fire Guidelines up to current State standards and incorporate changes to the Fire Code and align it with current State fire zone maps. Evacuation requirements will be addressed in Phase 3 of the Fire Guidelines update. If adopted, the Updated Fire Guidelines would apply to all new development projects and in-process projects that have not yet been approved by the County. The action in front of the Board today is to approve the second phase of this Board directed effort.

The updated Fire Guidelines presented for adoption today will ensure that new development is safe and implements measures to minimize the risk and impacts of wildland fires by providing clarity and standardize the review process for developers. After the Board considers the updated Fire Guidelines, staff will move into Phase 3 to develop evacuation standards and criteria and return to the Board for consideration in 2025.

RECOMMENDATION(S)

PLANNING COMMISSION
On March 22, 2024, Planning Commission considered staff's recommendation to adopt the County's CEQA Wildfire and Fire Protection Guidelines (Fire Guidelines) and recommended approval of staff's recommendation to the Board.

DEPARTMENT OF PLANNING & DEVELOPMENT SERVICES
Planning & Development Services concurs with the Planning Commission's recommendations stated below.

1. Find that the proposed action is not a project as defined in Public Resources Code section 21065 and CEQA Guidelines section 15378, and is therefore not subject to CEQA pursuant to CEQA Guidelines section 15060(c)(3).

2. Adopt the County's CEQA Wildfire and Fire Protection Guidelines (Attachment B) and revisions included in Attachment C by the following Resolution:

   RESOLUTION OF THE COUNTY OF SAN DIEGO BOARD OF SUPERVISORS ADOPTING THE COUNTY OF SAN DIEGO GUIDELINES FOR DETERMINING SIGNIFICANCE AND REPORT FORMAT AND CONTENT REQUIREMENTS FOR WILDLAND FIRE AND FIRE PROTECTION

SUBJECT: UPDATES TO FIRE SAFETY GUIDELINES AND STANDARDS DURING ENVIRONMENTAL REVIEW IN THE UNINCORPORATED AREAS AND FINDING THESE UPDATES ARE NOT SUBJECT TO CEQA (DISTRICTS: ALL)

EQUITY IMPACT STATEMENT
Planning & Development Services (PDS) is guided by several Regulatory Codes, Administrative Codes, Board Policies and Guidelines to serve the region and customers consistently and equitably. The updates to the County's CEQA Wildfire and Fire Protection Guidelines will ensure that new development in all communities within the unincorporated areas implements improved fire safety measures and minimizes impacts to existing residents and communities. The updates will enhance the County's evaluation of new development projects, ensuring they equitably address fire safety and mitigate wildfire impacts to the extent feasible.

SUSTAINABILITY IMPACT STATEMENT
The proposed action to update the County's CEQA Wildfire and Fire Protection Guidelines (Fire Guidelines) will contribute to the County of San Diego's Strategic Initiatives Sustainability Goal No. 4 to protect the health and wellbeing of everyone in the region by ensuring that new development addresses and mitigates impacts related to wildfire risk. The updated Fire Guidelines will require additional analysis be completed for projects located within high and very high fire risk areas to ensure they are safe, minimize impacts to existing residents and communities, and implement measures to reduce the risk of wildfire.

FISCAL IMPACT
There is no fiscal impact associated with these recommendations. The updates to County's CEQA Wildfire and Fire Protection Guidelines will be implemented through privately initiated projects which are privately funded. Private development costs will be paid for by the private sector through the entitlement and permit processes. There will be no change in net General Fund costs and no additional staff years.

BUSINESS IMPACT STATEMENT
N/A

PLANNING COMMISSION VOTE
On March 22, 2024, Planning Commission voted (4 Ayes, 0 Noes, 2 Absent) to recommend approval to the Board of Supervisors for the County's CEQA Wildfire and Fire Protection Guidelines (Fire Guidelines) and requested staff to assess fuel management best practices within open space and undeveloped properties. The Planning Commission's request does not involve the proposed revised Fire Protection Plan Guidelines as the guidelines do not regulate fuel modification requirements. The request from the Planning Commission would involve updates to the County's Consolidated Fire Code and associated environmental review, including an Environmental Impact Report. As a result, it would require the Board to approve and allocate funding as well as potentially additional staffing positions. Staff also anticipates the request would require extensive stakeholder outreach and would pose significant challenges to implement due to open space land being set aside for mitigation, property owner opposition, and environmental constraints and permitting for impacts to endangered and threatened species. As a result, staff are not recommending the Board approve the Planning Commission's recommendation regarding the fuel management requirements within open space and vacant and undeveloped properties. (Ayes: Edwards, Ashman, Barnhart, Hitzke; Noes: N/A; Absent: Calvo, Pallinger).

SUBJECT: UPDATES TO FIRE SAFETY GUIDELINES AND STANDARDS DURING ENVIRONMENTAL REVIEW IN THE UNINCORPORATED AREAS AND FINDING THESE UPDATES ARE NOT SUBJECT TO CEQA (DISTRICTS: ALL)

BACKGROUND

The Fire Guidelines were originally adopted by Planning & Development Services (PDS) on March 19, 2007. The Fire Guidelines assist staff, project applicants, and the public in understanding whether a proposed development project will create significant risks associated with wildfire because of its location, design or other factors. The Fire Guidelines aid in the review of discretionary projects (projects that require a public agency to exercise judgment or deliberate before deciding if the project will be approved or a permit will be issued) and associated environmental documents to determine whether a project may have a significant effect related to wildland fire. These guidelines also establish standards to reduce the risk of development projects exposing people or structures to a significant risk of loss, injury or death involving wildland fires. The Fire Guidelines do not propose any development.

On September 28, 2022 (6), the Board directed staff to update the Fire Guidelines in three phases to ensure that new projects in the unincorporated areas that are in fire zones go through additional analysis and implement mitigation to reduce impacts from wildfire to the extent feasible. Phase 1 was adopted by the Board on January 25, 2023 (7) and included the clarification that: (A) a Fire Protection Plan is required for projects located within high and very high fire zones; (B) that any waivers of standards in the State Fire Code shall be replaced with an alternative measure that provides the same practical effect, and; (C) various editorial changes.

The updated Fire Guidelines will provide clarity and standardize the review process for applicants while ensuring new development is safe and implements any measures needed to minimize the risk and impact of wildland fires. The Fire Guidelines would not prevent or restrict development but detail the requirements that need to be analyzed on each individual project. The Fire Guidelines would only apply to new proposed projects and would not apply to existing communities. In terms of cost, the Fire Guidelines would not add any additional cost to applicants because projects are still required to prepare Fire Protection Plans under the current guidelines, but they are out of date and do not explain all the current State and County requirements that need to be addressed. The updated Fire Guidelines will also make it easier for consultants to prepare Fire Protection Plans and reduce the number of overall reviews by technical staff, which would reduce the overall cost.

PROJECT ANALYSIS

On September 28, 2022 (6) the Board directed staff to update the Fire Guidelines in three phases. Phase 1 was approved by the Board in January 2023. Today's action includes Phase 2, which has been prepared pursuant to the Board's direction. It involves a comprehensive update to the Fire Guidelines to update all the requirements of a Fire Protection Plan, including water supply, access, fuel modification, and building standards. The comprehensive update in Phase 2 would bring the Fire Guidelines up to current State standards and incorporate changes to the Fire Code and align it with current State fire zone maps. Evacuation requirements will be addressed in Phase 3 of the Fire Guidelines update. If adopted, the updated Fire Guidelines would apply to all new projects and in-process projects that have not yet been approved.

SUBJECT: UPDATES TO FIRE SAFETY GUIDELINES AND STANDARDS DURING ENVIRONMENTAL REVIEW IN THE UNINCORPORATED AREAS AND FINDING THESE UPDATES ARE NOT SUBJECT TO CEQA (DISTRICTS: ALL)

The Fire Guidelines provide guidance to planners, applicants, consultants, fire professionals and other interested parties for evaluating adverse environmental effects that a proposed project may have from wildland fire and only apply to new developments, not existing communities. They also establish standards to ensure that development projects do not unnecessarily expose people or structures to a significant risk of loss, injury or death involving wildland fires. The updated guidelines have been prepared based on Board direction and include the following:

1. Addressing the requirements of California Environmental Quality Act (CEQA) related to fire safety.
2. Incorporating current State and County regulations and standards.
3. Evaluating and updating fire access road, fuel modification, water supply, and construction State and County standards.
4. Incorporating best practices, where feasible.
5. Discussion of Fire Hazard Severity Zones and mapping; and
6. Evaluating and recommending fire modeling software for developers and consultants, and considering pre-identified weather inputs for modeling.

Implementing these guidelines will assist the County in reducing a new neighborhood's vulnerability to wildfire and establishing resilient communities. The updated Fire Guidelines have also been condensed and synthesized into more accessible language. New State regulations, requirements and County guidance documents have been incorporated into the update with updated links.

The updated Fire Guidelines will also ensure that developments located within fire hazard areas have an approved Fire Protection Plan (FPP) that identifies the measures needed to ensure public safety. An FPP describes the level of fire hazard that would affect or be caused by a proposed development and how a project applicant proposes to minimize that hazard. The FPP also evaluates the consistency of the proposed project with applicable fire protection regulations and provides guidance for evaluating adverse environmental effects that a proposed project may have realted to wildland fire. A FPP also establishes standards to ensure that development projects do not unnecessarily expose people or structures to a significant risk of loss, injury or death involving wildland fires.

All changes made to the updated Fire Guidelines have been reviewed and accepted by the San Diego County Fire Protection District.

SUBJECT: UPDATES TO FIRE SAFETY GUIDELINES AND STANDARDS DURING ENVIRONMENTAL REVIEW IN THE UNINCORPORATED AREAS AND FINDING THESE UPDATES ARE NOT SUBJECT TO CEQA (DISTRICTS: ALL)

PUBLIC INPUT

The updates to the Fire Guidelines included an extensive public outreach process including coordination with internal PDS specialists, other County Departments, Community Planning/Sponsor Groups, Design Review Boards and other external stakeholders including the PDS Environmental Stakeholders Working Group, which consists of environmental NGOs and advocates, the Land Development Technical Working Group, which consists of land development practitioners; and the Building Industry Association. Four additional stakeholder outreach meetings were carried out from November 2023 to February 2024 including with the Farm Bureau, the Land Development Technical Working Group, and the Environmental Coalition.

The Updated Fire Guidelines were advertised for a 30-day public review period from January 11, 2024, to February 10, 2024. Staff received 10 letters primarily requesting clarifications or recommending language updates and are included in Attachment C. The letters also raised concerns regarding evacuation procedures and increased density growth. Emergency evacuation procedures will be addressed in Phase 3 of the Fire Guidelines update. The purpose of this Phase 2 Updated Fire Guidelines is to assist developers with drafting Fire Protection Plans. Phase 2 and does not regulate density. Density provisions are regulated by the County's General Plan. Staff incorporated these edits to the updated Fire Guidelines in track changes within Attachment B.

DEPARTMENT REASONS FOR RECOMMENDATION

The Updated Fire Guidelines would assist staff, development project applicants, and the public in understanding whether a proposed development project will create significant risks associated with wildfire because of its location, design or other factors. These guidelines also establish standards to reduce the risk of development projects exposing people or structures to a significant risk of loss or injury involving wildland fires.

ENVIRONMENTAL STATEMENT

The adoption of the resolution for the proposed Wildlife and Fire Protection Guidelines (Fire Guidelines) is not a "project" as defined in the Public Resources Code section 21065 and California Environmental Quality Act (CEQA) Guidelines section 15378 and is therefore not subject to CEQA pursuant to CEQA Guidelines section 15060(c)(3). A project, as defined by CEQA, is the whole of an action that has the potential to result in either a direct physical change or reasonably foreseeable indirect physical change to the environment. While the Fire Guidelines facilitate analysis of wildland fire risk under CEQA, they do not substitute for or diminish that analysis for any project. In addition, the Fire Guidelines do not authorize or ban any development or exempt any project from CEQA review, and therefore there is no possibility that their adoption may have a significant effect on the environment. The adoption of the Fire Guidelines is also subject to the commonsense exemption in CEQA Guidelines section 15061(b)(3) because it can be seen with certainty that there is no possibility that adopting the Fire Guidelines may have a significant effect on the environment. The Fire Guidelines do not authorize or prohibit any development and therefore will not cause environmental impacts. In accordance with CEQA Guideline section 15064.7, the Fire Guidelines have been circulated for public review and are proposed to be adopted by Resolution of the Board.

SUBJECT: UPDATES TO FIRE SAFETY GUIDELINES AND STANDARDS DURING ENVIRONMENTAL REVIEW IN THE UNINCORPORATED AREAS AND FINDING THESE UPDATES ARE NOT SUBJECT TO CEQA (DISTRICTS: ALL)

LINKAGE TO THE COUNTY OF SAN DIEGO STRATEGIC PLAN

Today's proposed action supports the Sustainability, Community, and Equity (Resiliency/Housing) strategic initiatives in the County of San Diego's 2024-2029 Strategic Plan by pursuing policy and program changes that enhance the community through increasing the well-being of residents and the environment. These actions will also provide guidance for State standards resulting in housing opportunities that meet the needs of the community.

Respectfully submitted,



DAHVIA LYNCH
Interim Deputy Chief Administrative Officer

ATTACHMENT(S)

Attachment A – RESOLUTION OF THE COUNTY OF SAN DIEGO BOARD OF SUPERVISORS ADOPTING THE COUNTY OF SAN DIEGO GUIDELINES FOR DETERMINING SIGNIFICANCE AND REPORT FORMAT AND CONTENT REQUIREMENTS FOR WILDLAND FIRE AND FIRE PROTECTION
Attachment B – Updated Guidelines for Wildland Fire and Fire Protection
Attachment C – Public Comments on the Updated Fire Guidelines and Staff Responses

ATTACHMENT B - Updated Guidelines for Wildland Fire and Fire Protection

Section III:
Fire Protection Plan Guidelines for Planning Team

San Diego County- Fire Protection District /

County of San Diego- Land Use & Environmental Group, Planning & Development Services

County of San Diego
Fire Protection Plan Guidelines for Staff
DRAFT 3/10/24

ROHDE & ASSOCIATES
WILDFIRE RISK MITIGATION

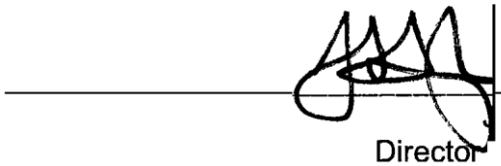


APPROVAL

I hereby certify that these **Guidelines for Determining Significance and Report Format and Content Requirements for Wildland Fire and Fire Protection** are a part of the County of San Diego, Land Use and Environment Group's Guidelines for Determining Significance and Technical Report Format and Content Requirements, were considered by the Director of Planning & Development Services, in coordination with the Director of Public Works, and approved by the County of San Diego Board of Supervisors on _____, .

DAHVIA LYNCH ~~ERIC GIBSON~~

Director of Planning & Development



Director
Services ~~and Land Use~~

I hereby certify that these Guidelines for Determining Significance and Report Format and Content Requirements for Wildland Fire and Fire Protection are a part of the County of San Diego, Land• Use and Environment Group's Guidelines for Determining Significance and Technical Report Format and Content Requirements and are hereby approved by the Deputy Chief Administrative Officer (DCAO) of the Land Use and Environment Group ~~of August, 2010~~ __. ~~The Director of Planning and Land Use is authorized to approve revisions to these Guidelines for Determining Significance and Report Format and Content Requirements for Wildland Fire and Fire Protection, except any revisions to the Guidelines for Determining Significance presented in Chapter 4.0 must be approved by the DCAO~~

Approved, ~~August 31, 2010~~

Text
Approved
March 19, 2007

First Revision
December 19, 2008

Second Revision
August 31, 2010

Third Revision
_____

CHANDRA WALLAR
SARAH AGHASSI
Deputy CAO

EXPLANATION

The risk of home losses and fatalities is a function of hazard (probabilities of fire frequencies or flame lengths), exposure (including home locations), and vulnerability (ease of defense or protection from structure ignition). Over the long term, wildfire activity in a region can also be strongly influence by development patterns themselves. Therefore, development proposals should be evaluated according to how they will threaten (or protect) existing communities.

The development process provides a unique opportunity to mitigate wildfire risk at a neighborhoods scale, rather than at the individual lot scale, which forms the basis of current building and fire code requirements. Planning a community with wildfire in mind requires integrating risk-reduction strategies into the design, layout, and development of homes and neighborhoods.

These Guidelines and information presented herein shall be used by County and Fire staff for the review of discretionary projects and environmental documents pursuant to the California Environmental Quality Act (CEQA). These Guidelines present a range of quantitative, qualitative, and performance levels for particular environmental effects. Normally, (in the absence of substantial evidence to the contrary), an affirmative response to any one Guideline will mean the project will result in a significant effect, whereas effects that do not meet any of the Guidelines will normally be determined to be "less than significant." Section 15064(b) of the State CEQA Guidelines states:

> "The determination whether a project may have a significant effect on the environment calls for careful judgment on the part of the public agency involved, based to the extent possible on factual and scientific data. An ironclad definition of significant effect is not always possible because the significance of an activity may vary with the setting."

The intent of these Guidelines is to provide a consistent, objective and predictable evaluation of significant effects. These Guidelines are not binding on any decision- maker and do not substitute for the use of independent judgment to determine significance or the evaluation of evidence in the record. The County reserves the right to modify these Guidelines in the event of scientific discovery or alterations in factual data that may alter the common application of a Guideline.

The Fire Protection Plan also provides guidance for evaluating adverse environmental effects that a proposed project may have from wildland fire and establishes standards to ensure that development projects do not unnecessarily expose people or structures to a significant risk of loss, injury or death involving wildland fires.

LIST OF ACRONYMS

ALS	Advanced Life Support
BEHAVE+	BehavePlus (a wildfire modeling system)
BI	Burning Index (an indicator of wildfire potential intensity)
BLS	Basic Life Support
BOF	Board of Forestry, State of California
BTU	British Thermal Unit
CAG	California Attorney General
CAL FIRE	California Department of Forestry and Fire Protection
CBSC	California Building Standards Code
CFC	California Fire Code
CCFC	County Consolidated Fire Code, County of San Diego
CCR	California Code of Regulations
CDFG	California Department of Fish and Game
CEQA	California Environmental Quality Act
CPUC	California Public Utilities Commission
CSA	County Service Area
CSFM	California State Fire Marshal
EMS	Emergency Medical Services
EMT	Emergency Medical Technician
FAHJ	Fire Authority Having Jurisdiction
FBAN	Fire Behavior Analyst
FPD	Fire Protection District
FPP	Fire Protection Plan
FL	Flame Length (indicator of fireline intensity)
FMZ	Fuel Modification Zone
GIS	Geographic Information System
IAFC	International Association of Fire Chiefs
IBC	International Building Code
ICC	International Code Council
IFC	International Fire Code
IPCC	Intergovernmental Panel on Climate Change
ISO	Insurance Services Office
LAFCO	Local Agency Formation Commission
LBZ	Limited Building Zone
LRA	Local Responsibility Area
LUEG	Land Use & Environmental Group, a sub-division of County PDS
MOU	Memorandum of Understanding
MWD	Municipal Water District
NEC	National Electric Code
NEPA	National Environmental Policy Act
NFDRS	National Fire Danger Rating System
NFPA	National Fire Protection Association
PAHJ	Planning Authority Having Jurisdiction
PDS	Planning & Development Services, County of San Diego
RAWS	Remote Automated Weather Station

SANDAG	San Diego Association of Governments
SDCFPD	San Diego County Fire Protection District
SRA	State Responsibility Area
USDA	United States Department of Agriculture
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
WFCA	Western Fire Chiefs Association
WUI	Wildland Urban Interface

TABLE OF CONTENTS

INTRODUCTION

1.0 GENERAL PRINCIPLES AND EXISTING CONDITIONS
- 1.1 Wildland-Urban Interface Ignition Factors
  - 1.1.1 Fire Brands
  - 1.1.2 Direct Flame Contact
  - 1.1.3 Radiant Heat Exposure
- 1.2 Wildfire Risk in San Diego County

2.0 ADOPTED PLANS AND GUIDELINES
- 2.1 General Plan
  - 2.1.1 Land Use Element
  - 2.1.2 Housing Element
  - 2.1.3 Safety Element
- 2.2 General Plan Implementation Plan
- 2.3 Multijurisdictional Hazard Mitigation Plan

3.0 APPLICABLE REGULATIONS
- 3.1 Building and Fire Codes
  - 3.1.1 County Fire Code/County Consolidated Fire Code
  - 3.1.2 County Building Code
- 3.2 Subdivision Ordinance
- 3.3 Memorandum of Understanding
- 3.4 Other Applicable Regulations and Recognized Standards

4.0 GUIDELINES FOR DETERMIINING SIGNIFICANCE
- 4.1 California State Attorney General Opinion
- 4.2 Lead Agency Determination
- 4.3 Analyzing Project Impact
- 4.4 Analyzing Project Impact on Evacuation and Emergency Access
- 4.5 Temporary Shelter in Place
- 4.6 Mitigating Wildfire Risk, Evacuation, and Emergency Access Impacts

5.0 FIRE PROTECTION PLAN
- 5.1 Wildfire Hazard and Risk Assessment
  - 5.1.1 State Responsibility Area
  - 5.1.2 Local Responsibility Area
  - 5.1.3 Fire Hazard Map Update
  - 5.1.4 Hazard and Risk
  - 5.1.5 Fire Hazard Map Significance
- 5.2 Siting of Development
  - 5.2.1 Siting Near Open Space
  - 5.2.2 Siting Near Existing Development
- 5.3 Housing Density Consideration
  - 5.3.1 Parcels

5.3.2 Clustered/High Density Communities
5.3.3 Traditional/Lower Density Communities
5.4 Building Construction
5.5 Access, Egress, and Evacuation Route Planning
5.5.1 Applicable Code/Regulations
5.5.2 Maximum Length of Dead-End Roads
5.5.3 Fire Access Road Width
5.5.4 Fire Access Road Grade
5.5.5 Fire Access Road Surface Type
5.6 Water
5.6.1 Inside Water District
5.6.2 Outside Water District
5.7 Subdivision Landscaping and Vegetation Management
5.7.1 Guidelines
5.7.2 Community Fuel Modification
5.7.3 Defensible Space for Structures
5.7.4 Roadways
5.7.5 Open Spaces
5.7.6 Ornamental Landscaping and Plants
5.7.7 Plans
5.8 Protection of Critical Infrastructure
5.8.1 Electrical
5.8.2 Fuel
5.8.3 Communication Towers & Renewable Energy Installations
5.8.4 Essential Facilities/Community Refuges
5.9 Emergency Services
5.10 Alternatives to the Standards
5.10.1 Emergency Response-related
5.10.2 Community Adaptation-related
5.10.3 Required Findings for Alternatives to Standards
5.10.4 Scenarios where Acceptable Alternative are Unlikely
5.11 Plan Acceptance Process
6.0 REFERENCES

LIST OF FIGURES

Figure 1: Risk to Homes/Wildfire Likelihood
Figure 2: Building Materials and Components - Baseline, Enhanced & Optimum Scenarios
Figure 3: Measuring Length of Dead-End Roadways
Figure 4: Sample Community Fuel Modification Plan
Figure 5: Defensible Space Zones
Figure 6: Defensible Space Guidance for Fuels
Figure 7: Travel Time Standards from the Closest Fire Station

LIST OF ATTACHMENTS

Attachment A: Definitions
Attachment B: CEQA Checklist
Attachment C: Summary of Revisions

INTRODUCTION & SCOPE

The unincorporated portion of San Diego County encompasses approximately 2.3 million acres, or 3,570 square miles. Most of the unincorporated land, more than 90 percent, is either open space or undeveloped. This includes several large federal, state, and regional parklands that encompass much of the eastern portion of the County. Only 35 percent or about 807,000 acres of the unincorporated County is privately owned.

San Diego has a history of destructive wildfires. These wildfire events have highlighted that a more holistic approach to wildfire resiliency is needed. Actions can and should be taken at the Community level, the Neighborhood/Subdivision level, and at the individual Parcel/Building level.

Community planners, officials, developers, and residents also need to understand the relationship of their community to the surrounding area in the context of wildfire. Large scale landscape management and fire suppression needs should be considered including establishing and maintaining fuel breaks, managing community open spaces in-house or through contracted landscapers, and ensuring sufficient evacuation routes are available and well-marked. Local hazard mitigation plans should address wildfire risk and actions for the community as well as those required at the Neighborhood/Subdivision and Parcel/Building levels. As evidenced by recent fires, dry grasslands in combination with high winds and inconsistent implementation of Wildland Urban Interface (WUI) practices at various scales in the built and natural environment can pose a significant threat.

Neighborhood/Subdivision - Building owners, developers and design professionals need to incorporate natural hazard mitigation, especially for the wildfire hazard, when designing neighborhoods and subdivisions in striving for the perfect balance between economics and risk. There are many well-known practices and resources available. Community planners, designers, and engineers need to consider natural topography effects on wildfire and potential unintentional effects mitigation for one hazard can have on another.

Parcel/Building - Much research has been completed and communicated focusing on building and parcel level mitigation and this remains an important area of focus. Post fire damage assessments identify several instances of houses that had been hardened and established defensible space that survived, while houses around them burned to the ground.

This document provides guidance to planners, applicants, consultants, fire professionals and other interested parties for evaluating adverse environmental effects that a proposed project may have from wildland fire and establishes standards to ensure that development projects do not unnecessarily expose people or structures to a significant risk of loss, injury or death involving wildland fires.

1.0 GENERAL PRINCIPLES AND EXISTING CONDITIONS

1.1 Wildland-Urban Interface Ignition Factors

Fires can ignite naturally or be caused by people. In the montane coniferous forests of the Southwest, lightning-ignited fires are abundant and human ignitions are far less important than in lower-elevation shrublands of southern California where lightning is uncommon and humans cause most of the fires (Keeley and Fotheringham 2003). Over 95 percent of fires in southern California shrublands are started by people, which has increased fire frequency and increased the chances of ignitions during Santa Ana winds (Keeley and Fotheringham 2003). In general, more people move to the shrublands than to the forests since most of the development in San Diego County is on the coastal plain and in the foothills. People living in the wildlands, traveling on roads built through the wildlands, and recreating in the wildlands can ignite wildland fires inadvertently. In addition, wildland fires are sometimes ignited by arsonists. All these situations create more opportunities for potential wildland fire danger to people and their structures.

There are three components necessary for ignition and combustion to occur. A fire requires fuel to burn, air to supply oxygen, and a heat source to bring the fuel to ignition temperature. After combustion occurs and a fire begins to burn, there are several factors that determine how the fire spreads: fuel, weather, and topography. These factors make the difference in fire intensity and speed.

Wildfires spread based on the type and quantity of fuel that surrounds it. Fuel includes anything from trees, underbrush, and dry grassy fields to homes. The amount of flammable material that feeds a fire is the “fuel load”. A large fuel load will cause the fire to burn more intensely and spread faster. The size and shape, arrangement, and moisture content of fuel all impact the fire. Fuels smaller in size, with a smaller ratio of surface area to volume, and larger spacing dry out and ignite faster during a wildfire.

Weather also plays a major role in the ignition, growth, and death of a wildfire. The weather factors are temperature, wind, and moisture. Higher temperatures dry the fuels and allow fires to ignite and burn faster and wind supplies additional oxygen and spreads the fire faster. Moisture, on the other hand, works against the fire. Humidity and precipitation make fuels harder to ignite and can slow a fire down and reduce its intensity.

Finally, topography can aid or hinder fire progression. Slope is the most important factor. Fire typically burns uphill at a faster rate as ambient wind usually flows uphill and the rising smoke and heat preheat the fuels up-slope.

Common causes of structure ignition are firebrands, direct flame contact, and radiant heat exposure.

1.1.1 Firebrands

Firebrands are small, often smoldering embers which break off vegetative or structural materials during wildland fires and can loft up to several kilometers ahead of the main fire front, igniting new spot fires. Firebrands can be created from virtually any fuel source that is light enough to be blown upwards; however, vegetation is the most common source of firebrands. A burning structure also creates burning embers, particularly at collapse.

Firebrands are the leading cause of building ignition during wildland–urban fires. This is attributed both to direct ignition of material on, in, or attached to the building, and indirect ignition where they ignite vegetation or other combustible material near the building, which results in a radiant heat and/or direct flame contact exposure that ignites the building. Indirect ignition of a building can occur when embers accumulate on and ignite nearby combustible fuel, resulting in radiant heat or flame constant exposure. Flammable vegetation adjacent to (within ten feet of) a structure and other combustible materials (wood piles, combustible fences, decks, etc.) acts as a receptacle for fire brands, and will impact the structure.

Factors that influence ember accumulation near a building include building geometry, such as flat wall and re-entrant corners, building wind angle, wind speed and the surface roughness characteristics of the horizontal landscape close to the building. Experiments conducted at the Insurance Institute for Business & Home Safety (IBHS) Research Center using full-scale buildings provided a means to quantify ember accumulation on a mass per unit area basis and found ember accumulation was greatest at locations immediately adjacent to the building and higher wind speeds allowed more embers to reach the building.

1.1.2 Direct Flame Contact

This occurs when flames are in direct contract with the structure, igniting combustible materials, Direct flame contact is the most aggressive type of fire spread, which can be caused by ember deposition on a vulnerable material.

Flame impingement, a form of heat conduction, involves heat transfer from a flame that directly strikes a structure, potentially causing ignition of the structure. Flame size and the duration of flame impingement directly affect the potential for ignition of a structure.

1.1.3 Radiant Heat Exposure

Radiant heat is the thermal energy you feel when standing next to a fire. As this energy is transferred to nearby materials, their temperature rises, and a vulnerable material will ignite once a critical temperature is reached. In this scenario, the heat source can be a burning woodpile, outbuilding, shrub, or the approach of the fire front itself.

Radiation is energy transfer that travels across space without the need for intervening medium such as air. Examples in wildfires include ignition of light combustibles in advance of the flame front, like dry fine grasses or curtains behind a window. Radiation does not require flames to strike a structure to cause ignition. The source of flame radiation is the flame front. Dependent on the length, height, and width of the flame- front (the leading edge of a wildland fire), and the flame duration, an unprotected structure can be ignited by radiant heat.

1.2 Wildfire Risk in San Diego County

The risk to homes in San Diego County, defined as the integration of wildfire likelihood (probability of wildfire occurring) and wildfire intensity (the energy release by a wildfire) with expected consequences to homes, is greater than 64% of California counties. The wildfire likelihood, or annual probability of a wildfire occurring in a specific location, is greater than in 65% of California counties.

Nationally, the risk to homes in San Diego is greater than in 95% of counties and the likelihood of wildfire is greater than in 94% of counties. (A Profile of Wildfire Risk, San Diego County, CA, Headwaters Economics, Economic Profile Systems, August 31, 2023).

The USDA Forest Service also assesses wildfire risk nationally and states San Diego County has a very high risk of wildfire – higher than 95% of counties in the US: https://wildfirerisk.org/explore

FIGURE 1: Risk to Homes/Wildfire Likelihood



2.0 ADOPTED PLANS & GUIDELINES

2.1 General Plan

All cities and counties in California are required by state law to adopt a general plan, which sets forth a long-term vision of a community's future. Each general plan to address a minimum set of mandatory elements: land use, circulation, housing, conservation, open space, noise, and safety.

In 2011, the Board of Supervisors approved the update to the County's General Plan. Major changes to the General Plan included:

- Reduced Land Use Capacity by 46,363 units (15%) to 239,984 units,
- Focused development in village cores to retain the county's rural character,
- Shifted 20% of the remaining Dwelling unit capacity to the most western portions of the unincorporated area, and
- Located 80% of the Dwelling Unit Capacity where water can be imported and distributed by the County Water Authority.

2.1.1 Land Use Element

The Land Use Element provides a framework to accommodate future development in an efficient and sustainable manner that is compatible with the character of unincorporated communities and the protection of valuable and sensitive natural resources. Relevant findings include:

- Most new development—approximately 80 percent—is planned within the County Water Authority (CWA) boundary.
- Focusing development in and around existing unincorporated communities allows the County to maximize existing infrastructure, provides for efficient service delivery, and strengthens town center areas while preserving the rural landscape that helps define the unique character of the unincorporated County.
- Related Land Use Elements adopted:

  LU-6.9 **Development Conformance with Topography.** Require development to conform to the natural topography to limit grading; incorporate and not significantly alter the dominant physical characteristics of a site; and to utilize natural drainage and topography in conveying stormwater to the maximum extent practicable.

  LU-6.10 **Protection from Hazards.** Require that development be located and designed to protect property and residents from the risks of natural and man-induced hazards.

  LU-6.11 **Protection from Wildfires and Unmitigable Hazards.** Assign land uses and densities in a manner that minimizes development in extreme, very high and high fire threat areas or other unmitigable hazardous areas.

2.1.2 Housing Element

The current Housing Element of the General Plan, April 15, 2021, through April 15, 2029, contains the following relevant considerations:

- Considerations included fire and other environmental risks during the development of the **Sites Inventory.** Units located within very high fire hazard risk areas were screened out from the Sites Inventory. Additional actions taken included removing units located within floodways, steep slopes, and sensitive habitats.
- **ADUs Affordable Accessory Dwelling Units (ADUs).** By 2023, develop a program and pursue funding to spur the development of affordable housing through the construction of ADUs.
- **Senior Housing Program Options**. Explore the feasibility of developing a program that would facilitate/remove barriers to senior and assisted living housing development, and return to the Board with recommendations.

Safety Element

California Government Code Section 65302 (g) was amended to include wildfire related requirements that should be addressed in a community's general plan safety element. These requirements are organized into five subsections applicable to structural development which are found in the San Diego County General Plan, Section 7-Safety Element, are summarized below:

- 65302 (g) (1) identifies the primary hazards/issues that should be included in the safety element, which include: seismically induced surface rupture, ground shaking, ground failure, slope instability leading to mudslides and landslides, tsunami, seiche, dam failure, flooding, subsidence, liquefaction, other geologic hazards, wildland and urban fires, evacuation routes, military installations, peak load water supply requirements, and minimum road widths and clearances around structures, as those items relate to identified fire and geologic hazards
- 65302 (g) (3) adopted through SB 1241 (2012) identifies the requirements for updating wildfire mapping, information, and goals and policies to address wildfire hazards
- 65302 (g) (4) adopted through SB 379 (2015) identifies the requirements for updating the safety element to address potential impacts associated with climate change and potential strategies to adapt/mitigate these hazards
- 65302 (g) (5) adopted through SB 99 (2019) requires identification of specified evacuation constraints associated with residential developments
- 65302 (g) (9) allows cities to adopt a County Safety Element if adequate detail is provided to address city level concerns

The purpose of the Safety Element within the General Plan is to include safety considerations in the planning and decision-making process by establishing policies related to future development that will minimize the risk of personal injury, loss of life, property damage, and environmental damage associated with natural and human-caused hazards. The County's Element addresses natural hazards and human activities that may pose a threat to public safety within nine topic areas that include Hazard Mitigation Planning and Disaster Preparedness, Evacuations, Fire Protection and Emergency Response, and Climate Change.

The Safety Element provides policy direction that supports laws and regulations related to safety hazards and policies that support the guiding principles established for this General Plan. Of these key topic areas, wildfires, flooding, climate change, and geological and seismic hazards pose the greatest challenges to the County.

The following summarizes polices adopted by San Diego County regarding wildfire risks and development:

San Diego County General Plan-Safety Element ***Policies***	
Public Safety S-1.7 Community Plan Updates	A series of criteria for community plan updates that incorporate public safety components.
GOAL S-2 Evacuation. Enhanced public safety through effective evacuation planning and establishment of an effective evacuation network.	
Evacuations S-2.1 Future Fire Protection Plans	Future Fire Protection Plans shall evaluate evacuations in accordance with the evacuation standards adopted by the San Diego County Fire Protection District.
Evacuations S-2.2 Evacuation Impediments	Advise, and where appropriate, require all new developments to help eliminate impediments to evacuation within existing community plan areas, where limited ingress/egress conditions could impede evacuation events.
Evacuations S-2.3 Community Plan Evacuation	Identify community plan areas that have reduced or limited circulation access and develop an evacuation plan, including an Evacuation Traffic Management Plan and recommended improvements to ensure adequate evacuation capabilities. Community Evacuation Plans should be evaluated and revised to address changes in at-risk areas and populations to ensure effectiveness.
Evacuations S-2.4 Prioritize CIP Roadways	Future CIP projects should prioritize roadways that serve as evacuation routes or require roadway improvements to better function under evacuation purposes.
Evacuations S-2.5 Existing Development within Hazard Zones	Implement warning systems and evacuation plans for developed areas located within known hazard areas (i.e., flood, wildfire, earthquake, other hazards).

Evacuations S-2.6 Effective Emergency Evacuation Programs	Develop, implement, and maintain an effective evacuation program for areas of risk in the event of a natural or human-caused disaster.
Evacuations S-2.7 Evacuation Access	All development proposals are required to identify evacuation routes at the Community Plan level and identify and facilitate the establishment of new routes needed to ensure effective evacuation. Evacuation routes should be incorporated into existing Community Wildfire Protection Plans where available.
GOAL S-4 Minimized Fire Hazards. *Minimize injury, loss of life, and damage to property resulting from structural or wildland fire hazards.*	
Minimized Fire Hazards S-4.5 Access Roads	Require development to provide additional access roads where feasible to provide for safe access of emergency equipment and civilian evacuation concurrently. The width, surface, grade, radius, turnarounds, turnouts, bridge construction, and lengths of fire apparatus access roads shall meet the requirements of the State Fire Code and the San Diego County Consolidated Fire Codes. All requirements and any deviations will be at the discretion of the Fire Code Official.
Regional Fire Protection S-6.4 Regional Evacuation Coordination	Coordinate with State and Federal landowners regarding joint use and access agreements for roadways located on state and federal lands that can be used for evacuation purposes.
Defensible Development. S-4.1	Require development to be located, designed, and constructed to provide adequate defensibility and minimize the risk of structural loss and life safety resulting from wildland fires.
Development in Hillsides and Canyons S-4.2	Require development located in wildland areas, near ridgelines, top of slopes, saddles, or other areas where the terrain or topography affects its susceptibility to wildfires to be located and designed to account for topography and reduce the increased risk from fires. Density reduction may be necessary to reduce fire hazards if the location and design of the development cannot reduce the threat effectively.
Minimize Flammable Vegetation S-4.3	Site and design development to minimize the likelihood of wildfire spreading to structures by minimizing pockets or peninsulas or islands of flammable vegetation within a development.
Service Availability S-4.4	Plan for development where fire and emergency services are available or planned.
Access Roads S-4.5	Require development to provide additional access roads where feasible to provide for safe access of emergency equipment and civilian evacuation concurrently. The width, surface, grade, radius, turnarounds, turnouts, bridge construction, vegetative management and brush clearance around roadways, and lengths of fire apparatus access roads shall meet the requirements of the State and San Diego County Consolidated Fire Codes. All requirements and any deviations will be at the discretion of the Fire Code Official of the FAHJ.

Fire Protection Plans S-4.6	Ensure that development located within fire hazard areas implement measures in a Fire Protection Plan that reduce the risk of structural and human loss due to wildfire. Mitigation measures identified in the Fire Protection Plan should be implemented and may include, but are not limited to, the use of ignition resistant materials, multiple ingress and egress routes, and fire protection systems
Fire Resistant Construction S-4.7	Require all new, remodeled, or rebuilt structures to meet current ignition resistance construction codes and establish and enforce reasonable and prudent standards that support retrofitting of existing structures in high fire hazard areas.
Fire Threat Reduction S-4.8	Reduce human-caused fires with a high visibility prevention program in all publicly accessible wildfire prone areas.
GOAL S5- Managed Fuel Loads. *Managed fuel loads, including ornamental and combustible vegetation.*	
Fuel Management Programs S-5.1	Support programs and plans, such as Strategic Fire Plans, consistent with state law that requires fuel management and modification, and that balance fuel management needs to protect structures with the preservation of native vegetation and sensitive habitats.
Coordination to Minimize Fuel Management Impacts S-5.2	Consider comments and recommendations from CAL FIRE, U.S. Forest Service, local fire districts, and wildlife agencies regarding the mitigation of impacts to habitat and species for fuel management projects.
Forest Health S-5.3	Encourage the protection of woodlands, forests, and tree resources and limit fire threat through appropriate fuel management such as removal of dead, dying, and diseased trees.
Regional Coordination Support S-6.1	Advocate and support regional coordination among fire protection and emergency service providers.
Fire Service Provider Agreements S-6.2	Encourage agreements between fire service providers to improve fire protection and to maximize service levels in a fair, efficient, and cost-effective manner.
Reassessment of Fire Hazards S-6.3	Coordinate with fire protection and emergency service providers to reassess fire hazards after wildfire events to adjust fire prevention and suppression needs, as necessary, commensurate for both short- and long-term fire prevention needs.
Regional Evacuation Coordination S-6.4	Coordinate with State and Federal landowners regarding joint use and access agreements for roadways located on state and federal lands that can be used for evacuation purposes.

GOAL S-7 Adequate Fire and Medical Services. *Adequate levels of fire and emergency medical services (EMS) in the unincorporated county.*	
Water Supply S-7.1	Ensure that water supply infrastructure adequately supports existing and future development and provides adequate water flow to combat structural and wildland fires. Water systems shall equal or exceed the California Fire Code, California Code of Regulations, or, where a municipal-type water supply is unavailable, the latest edition of National Fire Protection Association (NFPA) 1142, "Standard on Water Supplies for Suburban and Rural Fire Fighting."
Funding Fire Protection Services S-7.2	Require development to contribute its fair share towards funding the provision of appropriate fire and emergency medical services as determined necessary to adequately serve the project.
Fire Protection Services for Development S-7.3	Require that new development demonstrate that adequate fire services can be provided that meet the minimum staffing of personnel and that meet the minimum travel times (see Section 5.9).
Concurrency of Fire Protection Services S-7.4	Ensure that fire protection staffing, facilities, and equipment required to serve development are operating prior to, or in conjunction with, the development. Allow incremental growth to occur until a new facility can be supported by development.

2.2 General Plan Implementation Plan

The Implementation Plan contains actions and procedures necessary to achieve the goals and policies set forth in the San Diego County General Plan. The broad array of actions, strategies, and processes undertaken to implement the General Plan will help achieve the County's vision for its growth and development. Applicable guidance includes:

- 6.2.1G **Minimizing Risks**. Implement County Guidelines for Determining Significance for Wildland Fires & Fire Protection, to ensure development projects do not unnecessarily expose people or structures to a significant risk of loss from wildland fires, and apply appropriate mitigation when impacts are significant.
- 6.2.2B **Weed Abatement Ordinance**. Implement the Combustible Vegetation and Other Flammable Materials Ordinance (Weed Abatement Ordinance) and require prudent brush management techniques to enforce proper techniques for maintaining defensible space around structures. The Weed Abatement Ordinance addresses the accumulation of weeds and rubbish on a private property in the unincorporated County outside fire districts' jurisdictions that is found to be a fire hazard and requires brush management around new and existing structures to protect life and structures from wildfires. The desire is to provide consistent weed abatement within all fire districts.
- 6.2.2D **Resource Management Plans**. Implement procedures to require Resource Management Plans to ensure brush management requirements are being implemented and that habitat-specific fire controls are addressed. Resource Management Plans are reviewed during development review to implement brush

management requirements. Ensure that any variance or project approval does not result in a transfer of brush management responsibilities to another jurisdiction.

- 6.2.2E **Brush Management in Development Projects**. Coordination with the Local Fire Agency Having Jurisdiction (LFAHJ) to ensure that district goals for fuel management and fire protection are being met. LFAHJ enforcement implements brush management requirements for discretionary development projects.
- 6.2.2F **Vegetation Management**. Implement the Vegetation Management procedures to manage vegetation in the unincorporated County to reduce the risk of wildland fires. Development projects are required to provide adequate defensible space as part of project processing; the County shall work closely with the local fire authority in identifying the areas and amounts of vegetation treatments necessary to protect life and property.

2.3. Multijurisdictional Hazard Mitigation Plan (MJHMP)

The Federal Disaster Mitigation Act of 2000 requires all local governments to create a disaster plan to qualify for hazard mitigation funding. The county last revised the plan in 2023 to reflect changes to both the hazards threatening San Diego County, as well as the programs in place to minimize or eliminate those hazards.

The County's MJHMP identifies major wildfires larger than 5,000 acres from 1950 through 2014, which have accounted for over 1,158,468 acres burned, affected over 8,400 structures (damaged/destroyed), and resulted in 30 deaths. Between 2014 and 2019, approximately 250 dwellings were destroyed from wildland fires, which accounted for 0.6% of total structures destroyed statewide by wildfire.

The topographic, geographic, and climatic conditions within the County lead to the overall regional fire problem. Over half of the land acreage of the unincorporated county is public land owned by the federal government, state government, or local government. Therefore, policies focus on minimizing the impact of wildfires through land use planning techniques and other mitigation measures. Key issues include:

- ***Defensible Space/Fuel Modification Zones****:* Fuel Modification Zones refers to a separation zone between wildlands and structures where fuels (including natural and ornamental vegetation), human-made combustible materials, and ancillary structures is managed or modified to minimize the spread of fire to the structure and allow space for defending structures from burning vegetation. This separation is important to improving the survivability of structures in a wildland fire event and is most readily maintained when planned for as part of project design.
- ***Wildland Urban Interface****:* The wildland urban interface (WUI) refers to areas where structures and other human developments meet or intermingle with undeveloped wildland. Much of the unincorporated county is located within the WUI.
- ***Home Hardening****:* For optimal protection against wildfires, structures should also be "hardened" to make them more ignition resistant. Limit structure vulnerability using

construction techniques (during new construction or home improvements) that include closed eaves, ember vents, Chapter 7A construction standards, five feet of hardscape around outer walls of structures, and other elements to reduce wildfire vulnerability.

- ***Strategic Vegetation Management****:* Outside of fuel modification zones around structures, reducing, thinning, or otherwise modifying the amount of vegetation (fuel) may reduce the risk of wildfire within conifer forests as well as through strategic fuel breaks near the WUI in low wind conditions.
- ***Protection of Evacuation Corridors****:* Development in the WUI to include multiple access/egress routes when the maximum dead-end road distance is exceeded.
- ***Funding Fire Services****:* Existing funding for fire services is limited and variable. Full-time funding for fire services is crucial for assuring long-term commitment of adequate coverage.
- ***Travel Time Standards****:* The minimum travel time standards to respond to a fire hazard or medical emergency facilitate the ability to identify future fire facility needs and to determine public service requirements for proposed development. Travel time standards indicate that expectations for service levels are different in urbanized areas than in rural areas.
- ***Building and Site Design***: Requiring the location of structures to minimize the risk from wildland fires.

3.0 APPLICABLE REGULATIONS

While myriad plans serve as the policy foundation for addressing the WUI, regulations provide communities with the legal means to implement these policies. WUI regulations can address both existing and future development in the WUI, including structures and attachments, roads and other infrastructure, landscaping, current and future land uses, and additional development features.

Communities have a variety of regulatory options for addressing the WUI and related wildfire hazard conditions. Like plans, there are some state regulations, such as building codes, that must be adopted by local communities when tied to specific fire hazard severity zones or SRA. Other regulations are adopted voluntarily at the local level. Collectively, these tools can be implemented at a range of scales: from the larger community-level scale, through the neighborhood or subdivision scale, down to the individual building or lot scale. They provide planners with options for reducing risk through different interventions, such as locating specific uses away from wildfire hazard areas, creating effective landscaping ordinances that are compatible with multiple objectives, and ensuring communities have safe evacuation routes.

3.1 Building and Fire Code

Wildfire requirements in the California Building Standard Code (CBSC) are designed to establish minimum standards for the protection of life and property by increasing the ability of buildings to resist the intrusion of flames or burning embers projected by a vegetation fire and reducing structure losses.

Minimum wildfire requirements and referenced performance-based test standards for building construction are found in different parts of the CBSC: Part 2 - California Building Code, Chapter 7A Materials and Construction Methods for Exterior Wildfire Exposure (typically referred to as “Chapter 7A”) and Chapter 15 Roof Assemblies and Rooftop Structures; Part 2.5 - California Residential Code; Part 9 - California Fire Code; and Part 12 - California Referenced Standards Code. Similar wildfire protection requirements for mobile homes and other types of manufactured buildings are regulated by the California Department of Housing and Community Development (HCD) (CCR Title 25).

The Office of the State Fire Marshal (OSFM) is responsible for promulgating wildfire safety regulations based on Health and Safety Code § 13108.5. State law designates where CBSC wildfire requirements shall apply based on fire hazard severity zone classifications in the SRA and Local Responsibility Area (LRA).

California Health and Safety Code Sections 17922, 17958, 17958.5 and 17958.7 provide that the County adopt the California Fire Code by reference as the County’s own fire code (**County Fire Code**) and make such changes or modifications that the Board of Supervisors expressly finds are reasonably necessary because of local climatic, geological, or topographical conditions.

3.1.1 County Fire Code/Consolidated County Fire Code

The California State Fire Code, contained in the CBSC, establishes minimum requirements for providing a reasonable level of life safety and property protection from the hazards of fire, explosion, panic, or dangerous conditions in new buildings & structures and a reasonable level of safety to firefighters and emergency responders during emergency operations.
The County adopts modifications and makes changes to the California Fire Code that are reasonably necessary because of the County's climatic, geological, and topographical conditions. The County Consolidated Fire Code is the County Code, amended as needed by 11 other Fire Districts in the County including:

Note: Borrego Springs Fire Protection District and Ramona Fire Department (Municipal Water District) consolidated into SDCFPD in 2023.

Alpine Fire Protection District
Bonita-Sunnyside Fire Protection District
Deer Springs Fire Protection District*
Lakeside Fire Protection District
Lower Sweetwater Fire Protection District
North County Fire Protection District
Rancho Santa Fe Fire Protection District
Rincon Del Diablo Municipal Water District**
San Marcos Fire Protection District
San Miguel Fire Protection District
Valley Center Fire Protection District
Vista Fire Protection District

* Fire service provided by San Diego County Fire Protection Dist.
**Fire Service provided by Escondido City Fire Dept.

It is important for users to know the Fire Agency Having Jurisdiction (FAHJ) when referencing this document.

Specific to wildfire, the California State Fire Code contains Chapter 49 – Requirements for Wildland- Urban Interface Fire Areas. This chapter provides minimum standards for hazardous vegetation and fuel management, defensible space, and building construction in accordance with other state codes and regulations. Other chapters and appendices in the state fire code establish minimum standards for emergency access and water supply for fire response.

In April 2023, the Board of Supervisors adopted an ordinance moving the requirements for defensible space from the Defensible Space for Fire Protection Ordinance to the County Fire Code for efficiency and clarity.

3.1.2 County Building Code

The County adopts modifications and makes changes to the California Building Code that are reasonably necessary because of the County's climatic, geological, and topographical conditions. The County also amends and adopts the International and California Building Code by reference. Together, these documents are the County Building Code.

The County Building Code revises and replaces Chapter 7A Materials and Construction Methods for Exterior Wildfire Exposure, in its entirety, to address building materials, system, and/or assemblies used in the exterior design and construction of new and remodeled buildings located within a wildland-urban interface fire area.

3.2 Fire Safe Regulations

Public Resources Code § 4290 requires the California State Board of Forestry and Fire Protection to adopt regulations for minimum fire safety standards related to defensible space, road standards for fire equipment access, standards for signs identifying streets, roads, and buildings, minimum private water supply reserves for emergency fire use, fuel breaks and greenbelts, and measures to preserve undeveloped ridgelines to reduce fire risk and improve fire protection. These regulations are known as the Fire Safe Regulations and are codified in CCR, Title 14 (Natural Resources), Division 1.5 (Department of Forestry), Chapter 7 (Fire Protection) under Subchapter 2. The Fire Safe Regulations apply to the perimeters and access to all residential, commercial, and industrial building construction within State Responsibility Areas (approved after January 1, 1991) and lands classified and designated as VHFHSZs (approved after July 1, 2021).

The State Board of Forestry and Fire Protection is also required to periodically update regulations for fuel breaks and greenbelts for greater fire safety. These regulations do not supersede local regulations which equal or exceed minimum regulations adopted by the State.

3.3 Subdivision Ordinance

Subdivision ordinances describe the conditions and procedures under which land may be subdivided. The Subdivision Map Act (GC § 66410, et seq.) establishes the basic subdivision procedures, while giving local government the authority to regulate the design and improvement of subdivisions, require dedications of public improvements, require payment of impact fees, and require compliance with the objectives and policies of the general plan. These regulatory powers can promote land use, circulation, open space and safety element objectives, policies, and implementation measures.

Regulation of subdivision design can address wildfire safety by incorporating measures such as emergency access, adequate infrastructure and facilities, separation between buildable lots and wildland areas, fuels reductions and fire protection measures such as residential sprinkler systems in homes abutting open space or where there is inadequate water for structural fire suppression. Local governments can also require dedication of public improvements and land (through fee title or easements) to serve the subdivision.

A tentative subdivision map or parcel map cannot be approved unless the county finds that the subdivision, together with design and improvement conditions, is consistent with all aspects of the general plan or any applicable specific plan (GC § 66474). Two of the findings that can cause a subdivision to be denied are (1) that the site is physically ill-suited for the proposed type or density of the development or (2) that the subdivision's design or improvements are likely to cause substantial environmental damage or cause public health or safety problems (GC § 66474). These are important considerations for counties who are reviewing subdivision proposals in areas that are subject to wildland fire hazard.

Standards are established to protect public health and safety by reducing and mitigating hazards associated with wildfire that could affect development proposals in the Fire Hazard Severity Zone (FHSZ). The provisions apply to all lands in the FHSZ unless otherwise provided in the County Code or state law.

1. The applicant should consult with Public Works and the Fire Department regarding, but not be limited to, an evaluation of slope, aspect, fire topography, fire history/potential, habitat, adjacent properties (existing structures, fuel modification, habitat, parkland status), existing vegetation, fuel modification, type of plants to be planted on site, fire hydrant locations and fire flows, and access standards (e.g., width, grade, slope, paving, overhead clearance).
    - After consulting with Public Works and the Fire Department, the applicant shall prepare all necessary plans, including but not limited to a site plan for the proposed project that includes all mitigation measures necessary to comply with the recommendations and requirements of those agencies. The site plan shall show all aspects of development including, but not limited to, grading, construction of retaining walls or flood control devices, fuel modification areas, accessways, water lines, and irrigation systems necessary to mitigate any hazards on the property.
2. **Required Findings and Analysis.** Written findings of fact, analysis and conclusions addressing fire hazards must be included in support of all approvals, denials or conditional approvals of development located on a site. Such findings shall address the specific project impacts relative to the applicable development standards. The findings shall explain the basis for the conclusions and decisions of the County and shall be supported by substantial evidence in the record. Approval for the proposed development shall only be granted if the County's decision-making body is able to find that:
    - The project, as proposed, will be designed to minimize fire hazards due to project design, location on the site or other reasons.

- The project, as conditioned, will not have significant adverse impacts on fire hazards due to required project modifications, landscaping or other conditions.

If found to be necessary to conform to the development standards or other provision of the County Code, the proposed development shall be modified, by special condition, relative to height, size, design, or location on the site and may be required to incorporate other methods to avoid or minimize fire hazards. If special conditions of approval are required to bring the project into conformance, the findings shall explain how the special condition(s) alleviate or mitigate the adverse effects that have been identified.

3. **Development Standards.** All new development shall be sized, sited, and designed to minimize risks to life and property from fire hazard, considering changes to fire risk caused by increasing global temperatures. In addition, all new development shall comply with the following requirements:
    - New development shall be required to use design and construction techniques and materials that minimize risks to life and property from fire hazard. Structures shall be constructed with appropriate features and building materials, including but not limited to fire-resistant exterior materials, windows and roofing; and eaves and vents that resist the intrusion of flame and burning embers. Development sites and structures shall be located off ridgelines and other dangerous topographic features such as chimneys, steep draws, and saddles.
    - New development shall incorporate fuel modification and brush clearance techniques and shall be designed and carried out to minimize clearance of natural vegetation and reduce impacts to sensitive natural habitat to the maximum extent feasible.
    - New development shall provide for emergency vehicle access and adequate fire-flow water supply in compliance with applicable fire safety regulations. Development in areas with insufficient access, water pressure, fire flows, or other accepted means for adequate fire protection shall be prohibited.
    - New development shall be limited if served by a street or street system restricted to a single route of access to a highway (see Best Practice by LA County and page 54).

- Prior to development approval, all new development shall demonstrate the availability of an adequate water supply for fire protection in compliance with applicable fire safety regulations. Where feasible, alternative water resources for fire-fighting purposes shall be maintained on development sites. Water tanks shall be sized consistent with County minimum requirements and clustered with approved structures.
- Residential structures shall be clustered to provide for more localized and effective fire protection measures such as consolidation of required fuel modification and brush clearance, fire break maintenance, firefighting equipment access, and water service. Structures shall also be located along a certified all-weather accessible road, which in some cases may consist of permeable surfaces, in a manner that provides firefighters adequate vehicle turnaround space on private properties. Where feasible, new development shall be accessed from existing roads.

4. As a condition of approval of new development within or adjacent to an area subject to high wildfire hazards, prior to development approval, the property owner shall be required to submit a signed document that shall indemnify and hold harmless the County, its officers, agents, and employees against any and all claims, demands, damages, costs, and expenses of liability arising out of the acquisition, design, construction, operation, maintenance, existence, or failure of the permitted project in an FHSZ.(incorporated in these guidelines).

BEST PRACTICE: Los Angeles County's subdivision regulations limit the number of lots that can be located on a single point of access. These regulations were established to control the number of County residents who may be placed at risk need to evacuate, limit the number of structures that may be destroyed, and reduce the risks to firefighters created in defending those structures. This is particularly important in limiting the development of new primary dwelling units in FHSZs as recent California legislation permitting up to two ADUs on many single-family lots significantly increases the existing risks by increasing the potential number of County residents that may be at risk when wildfire emergencies occur. Any increase in occupancy in FHSZs creates additional risk, regardless of whether occupancy occurs in primary dwelling units or ADUs (incorporated in guidelines, see pg. 54).

3.4 Memorandum of Understanding

An MOU was created to establish guidelines by which CAL FIRE and local fire districts can continue to engage in fuel management activities and the USFWS and CDFG can assess, minimize, and account for potential adverse impacts to habitats and species from such activities. Agreement between the United States Department of Interior Fish and Wildlife Service (USFWS), California Department of Fish and Game (CDFG), CAL FIRE, San Diego County Fire Chief's Association and the Fire District's Association of San Diego County (http://www.sdcounty.ca.gov/dplu/Resource/docs/3~pdf/MemoofUnder.pdf).

3.5 Other Applicable Regulations and Recognized Standards

Other regulations and recognized standards that should be referenced:

- National Environmental Policy Act, (43 USC 4321 et seq.). This Federal regulation considers potential public health and safety hazards, including wildfires, when considering environmental impacts of proposed federal projects.
- International Wildland-Urban Interface Code. This is a model code published by the International Code Council which may be adopted by a jurisdiction.
- Standard for Wildland Fire Protection (NFPA 1140). This standard, published by the National Fire Protection Association, consolidated several previous standards related to wildfire (NFPA 1051, 1141, 1143, and 1144) into a single document.
- The National Cohesive Wildland Fire Management Strategy. This plan represents a strategic push to work collaboratively among all stakeholders and across all landscapes, using best science , to make meaningful progress towards the three goals: Resilient Landscapes, Fire Adapted Communities, Safe and Effective Wildfire Response. Last updated in July 2023, it is an excellent strategy toward the vision to "Safely and effectively extinguish fire, when needed; use fire where allowable; manage our natural resources; and collectively, learn to live with wildland fire."
- California Strategic Fire Plan, 2018, is the State's road map for reducing wildfire risk. The plan is a cooperative effort between the State Board of Forestry and CAL FIRE and looks to reduce firefighting costs and property losses, increase firefighter safety, and contribute to overall ecosystem health.
- Community Wildfire Protection Plan is a planning and funding prioritization tool created by the Healthy Forests and Restoration Act of 2003 as an incentive for communities to engage in fire hazard planning and help define and prioritize local implementation and funding needs. Thirty-five communities around San Diego County have an approved SWPP in place.

4.0 GUIDELINES FOR DETERMINING SIGNIFICANCE

The California Environmental Quality Act (CEQA), Public Resources Code section 21000 et seq. requires lead agencies to detail specific risks for development in wildfire-prone areas as part of the environmental review process, and to adopt all feasible mitigation measures. Those areas mapped by CAL FIRE as “High” or Very High” Fire Hazard Severity Zones, or related high-fire risk areas as designated by local ordinance must comply with these CEQA requirements.

4.1 California State Attorney General Opinion

The California State Attorney General (CAG) has litigated against development projects where the CEQA review was judged inadequate. (Some of these cases have been in San Diego County). The CAG has published “Best Practices for Analyzing and Mitigating Wildfire Impacts of Development Projects Under the California Environmental Quality Act” in October of 2022. The following is a synopsis of this report. The CAG has identified that;

a. The rate of wildfire occurrence and severity of impact is increasing in California.
b. Many of the increasing number of wildfires have been sparked by electrical sources such as power lines serving development, and other human activity.
c. Wildfires can have a dramatic ecological impact leading to habitat loss and fragmentation, shifts in vegetative composition, reductions in animal populations, and accelerated loss of species.
d. Wildfires can have adverse effects on erosion and water quality.
e. Wildfires can have tragic consequences for California residents through loss of housing and property, health hazards posed from degradation of air quality.
f. Social impacts of wildfire include desperate impact on low-income households that are chronically underinsured and the high public cost of wildfire suppression, including the increasing burden to limited Statewide firefighting resources.
g. The introduction of more people into former wildlands through development increases the probability of wildfire ignition.
h. Development of wildlands situates more people into “harm’s way” for wildfire exposure. In particular, the AG cites the lack of adequate evacuation planning or evacuation impediment due to lack of sufficient transportation infrastructure.

4.2 Lead Agency Determination

A lead agency must determine the appropriate level of CEQA compliance for each specific project. Commonly, a full Environmental Impact Report (EIR) is required, however smaller projects may comply with a Mitigated Negative Declaration. Determination for compliance occurs if the project may potentially have a significant impact on the environment and is not otherwise exempt from CEQA. Under CEQA, local jurisdictions may act as lead agencies with responsibility for preparing the EIR (or other CEQA document), or as responsible agencies relying on an EIR prepared by a lead agency. CEQA provides a critical process for local jurisdictions to understand how new developments will exacerbate existing wildfire risks, allowing them to consider project design features, alternatives, and mitigation measures that provide for smarter development and the protection of existing communities. It is recommended that in the CEQA response, that those issues of concern to the CAG be fully detailed, and mitigations (if any) identified.

The CAG has identified recommended best practices to disclose, analyze, and mitigate wildfire impacts. The State of California has made available a checklist for determination of these impacts which can be obtained at the Office of Planning and Research website: *https://www.opr.ca.gov/docs/SB375-Intro-Charts.pdf* A checklist is also available that guides compliance in Appendix B.

What is required in the CEQA full detailing of risk includes the following issues:

a. A complete baseline description of the environmental character of the area proposed for development, including details regarding open spaces, habitat, and project related impacts.
b. A detailed description of the fire history of the project site, including determination of historic wind and weather influences, geographic influences, vegetation condition and flammability, and likely wildfire behavior. Fire modeling or related spatial and statistical analysis is recommended to fully quantify wildfire risks.
c. A detailed description of firefighting resource availability, including water supply.
d. An analysis of "any significant environmental effects the project might cause or risk exacerbating by bringing development and people into the area affected," including by locating development in wildfire risk areas.
e. A determination of the following wildfire impact questions:
    1. Substantially impair an adopted emergency response plan or emergency evacuation plan;

2. Due to slope, prevailing winds, and other factors, exacerbate wildfire risks, and thereby expose project occupants to pollutant concentrations from a wildfire or the uncontrolled spread of a wildfire;
3. Require the installation or maintenance of associated infrastructure (such as roads, fuel breaks, emergency water sources, power lines or other utilities) that may exacerbate fire risk or that may result in temporary or ongoing impacts to the environment; or
4. Expose people or structures to significant risks, including downslope or downstream flooding or landslides, because of runoff, post-fire slope instability, or drainage changes.

In addition to the four questions above, agencies must consider whether a project will "expose people or structures, either directly or indirectly, to a significant risk of loss, injury or death involving wildland fires." In answering these questions, lead agencies must utilize both fire and evacuation modeling and consider both on- and off-site impacts.

4.3 Analyzing a Project's Impacts

The CAG recommends the local agency focus on three specific issues in the analysis of a project:

1) **Project Density:** Project density influences how likely a fire is to start or spread, and how likely it is that the development and its occupants will be in danger when a fire starts. Fire spread and structure loss is more likely to occur in low- to intermediate-density developments. This is because there are more people present to ignite a fire (as compared to undeveloped land), and the development is not concentrated enough.
2) **Project Location in the Landscape:** Project placement in the landscape relative to fire history, topography and wind patterns also influences wildfire risk. Although wildfire ignitions are primarily human caused in California, wildfire behavior is largely driven by topography, fuel, climatic conditions, and fire weather (such as low humidity and high winds). How a development project is planned within the landscape determines to what extent it will influence fire risk. For example, if a project site is in a wind corridor, above-ground power lines may become a source of ignition. Similarly, siting residential structures in rugged terrain or on the top of steep hills may increase the wildfire risk. By contrast, if a project site includes landscape features that could prevent or slow the spread of fire, such as a lake or an irrigated golf course, the development may be strategically located to capitalize on that feature as a natural fuel break.

3) **Water Supply and Infrastructure**: As part of evaluating a project's wildfire risk impacts, an EIR should analyze the adequacy of water supplies and infrastructure to address firefighting within the project site. This analysis should consider the potential loss of water pressure during a fire, which may decrease available water supply and the potential loss of power, which may eliminate the supply.

Lead agencies are encouraged to develop thresholds of significance that either identify an increase in wildfire risk as a significant impact or determine, based on substantial evidence, that some increase in the risk of wildfires is not considered a significant impact. Relevant factors should include the project's impact on ignition risk, the likelihood of fire spread, and the extent of exposure for existing and new residents based on various fire scenarios. Modeling the various scenarios enables local agencies to quantify increased wildfire risks resulting from a project adding more people to wildfire prone areas and to assess the risks according to the threshold of significance.

Some EIRs have concluded that the conversion of some wildland vegetation into paved development reduces or does not increase wildfire risk. This conclusion is contrary to existing evidence and the well-accepted understanding that the fundamental driver of increased wildfire risk is the introduction of people into a flammable landscape. Accordingly, the conversion of vegetation into developed land does not obviate the need for lead agencies to carefully consider and model how the addition of development into wildfire prone areas contributes to the risk of wildfire.

In San Diego County, the County Fire Chiefs Association and numerous fire agencies have completed Wildland-Urban Interface Fire Emergency Response Plans for many Wildland-Urban Interface and undeveloped areas of the County. A full detailing of existing environmental and wildfire risk conditions is included in these plans, as well as extensive wildfire modeling and fire behavior analysis. Most of these plans include detailed evacuation planning for the plan area. These plans should be consulted as part of a development environmental analysis.

4.4 Analyzing Project Impact on Evacuation and Emergency Access

The analysis of evacuation access and routing must analyze both the impacts on existing residents and routes as well as the adequacy of proposed routes for the new development. The EIR should evaluate these impacts both during construction and over the life of the project.

For projects located in high wildfire risk areas that present an increased risk of ignition and/or evacuation impacts, evacuation modeling and planning should be considered and developed at the time of project review and approval—when there is greater flexibility to modify a project's design, density, siting, and configuration to address wildfire considerations—rather than deferred to a later stage of the development process.

Lead agencies will be best positioned to ensure proposed development projects facilitate emergency access and ease constraints on evacuation with this information in hand prior to project approval. The use of professional traffic engineering services to evaluate traffic flows is important to the assessment of proposed routes. The ultimate objective is to allow for informed decision-making that minimizes the environmental and public safety hazards associated with new developments that increase the risk of ignition and impede evacuation in high wildfire prone areas.

Local jurisdictions are encouraged to develop thresholds of significance for evacuation times. These thresholds should reflect any existing planning objectives for evacuation. According to the CA-AG, Evacuation modeling and analysis should include the following:

a. Evaluation of the capacity of roadways to accommodate project and community evacuation and simultaneous emergency access.
b. Assessment of the timing for evacuation.
c. Identification of alternative plans for evacuation depending upon the location and dynamics of the emergency.
d. Evaluation of the project's impacts on existing evacuation plans.
e. Consideration of the adequacy of emergency access, including the project's proximity to existing fire services and the capacity of existing services.
f. Traffic modeling to quantify travel times under various likely scenarios.

The CAG recommends In considering these evacuation and emergency access impacts, lead agencies may use existing resources and analyses, but such resources and analyses should be augmented when necessary. For example, agencies should:

a. Consider the impacts of emergency travel times during congested traffic periods.
b. Consult with local fire officials and ensure that assumptions and conclusions regarding evacuation risk are substantiated with sound facts.
c. Consider impacts to existing community evacuation plans. A goal of San Diego County will be to not detract from evacuation times for existing communities if new development is determined to use the same routes. New road improvements or infrastructure may be needed to achieve this goal.
d. Consider simultaneous means of emergency vehicle response access commensurate with public evacuation.

4.5 Temporary Shelter-in-Place

The ability to temporarily shelter-in-place as an emergency measure is frequently an essential option, even though the primary objective may be to remove impacted civilians completely from the emergency area. Reasons for this measure include the following:

a. Wildfires may originate very close to development and not allow enough time for public notice and safe evacuation, or evacuees may delay their departure until too late for safe transit.
b. Wildfire rate of spread or trajectory may overcome evacuation routes with adjacent wildland exposure, posing lethal risk to evacuees on roadways.

For proposed development sites where evacuees must transgress open areas or wildlands during evacuation and may become exposed to wildfire risks while in transit, it will be essential to include areas of temporary safe refuge within planned development communities that may be used if these principal routes are compromised. These may include institutional sites such as schools, churches, or community administrative sites, large parking areas such as those for commercial complexes, parks, golf courses, or managed green belts. These sites must be readily accessible, with vehicle access that does not otherwise obstruct available roads, and managed fuel exposure that limits user exposure to products of combustion. Temporary safe refuge sites are not to a substitute for permanent or safe evacuation alternatives.

The principal evacuation plan should be to ensure movement of civilian populations from an emergency area into a known safe location where public services, emergency health care, fuel, food, water, and supplies may be made available.

Evacuation planning should include contingencies for large animal safety when such animals are present.

4.6 Mitigating wildfire risk, evacuation, and emergency access impacts

If a project presents significant increased wildfire risks and/or evacuation and access impacts, CEQA requires the lead agency to consider and adopt feasible alternatives and mitigation measures to avoid or reduce the project's impacts (or make a finding of overriding consideration).

According to the CAG, an EIR that concludes that certain project design features or mitigation measures will reduce or eliminate all potential wildfire risks, without first describing those risks, fails to fully analyze the project's impacts. Compressing the analysis of impacts and mitigation deprives decision makers of a full description of the project's adverse impacts and, therefore, fails to equip the decision makers with the necessary information to properly address the impacts by adopting project design features, mitigation measures, or alternatives. To avoid this error and provide for better project design, the project EIR should fully analyze the increased wildfire risks and evacuation impacts.

The CAG has recommended alternatives in development plans that often mitigate wildfire risks. These include:

a. Increasing housing density and consolidated design, relying on higher density infill developments as much as possible.
b. Avoidance and minimization of low-density exurban development patterns or leapfrog-type developments (i.e., those with undeveloped wildland between developed areas).
c. Decreasing the extent and amount of "edge," or interface area, where development is adjacent to undeveloped wildlands.
d. Creation of buffer zones and defensible space within and adjacent to the development, with particular attention to ensuring that vegetation will not touch structures or overhang roofs. It is also important that legal obligations are structured so that defensible space measures are retained over time.
e. Siting projects to maximize the role of low-flammability landscape features that may buffer the development from fire spread.
f. Undergrounding power and telecommunications lines and hardening of utilities infrastructure.
g. Limiting development along steep slopes and amidst rugged terrain, to decrease exposure to rapid fire spread and increase accessibility for firefighting, potentially consolidating development in sites with less risk.
h. Placement of development close to existing or planned ingress/egress and designated evacuation routes to efficiently evacuate the project population and the existing community population, consistent with evacuation plans, while simultaneously allowing emergency access.
i. Placement of projects close to adequate emergency services.
j. Construction of additional points of ingress and egress and modification of evacuation routes to minimize or avoid increasing evacuation times or emergency access response times.
k. Fire hardening structures and homes—upgrading the building materials and installation techniques to increase the structure's resistance to heat, flames, and embers—beyond what is required in applicable building codes, both for new structures and existing structures in proximity to the new development.
l. Requiring fire-hardened communication to the project site including high-speed internet service.

m. Enhanced communication to the project population about emergency evacuation plans and evacuation zones.
n. Parking limitations to ensure access roads are not clogged with parked vehicles.
o. On-site water supply/storage to augment ordinary supplies that may be lost during a wildfire.

The applicable rules, requirements, and analytical tools available to reduce wildfire risk are evolving, The CAG guidance is intended to provide suggestions for how best to comply with CEQA when analyzing and mitigating the wildfire risks of development projects in the wildland-urban interface and other fire prone areas.

5.0 FIRE PROTECTION PLANS

To effectively mitigate wildland fire hazards in Southern California, a multi-lateral approach that involves federal, state, and local governments and fire agencies is usually necessary. Collectively, the County and fire agencies work together to prevent the loss of life in wildland fires; prevent the ignition of structures by wildland fires; prevent the encroachment of wildland fire upon communities; prevent a wildland-caused structural conflagration; prevent the spread of a structure fire to the wildland; and to limit the size of wildland fires.

Wildland fire mitigation measures and design considerations used in the planning and land use approval process vary depending on the wildland characteristics of the site and surrounding area. To allow this flexibility in project design, many wildland fire regulations are written using language that is often subject to interpretation (e.g., water supply may consist of reservoirs, pressure tanks, elevated tanks, water mains or other fixed systems …") as opposed to codes that are absolute (e.g., "Class "A" roofing material shall be required"). This may allow some projects with unique geographic and topographic conditions to adequately mitigate wildland fire risks through project design.

A Fire Protection Plan (FPP) is a document that describes the level of fire hazard that would affect or be caused by a proposed development and the methods proposed to minimize that hazard. The FPP also evaluates the consistency of the proposed project with applicable fire protection regulations. To minimize hazards and meet fire code requirements, the FPP may include recommendations that involve limitations on future land use on the subject property, building construction standards, vegetation management, access improvements, installation of fire suppression facilities, and other design measures. The FPP must include measures to address the specific location, topography, geology, level of flammable vegetation and climate of the proposed project site. The FPP must be prepared consistent with applicable fire codes and be accepted by the FAHJ and County. The plan must demonstrate compliance with the applicable fire code or how the measures proposed to reduce fire hazards are adequate to meet the intent of the code. The following elements must be addressed in a FPP required as part of the review of a discretionary permit application:

- Wildfire hazard and risk assessment
- Siting of development
- Housing density considerations
- Construction
- Access, egress, and evacuation planning
- Water sources for firefighting
- Subdivision landscaping and vegetation management
- Protection of critical infrastructure
- Emergency Services - Availability and Travel Time

Each of these design considerations is detailed below and includes discussions on relevant federal, state, and local codes and the standards that are used to ensure compliance with the regulations. Failure to comply with either the fire code/regulations or the standards may result in a potentially significant impact.

5.1 WILFIRE HAZARD AND RISK ASSESSMENT

The effective use of wildfire hazard information in the early planning or entitlement phases of new development is critical to allowing the county to more comprehensively plan and design against potential loss of life, property, or other assets. It is fundamental that the evaluation of wildfire hazard conditions is not only conducted at the parcel level, but also the subdivision and community scales. The maps resulting from a wildfire hazard assessment can help communities to:

- decide where development should be encouraged or avoided;
- justify where regulations may be applied differently across the landscape;
- establish authority to make codes enforceable;
- require adequate fire protection standards;

- identify permitted and conditional land uses in higher risk areas;
- prioritize fuel reduction efforts;
- educate and communicate risk to the public; and
- empower county and city staff to act.

While the California Fire Hazard Severity Zones Maps are discussed below, also look at:

- Cal-Adapt
- CPUC Fire-Threat Maps and High Fire-Threat District
- US Wildfire Hazard Potential (firelab.org)
- USFS Wildfire Hazard Potential Tool and CALVEG Map
- CAL FIRE's Wildfire Perimeters Map, WUI Map, and Landcover Map
- Fire Probability Models (Fire Probability and Carbon Accounting, SFM)
- CalOES MyHazards Tool

5.1.1 State Responsibility Areas

The California Public Resources Code (PRC) Section 4102 defines "state responsibility area" (SRA) to mean areas of the state in which the financial responsibility of preventing and suppressing fires has been determined by the State Board of Forestry to be primarily the responsibility of the State. As of July 2020, approximately 31% of the state is within the SRA. For reference, 48% of the California is within the Federal Responsibility Area (FRA).
Public Resources Code sections 4201-4204 originally directed the California Department of Forestry and Fire Protection (CAL FIRE) to map fire hazard within State Responsibility Areas (SRA) based on fuel loading, slope, fire weather, and other relevant factors present, including areas where winds have been identified by the department as a major cause of wildfire spread.

There are three FHSZ designations, based on increasing fire hazard. Hazard is based on the physical conditions that create a likelihood and potential fire behavior over a 30 to 50-year period. Classification of a zone as Moderate, High, or Very High fire hazard is based on a combination of how a fire will behave and the probability of flames and embers threatening buildings. Each area of the map gets a score for flame length, embers, and the likelihood of the area burning.

The boundaries of the SRA are identified by the Board of Forestry and Fire Protection, as directed by PRC Section 4125, using the criteria provided in PRC Sections 4126-4135.

5.1.2 Local Responsibility Areas

Local responsibility area is defined as those areas of land classified by the Board of Forestry and Fire Protection where the financial responsibility of preventing and suppressing wildfires is not that of the state or federal government, pursuant to PRC section 4125. Approximately 21% of the state is within the LRA.

The "Bates Bill" (AB 337, 1992), Government Code Section 51175, was prompted by the devastating Oakland Hills Fire of 1991. The legislation calls for CAL FIRE to evaluate fire hazard severity in local responsibility area and to make a **recommendation** to the local jurisdiction where **very high FHSZ**s exist. The Government Code then provides direction for the local jurisdiction to take appropriate action.

CAL FIRE used an extension of the state responsibility area Fire Hazard Severity Zone model as the basis for evaluating fire hazard in local responsibility area. The local responsibility area hazard rating reflects flame and ember intrusion from adjacent wildlands and from flammable vegetation in the urban area. Scientists at the U. C. Berkeley Center for Fire Research and Outreach provided an urban fuels model that was incorporated in the hazard rating.

CAL FIRE published a list of incorporated cities or areas within the LRA for which it has made recommendations on VHFHSZs. Local agencies were required to designate VHFHSZs within their jurisdictions within 120 days of receiving recommendations from the Director or file a finding supported by substantial evidence in the record that equivalent measure exist at the local level and the requirements of Section 51182 are not necessary for effective fire protection within the area. Many jurisdictions did not adopt the FHSZ designations in the LRA

5.1.3 Fire Hazard Map Update

The PRC requires maps to be periodically reviewed and revised. Since the maps were last updated in 2007, the PRC was revised to transfer responsibility for mapping to the State Fire Marshal (SFM). (GC § 51179(a)). Another PRC amendment will restrict local agency authority regarding VHFHSZs in the LRA to the *addition* of areas not identified as VHFHSZs by the SFM, as VHFHSZs following a finding supported by substantial evidence in the record that the requirements of Section 51182 are necessary for effective fire protection within the area (GC § 51179(b)).

Improved fire science, data, and mapping techniques available to identify the most effective measures for fire prevention, intensity, and spread prompted the SFM to revise the maps in 2022. The hazard mapping process incorporates new science in local climate data and improved fire spread modeling in determining hazard ratings. A two-kilometer grid of climate data covering the years 2003-2018 was used as the foundation for the model.

The previous model used stock weather inputs across the state to calculate wildland fire intensity scores. The updated model adjusts fire intensity scores based on the most extreme fire weather at a given location, considering temperature, humidity, and wind speed. In addition, ember transport is modeled based on local distributions of observed wind speed and direction values instead of using a generic buffer distance for urban areas adjacent to wildlands. A FHSZ class is assigned based on the average hazard across the area included in the zone.

The SFM reports the criteria used is science based and field tested. The factors influencing fire behavior and fire likelihood over 30 – 50 years are combined into the term "hazard" to refer to the physical conditions that create fire behavior that can lead to damage. Factors used include:

- Fire history
- Existing and potential fuel
- Predicted flame length
- Blowing embers
- Terrain
- Typical fire weather (temp, humidity, wind)

The new hazard maps, released in January 2023, more accurately reflect the zones in California that are susceptible to wildfire. The area designated VH was expanded from 48% → 55% of the SRA. The public comment period for SRA maps was extended twice and is finalized in late 2023 with an effective date of April 1, 2024. The LRA maps are under development and release will be delayed until sometime in 2024.

5.1.4 Hazard and Risk

The FHZ maps produced by the SFM depict hazards based on limited factors. As discussed on their website, there is a significant difference between hazard and risk. Whereas hazard is defined as physical conditions that can cause damage and is somewhat fixed, risk is the expected damage a particular hazard is estimated to produce and, therefore, varies. Therefore, the SFMs are prescriptive of impacts (like flood maps) – no mitigation measures are considered.

Risk identifies where wildfire is most likely to threaten a community value (human life, property) and is defined by the combination of hazard, exposure, and vulnerability. Specifically, **Risk** can be designed as:

Hazard	x	**Vulnerability**
Likelihood: probability of wildfire starting & spreading *Intensity: the energy released by a wildfire)*		*Exposure: spatial overlap of wildfire and communities* *Susceptibility: whether a community may be harmed*

5.1.5 Fire Hazard Map Significance

The requirements for legal compliance within the SFM's regulatory scope are not changed by the FHSZ classifications. In the SRA, fire prevention requirements within the SFM's regulatory authority are enforced uniformly. All locations in the SRA are subject to the same requirements, rights, responsibilities, conditions, prescriptions, or other regulatory elements within the SFM's jurisdiction.

However, separate statutory mandates outside of the SFM's regulatory scope require that all property in High or Very High FHSZs comply with Civil Code 1102.6f, real estate disclosures Assembly Bill 38 (Wood, Chapter 391, Statutes of 2019). These disclosures are known as "AB 38 Defensible Space Inspections," and are not required for property in Moderate FHSZs. As a result of the new maps, the boundaries of Moderate, High, or Very High FHSZs may shift, altering which properties are required to comply. However, every FHSZ in the SRA is already required to comply with the underlying defensible space requirements of AB 38 located in PRC Section 4291.

- California Building Code Chapter 7A: Materials and Construction Methods for Exterior Wildfire Exposure
- California Government Code 51182: Vegetation Clearance Requirements/Defensible Space
- Board of Forestry and Fire Protection Fire Safe Regulations (California Public Resource Code 4290, July 2021)
- Road Standards
- Signage
- Private Water Supply
- Fuel Breaks and Greenbelts

5.2 Siting of Development

Location of development on the landscape is a major driver of its wildfire risk. Local site conditions (topography, vegetation characteristics, vegetation maintenance, proximity of fuels and other developments, weather, and orientation of a site) can markedly influence site-specific wildfire hazards and exposures (landscape level fire hazards). It is prudent to address fire risk before other considerations are finalized: concentrate in least hazardous areas and buffer against wildfires.

Fire modeling will highlight any vulnerabilities due to the presence of local topographic conditions (hilltops, ridges, steep slopes) and will show potential fire flow paths from neighborhood-or community level features such as greenbelts, open spaces, or drainages. Drainages and other communal open spaces provided an avenue for wildfire spread into more developed urban-suburban environments in several recent wildfires.

5.2.1 Siting Near Open Space

Title 14/Fire Safe Regulations includes, in Section 1276.02, requirements related to ridgelines:
(a) The Local Jurisdiction shall identify Strategic Ridgelines, if any, to reduce fire risk and improve fire protection through an assessment of the following factors:

(1) Topography;

(2) Vegetation;

(3) Proximity to any existing or proposed residential, commercial, or industrial land uses;

(4) Construction where mass grading may significantly alter the topography resulting in the elimination of Ridgeline fire risks;

(5) Ability to support effective fire suppression; and

(a) Other factors, if any, deemed relevant by the Local Jurisdiction.

(b) Preservation of Undeveloped Ridgelines identified as strategically important shall be required pursuant to this section.

(c) New Buildings on Undeveloped Ridgelines identified as strategically important are prohibited, as described in subsections (c)(1), (c)(2), and (c)(3).

(6) New Residential Units are prohibited within or at the top of drainages or other topographic features common to Ridgelines that act as chimneys to funnel convective heat from Wildfires.

(7) Nothing in this subsection shall be construed to alter the extent to which utility infrastructure, including but not limited to wireless telecommunications facilities, as defined in Government Code section 65850.6, subdivision (d)(2), or Storage Group S or Utility and Miscellaneous Group U Structures, may be constructed on Undeveloped Ridgelines.

(8) Local Jurisdictions may approve Buildings on Strategic Ridgelines where Development activities such as mass grading will significantly alter the topography that results in the elimination of Ridgeline fire risks.

(9) The Local Jurisdiction may implement further specific requirements to preserve Undeveloped Ridgelines.

The County Fire Code also has requirements for setbacks adjacent to protected areas. Buildings and structures shall be setback a minimum of 100 feet from any property line adjacent to a national forest, state park or open space preserve. This setback may be reduced when existing permitted buildings and structures are located within 100 feet of the property line or additional mitigation measures are employed that are satisfactory to both the FAHJ and the building official.

The following general guidance for siting a subdivision or development can also help reduce wildfire risk:

- Avoid selecting a construction site along a gully or in a narrow canyon
- Avoid selecting a construction site in or adjacent to a saddle or narrow mountain pass
- Avoid impacts to nature reserves, conservancies, similar public lands
- Avoid constructing a new development adjacent to or on a steep slope. If a ridgetop site is selected, consider the following:
    - Choose an area that allows for a minimum 30–100-foot setback from wildland vegetation on the downslope side.
    - Increase the setback at sites with heavier fuels such as in a forested environment.
    - Develop a fuel modification and long-term vegetation management plan for the steep slopes proximate to the development site. Given specific topographic and vegetative conditions more than 100 feet of defensible space will likely be needed. In some jurisdictions, this can be as much as 200+ feet (e.g., Los Angeles County and Orange County).
- Avoid constructing a new development adjacent to an unmanaged open or wildland space where 50 to 100 feet of defensible space cannot be provided on the proposed site. If a site is selected that is proximate to an unmanaged open or wildland space, consider the following design features:
    - Integrate inherent fuel breaks such as fruit orchards, irrigated landscaping/greenbelts, golf course or other similar low-wildfire hazard features.
    - Consider providing increased structural hardening measures for structures proximate to the open or wildland space such as 6-foot non-combustible perimeter walls or 1-hour fire-resistant exterior walls and protected openings.
    - Consider other building-scale defenses, e.g., building orientation relative to fire flow paths, debris and ember accumulation, window number, and orientation.

BEST PRACTICE: Siting requirement in the land-use development standards described in Santa Barbara County's Gaviota Coast Plan

Dev Std LU-3: Fire Protection. Development shall be sited to minimize exposure to fire hazards and reduce the need for grading, fuel modification, and clearance of native vegetation to the maximum extent feasible. Building sites should be located in areas of a parcel's lowest fire hazard and should minimize the need for long and/or steep access roads and/or driveways.

BEST PRACTICE: Marin County: County-wide agricultural land designation and more localized zoning and potential development patterns that take advantage of agricultural buffers. Site subdivision so they take advantage of major landscape features that can act as a lasting buffer (preserved over long term and protected for removal when rezoning).

BEST PRACTICE: Alberhill: Concentrate homes on the inner side of perimeter roads. Roads, sidewalks, and yards all become defensible space between wildlands and structures. Reduce the neighborhood's perimeter-to-area ratio, further separating homes from flammable hazards.

5.2.2 Siting Near Existing Development

In recent catastrophic wildfire incidents (e.g., 2017 Camp Fire in Paradise, 2021 Marshall Fire in Colorado), fire spread rapidly not only via wildlands and other open spaces, but also from structure to structure (via direct flame contact, hot gases, radiation, and embers). Given the devastating influence nearby subdivisions can have during a wind-driven fire incident, the extent and proximity of surrounding developments and their influence on fire behavior should be considered. The following provides general guidance for siting a subdivision or development relative to other existing or future developments:

- Avoid construction sites proximate to an existing or future development in a high or very high fire hazard severity zone, where a minimum 30-foot setback to the property line cannot be provided. Where this cannot be avoided, consider integrating design features, such as fuel breaks and increased structural hardening measures, like those described for sites proximate to unmanaged open or wildland space.
- If there will be any hazardous land uses on the site that could potentially exacerbate risk (e.g., storage of combustible materials, fuel storage facilities) and which cannot be restricted, consider providing additional mitigation measures such as larger setbacks and defensible space areas, secondary emergency water supplies and associated emergency power, increasing exterior wall fire resistance rating (e.g., 1-hour to 2-hour).

5.3 Housing Density Considerations

Historically, wildfires have destroyed more homes built at low and medium densities than high densities. In several destructive WUI fires (Camp Fire, 2018 and 2017 Tubbs Fire in Santa Rosa) homes themselves were often the fuel that carried fire to other homes, regardless of the distance between homes.

5.3.1 Parcels

State law and the County Fire Code both address building separation.

California Fire Safe Regulations (Title 14) provides minimum requirements for parcels in Section 1276.01:

(a) All parcels shall provide a minimum thirty (30) foot setback for all Buildings from all property lines and/or the center of a Road, except as provided for in subsection (b).

(b) A reduction in the minimum setback shall be based upon practical reasons, which may include but are not limited to, parcel dimensions or size, topographic limitations, Development density requirements or other Development patterns that promote low-carbon emission outcomes; sensitive habitat; or other site constraints, and shall provide for an alternative method to reduce Structure-to-Structure ignition by incorporating features such as, but not limited to:

(1) non-combustible block walls or fences; or

(2) non-combustible material extending five (5) feet horizontally from the furthest extent of the Building; or

(3) hardscape landscaping; or

(4) a reduction of exposed windows on the side of the Structure with a less than thirty (30) foot setback; or

(5) the most protective requirements in the California Building Code, California Code of Regulations Title 24, Part 2, Chapter 7A, as required by the Local Jurisdiction.

Section 4907.4.1 of the County Fire Code contains similar general setbacks. It requires buildings and structures to be setback a minimum of 30 feet from property lines and biological open space easements unless existing permitted buildings and structures are located within 30 feet of the property line or the County Zoning Ordinance requires a greater minimum. When the property line abuts a roadway, the setback shall be measured from the centerline of the roadway.

Exception: When both the building official and the FAHJ determine that the hazard from a wildland fire is not significant or when the terrain, parcel size or other constraints on the parcel make the required setback infeasible.

5.3.2 Clustered/High Density Communities

Clustering structures reduces collective exposure as well as expansion into wildfire hazard areas while minimizing the overall number of houses on a site. It also helps limit impacts to environmental services, ecological needs, and recreational goals for open space, while reducing the distribution of firefighting resources during a major wildfire incident.

Combining more compact housing with buffering patches of less-flammable land use (commercial or small-scale agriculture) can also result in synergistic benefits: safe pedestrian and biking infrastructure.

It is important to note that higher densities increase the risk of home-to-home ignitions and necessitates fire-resistant construction, evacuation plans, and safe refuge.

5.3.3 Traditional/Lower Density Communities

Traditional housing developments, with lower density designs, allow each individual home/structure to directly integrate wildfire safety provisions (e.g., structural hardening measures and defensible space) prescribed in wildfire codes and standards for each individual building or home. However, lower-density housing, collectively, requires a higher amount of land area dedicated to defensible space compared to higher-density designs, which can have negative impacts to environmental services and other ecological goals of the community. Lower density developments can also result in the need to disperse firefighting resources and suppression activities in the event of a major wildfire incident, given the larger spread of development.

Another consideration is existing subdivisions or structures on adjacent lots that may not have been designed to meet an equivalent level of safety as required by this document and, therefore, the fire risk they can present to surrounding properties is uncertain. This uncertainty can be mitigated by requiring fire safety measures at the neighborhood level during planning and development specific to subdivisions, such as communal defensible space or high- density vs low-density design options.

BEST PRACTICE: Poway sited a higher density subdivision next to an existing lower density subdivision decreasing amounts of flammable vegetation in the development and making defensible space easier to maintain and homes more easily defended with fewer resources in a wildfire.

Best practices also include separation/maximizing defensible space by using non-flammable amenities in design, employing safe setbacks on slopes, concentrating homes on interior side of roadways.

5.4 Ignition-Resistent Building Construction

Chapter 7A of the County Building Code and Section R337 of the Residential Code regulates construction in the fire hazard areas of San Diego. The purpose of these code is to establish minimum standards for the protection of life and property by increasing the ability of a building located in any Fire Hazard Severity Zone within State Responsibility Areas, The Very High Fire Hazard Severity Zones of the Local Responsibility Areas, and/or any Wildland-Urban Interface Fire Area to resist the intrusion of flames or burning embers projected by a vegetation fire and contributes to a systematic reduction in conflagration losses. California Referenced Standards Code, Chapter 12-7A includes testing and labeling requirements for building materials.

Building elements covered include:

- Roof – roof covering, vents, roof edge, and gutters (including gutter covers and drip edge)
- Under-eave area – eaves, soffit, and vents
- Exterior wall – siding, windows, doors, trim, and vents
- Attached deck – horizontal surface area, rails, and under-the-deck footprint
- Accessory Structures

The Society of Fire Protection Engineers (SFPE) and SFPE Foundation published a WUI Virtual Handbook for Property Fire Risk Assessment & Mitigation (3/7/2023) which is an excellent compilation of related resource materials leveraging expertise of the fire service, engineering, and insurance industries: www.sfpe/wuihandbook/home.

BEST PRACTICES: Full-scale fire tests by the Insurance Institute for Business & Home Safety identifies elements of a “Wildfire Ready Home” which are more ignition-resistant than a home constructed to Chapter 7A requirements. The table in Figure 2 summarizes findings from IBHS research published by Headwaters Economics in *Construction Costs for Wildfire-Resistant Home, California Edition* (July 2022).
https://headwaterseconomics.org/wp-content/uploads/2022_HE_IBHS_WildfireConstruction.pdf

Some of the most important differences include:

- Noncombustible near-home zone (0-5’) (adopted by San Diego County)
- Require decks to be enclosed
- Specify dual glazing with *inner* pane tempered

Building materials and components in the Baseline, Enhanced, and Optimum scenarios.

	BASELINE		ENHANCED		OPTIMUM	
	Northern California	**Southern California**	**Northern California**	**Southern California**	**Northern California**	**Southern California**
Roof						
Fascia	Wood	Wood	Wood	Wood	Fiber-cement	None
Gutter	Vinyl	Vinyl	Vinyl	Vinyl	Metal with metal gutter guards	Metal with metal gutter guards
Roof surface	Asphalt composition shingle	Asphalt composition shingle	Asphalt composition shingle	Asphalt composition shingle	Steel roof panels, metal drip edge	Clay tiles, noncombustible end caps, metal drip edge
Underlayment	None	None	None	None	Synthetic, fire-resistant	Mineral-surfaced roll roofing
Under-Eave Area						
Soffit	Open eaves (no soffit)	Open eaves (no soffit)	Open eaves (no soffit)	Open eaves (no soffit)	Fiber-cement	Stucco
Under-eave vent	Circular metal vents between rafters	Circular metal vents between rafters	Circular metal vents between rafters	Circular metal vents between rafters	Metal strip vents	Metal strip vents
Exterior Walls						
Door	Solid-core birch wood; vinyl-clad wood-framed sliding glass door; fiberglass garage door	Solid-core birch wood; vinyl-clad wood-framed sliding glass door; fiberglass garage door	Solid-core birch wood; vinyl-clad wood-framed sliding glass door; fiberglass garage door	Solid-core birch wood; vinyl-clad wood-framed sliding glass door; fiberglass garage door	Galvanized steel with insulated glass panel; aluminum-framed tempered-insulated-glass sliding door; metal garage door	Galvanized steel with insulated glass panel; aluminum-framed tempered-insulated-glass sliding door; metal garage door
Dryer vent	Plastic, louvered	Plastic, louvered	Plastic, louvered	Plastic, louvered	Metal	Metal
Siding	Wood composite cladding, gypsum wallboard (ending six inches above grade)	Wood composite cladding, gypsum wallboard (ending six inches above grade)	Wood composite cladding, gypsum wallboard (ending six inches above grade)	Wood composite cladding, gypsum wallboard (ending six inches above grade)	Fiber-cement lap siding	Stucco
Trim	Wood composite	Wood composite	Wood composite	Wood composite	Fiber-cement	Stucco
Attached Deck						
Deck surface	Redwood (non-fire-retardant-treated)	Plastic composite, uncapped	Redwood (non-fire-retardant-treated)	Plastic composite, uncapped	Plastic composite, capped; metal grate at deck-to-wall junction	Metal decking; metal grate at deck-to-wall junction
Fascia	Redwood	Plastic composite	Redwood	Plastic composite	Plastic composite, capped	Metal
Railing	Redwood	Plastic composite	Redwood	Plastic composite	Plastic composite	Metal
Structural support system	Preservative-treated wood	Preservative-treated wood	Preservative-treated wood	Preservative-treated wood	Foil-faced bitumen tape on top and sides of supporting joists	Metal
Underdeck area	Not enclosed	Not enclosed	Enclosed with 1/8 inch metal mesh	Enclosed with 1/8 inch metal mesh	Enclosed with 1/8 inch metal mesh	Enclosed with 1/8 inch metal mesh
Near-Home Landscaping						
Fencing and gate	Cedar	Cedar	Metal chain-link	Metal chain-link	Metal chain-link	Metal chain-link
Mulch	Bark mulch	Bark mulch	Pea gravel and landscaping fabric	Pea gravel and landscaping fabric	Pea gravel and landscaping fabric	Pea gravel and landscaping fabric

BEST PRACTICE: NIST, CALFIRE, and IBHS have developed the Hazard Mitigation Methodology (HMM). The goal of HMM is to reduce the vulnerability of structures and parcels in a cost-efficient and implementable way. The HMM was conceived to allow structures in the WUI to “stand alone” and survive fire and ember exposures without contributions from first responders. This was deemed necessary as field data has demonstrated that wildfire progression can quickly outpace the efforts of first responders during large and/or concurrent WUI fires. NIST WUI reconstruction data has also shown the efficient and effective structure protection actions by first responders; very little or no meaningful improvement can be achieved in this area. The emphasis must be shifted to making structures stand alone.

The following list contains information intended to capture the relationships between exposures, parcel and structure hardening, and community structural losses. The relationships are intended to provide relative performances and highlight trends and critical thresholds. Actual conditions, including construction, parcel sizes and fuel loading, structure separation distances, parcel and structure hardening, local weather, ignition sequencing, and defensive actions, will impact actual fire spread and community resilience.

General Relationships between Exposure and Hardening

1. Low fire exposures are relatively easy to address by hardening the structure.
2. High fire exposures (direct flame impingement from large sources such as a burning residence) are very difficult to address by hardening the structure. This is because both the cladding (siding and roofing) material and the assembly need to be hardened not only to withstand the exposure but also to withstand it for the entire exposure duration, therefore potentially propagating energy into the assembly past the external cladding component.
3. Fire exposures from a fully involved single family residence will result in fire propagation that will be very difficult to stop in the presence of wind in high density communities.
4. High fire exposures can readily cause direct ignition of exposed combustibles.
5. The ember hardening and structure survivability relationship is not linear. Hardening 80% of the vulnerabilities will not necessarily result in 80 % decrease in structure ignition potential. While the actual values will vary based on local conditions and specifics of hardening, the relationship will apply to almost all scenarios.
6. In situations where a potential fuel source is located near a residential/commercial structure and when fuel reduction, relocation, or removal cannot alleviate severe fire exposures to that structure, hardening the structure for fire may frequently add limited value. In these situations, ignition prevention of the fuel source will be the critical path to reducing the ignition of the residential/commercial structures.

Additional information, including separation distances for accessory structures, is found at:
https://nvlpubs.nist.gov/nistpubs/TechnicalNotes/NIST.TN.2205.pdf

5.5 Access, Egress And Evacuation Route Planning

Both road infrastructure and evacuation planning are key components at the neighborhood- and community-scales in high wildfire prone settings, such that people can evacuate during a major wildfire safely and quickly along primary and secondary routes, and first responders can effectively gain access to conduct emergency operations.

This includes providing a sufficient number, arrangement, and capacity of road networks, as well as meeting specific roadway standards, and understanding the impact of new development on the regional road network.

Developments with inadequate access (e.g., long roads with a single access point, roads over steep grades, improper road surfaces, and/or narrow roads) significantly contribute to the inability to effectively evacuate residents during a disaster (wildfire, earthquake, or flood) and provide necessary emergency access for fire, ambulance, or law enforcement personnel.

Requirements may be modified where topographic conditions, title limitations, or the pattern of ownership or the state of development of parcels in the immediate vicinity of a division of land make the strict application of the provisions of these sections impossible or impractical and that the public health, safety and general welfare will not be adversely affected thereby.

5.5.1 Applicable Codes/Regulations

- *County Consolidated Fire Code*
- *Fire Safe Regulations CCR, Title 14 (Natural Resources), Division 1.5 (Department of Forestry), Chapter 7 (Fire Protection) under Subchapter 2.*
- *County of San Diego Department of Public Works Public & Private Road Standards*

5.5.2 Maximum Length of Dead-End Roads

The intent of limiting the allowable length of a dead-end road is to ensure that firefighters have access flexibility to deal with changing dynamics in wildfires and other emergencies, and that civilians have safe, reliable, and known evacuation alternatives during emergencies.

In part, the concept of dead-end road regulations relates to limiting the number of persons attempting to evacuate on the road and to limit the time needed for safe evacuation. Steep, narrow, and winding roads delay evacuation. Long dead-end roads in rural wildland areas place people and emergency personnel at increased risk. The following general standards apply to projects that utilize dead-end roads:

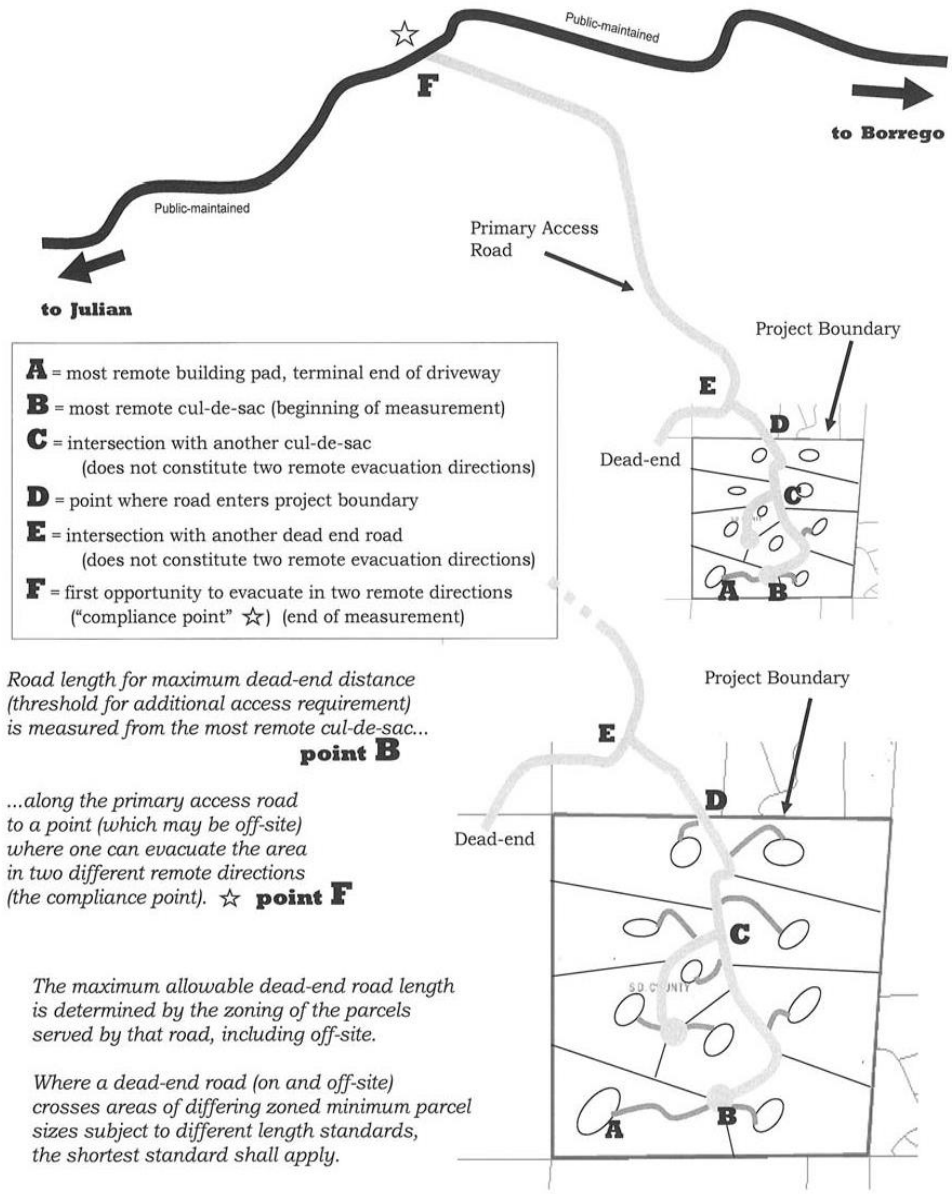
- Road length is measured from the beginning of the primary access road at a point where one can evacuate in two different directions (which may be off-site), measured to the end of the most remote cul-de-sac. Refer to Figure 3 for guidance on measuring dead-end road length.
- Projects with an access road that exceeds the regulations for dead-end roads should first consider providing an alternate means of access and egress before resorting to other possible alternatives.
- If a street or street system is restricted to a single route of access to a road shown on the Roads Plan, except for a limited secondary highway, which is maintained and open to public travel, whether at the point of intersection with the highway or at some point distant from the highway, the street or street system shall serve not more than:
    - 150 dwelling units where the restriction is designed to be permanent and the street or street system does not traverse a wildland area which is subject to hazard from brush or forest fire;
    - 75 dwelling units where the restriction is designed to be permanent and the street or street system traverses a wildland area which is subject to hazard from brush or forest fire;
    - 300 dwelling units, where the restriction is subject to removal through future development.

  If the roadway paving on that portion of the street or street system forming the restriction is less than 36 feet in width and is not to be widened to 36 feet or more as a part of the development of the division of land, the permitted number of dwelling units shall be reduced by 25 percent if the pavement is 28 feet or more in width, and by 50 percent if the pavement is less than 28 feet in width. If the roadway paving on that portion of the street or street system forming the restriction is 64 feet or more in width and the restriction is subject to removal through future development, the permitted number of dwelling units may be increased to 600. In no event shall the pavement width be less than 20 feet.

- An important factor in evaluating existing and proposed access roads is road connectivity. When feasible, projects should extend on-site roads to the edge of the property for possible future connectivity.
- To ensure that necessary access to the project site remains available in perpetuity, the applicant needs to provide evidence that a permanent and reliable right of access has been obtained. These rights would generally be in the form of an easement that runs with the land.
- Access may be proposed over tribal lands held in trust only if the Tribe waives its sovereign immunity and allows the Tribe to be sued in state court to enforce the right of access over the tribal lands. The requirement to waive sovereign immunity does not apply if the Bureau of Indian Affairs grants the access rights.
- Security (privacy) gates or other types of barricades are generally discouraged as they can obstruct civilian egress and responder ingress during a fire emergency. However, in certain circumstances, gates can be allowed if they provide a rapid and reliable means of firefighter ingress and unobstructed egress for civilian evacuation as determined by the FAHJ. For example, entry gates positioned at the entrance to a subdivision must provide for rapid entry by emergency responders. The rapid opening of the gate for responders may be activated by personnel stationed at the gate on a 24-hour basis, emergency vehicle traffic signal pre- emption strobe detectors, close proximity public safety radio transmissions, battery back-up with "lock open" on power failure, or key- operated electric override switch. In all cases, exiting from the subdivision through the gated entry should be unobstructed and not require any activation measures unless the FAHJ assumes responsibility to activate the gate during times of emergency. All gates must comply with County Consolidated Fire Code.

FIGURE 3: Measuring Length of Dead-End Roadways

Guidance for Determining Primary Access Road Length



A = most remote building pad, terminal end of driveway

B = most remote cul-de-sac (beginning of measurement)

C = intersection with another cul-de-sac (does not constitute two remote evacuation directions)

D = point where road enters project boundary

E = intersection with another dead end road (does not constitute two remote evacuation directions)

F = first opportunity to evacuate in two remote directions ("compliance point" ☆) (end of measurement)

Road length for maximum dead-end distance (threshold for additional access requirement) is measured from the most remote cul-de-sac... **point B**

...along the primary access road to a point (which may be off-site) where one can evacuate the area in two different remote directions (the compliance point). ☆ **point F**

The maximum allowable dead-end road length is determined by the zoning of the parcels served by that road, including off-site.

Where a dead-end road (on and off-site) crosses areas of differing zoned minimum parcel sizes subject to different length standards, the shortest standard shall apply.

5.5.3 Fire Access Road Width

The minimum width identified in the codes should not be obstructed at any time. Parking should be outside the required fire access road width. The exception allowance under the code is often considered for reductions in width for a short section where extreme topographic constraints make it impossible to obtain the minimum required width or where impacts to sensitive biological resources can be avoided. Any exception allowance under the code shall be replaced with an alternative measure that provides the same practical effect. This finding should be supported by the Director of Public Works, the FAHJ and the County Fire Marshal based on extreme topographic or biological constraints.

5.5.4 Fire Access Grade

Full compliance with the code is required. Exceptions would be considered where full compliance with the standard could not be achieved because of extremely steep terrain. Any exception allowance under the code shall be replaced with an alternative measure that provides the same practical effect.

5.5.6 Fire Access Surface Type

Full compliance with the code is required.

5.6 Water Supply

Providing adequate water supply, volume, and pressure, is crucial in fighting not only wildland fires, but smaller scale residential fires as well. History has shown that most fire related responses are to residential fires. In some cases, however, residential fires escape the confines of the house and become wildfires. As such, it is important that water resources are adequate to meet the volume and flow needs to properly fight fires either at an individual home or the surrounding neighborhood. A municipal water supply (waterlines and hydrants) is always preferable to on-site tanks.

5.6.1 Inside Water District

Full compliance with the code. For water main extensions, the measurement of distance to the water main should be taken from the existing main to the nearest portion of the subject parcel (to the property line), not to the proposed hydrant location.

5.6.2 Outside Water District

Full compliance with the code. Structures or clusters of structures substantially greater than roughly 5,000 square feet should provide additional water storage to increase fire suppression capacity.

When a water supply for structure defense is required to be installed, such protection should be installed and made serviceable prior to and during the time of construction.

Standardize and document as with municipal supply systems to ensure they are filled, maintained, and periodically tested. NFPA 1142, "Standard on Water Supplies for Suburban and Rural Fire Fighting," provides guidance.

BEST PRACTICE: San Diego County Water Tank Standard
Mendocino County Fire Safe Council also has an excellent 4-page pamphlet

5.7 Subdivision Landscaping And Vegetation Management

In April 2023, the Board of Supervisors adopted an ordinance moving the requirements of the County's Defensible Space Ordinance to the County Consolidated Fire Code to improve efficiency and clarity.

Specific planting requirements from the County Fire Code include:

- Shrubs limited to 6' in height.
- Grouping of shrubs limited to a maximum aggregate diameter of 10'.
- Separation of shrub groupings of a least 15'.
- Separation of groupings from structure of at least 30'.
- Shrubs located below or within a tree drip line shall be a separated from the lowest tree branch by a minimum of three times the height of the understory shrubs or 10 feet, whichever is greater.
- Tree driplines must be maintained at not less than 10 feet from any combustible structure.
- The horizontal distance between tree crowns must be not less than 10 feet.

In addition, the State Minimum Fire Safe Regulations, Title 14, requires fuel breaks. These may be synonymous with community "fuel modification" zones, based on application. Specifically, Section 1276.03 states:

(a) When Building construction meets the following criteria, the Local Jurisdiction shall determine the need and location for Fuel Breaks in consultation with the Fire Authority:

(1) the permitting or approval of three (3) or more new parcels, excluding lot line adjustments as specified in Government Code (GC) section 66412(d); or

(2) an application for a change of zoning increasing zoning intensity or density; or

(3) an application for a change in use permit increasing use intensity or density.

(b) Fuel Breaks required by the Local Jurisdiction, in consultation with the Fire Authority, shall be located, designed, and maintained in a condition that reduces the potential of damaging radiant and convective heat or ember exposure to Access routes, Buildings, or infrastructure within the Development.

(c) Fuel Breaks shall have, at a minimum, one point of entry for fire fighters and any Fire Apparatus. The specific number of entry points and entry requirements shall be determined by the Local Jurisdiction, in consultation with the Fire Authority.

(d) Fuel Breaks may be required at locations such as, but not limited to:

(1) Directly adjacent to defensible space to reduce radiant and convective heat exposure, ember impacts, or support fire suppression tactics;

(2) Directly adjacent to Roads to manage radiant and convective heat exposure or ember impacts, increase evacuation safety, or support fire suppression tactics;

(3) Directly adjacent to a Hazardous Land Use to limit the spread of fire from such uses, reduce radiant and convective heat exposure, or support fire suppression tactics;

(4) Strategically located along Ridgelines, in Greenbelts, or other locations to reduce radiant and convective heat exposure, ember impacts, or support community level fire suppression tactics.

(e) Fuel Breaks shall be completed prior to the commencement of any permitted construction.

(f) Fuel Breaks shall be constructed using the most ecologically and site appropriate treatment option, such as, but not limited to, prescribed burning, manual treatment, mechanical treatment, prescribed herbivory, and targeted ground application of herbicides.

(g) Where a Local Jurisdiction requires Fuel Breaks, maintenance mechanisms shall be established to ensure the fire behavior objectives and thresholds are maintained over time.

(h) The mechanisms required shall be binding upon the property for which the Fuel Break is established, shall ensure adequate maintenance levels, and may include written legal agreements; permanent fees, taxes, or assessments; assessments through a homeowners' association; or other funding mechanisms.

The intent is to ensure all flammable vegetation or other combustible growth is managed to reduce the threat from wildfires. Reports on destructive fires contain common problem areas near structures, including:

- Overgrown or unmanaged vegetation
- Combustible mulches
- Woodpiles
- Trash and recycling receptacle storage locations
- Hazardous plants and vegetative debris
- Clustering of trees and shrubs

5.7.1 Guidelines for Subdivision Landscaping and Vegetation Management

In addition to the County Fire Code and Title 14, maintenance requirements and suggestions for landscaping within fuel modification and defensible space areas are provided in:

- *"California Vegetation Treatment Program" (https://bof.fire.ca.gov/projects-and-programs/calvtp/)*
- "Fire, Defensible Space *and You*…" (http://sdcounty.ca.gov/dplu/fire_resistant.html);
- "Fire-safe Landscaping Can Save your Home" (http://www.sdcounty.ca.gov/oes/docs/fswy12.pdf)**;**
- The California Native Plant Society's "Native Plant Landscaping to Reduce Wildfire Risk" (http://www.cnpssd.org/fire/ReduceFireRisk.pdf).
- "Ready, Set, Go" (http://www.readyforwildfire.org/)

There are generally three levels of vegetation management:

1. Community Fuel Modification (FM)
2. Defensible Space around Structures (DS)
3. Ornamental Landscaping outside FM and DS

Any project that is required to prepare and implement a full FPP may also be required to prepare a **Fire Behavior Model** that evaluates a worst-case scenario wildfire based on site topography, weather and vegetation. The modeling, combined with the consultant/fire authority's expertise may result in the consultant proposing greater or lesser buffers to minimize building and occupant safety risks.

Landscape plans shall be provided to the FAHJ or a designated third party for any new construction and or addition for residential and commercial buildings or accessory thereof. Plans shall be submitted and approved prior to any framing inspection. In addition, plans shall be provided when modifications occur to any previously approved landscape plan or to the Home Ignition Zones.

Plans shall be prepared by a California Licensed Landscape Architect, Architect, or Civil Engineer. A landscape designer could prepare planting plans only (not irrigation) for a single-family residence but would need one of the above professionals to stamp the plans verifying compliance with the regulations. Plans shall include:

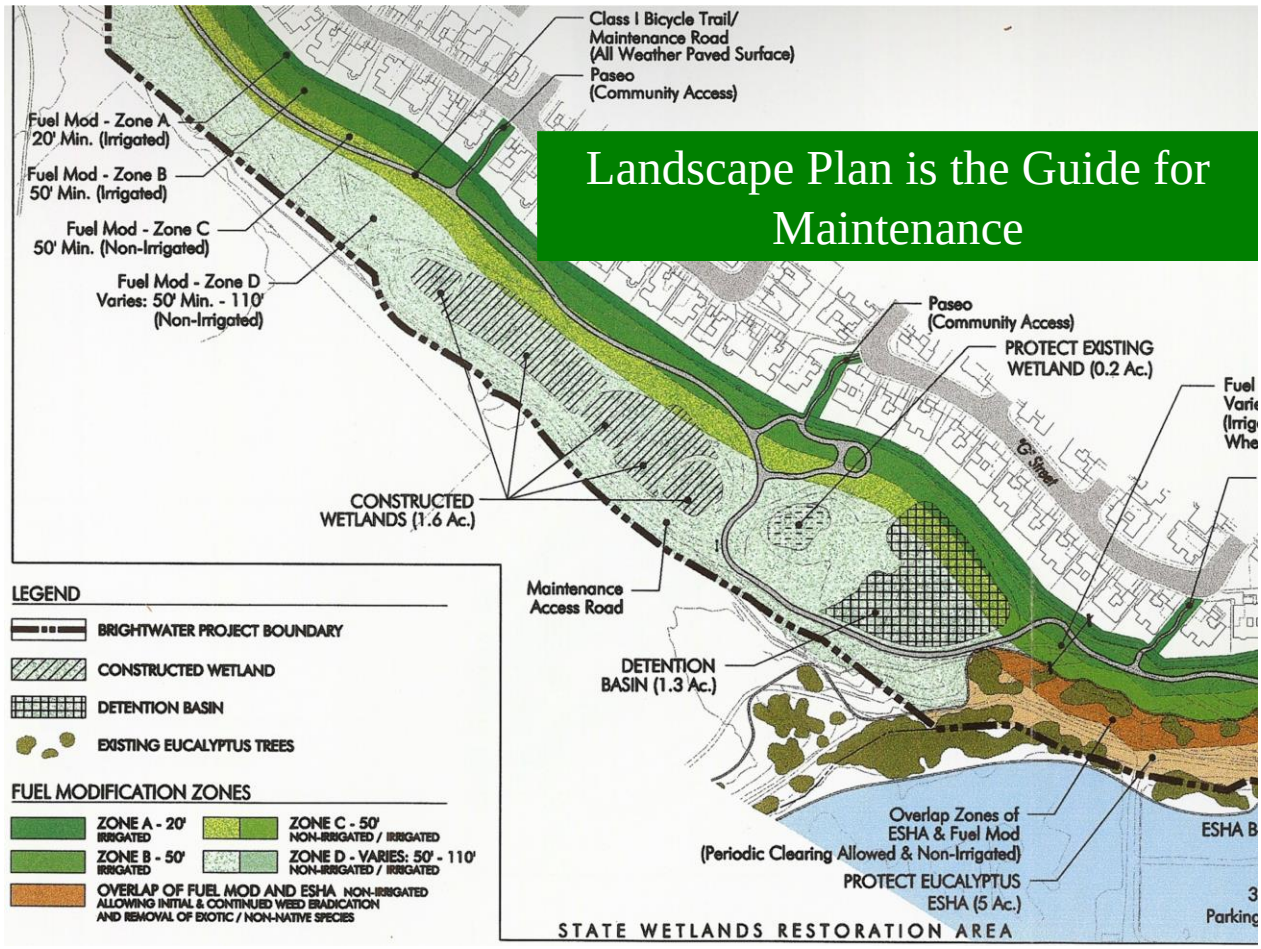
1. A readable (Engineer or Architect) scale.
2. Delineation of Fuel Modification Zones and Defensible Space/Home Ignition Zones with a general description of zone dimensions and character.
3. Describe and show existing vegetation on plan.
4. Include a Plant Legend with the plant-life form, scientific and common name, and expected height and width for mature growth.
5. Describe vegetation reduction around emergency access and evacuation routes.
6. Include quantities of trees and large shrubs being proposed.
7. Identify irrigated and non-irrigated areas on the plan.
8. Identify points of access for equipment and personnel to maintain vegetation.
9. Define all symbols, site amenities, features, and shaded areas, etc. used on the plans.
10. Legally binding statements regarding community responsibility for fuel modification zones
11. Legally binding statements to be included in covenants, conditions, and restriction regarding property owner's responsibilities for vegetation maintenance.

5.7.2 Community Fuel Modification

Community level fuel modification should be required as a condition of issuing a construction permit (preliminary) and certificate of occupancy (final) for permitting or approval of three or more parcels (Title 14, Section 1276.03, pg. 56). Fuel modification zones should be designed to protect a new community by reducing the fuel loads adjacent to a community and buildings within it. (Figure 4). The developer shall assign the land on which any fuel modification zone is established to the association or other common owner group that succeeds the developer as the person responsible for common areas within the community.

Once a fuel modification zone has been established, the land on which the zone is located shall be under the control of an association or other common ownership established in perpetuity, for the benefit of the community to be protected.

FIGURE 4: Sample of a Community Fuel Modification Plan



BEST PRACTICE: The Orange County Fire Authority has been requiring 170' of fuel modification around all new developments since the late 1970's. Three of the four zones are 50' in width (measured through air rather than along ground) and require various vegetation management strategies related to plant type, spacing, irrigation, etc. Maintained by the homeowner association, it has proven successful in protecting many neighborhoods from wildfire.

5.7.3 Defensible Space for Structures (See Figures 5 and 6)

The County Fire Code requires defensible space around every building that is designed primarily for human habitation or use, or a building designed specifically to house farm animals. Decks, sheds, gazebos, freestanding open-sided shade covers and similar accessory structures less than 250 square feet and 50 feet or more from a dwelling, and fences more than 5 feet from a dwelling, are not considered structures for the establishment of a fuel modification zone. Defensible space shall comply with the following:

a. When a building or structure in a hazardous fire area is located 100 feet or more from the property line, the person owning or occupying the building or structure shall maintain defensible space within 100 feet of the building or structure.
b. The fire code official may increase the defensible space more than the 100-foot minimum if fuel and/or topography are determined to increase the fire hazard severity.
c. When a building or structure in a hazardous fire area is setback less than 100 feet from the property line, the person owning or occupying the building or structure shall meet the requirements in subsection (a) above, to the extent possible, in the area between the building or structure and the property line.
d. The building official and the FAHJ may provide lists of prohibited and recommended plants.
e. A Structures defensible space shall be located entirely on the subject property unless approved by the FAHJ. This required defensible space may be reduced as allowed in subsection (c) above or increased as required by a fire protection plan.
f. When the subject property contains an area designated to protect biological or other sensitive habitat or resource, no building or other structure requiring a defensible space shall be located to extend the defensible space into a protected area. Improved Property: Property owners shall be permitted to clear all combustible vegetation within a one hundred (100) foot radius of all buildings and structures using methods, such as mowing and trimming that leave plant root structure intact to stabilize soil. Clearing is not limited to these methods and discing, which exposes bare mineral soil, may be used if deemed necessary by the FAHJ.
g. Where the distance from the structure to the property line of the parcel on which the building is located is less than the distance required to be cleared, (100'), the adjacent parcel owner may be required to establish the required fuel break to achieve the required distance of defensible space if such requirement is approved by the Fire Code Official.

Maintenance of defensible space is required by the owner or occupant.

BEST PRACTICE: San Diego County adopted Home Ignition Zones within their County Fire Code, in accordance with full-scale fire testing identifying the critical need as part of a "hardened home".

Zone 0 "Immediate Zone" 0-5' Measured from the exterior wall surface or patio, deck, or attachment to building or structure extending 5 feet on a horizontal plane. This zone shall be constructed of continuous hardscape or non-combustible materials.

Zone 1 "Intermediate Zone" from Zone 0 to 50' measured from the immediate edge of Zone 0 extending out in a horizontal plane. This zone shall consist of planting of low growth, drought tolerant and fire resistive plant species. The height of the plants in this zone starts at 6" adjacent to Zone 0 and extending in a linear fashion up to a maximum of 18" at intersection with Zone 2.

Zone 2 "Extended Zone" from Zone 1 to 100' measured from the immediate edge of Zone 1 extending out in a horizontal plane for 50'. This zone consists of planting of drought tolerant and fire resistive plant species of moderate height. This area would be considered selective clearing of natural vegetation and dense chaparral by removing a minimum 50% of the square footage of this area.

FIGURE 5: Defensible Space Zones

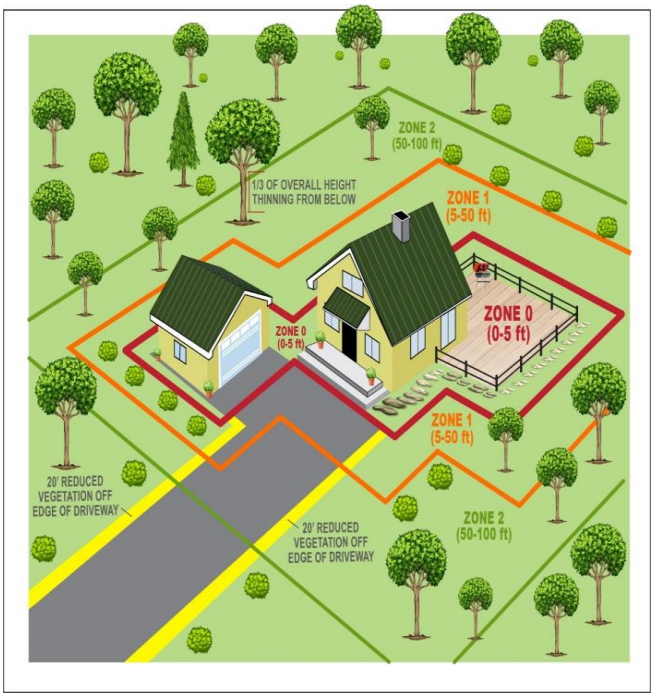
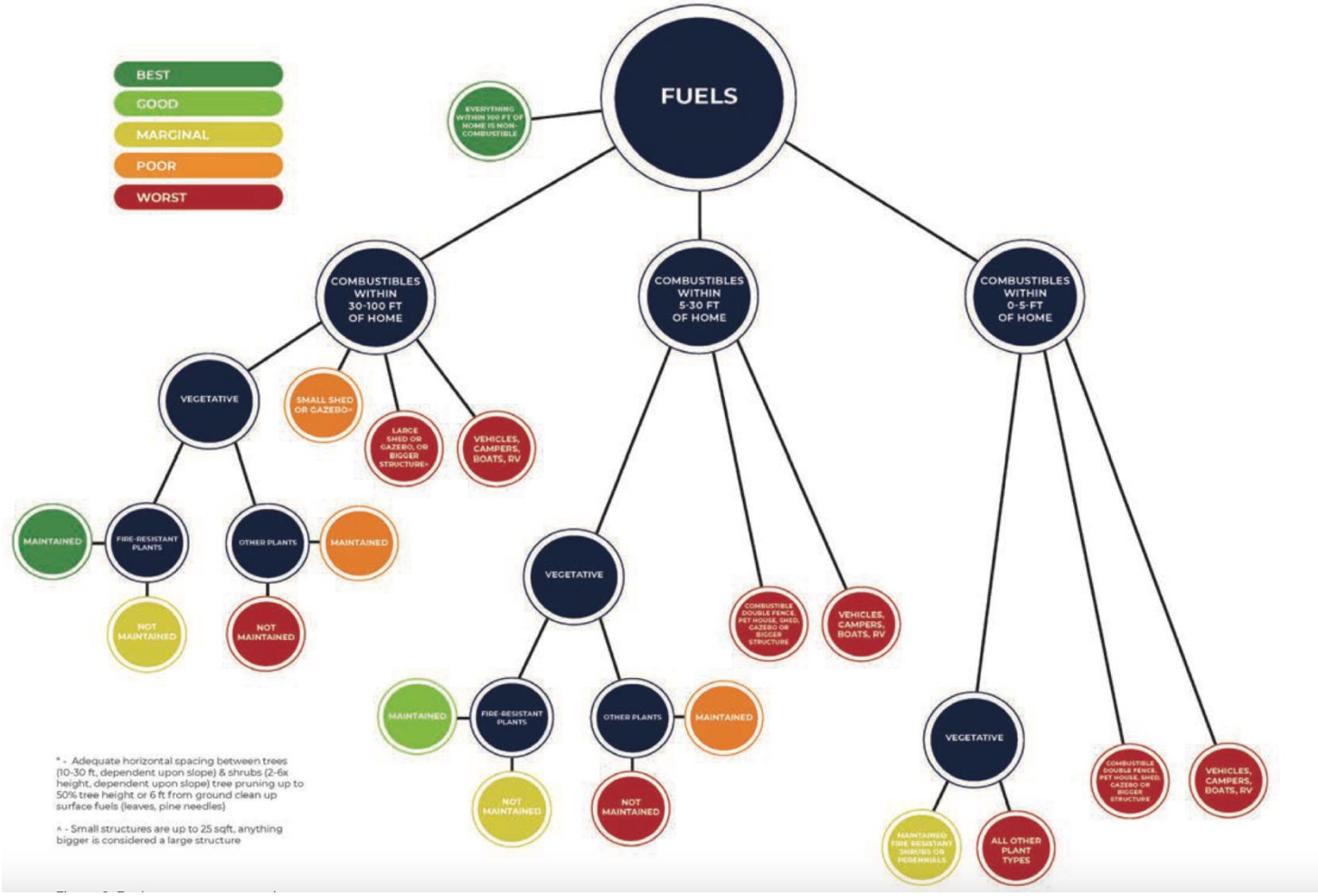


FIGURE 6: Defensible Space Guidance for Fuels



5.7.4 Roadways

The FAHJ may require a property owner to modify combustible vegetation in the area within 20 feet from each side of the driveway or a public or private road adjacent to the property to establish a fuel modification zone.

5.7.5 Open Spaces

Natural and man-made land use features (i.e., mostly unmanaged, or minimally maintained vegetation in various open spaces, drainage ditches, etc.) amplified not only the intensity and behavior of the wildfire, but also the associated impacts to the surrounding communities. Conversely, where vegetation was well maintained (e.g., irrigated, mowed, trimmed back) fire intensity, spread, and associated damage were reduced.

Most of the observed open spaces, drainage ditches, greenbelts, and recreational spaces adjacent to, intermixed or interwoven with the rural and urban/suburban communities in the impacted areas of the Marshall Fire (Colorado, 2021) did not appear to have a long-term, wildfire-specific land resource management strategy. Such a strategy would help prevent, mitigate and/or manage vegetative fuel loads, particularly high hazard vegetation, adjacent to suburban/urban development.

Creating a long-term, wildfire-specific land resource management strategy may be a challenge due to the diverse set of stakeholders and jurisdictions responsible for managing these public and private land use spaces such as municipal parks, open spaces, conservation areas, and jointly managed county/city open space. Limited resources, limited wildfire-specific land use management and/or multi-hazard codes, and standards and guidance documents, etc. may also present challenges.

Place open spaces within the development site with consideration to underlying wildfire hazard and risk. This may include designating areas of high wildfire hazard as permanently conserved open spaces (with ongoing fuel reduction treatments), thereby reducing the introduction of people and property in higher-hazard areas. An added benefit of this technique may be conserving useful habitat for native plants and animals.

Consider the different types of open space which may exist or be built within the development. Small, landscaped, and manicured open spaces have a lower risk profile than large spaces with non-native, and possibly more flammable, vegetation. Surround larger spaces with defensible space and plan for them to burn periodically. The outside perimeter of a development is a good place to locate walkways and trails, to reduce fuel loading adjacent to structures.

Common open spaces (parks, play areas, undeveloped lots, road medians, trails) need to be planned with fire-adaptive landscape design features. In addition to initial design and planning, long-term maintenance plans must be designed and implement. The placement of open spaces within a development, specific types of plants to use and avoid, and ongoing maintenance are all important planning elements. Consider placement of vegetation within each open space. Recommended separation distances will vary by community and vegetation type. Reference recommendations and requirements for tree spacing based on the slope and location of the property.

BEST PRACTICE: Use of nonflammable amenities in the layout of a subdivision to maximize defensible space. Amenities are placed in a way that they ring the subdivision are part of a larger defensible-space strategy.

- Golf course placement around a development near Arcilla limits home exposure to wildfire.
- Small orchards near Escondido provide a partial barrier for some homes.
- The Orchard Hills development in Irvine uses an avocado orchard as part of an agricultural-urban interface protecting the development.

5.7.6 Ornamental Landscaping and Plants

Specific plant types should be selected based on fire-resistance. Also be aware of plants to avoid. Invasive plants can have a higher potential for ignition than native vegetation because they often produce more flashy fuels which ignite and burn quickly. However, native vegetation can also be highly flammable. Common characteristics of prohibited plants include volatile resins and oils, generally aromatic when crushed (e.g., eucalyptus), narrow leaves or long, thin needles, waxy or fuzzy leave, accumulates dead leave and twigs on and/or under the plant (e.g., Italian Cypress), loose or papery bark, invasive species.

All new vegetation shall be *drought tolerant* and fire-resistant vegetation in accordance with the County Fire Code which also has height and spacing requirements for shrubs and trees. Characteristics of “fire-adapted” plants include: Drought-resistant, pest-resistant, native to area, noninvasive, slow-growing, wind-resistant, sustainable without supplemental fertilization.

All ornamental landscaping must also be consistent with County’s Landscape Ordinance and Landscape Design Manual. Projects requiring landscape plans should clearly identify the type of plant materials, locations and spacing of plant materials, and irrigated and non-irrigated landscaping. The landscape consultant may recommend in the text the inclusion or exclusion of specific varieties for review by the County landscape architect.

In addition to initial vegetation and landscape planning, ongoing vegetation management and maintenance is crucial. This includes all areas with vegetation in the development—both heavily landscaped open spaces and those dominated by native vegetation. Regular fire mitigation over the long-term should be required or performed.

Revise to BEST PRACTICE: Non-fire-resistant vegetation. New trees not classified as fire resistant vegetation, such as conifers (*including Junipers and Cypress*), palms *with fibrous tissues*, pepper trees, *acacia species, bamboo species* and eucalyptus species, and other species deemed highly flammable are currently permitted provided the tree is planted and maintained so that the tree's drip line at maturity is a minimum 30 feet from any combustible structure. **Consider prohibiting these species in FHZs.**

5.8 Protection Of Critical Infrastructure

Critical infrastructure protection (access/egress routes, communication systems, water supplies/infrastructure, electrical power infrastructure) from wildfire hazards, as well as limiting the potential sources of wildfire ignitions due to some of these features, is an important planning consideration where relevant to a new development or subdivision.

Critical infrastructure may span across multiple jurisdictions and may have multiple responsible entities (e.g., public utilities, city, county). Coordinate with all responsible parties. Infrastructure should be inventoried and assessed to determine vulnerability. Mitigation strategies, such as the removal of hazardous vegetation, may be part of an existing CWPP or HMP. If a critical infrastructure plan exists separately, planners should seek connections between these plans. Consider hiring a fire protection engineer or wildfire safety specialist to evaluate and recommend wildfire safety provisions, protection measures, etc.

5.8.1 Electrical

Where possible, place all electrical distribution equipment in conduit underground. Where underground distribution equipment is infeasible, consult any relevant fire safety ordinances for adequately designing overhead electrical distribution lines and associated equipment (e.g., transformers) to reduce the likelihood of this equipment providing a source for wildfire ignitions. Consideration should be given not only to the hardening of the equipment, but also in providing adequate vegetation clearance, appropriate plant selection such that fall-in, grown-in and lean-in of vegetation is minimized, and long-term management.

5.8.2 Fuel

Fuel tanks (e.g., propane) can present a significant hazard to both structures and first responders if they start off-gassing or explode during a wildfire. Exposed, fuel lines can also be vulnerable to wildfire damage (see NFPA 58). Bury or shield fuel lines to protect them from the effects of radiation, direct flaming, and ember exposure. Bury pressurized fuel-storage vessels underground, where possible. Where fuel storage tanks are stored or installed above ground, the following guidance should be considered:

- Install tanks a minimum of 30 feet from habitable structures.

- For cylindrical tanks, use vertical tank or orient horizontal tanks so that the circular ends are pointed away from residences or structures since the ends are weaker than the tank body.
- Install tanks on and surrounded by noncombustible surface.
- Provide a noncombustible masonry wall enclosure, where possible
- Avoid installing tanks near high-risk topographic features (e.g., steep slopes, drainages)
- Maintain at least 10 feet of clearance from other combustibles.
- Avoid installing tanks in proximity to primary or secondary egress routes.
- Ensure pressurized storage tanks have a pressure-relief valve and that the valve/vent is directed away from residences and structures.
- Provide signage or other form of notification of type and location of fuel-related utilities, where concealed or inconspicuous.
- Critical fire-protection equipment (e.g., water tanks, water supply pumps, pump houses) may necessitate fire-hazard reduction measures to protect this infrastructure from being damaged or lost during a wildfire incident.

5.8.3 Communication Towers & Renewable Energy Installation

Consider providing 30 feet of hardscaping or brush clearance around communication towers, and associated equipment. Consult with local fire authorities for any local requirements, guidance, and best practices. Where no local guidance is provided, consult NFPA 1, NFPA 1140 or IWUIC.

NFPA 1 recommends a noncombustible base and clear area of 10’ around ground-mounted photovoltaic installations.

Battery energy storage facilities NFPA 855 recommends 100’ clearance for energy storage systems in remote outdoor installations.

5.8.4 Water

Water supply and water storage, including on-site storage, are components of critical infrastructure within a development.

The reliability of water storage and pumping facilities must be protected from wildfire. At a minimum, 30 feet of brush clearance should be maintained around critical fire protection equipment.

5.8.5 Essential Facilities/Community Refuges

Construct fire-resistant public facilities and create community refuges to provide safety for vulnerable populations and last-resort options for worst-case scenarios. Schools, nursing homes, hospitals on interior and ignition resistant. Different than “safety zones” which are typically large open areas sized based on vegetation height, slope steepness, and winds.

BEST PRACTICE:

- Australia: Design and Construction of Community Bushfire Refuges Handbook.
- Mendocino County Fire Safe Council: Creating a Safety Zone for Wildfire Emergency

5.9 Emergency Services

Fire protection and emergency services are among the most vital and basic of community needs. Firefighters, who are generally the first responders to disasters, must be prepared to respond quickly and effectively to all types of emergencies, including wildland fires. For this reason, the provision of adequate facilities for fire protection and emergency services is fundamental to protecting the health, safety, and general welfare of the residents of San Diego County.

Projects must comply with the emergency travel time requirements specified in the *County General Plan* (Figure 7). Travel time is defined as the estimated time it will take for a responding agency to reach the furthest structure in a proposed development project. Travel time is determined by measuring the safest, most direct, appropriate, and reliable route between the fire station and the project with consideration given to safe operating speeds for heavy fire apparatus. Travel time does not include reflex or reaction time, or on-scene size-up and set-up prior to attacking the fire, all of which are critical precursors to actual firefighting. Travel time may be calculated by using NFPA 1142 Table C.11(b), SANDAG layering, PDS-GIS software travel time mapping, actual emergency travel time run data or actual driving tests. If the travel time determined in the FPP is less than the travel time determined by the FAHJ, the travel time determined by the FAHJ shall take precedence.

NOTE: Stations that are seasonal (not open all year) or staffed with volunteers without legal responsibility to respond to emergencies, should not be used for determining consistency with travel time requirements of the County General Plan.

Where projects exceed these time requirements, the Director of PDS may, upon concurrence with the FAHJ, accept mitigation measures. Acceptable mitigation may include, but is not limited to:

- Alternative construction methods and measures not otherwise required;
- Extending fuel modification and defensible space zones;
- Increased roadway widths;
- Reduced fire hydrant spacing;
- Automatic Aid agreement(s);
- Upgrading existing facilities or infrastructure, including undergrounding of utilities;
- Constructing new facilities; or
- Implementing a long-term binding agreement aimed at reducing the response time to acceptable limits.
- See 5.10.1 below for additional alternatives

Proposed mitigation should be implemented prior to implementation of the discretionary permit (prior to recordation of the final map for subdivisions and prior to issuance of building permits or use and reliance for use permits/site plans).

If a modification is proposed, the requirements of the County Consolidated Fire Code specific to modifications apply. Documentation of mitigation should appear not only in the FPP, but also in the files of the FAHJ as prescribed in the Fire Code. See 5.10.2 below.

Figure 7: *Travel Time Standards from the Closest Fire Station

Travel Time	Regional Category (and/or Land Use Designation)	Rationale for Travel Time Standards**
5 min	■ Village (VR-2 to VR-30) and limited Semi-Rural Residential Areas (SR-1) ■ Commercial and Industrial Designations in the Village Regional Category ■ Development located within a Village Boundary	In general, this travel time standard applies to the County's more intensely developed areas, where resident and business expectations for service are the highest.
10 min	■ Semi-Rural Residential Areas (> SR-1 and SR-2 and SR-4) ■ Commercial and Industrial Designations in the Semi-Rural Regional Category ■ Development located within a Rural Village Boundary	In general, this travel time provides a moderate level of service in areas where lower-density development, longer access routes and longer distances make it difficult to achieve shorter travel times.
20 min	■ Limited Semi-Rural Residential areas (>SR-4, SR-10) and Rural Lands (RL-20) ■ *All* Commercial and Industrial Designations in the Rural Lands Regional Category	In general, this travel time is appropriate for very low-density residential areas, where full-time fire service is limited and where long access routes make it impossible to achieve shorter travel times.

>20 min	■ Very-low rural land densities (RL-40 and RL-80)	Application of very-low rural densities mitigates the risk associated with wildfires by drastically reducing the number of people potentially exposed to this hazard. Future subdivisions at these densities are not required to meet a travel time standard. However, independent fire districts should impose additional mitigation requirements on development in these areas.

* The most restrictive standard will apply when the density, regional category and/or village/rural village boundary do not yield a consistent response time standard.

** Travel time standards do not guarantee a specific level of service or response time from fire and emergency services. Level of service is determined by the funding and resources available to the responding entity.

5.10 Alternatives To The Standards

Due to unique site characteristics, there may also be combinations of site/project improvements and opportunities that make adequate mitigation achievable when standards cannot be met. The standards listed below are considered a "starting point". Nothing in these standards precludes a FAHJ and/or the County from identifying other measures that would adequately mitigate unique site characteristics/conditions. Any exceptions under the code shall be replaced with an alternative measure that provides the same practical effect at a ratio of 2:1.

5.10.1 Emergency Response-related Standards

- The type and number of fire apparatus available to serve the project are reliable, well-staffed and redundant. Examples include multiple engines with full-time career or reserve staff, with travel times approximating the "first–in" engine.
- Adequate funding is legally committed in perpetuity to the fire authority for staffing inspections, enforcement and educational programs.
- Adequate road widening and improved road surfacing that generally improves the access to the subject property and surrounding uses.
- The project is supported with a public water system with fire hydrants along access roads at reduced distances and with at least a fire flow of 2,500 gallons per minute.
- Security (privacy) gates or other types of barricades are generally discouraged as they can obstruct civilian egress and responder ingress during a fire emergency. However, in certain circumstances, gates can be allowed if they provide a rapid and reliable means of firefighter ingress and unobstructed egress for civilian evacuation as determined by the FAHJ. Refer to section 5.2.1.2 of these guidelines.
- The project provides funding in perpetuity to support adequate fire agency staffing for fire suppression, fire code enforcement and community safety education. An example would be the establishment of a Community Facilities District to assist in the long-term funding of fire district operations and management.

5.10.2 Community Adaptation-related Standard

- The project is in a developed area or an area with long-standing agricultural operations.
- Adequate Fuel Modification separates the project and open space/wildland areas, including vegetation with low probability of ignition, rapid spread, or high intensity around project access points.
- Siting configurations meet the most recent scientific findings for fire spread.

- Construction standards meet the most recent scientific findings for ignition resistance (see table in Figure 2)
- Limit the number of lots that can be located on a single point of access.
    - 150 dwelling units where the restriction is designed to be permanent and the street or street system does not traverse a wildland area which is subject to hazard from brush or forest fire;
    - 75 dwelling units where the restriction is designed to be permanent and the street or street system traverses a wildland area which is subject to hazard from brush or forest fire;
    - 300 dwelling units, where the restriction is subject to removal through future development.

  If the roadway paving on that portion of the street or street system forming the restriction is less than 36 feet in width and is not to be widened to 36 feet or more as a part of the development of the division of land, the permitted number of dwelling units shall be reduced by 25 percent if the pavement is 28 feet or more in width, and by 50 percent if the pavement is less than 28 feet in width. If the roadway paving on that portion of the street or street system forming the restriction is 64 feet or more in width and the restriction is subject to removal through future development, the permitted number of dwelling units may be increased to 600. In no event shall the pavement width be less than 20 feet.

5.10.1 Required Findings for Alternatives to Standards

Certain site-specific situations may make the strict adherence to the County Consolidated Fire Code either impracticable or infeasible. If a modification is proposed, the requirements of the County Consolidated Fire Code specific to modifications apply. The fire code official is authorized to approve a modification to the fire code requirements when the proposed modification is supported by the following “findings”:

- Special circumstances make the strict letter of the code impracticable;
- The modification is in compliance with the intent and purpose of the code, and provides the same practical effect;
- Such modification does not lessen health, life, and fire safety standards;
- Specific section(s) for which a modification is requested;
- Material facts supporting the need for a modification;
- Details of the modification or mitigating measure proposed, and if applicable, a map showing the proposed location of the modification or mitigation measures;
- The modification is documented in the FPP and separated provided to the FAHJ.

5.10.2 Scenarios where Acceptable Alternatives are Unlikely:

Alternate measures that do not exceed the level of safety provided by the requirements of the adopted plans, codes, and regulations, will not be approved. There also may be situations where a combination of site conditions/constraints, such as those listed below, are so severe that it is unlikely that sufficient mitigation could be provided. In such scenarios, projects may result in a significant impact:

- Project site is surrounded by large wildland areas with little existing or planned surrounding development.
- The primary access road is substandard with no proposal to adequately/reasonably improve it.
- Project site is surrounded by steep slopes and significant topographical constraints that could intensify fire behavior or limit fire suppression operational flexibility.
- Legal access rights have not been obtained for the primary access road and any necessary secondary access road.
- Fire stations available to serve the project site are located substantial distances from the project site such that response by multiple units is significantly delayed.
- The available water supply for fire suppression is limited to tanks, pools or ponds that have limited capacity and require pumping operations.

5.11 Plan Acceptance Process

FPP preparers should work with the local FAHJ. Once the plan is prepared and submitted to the local fire agency, it will be reviewed for compliance with all applicable ordinances and regulations. If practical difficulties in achieving compliance have been identified and modifications or alternate methods are proposed, they must also be evaluated by the FAHJ. If the FAHJ determines that the plan is incomplete or inadequate, it should be sent back to the preparer with a letter explaining why. If the plan proposes modifications due to practical difficulties in meeting the code requirements, the FAHJ should determine whether to grant a modification. If the FAHJ approves a modification, the FAHJ should send a letter to the applicant and PDS finding that special individual reasons make compliance with the strict letter of the code impracticable, the proposed modification complies with the intent and purpose of the code and provides the same practical effect, and the modification does not lessen health, life, and fire safety requirements. The FAHJ must include an explanation for each finding.

Concurrent with the process at the local FAHJ, the County PDS will also review the plan. The plan will be reviewed for completeness and code compliance. If the plan is found to be complete, code compliant and to have been accepted by the FAHJ, an acceptance letter will be prepared. If the plan is found to be incomplete, to be inconsistent with code requirements or not to have been accepted by the FAHJ, PDS will not accept the plan.

The County Consolidated Fire Code includes a procedure for appealing the decision of the FAHJ relating to the application of the applicable fire code.

The County will make every effort to provide sufficient time for the FAHJ to review and comment on the proposed project and associated Fire Protection Plan. If comments are not received from the FAHJ in a timely manner, PDS will assume that the FAHJ has no comments on the proposed Fire Protection Plan. PDS will advise the final decision- making body of the FAHJ's failure to comment on the Fire Protection Plan.

LIST OF PREPARERS and TECHNICAL REVIEW

4th Version- Oct. 2023

San Diego County Fire Protection District

- Tony Mecham, Fire Chief
- David Nissen, Deputy Chief/Fire Marshal
- Ryan Silva, Assistant Chief/ Fire Prevention
- David Sibbet, Fire Services Coordinator
- Julie Benner, Administrative Analyst

County of San Diego, Planning and Development Services

- Mark Slovick, Deputy Director
- Angelica Truong, Planning Manager

Rohde & Associates, LLC

- Michael S. Rohde, Principal/ CEO
- Laura Blaul, Senior Consultant

Stakeholders/Groups

- Dan Silver, Executive Director, Endangered Habitats League
- Community of Elfin Forest Town Council

PREVIOUS VERSIONS:

THIRD REVISION – JANUARY 25, 2023

Angelica Truong, PDS, Primary Author
Mark Slovick, PDS, Contributing Author

David Sibbet, County Fire Authority, Contributing Author

SECOND REVISION – AUGUST 31, 2010

County of San Diego

Jeff Murphy, DPLU, Primary Author
Paul Dawson, DPLU, Contributing Author
James Pine, DPLU, Contributing Author
Ralph Steinhoff, DPLU, Technical Review
Ken Miller, DPLU, Technical Review

FPP Technical Review Panel, continued

FPP Technical Review Panel

Robin Church, RC Biological Consulting Rolland Crawford, Loma Linda Fire Department,

Retired, Co-Chair of the Wildland-Urban Interface Committee, California Fire Chiefs Association, Fire Prevention Officers Section
Kathleen Edwards, Division Chief, Pre-Fire Division, CAL FIRE
Scott Franklin, Scott Franklin Consulting
Jim Hunt, Hunt Research Corp.
Cliff Hunter, Fire Marshal, Rancho Santa Fe Fire Protection District, member of the ICC Wildland Committee
Doug Logan, Current President of the North County Civil Engineers and Land Surveyors Association
Sid Morel, Fire Marshal, North County Fire Protection District
Dennis Moser, Moser Ventures, Inc
Don Oaks, Santa Barbara County Fire Department, Retired, Co-Chair of the Wildland-Urban Interface Committee, California Fire Chiefs Association, Fire Prevention Officers Section
Thom Porter, Staff Chief, Resource Management, CAL FIRE
Gregory Schreiner, Fire Marshal, Lakeside Fire Protection District
Howard Windsor, Unit Chief, CAL FIRE

FIRST REVISION – DECEMBER 19, 2008

County of San Diego

Jeff Murphy, DPLU, Primary Author
Paul Dawson, DPLU, Contributing Author
Ralph Steinhoff, DPLU, Technical Review
Ken Miller, DPLU, Technical Review

FPP Technical Review Panel

Robin Church, RC Biological Consulting
Rolland Crawford, Loma Linda Fire Department, Co-Chair of the Wildland-Urban Interface Committee, California Fire Chiefs Association, Fire Prevention Officers Section
Scott Franklin, Scott Franklin Consulting
Jim Hollingsworth, Fire Marshal, Ramona Fire Department

FPP Technical Review Panel, continued

Jim Hunt, Hunt Research Corp.
Cliff Hunter, Fire Marshal, Rancho Santa Fe Fire Protection District, member of the ICC Wildland Committee
Dennis Moser, Moser Ventures, Inc.
Don Oaks, Santa Barbara County Fire Department, Retired, Co-Chair of the Wildland-Urban Interface Committee, California Fire Chiefs Association, Fire Prevention Officers Section
Thom Porter, Staff Chief, Resource Management, CAL FIRE
Mike Scott, Urban Forester, Rancho Santa Fe Fire Protection District
Pete Scully, Battalion Chief, Border Division, CAL FIRE

APPROVED – MARCH 19, 2007

County of San Diego

Jeff Murphy, DPLU, Primary Author
Paul Dawson, DPLU, Contributing Author Ralph Steinhoff, DPLU, Technical Review Ken Miller, DPLU, Technical Review

FPP Technical Review Panel

Bill Clayton, Division Chief, CDF
Robin Church, RC Biological Consulting Rolland Crawford, Loma Linda Fire Department, Co-Chair of the Wildland-Urban Interface Committee, California Fire Chiefs Association, Fire Prevention Officers Section
Scott Franklin, Scott Franklin Consulting
Jim Hollingsworth, Fire Marshal Ramona Fire District
Jim Hunt, Hunt Research Corp.
Cliff Hunter, Fire Marshal, Rancho Santa Fe Fire Protection District, member of the ICC Wildland Committee
Dennis Moser, Moser Ventures, Inc Don Oaks, Santa Barbara County Fire Department, Retired, Co-Chair of the Wildland-Urban Interface Committee, California Fire Chiefs Association, Fire Prevention Officers Section
Thom Porter, Staff Chief, Resource Management, CAL FIRE
Mike Scott, Urban Forester, Rancho Santa Fe Fire Protection District
Pete Scully, Battalion Chief, Border Division, CAL FIRE
Andy Vanderlaan, Former Executive Director Western Fire Chief's Publishers of Uniform Fire Code, Current Chair LAFCO

REFERENCES CITED AND/OR CONSULTED

American Planning Association. Zoning News - Saving Homes from Wildfires: Regulating the Home Ignition Zone, May 2001.

Australasian Fire Authorities Council. Position paper on bushfires and community safety. November 2005.

Brooks, M. and C.M. D'Antonio. The role of fire in promoting plant invasions. In: M. Kelly (ed.), Proceedings of the California Exotic Pest Plant Council Symposium. Vol. 6:29-30. 2003.

Brooks, M.L., C.M. D'Antonio, D.M. Richardson, J.B. Grace, J.E. Keeley, J.M. DiTomaso, R.J. Hobbs, M. Pellant, and D. Pyke. Effects of Invasive Alien Plants on Fire Regimes. BioScience 54(7): 677-688. 2004.

Brown, T.J. The application and utilization of climate information for fire management and policy. In: Proceedings of the 3rd International Wildland Fire Conference, Sydney, Australia. October 2003.

Brown, T.
The application and utilization of climate information for fire management and policy. In Proceedings of the 3rd International Wildland Fire Conference. October 2003.
The impact of twenty-first century climate change on wildland fire in California. California Climate Watch, Pp. 1-2, August 2004.

Brown, T.J., B.L. Hall and A.L. Westerling. The impact of twenty-first century climate change on wildland fire danger in the western United States: an applications perspective. Climatic Change 62:365-288. 2004.

Burn Institute, Fire Safe San Diego County, San Diego County Fire Chiefs Association, County of San Diego Board of Supervisors. A Guide for the Homeowner: Living with Wildfire. San Diego Union Tribune, May 20, 2001.

Butler, C.P. The urban/wildland fire interface. In: Proceedings of Western States Section/Combustion Institute Papers, Vol. 74, No. 15. May 6-7, 1974; Spokane, WA. Pullman, WA: Washington State University; 1-17. 1974

Butler, B. W. and J. D. Cohen. Firefighting safety zones: a theoretical model based on radiative heating. International Journal of Wildland Fire 8(2): 73-77, 1998

California Code of Regulations. Guidelines for Implementation of CEQA, Appendix G, Title 14, Chapter 3, §15000-15387, 2004.

California Department of Forestry and Fire Protection. Fire Safe Guides for Residential Development in California, 2022.

California Office of the State Fire Marshall. California Laws Relating To Fires and Firefighters. Available at http://osfm.fire.ca.gov/.

California Public Resources Code. California Environmental Quality Act (PRC §21000-21178), 2004

California Public Utilities Commission
Investigation Report of the Woolsey Fire, 2019

California Building Standards Code. California Code of Regulations, Title 24, Parts 1-12, Building Code, Electrical Code, Mechanical Code, Plumbing Code, Energy Code, Elevator Safety Construction Code, Historical Building, Fire Code, Code for Building Conservation, Referenced Standards Codes. Available at http://osfm.fire.ca.gov/.

California Native Plant Society's Native Plant Landscaping to Reduce Wildfire Risk http://www.cnpssd.org/fire/ReduceFireRisk.pdf, accessed March 12, 2007.

Cohen, J.

Preventing Disaster: Home Ignitability in the Wildland-Urban Interface, Journal of Forestry, Vol. 57, No. 4, 1997.

Rocky Mountain Research Station, Fire Sciences Laboratory. Reducing the Wildland Fire Threat to Homes: Where and How Much? General Technical Report, PSW-GTR-173, pp. 189-195, 1999.

USDA Forest Service, Southeastern Forest Experiment Station. A Site-Specific Approach for Assessing the Fire Risk to Structure at the Wildland-Urban Interface, General Technical Report, SE-GTR-69, pp. 252-256, 1991.

Cohen, J and B.W. Butler Intermountain Fire Sciences Laboratory, Modeling Potential Structure Ignitions from Flame Radiation Exposure with Implications for Wildland/Urban Interface Fire Management. In Proceedings of the 13th Conference on Fire and Forest Meteorology, Fairfield, WA. International Association of Wildland Fire, 1998.

Cohen, J. and J. Saveland. Structure Ignition Assessment Can Help Reduce Fire Damages in the W-UI. Fire Management Notes, Vol. 57, No. 4, pp. 19-23, 1997.

Cave, T.J. Public Safety in the Urban-Wildland Interface: Should Fire-Prone Communities Have a Maximum Occupancy? Natural Hazards Review – ASCE (American Society of Civil Engineers). Pp. 99-108. August 2005.

County of Los Angeles
After Action Review of the Woolsey Fire, Citygate Associates, 2018

County of San Diego

County Building Code, San Diego County Code of Regulatory Ordinances, Title 9, Division 2, Chapter 1

County Consolidated Fire Code. County Health and Safety Code §13869.7

County of San Diego Standards for Private Roads, Department of Public Works. Adopted June 30, 1999.

County of San Diego Standards for Public Roads, Department of Public Works, February 2010.

Fire, Defensible Space and You. 2004.

Fire Prevention Measures to Provide Defensible Space in the Unincorporated Area of the County. Board of Supervisors, Land Use Agenda Item, May 15, 2002.

General Plan, Part VII Public Safety Element, April 2008.

General Plan, Part XII Public Facilities Element, October 2008

Plant List and Acceptable Plants for a Defensible Space in Fire Prone Areas. Department of Planning and Land Use, December 15, 1998.

Combustible Vegetation and Other Flammable Materials Ordinance, San Diego County Code of Regulatory Ordinances, Title 6 Health and Sanitation, Division 8 Sewage and Refuse Disposal, Chapter 4 Removal of Combustible Vegetation and Other Flammable Materials.

County Landscape Ordinance and Landscape Design Manual, January 2010.

Vegetation Management Report, Board of Supervisors, Land Use Agenda Item, March 25, 2009.

Cova, T.J. Public Safety in the Urban-Wildland Interface: Should Fire-Prone Communities Have a Maximum Occupancy? Natural Hazards Review – ASCE (American Society of Civil Engineers). Pp. 99-108. August 2005.

Dombeck, M.P., J.E. Williams, and C.A. Wood. Wildfire policy and public lands: integrating scientific understanding with social concerns across landscapes. Conservation Biology 18(4): 883-889, 2004.

Franklin, S.E. Sheltering in place: surviving catastrophic wildfire. American Fire Journal 365:12-13. 1998.

Fule, P.Z., J.E. Crouse, T.A. Heinlein, M.M. Moore, W.W. Covington, and G. Verkamp. Mixed-severity fire regime in a high- elevation forest of the Grand Canyon, Arizona, USA. Landscape Ecology 18:465-486. 2003.

Gill, S. ARI Final Report: Fire history, forest structure and early land uses in a Jeffrey pine-mixed conifor forest under an unmanaged fire regime. 2002.

Grossan, M. Wildfire/Brushfire Smoke Health Problems. http://www.ent-consult.com/wildfires.html , accessed March 13, 2007.

Halsey, R.W. Fire, Chaparral, and Survival in Southern California. Sunbelt Publications. 2005.

Headwaters Institute- Wildfire Risk Report, 2021

International Association of Fire Chiefs (IAFC) and Western Fire Chiefs Association (WFCA). Development Strategies in the Wildland/Urban Interface, 1996.

International Code Counsel. International Fire Code.

International Code Council. International Urban-Wildland Interface Code.

International Code Council. International Building Code.

Keeley, J.E. Fire Management of California shrubland landscapes. Environmental Management 29(3)395-408. 2002.

Impact of antecedent climate on fire regimes in coastal California. International Journal of Wildland Fire 13:173-182. 2004

Keeley, J.E. and C.J. Fotheringham.

The historical role of fire in California shrublands. Conservation Biology 15:1536-1548. 2001.

History and management of crown-fire ecosystems: a summary and response. Conservation Biology 15(6):1561-1567. 2001.

Impact of past, present, and future fire regimes on North American Mediterranean shrublands. In: T.T. Veblen, W.L. Baker, G. Montenegro, and T.W. Swetnam (eds). Fire and Climatic Change in Temperate Ecosystems of the Western Americas. Springer, New York. 2003.

Keeley, J.E., C.J. Fotheringham, and M. Morais.

Reexamining fire suppression impacts on brushland fire regimes. Science 284:1829-1832. 1999.

Lessons from the October 2003 wildfires in southern California. Journal of Forestry. October/November 2004.

Kramer, H.A., et. al., High Wildfire Damage in Interface Communities in California, International Journal of Wildland Fire, 2019

Lenihan, J.M., R. Drapek, R. Neilson. Climate change effects on vegetation distribution, carbon, and fire in California. Ecological Applications 13(6):1667-1681. 2003.

Lindroth, R. Community defense from wildfire, an international comparison. Poudre Fire Authority. Ft. Collins, Colorado. February 2005.

Llorett, F. M. Verdú, N. Flores-Hernández, and A.V. Valiente-Banuet. Fire and resprouting in Mediterranean ecosystems: Insights from an external biogeographical region, the Mexical shrubland. Am. J. Botany 86(12):1655-1661.

Menakis, J.P., D. Osborne, and M. Miller. Mapping the cheatgrass-caused departure from historical natural fire regimes in the Great Basin, USA. USDA Forest Service Proceedings RMRS-P-29. Pp. 281-287. 2003.

Minnich R.A., M.G. Barbour, J.H. Burk, and R.F. Fernau. Sixty years of change in Californian conifer forests of the San Bernardino Mountains. Conservation Biology 9(4):902-914.

Minnich R.A., M.G. Barbour, J.H. Burk, and J.Sosa-Ramirez. Californian mixed-conifer forests under unmanaged fire regimes in the Sierra San Pedro Martir, Baja California, Mexico. J. Biogeography 27:105-129. 2000.

Mitchell, J.W. Brand Dilution. Wildfire Magazine. March/April 2005.

Moreno, J.M. and W.C. Oechel. Fire intensity effects on germination of shrubs and herbs in southern California chaparral. Ecology 72:6):1993-2004. 1991.

Moritz, M.A. Analyzing extreme disturbance events: fire in Los Padres National Forest. Ecological Applications 7(4):1252-1262. 1997.

National Interagency Fire Center. Wildland Fire Statistics. Boise, ID, 2000.

Nave, R. Inverse square law – radiation. http://hyperphysics.phy-astr.gsu.edu/hbase/forces/isq.html, accessed March 13, 2007.

NewsNet5. Protect Your Lungs From Wildfire Smoke. http://www.newsnet5.com/health/2592720/detail.html 2003.

Nicholson, J. Mass evacuation: is total evacuation of a community threatened by wildfire a soung strategy. Paper presented to the Institution of Fire Engineers, New South Wales Branch, 1994 State Conference, Sydney, Australia. 1994.

Purcell, K.L. and S.L. Stephens. Changing fire regimes and the avifauna of California oak woodlands. Studies in Avian Biology 30:33-45.

Radeloff, V.C., R.B. Hammer, S.I. Stewart, J.S. Fried, S.S. Holcomb, and J.F. McKeefry. The wildland-urban interface in the United States. Ecological Applications 15(3):799- 805.

2005.

Radelof, K.L. et. al., Rapid Growth of the U.S. Wildland Urban Interface Raises Risks, Silvas Lab, Dept. of Forest and Wildlife Ecology, University of Wisconsin-Madison, 2018

Ramsay, G.C., N.A. McArthur, and V.P. Dowling. Preliminary results from an examination of house survival in the 16 February 1983 bushfires in Australia. Fire and Materials 11(1)49-51. 1987.

Rancho Santa Fe Fire Protection District. Sheltering in Place during Wildfires. 2004.

Skinner, C.N. and C. Chang. Fire regimes, past and present. Sierra Nevada Ecosystem Project: Final report to Congress, vol. II, Assessments and scientific bases for management options. Davis: University of California, Centers for Water and Wildland Resources 1996.

Skinner, C., S. Stephens, and R. Everett. Final report: fire regimes of forests in the Peninsular and Transverse Ranges of southern California. Joint Fire Science Program Project 01B-3-3-18. U.C. Berkeley. December 2006.

Syphard, A.D., et. al, Extent and Drivers of Type in Southern California Chaparral, 2019, Conservation Biology Institute

Southern California Society of American Foresters. Bark Beetle Info. www.socalsaf.org accessed March 5, 2007.

Therriault, S. Wildfire Smoke – A Guide For Public Health Officials. http://www.deq.state.mt.us/FireUpdates/WildfireSmokeGuide.pdf, accessed March 13, 2007.

Uniform Fire Code 2000 edition published by the Western Fire Chiefs Association and the International Conference of Building Officials, and the National Fire Protection Association Standards 13 &13-D, 2002 Edition, and 13-R, 2002 Edition. Available at http://www/buildersbooksite.com/codes400.htm

United States Code. National Environmental Policy Act (42 USC §4321), 1969. National Environmental Policy Act as amended [Pub. L. 91-190, 42 U.S. C. 4321-4347, January 1, 1970, as amended by Pub. L. 94-52, July 3, 1975, Pub. L. 94-83, August 9, 1975, and Pub. . 97-258, § 4(b), Sept. 13, 1982.

Verdú, M. Ecological and evolutionary differences between Mediterranean seeders and resprouters. J. Vegetation Science 11:265-268. 2000.

Wells, M.L., J.F. O'Leary, J. Franklin, J. Michaelsen, and D.E. McKinsey. Variations in a regional fire regime related to vegetation type in San Diego County, California (USA). Landscape Ecology 19(2):139-152. 2004.

Wildland Fire Task Force, Mitigation Strategies for Reducing Wildland Fire Risks, San Diego County Wildland Fire Task Force Findings and Recommendations, Report to the Board of Supervisors, August 13, 2003.

Zedler, P.H. and L.A. Seiger. Age mosaics and fire size in chaparral: a simulation study. In: Keeley, J.E., M. Baer-Keeley, and C.J. Fotheringham (eds.) 2nd Interface Between Ecology and Land Development in California.

ATTACHMENT A: DEFINITIONS

Behave:
A system of interactive computer programs for modeling fuels and fire behavior that includes two systems: BURN and FUEL.

CEQA:

The California Environmental Quality Act is a California law that requires public agencies and local governments to evaluate and disclose the environmental impacts of proposed projects adopt all feasible mitigation measures to reduce or eliminate those impacts.

Crown Fire:
The movement of fire through the crowns or tops of trees or shrubs more or less independently of the surface fire. A fire is said to be "crowning" when the flames get up into the tops of trees and spreads.

Defensible Space:
An area either natural or manmade where material capable of causing a fire to spread has been treated, cleared, reduced, or changed to act as a barrier between an advancing wildfire and resources or lives at risk. In practice, defensible space is generally defined as an area of 30 to 100 feet or more around a structure that is cleared of flammable brush or vegetation or other fuels. This will also create an area for fire suppression to occur.

FAHJ

Fire authority having jurisdiction is the designated entity providing enforcement of fire regulations as they relate to planning, construction and development. This entity may also provide fire suppression and other emergency services.

Fire Behavior:
The manner in which a fire reacts to the influences of fuels, weather, and topography.

Fire Front:
The part of a wildland fire in which continuous flaming combustion is taking place. Unless otherwise specified the fire front is assumed to be the leading edge of the fire perimeter. In ground fires, the fire front may be mainly smoldering combustion.

Fire Hazard Severity Zone

Areas of significant fire hazards based on fuels, terrain, weather, and other relevant factors. State law requires the State Fire Marshal to map areas as Very High, High, and Moderate to assist local agencies and the public with wildfire preparedness by determining where construction and other risk reduction standards apply.

Fire Intensity:
A general term relating to the heat energy released by a fire.

Fire Perimeter:
The entire outer edge or boundary of a fire, which may contain within it substantial areas of unburned fuels.

Flame Height:
The average maximum vertical extension of flames at the leading edge of the fire front fire front . Occasional flashes that rise above the general level of flames are not considered. The flame height is less than the flame length if flames are tilted by winds or slope.

Flame Length:
The distance between the flame tip and the midpoint of the flame depth at the base of the flame (generally the ground surface); flame length is an indicator of fire intensity.

Fuel:
Combustible material. Includes vegetation such as grass, leaves, ground litter, plants, shrubs, and trees that feed a fire, as well as homes and other structures.

Fuels Management:
Management of wildland fuel complexes to achieve hazardous fuel reduction, to achieve and maintain ecosystem restoration, and to maintain ecosystem health and other resource benefits. Management includes strategic planning and site-specific and landscape-scale treatments designed to improve abilities to protect life and property, and to maintain or restore the sustainability of healthy ecosystems. Fuel management is accomplished by the application and integration of a variety of treatments that will minimize the probability and effects of large-scale, high-intensity fires. These treatments, a variety of fire and non-fire techniques, include, but are not limited to, mechanical, chemical, biological, and manual methods, and prescribed fire and wildland fire use. Both naturally occurring fuels and hazardous fuel accumulations resulting from resource management and land use activities must be addressed.

Fuel Modification Zone:

A strip of land between an improved property and wildlands, where combustible vegetation has been thinned, modified, or both, and partially or totally replaced with approved drought- tolerant, fire-resistant, and/or irrigated plants to provide an acceptable level of risk from vegetation fires.

Fuel Model:
Simulated fuel complex (or combination of vegetation types) for which all fuel descriptors required for the solution of a mathematical rate of spread model have been specified.

Fuel Moisture:
The quantity of moisture in fuels expressed as a percentage of the weight when thoroughly dried at 212 degrees Fahrenheit. Also referred to as fuel moisture content.

Fuels Reduction:
Manipulation, including combustion or removal of fuels to reduce the likelihood of ignition and/or to lessen potential damage and resistance to control. Often includes thinning and/or prescribed burning.

Fuel Treatment:
Any vegetation manipulation and/or removal/modification of wildland fuels to reduce the likelihood of ignition, to reduce potential fire intensity and spread rates, to lessen potential damage and resistance to control, or to limit the spread and proliferation of invasive species and diseases. Fuels treatments achieve site-specific fire and resource management objectives under approved land use plans and with full compliance to NEPA and other regulatory statutes.

Fuel Type:
An identifiable association of fuel elements of a distinctive plant species, form, size, arrangement, or other characteristics that will cause a predictable rate of fire spread or difficulty of control under specified weather conditions.

Hazard Fuel Reduction:
Removal of excessive live or dead wildland fuel accumulations for the strict objective of reducing the potential for the occurrence of uncharacteristically intense wildland fire and increasing capabilities to protect life and property, including communities at risk and sensitive municipal watersheds; sensitive natural resources, including critical native plant communities and threatened and endangered species; and other socially important cultural resources.

Hazard Reduction:
Any treatment of a hazard that reduces the threat of ignition and fire intensity or rate of spread

Ladder Fuels:
Fuels which provide vertical continuity between strata, thereby allowing fire to carry from surface fuels into the crowns of trees or shrubs with relative ease. They help start and continue crowning on a fire.

National Environmental Policy Act (NEPA):
NEPA is the basic national law for protection of the environment, passed by Congress in 1969. It sets policy and procedures for environmental protection, and authorizes Environmental Impact Statements and Environmental Assessments to be used as analytical tools to help federal managers make land management decisions.

Prescribed Fire:
Any fire ignited by management actions under certain pre-determined conditions to meet specific objectives related to hazardous fuels reduction or habitat improvement. A written, approved prescribed fire plan must exist, and CEQA and NEPA requirements must be met prior to ignition. Prescribed fires are ignited and managed within a "window" of very specific conditions including winds, temperatures, humidity, and other factors specified in the burn plan. Prescribed fire is also referred to as a "controlled burn" or "prescribed burn".

Prevention:
Activities directed at reducing the incidence of fires, including public education, law enforcement, personal contact, and reduction of fuels hazards.

Wildfire:
Any non-structure fire, other than prescribed fire, that occurs in a wildland area.

Wildland/Urban Interface:
The line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuels. Often incorrectly referred to as the "interzone" or "urban/wildland interfac

ATTACHMENT B: CEQA Environmental Checklist

Instructions

Pages 1-3 are only needed when preparing a "checklist" IS. If the checklist will be used in the CEQA environmental document, proceed directly to Page 4 and use that as the beginning of the checklist and follow the guidance in the annotated outlines. Remove instructions before finalizing.

CEQA Environmental Checklist

PROJECT DESCRIPTION AND BACKGROUND

Project Title:

Lead agency name: **Address:**

Contact person: **Phone number:**

Project sponsor's name: **Address:**

Project Location:

General plan description:

Zoning:

Description of project:

Describe the whole action involved, including but not limited to later phases of the project, and any secondary, support, or off-site features necessary for its implementation.

Surrounding land uses and setting:

Briefly describe the project's surroundings.

Other public agencies whose approval is required (e.g. permits, financial approval, or participation agreements)**:**

NATIVE AMERICAN CONSULTATION

Have California Native American tribes traditionally and culturally affiliated with the project area requested consultation pursuant to Public Resources Code (PRC) section 21080.3.1? ☐ Yes ☐ No

If yes, ensure that consultation and heritage resource confidentiality follow PRC sections 21080.3.1 and 21080.3.2 and California Government Code 65352.4

Note: Conducting consultation early in the CEQA process allows tribal governments, lead agencies, and project proponents to discuss the level of environmental review, identify and address potential adverse impacts to tribal cultural resources, and reduce the potential for delay and conflict in the environmental review process. (See Public Resources Code section 21080.3.2.) Information may also be available from the California Native American Heritage Commission's Sacred Lands File per Public Resources Code section 5097.96 and the California Historical Resources Information System administered by the California Office of Historic Preservation. Please also note that Public Resources Code section 21082.3(c) contains provisions specific to confidentiality.

ENVIRONMENTAL FACTORS POTENTIALLY AFFECTED:

The environmental factors checked below would be potentially affected by this project. Please see the checklist beginning on page 4 for additional information.

- ☐ Aesthetics
- ☐ Agriculture and Forestry
- ☐ Air Quality
- ☐ Biological Resources
- ☐ Cultural Resources
- ☐ Energy
- ☐ Geology/Soils
- ☐ Greenhouse Gas Emissions
- ☐ Hazards and Hazardous Materials
- ☐ Hydrology/Water Quality
- ☐ Land Use/Planning
- ☐ Mineral Resources
- ☐ Noise
- ☐ Population/Housing
- ☐ Public Services
- ☐ Recreation
- ☐ Transportation
- ☐ Tribal Cultural Resources
- ☐ Utilities/Service Systems
- ☐ Wildfire
- ☐ Mandatory Findings of Significance

DETERMINATION

On the basis of this initial evaluation (choose one):

☐ I find that the proposed project COULD NOT have a significant effect on the environment, and a NEGATIVE DECLARATION will be prepared.

☐ I find that although the proposed project could have a significant effect on the environment, there will not be a significant effect in this case because revisions in the project have been made by or agreed to by the project proponent. A MITIGATED NEGATIVE DECLARATION will be prepared.

☐ I find that the proposed project MAY have a significant effect on the environment, and an ENVIRONMENTAL IMPACT REPORT is required.

☐ I find that the proposed project MAY have a "potentially significant impact" or "potentially significant unless mitigated" impact on the environment, but at least one effect 1) has been adequately analyzed in an earlier document pursuant to applicable legal standards, and 2) has been addressed by mitigation measures based on the earlier analysis as described on attached sheets. An ENVIRONMENTAL IMPACT REPORT is required, but it must analyze only the effects that remain to be addressed.

☐ I find that although the proposed project could have a significant effect on the environment, because all potentially significant effects (a) have been analyzed adequately in an earlier EIR or NEGATIVE DECLARATION pursuant to applicable standards, and (b) have been avoided or mitigated pursuant to that earlier EIR or NEGATIVE DECLARATION, including revisions or mitigation measures that are imposed upon the proposed project, nothing further is required.

Print Name	Signature	Date

CEQA Environmental Checklist

DIST-CO-RTE: **PM/PM:** **EA/Project No.:**

This checklist identifies physical, biological, social and economic factors that might be affected by the proposed project. In many cases, background studies performed in connection with the projects indicate no impacts. A NO IMPACT answer in the last column reflects this determination. Where there is a need for clarifying discussion, the discussion is included either following the applicable section of the checklist or is within the body of the environmental document itself. The words "significant" and "significance" used throughout the following checklist are related to CEQA, not NEPA, impacts. The questions in this form are intended to encourage the thoughtful assessment of impacts and do not represent thresholds of significance.

Instructions

Click on "Choose an item" under the CEQA Determination column to select the appropriate significance determination from the drop-down list. If discussions will be included after each resource table, follow the guidance provided in the annotated outlines.

AESTHETICS

Except as provided in Public Resources Code Section 21099, would the project:

Question	CEQA Determination
a) Have a substantial adverse effect on a scenic vista?	Choose an item.
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?	Choose an item.
c) In non-urbanized areas, substantially degrade the existing visual character or quality of public views of the site and its surroundings? (Public views are those that are experienced from a publicly accessible vantage point). If the project is in an urbanized area, would the project conflict with applicable zoning and other regulations governing scenic quality?	Choose an item.
d) Create a new source of substantial light or glare which would adversely affect day or nighttime views in the area?	Choose an item.

AGRICULTURE AND FOREST RESOURCES

In determining whether impacts to agricultural resources are significant environmental effects, lead agencies may refer to the California Agricultural Land Evaluation and Site Assessment Model (1997) prepared by the California Dept. of Conservation as an optional model to use in assessing impacts on agriculture and farmland. In determining whether impacts to forest resources, including timberland, are significant environmental effects, lead agencies may refer to information compiled by the California Department of Forestry and Fire Protection regarding the state's inventory of forest land, including the Forest and Range Assessment Project and the Forest Legacy Assessment Project; and the forest carbon measurement methodology provided in Forest Protocols adopted by the California Air Resources Board. Would the project:

Question	CEQA Determination
a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?	Choose an item.
b) Conflict with existing zoning for agricultural use, or a Williamson Act contract?	Choose an item.
c) Conflict with existing zoning for, or cause rezoning of, forest land (as defined in Public Resources Code section 12220(g)), timberland (as defined by Public Resources Code section 4526), or timberland zoned Timberland Production (as defined by Government Code section 51104(g))?	Choose an item.
d) Result in the loss of forest land or conversion of forest land to non-forest use?	Choose an item.
e) Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland, to non-agricultural use or conversion of forest land to non-forest use?	Choose an item.

AIR QUALITY

Where available, the significance criteria established by the applicable air quality management district or air pollution control district may be relied upon to make the following determinations. Would the project:

Question	CEQA Determination
a) Conflict with or obstruct implementation of the applicable air quality plan?	Choose an item.
b) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard?	Choose an item.
c) Expose sensitive receptors to substantial pollutant concentrations?	Choose an item.
d) Result in other emissions (such as those leading to odors) adversely affecting a substantial number of people?	Choose an item.

BIOLOGICAL RESOURCES

Would the project:

Question	CEQA Determination
a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Wildlife, U.S. Fish and Wildlife Service, or NOAA Fisheries?	Choose an item.
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Wildlife or U.S. Fish and Wildlife Service?	Choose an item.

Question	CEQA Determination
c) Have a substantial adverse effect on state or federally protected wetlands (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?	Choose an item.
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites?	Choose an item.
e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?	Choose an item.
f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?	Choose an item.

CULTURAL RESOURCES

Would the project:

Question	CEQA Determination
a) Cause a substantial adverse change in the significance of a historical resource pursuant to in §15064.5?	Choose an item.
b) Cause a substantial adverse change in the significance of an archaeological resource pursuant to §15064.5?	Choose an item.
c) Disturb any human remains, including those interred outside of dedicated cemeteries?	Choose an item.

ENERGY

Would the project:

Question	CEQA Determination
a) Result in potentially significant environmental impact due to wasteful, inefficient, or unnecessary consumption of energy resources, during project construction or operation?	Choose an item.
b) Conflict with or obstruct a state or local plan for renewable energy or energy efficiency?	Choose an item.

GEOLOGY AND SOILS

Would the project:

Question	CEQA Determination
a) Directly or indirectly cause potential substantial adverse effects, including the risk of loss, injury, or death involving: i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.	Choose an item.
ii) Strong seismic ground shaking?	Choose an item.
iii) Seismic-related ground failure, including liquefaction?	Choose an item.
iv) Landslides?	Choose an item.
b) Result in substantial soil erosion or the loss of topsoil?	Choose an item.
c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction or collapse?	Choose an item.

Question	CEQA Determination
d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial direct or indirect risks to life or property?	Choose an item.
e) Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?	Choose an item.
f) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?	Choose an item.

GREENHOUSE GAS EMISSIONS

Would the project:

Question	CEQA Determination
a) Generate greenhouse gas emissions, either directly or indirectly, that may have a significant impact on the environment?	Choose an item.
b) Conflict with an applicable plan, policy or regulation adopted for the purpose of reducing the emissions of greenhouse gases?	Choose an item.

HAZARDS AND HAZARDOUS MATERIALS

Would the project:

Question	CEQA Determination
a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?	Choose an item.
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?	Choose an item.

Question	CEQA Determination
c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?	Choose an item.
d) Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?	Choose an item.
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard or excessive noise for people residing or working in the project area?	Choose an item.
f) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan?	Choose an item.
g) Expose people or structures, either directly or indirectly, to a significant risk of loss, injury or death involving wildland fires?	Choose an item.

HYDROLOGY AND WATER QUALITY

Would the project:

Question	CEQA Determination
a) Violate any water quality standards or waste discharge requirements or otherwise substantially degrade surface or ground water quality?	Choose an item.
b) Substantially decrease groundwater supplies or interfere substantially with groundwater recharge such the project may impede sustainable groundwater management of the basin?	Choose an item.

Question	CEQA Determination
c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river or through the addition of impervious surfaces, in a manner which would: (i) result in substantial erosion or siltation on- or off-site;	Choose an item.
(ii) substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or offsite;	Choose an item.
(iii) create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff; or	Choose an item.
(iv) impede or redirect flood flows?	Choose an item.
d) In flood hazard, tsunami, or seiche zones, risk release of pollutants due to project inundation?	Choose an item.
e) Conflict with or obstruct implementation of a water quality control plan or sustainable groundwater management plan?	Choose an item.

LAND USE AND PLANNING

Would the project:

Question	CEQA Determination
a) Physically divide an established community?	Choose an item.
b) Cause a significant environmental impact due to a conflict with any land use plan, policy, or regulation adopted for the purpose of avoiding or mitigating an environmental effect?	Choose an item.

MINERAL RESOURCES

Would the project:

Question	CEQA Determination
a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?	Choose an item.
b) Result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?	Choose an item.

NOISE

Would the project result in:

Question	CEQA Determination
a) Generation of a substantial temporary or permanent increase in ambient noise levels in the vicinity of the project in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies?	Choose an item.
b) Generation of excessive groundborne vibration or groundborne noise levels?	Choose an item.
c) For a project located within the vicinity of a private airstrip or an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?	Choose an item.

POPULATION AND HOUSING

Would the project:

Question	CEQA Determination
a) Induce substantial unplanned population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure)?	Choose an item.
b) Displace substantial numbers of existing people or housing, necessitating the construction of replacement housing elsewhere?	Choose an item.

PUBLIC SERVICES

Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the following public services:

Question	CEQA Determination
a) Fire protection?	Choose an item.
b) Police protection?	Choose an item.
c) Schools?	Choose an item.
d) Parks?	Choose an item.
e) Other public facilities?	Choose an item.

RECREATION

Question	CEQA Determination
a) Would the project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?	Choose an item.

Question	CEQA Determination
b) Does the project include recreational facilities or require the construction or expansion of recreational facilities which might have an adverse physical effect on the environment?	Choose an item.

TRANSPORTATION

Would the project:

Question	CEQA Determination
a) Conflict with a program, plan, ordinance, or policy addressing the circulation system, including transit, roadway, bicycle and pedestrian facilities?	Choose an item.
b) Would the project conflict or be inconsistent with CEQA Guidelines section 15064.3, subdivision (b)?	Choose an item.
c) Substantially increase hazards due to a geometric design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?	Choose an item.
d) Result in inadequate emergency access?	Choose an item.

TRIBAL CULTURAL RESOURCES

Would the project cause a substantial adverse change in the significance of a tribal cultural resource, defined in Public Resources Code section 21074 as either a site, feature, place, cultural landscape that is geographically defined in terms of the size and scope of the landscape, sacred place, or object with cultural value to a California Native American tribe, and that is:

Question	CEQA Determination
a) Listed or eligible for listing in the California Register of Historical Resources, or in a local register of historical resources as defined in Public Resources Code section 5020.1(k), or	Choose an item.

Question	CEQA Determination
b) A resource determined by the lead agency, in its discretion and supported by substantial evidence, to be significant pursuant to criteria set forth in subdivision (c) of Public Resources Code Section 5024.1. In applying the criteria set forth in subdivision (c) of Public Resource Code Section 5024.1, the lead agency shall consider the significance of the resource to a California Native American tribe.	Choose an item.

UTILITIES AND SERVICE SYSTEMS

Would the project:

Question	CEQA Determination
a) Require or result in the relocation or construction of new or expanded water, wastewater treatment or storm water drainage, electric power, natural gas, or telecommunications facilities, the construction or relocation of which could cause significant environmental effects?	Choose an item.
b) Have sufficient water supplies available to serve the project and reasonably foreseeable future development during normal, dry and multiple dry years?	Choose an item.
c) Result in a determination by the wastewater treatment provider which serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments?	Choose an item.
d) Generate solid waste in excess of State or local standards, or in excess of the capacity of local infrastructure, or otherwise impair the attainment of solid waste reduction goals?	Choose an item.

Question	CEQA Determination
e) Comply with federal, state, and local management and reduction statutes and regulations related to solid waste?	Choose an item.

WILDFIRE

If located in or near state responsibility areas or lands classified as very high fire hazard severity zones, would the project:

Question	CEQA Determination
a) Substantially impair an adopted emergency response plan or emergency evacuation plan?	Choose an item.
b) Due to slope, prevailing winds, and other factors, exacerbate wildfire risks, and thereby expose project occupants to, pollutant concentrations from a wildfire or the uncontrolled spread of a wildfire?	Choose an item.
c) Require the installation or maintenance of associated infrastructure (such as roads, fuel breaks, emergency water sources, power lines or other utilities) that may exacerbate fire risk or that may result in temporary or ongoing impacts to the environment?	Choose an item.
d) Expose people or structures to significant risks, including downslope or downstream flooding or landslides, as a result of runoff, post-fire slope instability, or drainage changes?	Choose an item.

MANDATORY FINDINGS OF SIGNIFICANCE

Question	CEQA Determination
a) Does the project have the potential to substantially degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, substantially reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?	Choose an item.
b) Does the project have impacts that are individually limited, but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects)?	Choose an item.
c) Does the project have environmental effects which will cause substantial adverse effects on human beings, either directly or indirectly?	Choose an item.

ATTACHMENT C: SUMMARY OF REVISIONS

Guidelines for Determining Significance and Report Format and Content Requirements for Wildland Fire and Fire Protection were originally approved on March 19, 2007. The following is a summary of revisions made since original document approval.

Fourth Revision

- Rhode & Associates rewrote the guideline to meet best practices for wildfire mitigation.
- Additional revisions were made following staff review:
    - Fire history updated and included, including requirement for proposed projects to include
    - Thresholds for Full FPP and Letter FPP
    - Add examples of acceptable and unacceptable alternate methods/means mitigations
    - Clarify requirements for “Shelter in Place”
    - Link to county home hardening website
    - Include “Dead End Road” chart from Chapter 503 of the County Consolidated Fire Code
    - Include the “Travel Time” chart from the Safety Element of the General Plan
    - Clarify that consultants must request addition to the approved consultant to be eligible to prepare a FPP
    - Add criteria for determination of a third-party review of the FPP
    - Add a requirement to include a summary of proposed mitigation measure and overall determination of significance
    - Include CEQA checklist
- blah

Third Revision, XXXXXXX

- Updated to incorporate changes to the County Consolidated Fire Code
- Clarified that a Fire Protection Plan is required for any projects located within High/Very High Fire Hazard Zones
- Clarified that any waivers of standards shall be replaced with an alternative measure that provides the same practical effect
- Various editorial changes

Second Revision, August 31, 2010

- Updated to incorporate changes to the County Consolidated Fire Code
- Improved standards for dead end roads
- Improved standards for Shelter-in-Place
- Various editorial changes

First Revision, December 19, 2008

- Updated to incorporate changes to the Fire Code and the Building Code
- Updated to change California Department of Forestry (CDF) to CAL FIRE
- Added standards for dead end roads
- Various editorial changes

Section IV:

FIRE PROTECTION PLAN GUIDELINES FOR CONSULTANTS

San Diego County Fire Protection District /

County of San Diego Land Use & Environmental Group, Planning & Development Services

County of San Diego
Fire Protection Plan Guidelines for Consultants
DRAFT 3/10/24

ROHDE & ASSOCIATES
WILDFIRE RISK MITIGATION

TABLE OF CONTENTS



INTRODUCTION

1.0 BACKGROUND & INTENT
- 1.1 Wildfire History
- 1.2 Location & Extent/Probability of Occurrence & Magnitude

2.0 INTENT

3.0 PREPARING THE FPP
- 3.1 FPP (Full Report)
- 3.2 FPP (Letter Report)
- 3.3 FPP Development

4.0 FORMAT OF THE FPP

5.0 FPP OUTLINE (Full Report)

6.0 PROCESSING THE FPP

7.0 ALTERNATE MEANS AND METHODS
- 7.1 Emergency Response Related Standards
- 7.2 Community Adaptation Related Standards
- 7.3 Required Findings for Alternatives to Standards
- 7.4 Scenarios where AMMs will not be Considered
- 7.5 Scenarios where AMMs are Unlikely

8.0 COMMENT PERIOD FOR THE FPP

CONTENTS OF THE FPP

9.0 SECTION I: SUMMARY OF REQUIRED TOPICS

10.0 SECTION II: DETAILED REQUIREMENTS FOR THE FPP
- 10.1 VICINITY, SITE AND PROJECT DETAIL AND CEQA IMPACTS
- 10.2 BUILDING CONSTRUCTION
- 10.3 VEGETATION MANAGEMENT
- 10.4 COMMUNITY CRITICAL INFRASTRUCTURE
- 10.5 ACCESS AND EGRESS
- 10.6 COMMUNITY EVACUATION PLANS AND TEMPORARY SAFE REFUGE
- 10.7 WATER SUPPLY
- 10.8 EMERGENCY SERVICES
- 10.9 TRAFFIC ENGINEERING, ROAD STANDARDS, AND CIRCULATION (reserved)
- 10.10 ALTERNATE MEANS AND METHODS
- 10.11 WILDFIRE BEHAVIOR ASSESSMENT

11.0 **LIST OF PREPARERS & PERSONS/ORGANIZATIONS CONTACTED**

12.0 **REFERENCES**

13.0 **TECHNICAL APPENDICES**

14.0 **FPP LETTER**
- 14.1 Project Description
- 14.2 Environmental Setting
- 14.3 Project Exposure to Wildfires
- 14.4 Fire Access Roadways

LIST OF FIGURES

Figure 1: Major Wildfires in San Diego History
Figure 2: Wildfire Risk and Likelihood
Figure 3: Fire Hazard Severity Zone Map
Figure 4: CEQA Wildfire Checklist
Figure 5: Maximum Length of Dead-End Roadways
Figure 6: Measuring Dead-End Roadways
Figure 7: Evacuation Routes
Figure 8: Sample Community Fuel Modification Plan
Figure 9: Defensible Space Zones
Figure 10: Defensible Space Guidance for Fuels
Figure 11: Travel Time Standards from the Closest Fire Station
Figure 12: Climate Zones in San Diego County

LIST OF ATTACHMENTS

Attachment A: Building Materials and Components - Baseline, Enhanced & Optimum Scenarios

Attachment B: Outline for the FPP

BACKGROUND & INTENT

Wildfire is a chief vulnerability affecting development in San Diego County. When areas that were previously wildlands subject to periodic wildfires are developed, combustible structures and densified populations are necessarily introduced, and there may be changes to the threat potential for life and property. These vulnerabilities cannot be entirely eliminated but are significantly mitigated by development standards that require adherence to fire-resistant building codes; the creation and maintenance of fuel modification zones and defensible space; the avoidance of over-densification; the provision of safe and adequate population egress routes and the creation of buffer zones with low combustibility open spaces.

Wildfire History

San Diego County has a significant history of destructive wildfires. San Diego County's third worst wildfire in history, known as the Laguna Fire, destroyed thousands of acres in the backcountry in September of 1970. The fire resulted in the loss or destruction of 383 homes and 1,200 other structures.

In October 2003, the second-worse wild-land fire in the history of San Diego County destroyed 332,766 acres of land, 3,239 structures and 17 deaths at a cost of approximately $450M.

San Diego County's worst wildfire occurred in October 2007. At the height of the firestorm there were seven fires burning within the County. The fires destroyed 369,000 acres (13% of the County), 2,670 structures, 239 vehicles, and two commercial properties. There were 7 civilian deaths, 23 civilian injuries and 10 firefighter injuries. The cost of fire exceeded $1.5 billion.

Wildland fires prompted seven (7) Proclaimed States of Emergency, and Urban/Intermix Fires prompted four (4) Proclaimed States of Emergency in the County of San Diego between 1950-2020. The table below lists the most recent major wildfires in San Diego County (copied from the Multi-Jurisdictional Hazard Mitigation Plan, 2023).

Hazard impacts can include but are not limited to increased flooding risk over burn scar areas, environmental impacts/damage, air quality impacts, loss of resources such as utilities, asset/structure damage and/or total loss, injury, and death.

Each proposed project must include the wildfire history specific to the project vicinity (see Vicinity Description, Section 1A and Attachment B).

FIGURE 1: Major* Wildfires in San Diego History
(*larger than 5,000 acres of resulting in significant structure loss)

Fire	Date	Acres Burned	Structures Destroyed	Structures Damaged	Deaths
Conejos Fire	July 1950	62,000	Not Available	Not Available	0
Laguna Fire	October 1970	190,000	382	Not Available	5
Harmony Fire (Carlsbad, Elfin Forest, San Marcos)	October 1996	8,600	122	142	1
Viejas Fire	January 2001	10,353	23	6	0
Gavilan Fire (Fallbrook)	February 2002	6,000	43	13	0
Pines Fire (Julian, Ranchita)	July 2002	61,690	45	121	0
Cedar Fire	October 2003	280,278	5,171	63	14
Paradise Fire	October 2003	57,000	415	15	2
Otay Fire	October 2003	46,291	6	0	0
Roblar (Pendleton)	October 2003	8,592	0	0	0
Mataguay Fire*	July 2004	8,867	2	0	0
Horse Fire*	July 2006	16,681	Not Available	Not Available	0
Witch Creek Fire*	October 2007	197,990	1,125	77	2
Harris Fire*	October 2007	90,440	255	12	5
Poomacha Fire*	October 2007	49,410	139	Not Available	0
Ammo Fire*	October 2007	21,004	Not Available	Not Available	0
Rice Fire*	October 2007	9,472	208	Not Available	0
May 2014 San Diego County Wildfires	May 2014	26,000	65	19	0
Border Fire	June 2016	7,609	18	4	2
Lilac Fire	December 2017	4,100	157	64	0
West Fire	July 2018	504	48	Not Available	0
Valley Fire	September 2020	16,390	66	Not Available	0
Southern Fire	May 2021	5,366	5	Not Available	0
Border 32 Fire	September 2022	4,456	14	Not Available	0

** Information gathered from the California Department of Forestry and Fire Protection website*

Location & Extent/Probability of Occurrence & Magnitude

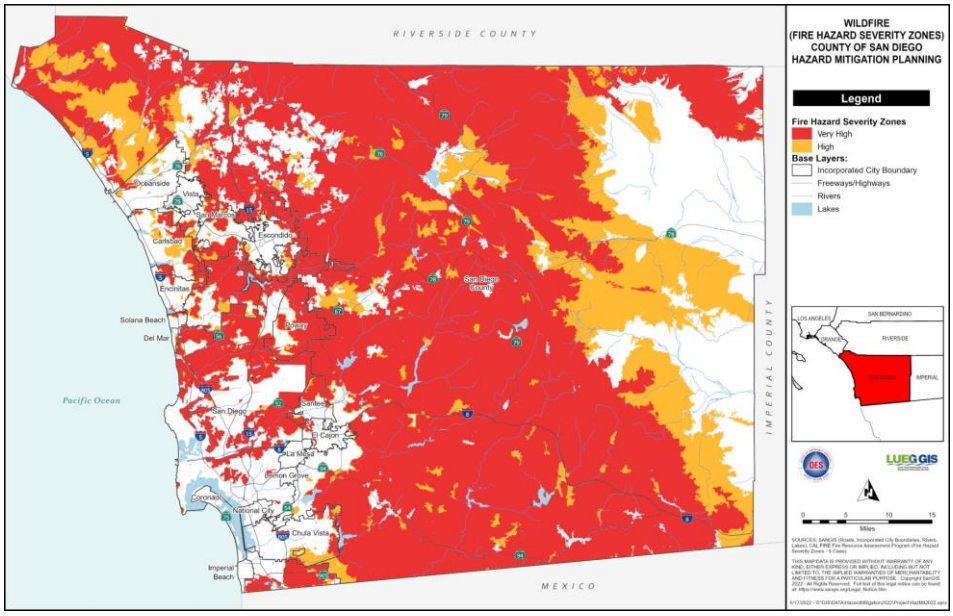
The USDA Forest Service also assesses wildfire risk nationally and states San Diego County has a very high risk of wildfire – higher than 95% of counties in the US: (https://wildfirerisk.org/wp-content/uploads/2020/04/WRC-Info-Sheet-2020-04.pdf)

FIGURE 2: Wildfire Risk and Likelihood



The wildfire maps use the CAL Fire Resource Assessment Program data for Fire Hazard Severity Zones. For the purpose of these guidelines, all zones are created equal:

FIGURE 3: Wildfire Hazard Severity Zone Map



Under current climate conditions, the wildfire threat to property, lives, and ecosystems in the San Diego region is very high. With hotter temperatures and possibly fewer rainy days in the coming decades, vegetation could become drier. As a result, it is likely that San Diego region will see an increase in the frequency and intensity of fires, making the region more vulnerable to devastating fires like the ones seen in 2003 and 2007. The fire season could also become longer and less predictable, making firefighting efforts more costly.

From May to October of each year, San Diego County faces a severe wildfire threat. Fires will continue to occur on an almost annual basis in the San Diego County Area. The threat of wildfire and potential losses consistently increase as human development and population increase in the wildland urban interface area in the County. According to the Cal Fire Redbook, there have been 1,113 wildfires recorded for San Diego County between 2015 and 2021. Based on climate and weather in San Diego County and the fuels, topography, past fire history, and the Cal Fire Redbook which indicates an average of 159 wildfires per year, the probability of future wildfire events are considered “Highly Likely”.

The effective use of wildfire hazard information in the early planning or entitlement phases of new development is critical to allowing the county to more comprehensively plan and design against potential loss of life, property, or other assets. It is fundamental that the evaluation of wildfire hazard conditions is not only conducted at the parcel level, but also the subdivision and community scales. The maps resulting from a wildfire hazard assessment can help communities to:

- decide where development should be encouraged or avoided;
- justify where regulations may be applied differently across the landscape;
- establish authority to make codes enforceable;
- require adequate fire protection standards;
- identify permitted and conditional land uses in higher risk areas;
- prioritize fuel reduction efforts;
- educate and communicate risk to the public; and
- empower county and city staff to act.

INTENT

A Fire Protection Plan (FPP) is a document that describes the level of fire hazard that would affect or be caused by a proposed development and the methods proposed to minimize or mitigate that hazard. The FPP also evaluates the consistency of the proposed project with applicable fire protection regulations, and the ability of emergency services to provide fire and life protection. To minimize hazards and meet fire code requirements, the FPP may include recommendations that involve limitations on future land use on the subject property, building construction standards, vegetation management, access improvements, installation of fire suppression facilities, and other design measures. The FPP must include measures to address the specific location, topography, geology, level of flammable vegetation and climate of the proposed project site. The FPP must be prepared consistent with applicable fire codes and be accepted by the FAHJ and County. The plan must demonstrate compliance with the applicable fire code or how the measures proposed to reduce fire hazards are adequate to meet the intent of the code. The following elements must be addressed in a FPP required as part of the review of a discretionary permit application:

- Wildfire hazard and risk assessment
- Siting of development
- Housing density considerations
- Construction
- Access, egress, and evacuation planning
- Water sources for firefighting
- Subdivision landscaping and vegetation management
- Protection of critical infrastructure
- Emergency Services - Availability and Travel Time

The FPP is also required by County Policy found in the Safety Element, Chapter 7 and is used to demonstrate fire safety compliance in accordance with requirements of the California Environmental Quality Act.

Fire risk mitigation considerations that are required to be detailed within the FPP are identified below and includes discussions on relevant fire and building codes, CEQA compliance, and standards that are used to ensure compliance with the regulations. Failure to comply with either the fire code/regulations or the standards may result in a potentially significant impact, or a recommendation against permitting.

Wildland fire mitigation measures and design considerations decided in the planning and land use approval process vary depending on the wildland characteristics of the site and surrounding area. In order to incorporate appropriate site specificity into project design and code compliance, the submitted FPP will be relied upon by both planners and stakeholders to understand the unique characteristics of described projects. Professional technical judgement and code interpretation will arise from information presented in the FPP. For this reason, it is essential that FPP preparers complete a rich and detailed document that accurately and robustly describes the project.

PREPARING THE FPP

The Fire Protection Plan (FPP) shall follow the formats and guidance in this document, including the outline provided in Attachment B. The overall length of the FPP and the amount of information included will vary depending on the size and scope of the project and associated environmental characteristics. Project applicants frequently utilize consultants to prepare the FPP/Full Report. All consultants must be listed on the County of San Diego CEQU Consultant List for Fire Protection Plans to be eligible to prepare a FPP. (https://www.sandiegocounty.gov/content/dam/sdc/pds/ProjectPlanning/docs/CeqaConsultantsList.pdf)

FPP (Full Report)

A FPP shall be prepared for projects located within High and/or Very High Fire Hazard Severity Zones as identified in the map adopted by the State Fire Marshal. A FPP is also required for large projects (an occupant load of 100 or more) or where the site has topographic, geographic, and/or combustible vegetation conditions that require detailed review and analysis, regardless of zone.

- **Third Party Review**
  The County/Fire Marshal may require review of the completed FPP by a third-party independent contractor, approved by the County and paid by the proponent. Determination of the need for third-party review is based on the scope, scale, and complexity of the project and is at the sole discretion of the County/Fire Marshal.
- **Fire Fuel Assessment (Fire Behavior Model)**
  Fire Behavior Modeling shall be conducted for projects located within High and/or Very High Fire Hazard Severity Zones as identified in the map adopted by the State Fire Marshal, and may be required in other areas in conjunction with a FPP (Full Report) for large projects and/or projects with high fuel loads and/or steep topography.

FPP (Letter Report)

A FPP – Letter Report may be authorized by the Fire Authority Having Jurisdiction (FAHJ) for infill projects with no wildlands in the immediate vicinity or low hazard commercial projects in Moderate Fire Hazard Severity Zones.

The FPP – Letter Report is a simple narrative documenting site information and fire code compliance and is not intended to require the services of a Fire Consultant. If, upon review of the FPP – Letter Report, code issues are determined to be unresolved or inadequately addressed, a FPP Full Report will be required.

The FAHJ may also waive FPP requirements altogether if the wildfire risk is determined to minimal. This determination may be based on the fire hazard rating for the area as well as occupancy classification and construction type of the proposed project.

FPP Development

Development of the FPP shall follow these general steps.

1. The applicant shall consult with Public Works and the Fire Authority Having Jurisdiction (FAHJ) regarding, but not be limited to, an evaluation of slope, aspect, fire topography, fire history/potential, habitat, adjacent properties (existing structures, fuel modification, habitat, parkland status), existing vegetation, fuel modification, type of plants to be planted on site, fire hydrant locations and fire flows, and access standards (e.g., width, grade, slope, paving, overhead clearance).
    - After consulting with Public Works and the FAHJ, the applicant shall prepare all necessary plans, including but not limited to a site plan for the proposed project that includes all mitigation measures necessary to comply with the recommendations and requirements of those agencies. The site plan shall show all aspects of development including, but not limited to, grading, construction of retaining walls or flood control devices, fuel modification areas, accessways, water lines, and irrigation systems necessary to mitigate any hazards on the property.
2. All new development shall be sized, sited, and designed to minimize risks to life and property from fire hazard, considering changes to fire risk caused by increasing global temperatures. In addition, all new development shall comply with the following requirements:
    - New development shall be required to use design and construction techniques and materials that minimize risks to life and property from fire hazard. Structures shall be constructed with appropriate features and building materials, including but not limited to fire-resistant exterior materials, windows and roofing; and eaves and vents that resist the intrusion of flame and burning embers. Development sites and structures shall be located off ridgelines and other dangerous topographic features such as chimneys, steep draws, and saddles.
    - New development shall incorporate fuel modification and brush clearance techniques and shall be designed and carried out to minimize clearance of natural vegetation and reduce impacts to sensitive natural habitat to the maximum extent feasible.
    - New development shall provide for emergency vehicle access and adequate fire-flow water supply in compliance with applicable fire safety regulations. Development in areas with insufficient access, water pressure, fire flows, or other accepted means for adequate fire protection shall be prohibited.
    - Prior to development approval, all new development shall demonstrate the availability of an adequate water supply for fire protection in compliance with applicable fire safety regulations. Where feasible, alternative water resources for fire-fighting purposes shall be maintained on development sites. Water tanks shall be sized consistent with County minimum requirements and clustered with approved structures.

- Residential structures shall be clustered to provide for more localized and effective fire protection measures such as consolidation of required fuel modification and brush clearance, fire break maintenance, firefighting equipment access, and water service. Structures shall also be located along a certified all-weather accessible road, which in some cases may consist of permeable surfaces, in a manner that provides firefighters adequate vehicle turnaround space on private properties. Where feasible, new development shall be accessed from existing roads.

3. As a condition of approval of new development within or adjacent to an area subject to high wildfire hazards, prior to development approval, the property owner shall be required to submit a signed document that shall indemnify and hold harmless the County, its officers, agents, and employees against any and all claims, demands, damages, costs, and expenses of liability arising out of the acquisition, design, construction, operation, maintenance, existence, or failure of the permitted project in an FHSZ.

FORMAT OF THE FPP

Unless an exception is granted by the County and FAHJ, the draft FPP shall have the components described in this Report Format and FPP content requirements. The report shall follow the outline provided in **Attachment B**.

- Documents that do not contain all mandatory sections will not be accepted as complete, unless the exception is approved by the Director, PDS and the FAHJ.
- The FPP shall be drafted in Microsoft Word (2003 version or later) in digital format. (County staff may also request PDF format in addition to digital versions)
- The length of the FPP shall be kept to a minimum and only contain what is required to accurately and factually convey legally required data and rational.
- The draft FPP must be properly edited for correct format, spelling, grammar, page numbering, internal consistency and other editorial matters. It must also be consistent with project submittals. The draft FPP must be prepared in a clear format, written in clear language for review and understanding by decision-makers and the public (see CEQA Guidelines, § 15140). Complex and extremely analytical materials must be summarized and simplified, with the details and harder to comprehend materials placed in the technical appendices. The document should be technical in nature but summarized where possible for clarity.
- The draft FPP must be written in a factual and objective manner. The document must provide a good-faith effort of full disclosure (e.g., if code requirements are not met, that information must be stated, accompanied by proposed mitigation measures).

- The draft FPP must cite all documents used in its preparation including, the section number of any relevant codes or regulations. Other documents may be incorporated by reference, provided that the referenced document is summarized in the draft FPP and is made available for public inspection at a public place identified in the draft FPP, which shall include a County office.
- The FPP must be inclusive of project data sufficient for the FAHJ to understand the full complexity of the project, the development site, and associated fire risks.
- Use consistent terminology and cite applicable policy and regulation as appropriate.
- All plot plans and maps must be to standard engineering scale and contain a North arrow and both number and bar scales and clearly legible.
- In draft copies of the report, all changes made in response to staff comments must be shown in strikeout/underline form. "Strikeout/underline" draft and "clean" copies should be submitted simultaneously. Final copies of the report must be clean, with all editing marks removed.
- The Draft FPP will be reviewed for technical accuracy and completeness by a County Fire Code Specialist and the FAHJ's Fire Marshal. The plan is considered to be draft until County staff determines the report to be complete.
- The FPP shall use mandatory, not permissive language, as the document will be binding on the project if the project is approved.

FPP OUTLINE (Full Report, See ATTACHMENT B)

Binder Cover and Cover Page

The Cover Page of the FPP shall include the following information:

- Project common name
- Project application numbers. Must include all associated discretionary permit numbers (e.g.TM XXXX, TPM XXXXX, ZAPXX-XXX) and the environmental log number (Log No. XX-XX-XXX)
- Date of the original report, followed by the date(s) of all iterations
- Principal author's name, firm name and address
- Signature of principal author
- Project applicants' names and addresses
- A statement that reads: "*Prepared for the County of San Diego*"
- Color photo of the project site

Table of Contents

The table of contents must follow the order and format outlined in this document. Page numbers should be assigned when possible. Titles of each attachment/appendix should be listed in the order in which they are found in the document. The Table of Contents must be formatted in the following manner:

Example:

CHAPTER I. CHAPTERS SHALL BE SPECIFIED BY NUMBER AND SHALL BE PRESENTED IN BOLD AND IN ALL CAPS

I.I First level subchapters shall be specified by number and shall be presented in upper and lower case, bold, and underlined

I.I.I Second level subchapters shall be specified by number and shall be presented in upper and lower case, and bold.

I.I.I.I Third level subchapters shall be specified by number and shall be presented in upper and lower case, italics, and bold.

Executive Summary

The purpose of the Executive Summary is to provide a quick reference for the public and decision-makers. Therefore, the language should be less technical than that used in the remainder of the document and should be no more than one page in length. The Executive Summery should include a brief summary of the project, associated wildfire risks and proposed mitigation. No information should be provided in the summary that is not further explained elsewhere in the document.

Every FPP shall include the following introductory language:

*"This FPP has been prepared for the (**insert common name of the project here**). The purpose of the FPP is to assess the potential impacts resulting from wildland fire hazards and identify the measures necessary to adequately mitigate those impacts.*

As part of the assessment, the plan has considered the property location, topography, aspect, geology, combustible vegetation (fuel types), climatic conditions, and fire history.

The plan addresses water supply, access (including secondary/emergency access where applicable), structural ignitability and fire resistive building features, fire protection systems and equipment, impacts to existing emergency services, defensible space, and vegetation management.

The plan identifies and prioritizes areas for hazardous fuel reduction treatments and recommends the types and methods of treatment that will protect one or more at-risk communities and essential infrastructures. The plan recommends measures that property owners will take to reduce the probability of ignition of structures throughout the area addressed by the plan".

PROCESSING THE FPP

FPP preparers should work with the local FAHJ for the proposed project site. Once the FPP is prepared and submitted to the local fire agency, it will be reviewed for compliance with all applicable ordinances and regulations. If practical difficulties in achieving compliance have been identified and modifications or alternate methods are proposed, they must also be evaluated by the FAHJ. If the FAHJ determines that the plan is incomplete or inadequate, it should be sent back to the preparer with a letter of explanation for the determination.

Concurrent with the process at the local FAHJ, the County PDS will also review the plan. The plan will be reviewed for completeness and code compliance. If the plan is found to be complete, code compliant and to have been accepted by the FAHJ, an acceptance letter will be prepared. If the plan is found to be incomplete, to be inconsistent with code requirements or not to have been accepted by the FAHJ, PDS will not accept the plan. The County Consolidated Fire Code includes a procedure for appealing the decision of the FAHJ relating to the application of the applicable fire code.

ALTERNATE MEANS AND METHODS

The project, through its FPP, may propose modifications to code compliance (known as "Alternative Means or Methods" or AMM) due to practical difficulties in meeting the code. Consideration of an AMM by the FAHJ requires the following conditions:

- Site specific and compelling reasons make compliance with the strict letter of the code requirements impracticable.
- The proposed modification complies with the intent of the code.
- The proposed modification provides the same practical effect
- The proposed modification does not lessen compliance with the intent of the code

AMM's must be site specific, often detailed lot-by-lot, and are considered for their effectiveness against site specific risks. The FPP must detail why compliance with the code is unachievable, must identify the proposed siting of the AMM by a map or other display, and must provide a rational for use of the AMM on the site in question.

Due to unique site characteristics, there may also be combinations of site/project improvements and opportunities that make adequate mitigation achievable when standards cannot be met. The standards listed below are considered a "starting point". Nothing in these standards precludes a FAHJ and/or the County from identifying other measures that would adequately mitigate unique site characteristics/conditions. Any exceptions under the code shall be replaced with an alternative measure that provides the same practical effect.

Emergency Response Related Standards

- The type and number of fire apparatus available to serve the project are reliable, well-staffed and redundant. Examples include multiple engines with full-time career or reserve staff, with travel times approximating the "first–in" engine.

- Adequate funding is legally committed in perpetuity to the fire authority for staffing inspections, enforcement and educational programs.
- Adequate road widening and improved road surfacing that generally improves the access to the subject property and surrounding uses.
- The project is supported with a public water system with fire hydrants along access roads at reduced distances and with at least a fire flow of 2,500 gallons per minute.
- Security (privacy) gates or other types of barricades are generally discouraged as they can obstruct civilian egress and responder ingress during a fire emergency. However, in certain circumstances, gates can be allowed if they provide a rapid and reliable means of firefighter ingress and unobstructed egress for civilian evacuation as determined by the FAHJ. Refer to section 5.2.1.2 of these guidelines.
- The project provides funding in perpetuity to support adequate fire agency staffing for fire suppression, fire code enforcement and community safety education. An example would be the establishment of a Community Facilities District to assist in the long-term funding of fire district operations and management.

Community Adaptation Related Standards

- The project is in a developed area or an area with long-standing agricultural operations.
- Adequate Fuel Modification separates the project and open space/wildland areas, including vegetation with low probability of ignition, rapid spread, or high intensity around project access points.
- Siting configurations meet the most recent scientific findings for fire spread.
- Construction standards meet the most recent scientific findings for ignition resistance (see table in Figure xx) and/or spacing.
- The number of lots that can be located on a single point of access are limited.
    - 150 dwelling units where the restriction is designed to be permanent and the street or street system does not traverse a wildland area which is subject to hazard from brush or forest fire;
    - 75 dwelling units where the restriction is designed to be permanent and the street or street system traverses a wildland area which is subject to hazard from brush or forest fire;
    - 300 dwelling units, where the restriction is subject to removal through future development.

If the roadway paving on that portion of the street or street system forming the restriction is less than 36 feet in width and is not to be widened to 36 feet or more as a part of the development of the division of land, the permitted number of dwelling units shall be reduced by 25 percent if the pavement is 28 feet or more in width, and by 50 percent if the pavement is less than 28 feet in width. If the roadway paving on that portion of the street or street system forming the restriction is 64 feet or more in width and the restriction is subject to removal through future development, the permitted number of dwelling units may be increased to 600. In no event shall the pavement width be less than 20 feet.

Required Findings for Alternatives to Standards

Certain site-specific situations may make the strict adherence to the County Consolidated Fire Code either impracticable or infeasible. If a modification is proposed, the requirements of the County Consolidated Fire Code specific to modifications apply. The fire code official is authorized to approve a modification to the fire code requirements when the proposed modification is supported by the following "findings":

- Special circumstances make the strict letter of the code impracticable;
- The modification is in compliance with the intent and purpose of the code, and provides the same practical effect;
- Such modification does not lessen health, life, and fire safety standards;
- Specific section(s) for which a modification is requested;
- Material facts supporting the need for a modification;
- Details of the modification or mitigating measure proposed, and if applicable, a map showing the proposed location of the modification or mitigation measures;
- The modification is documented in the FPP and separated provided to the FAHJ.

Scenarios where AMMs will not be Considered:

The following safety requirements are critical and alternatives will not be considered:

- Defensible space conditions within 0-5 feet of a structure and 5-50 feet of a structure
- Evacuation route roads that are paved and meet public road standards with 24-hour guaranteed access

Scenarios where AMMs are Unlikely:

Alternate measures that do not exceed the level of safety provided by the requirements of the adopted plans, codes, and regulations, will not be approved. There also may be situations where a combination of site conditions/constraints, such as those listed below, are so severe that it is unlikely that sufficient mitigation could be provided. In such scenarios, projects may result in a significant impact:

- Project site is surrounded by large wildland areas with little existing or planned surrounding development.

- The primary access road is substandard with no proposal to adequately/reasonably improve it.
- Project site is surrounded by steep slopes and significant topographical constraints that could intensify fire behavior or limit fire suppression operational flexibility.
- Legal access rights have not been obtained for the primary access road and any necessary secondary access road.
- Fire stations available to serve the project site are located substantial distances from the project site such that response by multiple units is significantly delayed.
- The available water supply for fire suppression is limited to tanks, pools or ponds that have limited capacity and require pumping operations.

The FAHJ will review AMM requests and determine if they are in agreement with the identified site constraints and proposed mitigations. If so determined, the FAHJ must process a letter to the project applicant and County PDS accepting the AMM in consideration of the four factors cited above and grant the exception. Should the FAHJ determine not to grant the exception, the applicant and County must also receive that decision in writing along with the reasons for the determination. The project applicant may appeal the decision in accordance with appeal provisions in the County Consolidated Fire Code.

COMMENT PERIOD FOR THE FPP

The County PDS will designate a comment period following receipt of a project's filing and FPP, allowing sufficient time for the FAHJ to review and comment on the proposed project and associated Fire Protection Plan. The County PDS and its fire agencies will work cooperatively in the review of these documents. Should the FAHJ elect to provide no comment during the specified comment period, the County will advise decision makers of the lack of comment by the FAH.

CONTENT OF THE FPP

The FPP content is summarized in Section I and detailed in Section II of this document.

SECTION I: SUMMARY OF REQUIRED TOPICS

The contents of the FPP are outlined in the County Consolidated Fire Code (CCFC). The following summarizes elements that must be addressed in a FPP as part of the review of the discretionary permit application:

Vicinity, Site and Project Description and CEQA Impacts

a. Vicinity Description: Information on adjoining properties on all sides
   - Current land uses
   - Existing structures and densities
   - Planned construction
   - Natural vegetation
   - Environmental restoration plans
   - Roads and parks

- Fire history (fire names, acreage burned, structure lost, etc.).

b. Site Description
   - Site and regional topographic, and aerial maps
   - A detailed 8.5”x11” or 11”x17” copy of the proposed subdivision map
   - Lot location map and development layout
   - Legal descriptions of the development property
   - Location of project relative to High or Very High Fire Hazard Severity Zone
   - Description of site topography and geology
   - Description of current site vegetative cover
   - Current ownership and land use
   - Description of neighboring/regional character

c. Project Description: A detailed description of all project components including;
   - Size of the project site and area of proposed development
   - Purpose and scale of proposed uses (residential, commercial, etc.)
   - Number, size, and purpose of proposed structures
   - Size of the structures
   - Location of all easements
   - Off-site improvements, roads utility corridors, and other features
   - Existing fire stations or other public facilities

d. The applicant should provide a narrative of anticipated fire behavior in the project vicinity including:
   - Fire history
   - Fuels
   - Terrain
   - Weather
   - Intensity, both before and after mitigation (if any).

   This narrative should include a brief summary of fire behavior modeling results and set the tone for project analysis and mitigation measures that follow.

e. CEQA Determination of Significance (see excerpt from *Appendix G Environmental Checklist* below)
   - Thresholds of Significance-List the thresholds for significance applicable to the project
   - Significant Impacts-The project shall summarize any significant impacts identified through the FPP’s detailed assessment, and any applicable mitigations.

FIGURE 4: CEQA Wildfire Checklist

XX. WILDFIRE. If located in or near state responsibility areas or lands classified as very high fire hazard severity zones, would the project:					
a)	Substantially impair an adopted emergency response plan or emergency evacuation plan?	☐	☐	☐	☐
b)	Due to slope, prevailing winds, and other factors, exacerbate wildfire risks, and thereby expose project occupants to pollutant concentrations from a wildfire or the uncontrolled spread of a wildfire?	☐	☐	☐	☐
c)	Require the installation or maintenance of associated infrastructure (such as roads, fuel breaks, emergency water sources, power lines or other utilities) that may exacerbate fire risk or that may result in temporary or ongoing impacts to the environment?	☐	☐	☐	☐
d)	Expose people or structures to significant risks, including downslope or downstream flooding or landslides, as a result of runoff, post-fire slope instability, or drainage changes?	☐	☐	☐	☐

Building Construction Standards and Requirements

a. Discuss methodology for compliance with Fire and Building Code
b. Identify ignition resistant construction methods and practices, including hardening against ember cast and ignition
c. Discuss use of fire sprinkler systems
d. Discuss fire resistiveness of attic vents
e. Discuss site layout and placement of structural development in relation to topography
f. Propose additional enhancements to mitigate severe fire hazards, as required
g. Discuss development and yard limitations required for fire safety
h. Discuss structural spacing and density and any means utilized to prevent fire transmission between structures.

Also see the San Diego Home Hardening Initiative information at: https://www.sandiegocounty.gov/content/sdc/sdcfa/crr/ca-wildfire-mitigation-program-.html

Vegetation Management

a. Identify native fuel conditions for the site and within one-mile of the project perimeter
b. Discuss fuel modification to protect the community
c. Discuss defensible space for structural development, including design
d. Detail defensible space for structure within 0-5 feet, 5-50 feet, and from 50-100 feet of all proposed structures.
e. Discuss fuel modification necessary to protect principle transit/evacuation routes and temporary safe refuge sites
f. Detail use of approved fire resistive plant pallet for ornamental planting and landscapes (fuel modification and defensible space)
g. Discuss maintenance methods, frequency and responsibility for fuel modification and defensible space

Community Critical Infrastructure:

a. Discuss fire hardening of water, telecommunications, and electrical distribution, storage, and transfer systems

b. Discuss utilities maintenance responsibility and targets for fire risk mitigation
c. Discuss the proposed development or utilization of any alternate energy technologies including solar, wind, battery, or other power supply, and associated fire risk mitigation.

Access and Egress:

a. Detail availability for simultaneous access and egress by emergency responders and evacuees
b. Present at least two routes of emergency access egress (unless condition is waived by FAHJ/Director-PDS/LUEG
c. Identify project proposed gating, gate staffing, and emergency access controls,
d. Discuss dimensions, grades, and design of principle circulation and roads, cul-de-sacs, turn-arounds, parking controls and ensure emergency vehicle access.
e. Identify any traffic calming features and potential impacts to emergency response and/or evacuation
f. Identify principal escape routes (must be built to County road standards and have 24hr. civilian Access, and assured power supply if gated)
g. Discuss of proposed evacuation routing is shared with any adjacent communities and identify potential impacts from joint and simultaneous use

Community Evacuation Plan and Temporary Safe Refuge

a. Plan for communicating wildfire emergency alerting
b. Plan for management of infirmed or disabled populations
c. Plan for Temporary safe refuge if evacuation cannot be completed safely, including location, access, and capacity
d. Plan for maintenance and dissemination to community of evacuation plan
e. Identify evacuation target locations and distances from the proposed development. Discuss wildfire entrapment potential on these routes, if any.
f. Identify community internet and cellular access for emergency notification

Water Supply

a. Detail fire suppression water supply distribution systems, reservoirs, and relate facilities
b. Describe fuel modification and facility hardening for critical water facilities
c. Identify any development areas that require pumping or lift to obtain fire flows and emergency redundancies
d. Identify water sources (groundwater, regional water systems, desalination, etc.
e. Identify and map water pressure, and hydrant placement and spacing,
f. Identify capacity of reservoirs and duration of fire flow
g. Ensure a minimum of 2,500 GPM fire flow from all fire hydrants

Emergency Services

Analysis of existing fire and emergency medical services capability to serve new development, and identification of new, development driven needs and proposed mitigations (if any)

Traffic Engineering, Road Standards, and Circulation

(This area is reserved for future study and requirements)

Alternative Means and Methods (AMM):

a. Identify the specific location, intent, and mitigation provided by any requested "Alternate Means and Methods", cite the fire or building code requirement involved, and discuss why strict compliance may not be achieved.
b. Include a site map demonstrating the placement of the AMM
c. Present AMM requests on a site specific or lot-by lot basis only

Wildfire Behavior Assessment

a. Description of wildfire history and trajectory within 5 miles of the development site
b. Description of 20-year average weather and climate conditions affecting wildfire behavior, including analysis of dominant weather conditions and Santa Ana wind episodes
c. Description of native fuels condition on the site both pre and post development
d. Describe the geographic features within and adjacent to the development site affecting wildfire behavior.
e. Complete fire behavior modeling for the development site to include vegetated areas up to one mile from the project perimeter. Complete modeling per this guidance in this document.

SECTION II – DETAILED REQUIREMENTS FOR FPP 5

The following sections detail the requirements and expectations for FPP development:

VICINITY, SITE AND PROJECT DESCRIPTION AND CEQA IMPACTS

a. Site and regional topographic, and aerial maps should be provided for the site, demonstrating both the current and proposed condition, including development layout. A lot map should be included with development layout
b. Provide the legal descriptions of the development property
c. Provide a description of site topography and geology
d. Provide a description of the current vegetative cover, including age, health, continuity, size, and type
e. Provide current land ownership and land use descriptions
f. Provide a description of neighboring/regional character
g. Describe the project's location relative to the San Diego County designated Fire Hazard Zones: https://www.sandiego.gov/fire/services/brush/severityzones
h. The size of project area and area proposed for development should be described
i. State the purpose and scale of the proposed use (i.e.: residential, commercial, etc.)
j. Identify all easements within the proposed development including open space, utilities, roads, limited building zones, etc.
k. Describe any proposed open space or riparian areas within the development site and any plans for retention of these areas.
l. Identify off-site improvements such as roads or utilities and how they will be affected or integrated into the project.

m. Identify public facilities within the proposed development (example: existing fire stations).
n. Evaluate project compliance with CEQA Significance Guidelines and thresholds
o. Summarize potential impacts exceeding CEQA identified thresholds as are determined or stated in the FPP and identify proposed mitigations. For each significant impact, determine if the proposed mitigation measures have reduced the significance level to "less than significant" in accordance with the stated Significance Guidelines and, if so, explain why.

Setbacks

Title 14/Fire Safe Regulations includes, in Section 1276.02, requirements related to ridgelines.

a. The Local Jurisdiction shall identify Strategic Ridgelines, if any, to reduce fire risk and improve fire protection through an assessment of the following factors:
    1) Topography;
    2) Vegetation;
    3) Proximity to any existing or proposed residential, commercial, or industrial land uses;
    4) Construction where mass grading may significantly alter the topography resulting in the elimination of Ridgeline fire risks;
    5) Ability to support effective fire suppression; and
        (a) Other factors, if any, deemed relevant by the Local Jurisdiction.
        (b) Preservation of Undeveloped Ridgelines identified as strategically important shall be required pursuant to this section.
        (c) New Buildings on Undeveloped Ridgelines identified as strategically important are prohibited, as described in subsections (c)(1), (c)(2), and (c)(3).
    6) New Residential Units are prohibited within or at the top of drainages or other topographic features common to Ridgelines that act as chimneys to funnel convective heat from Wildfires.
    7) Nothing in this subsection shall be construed to alter the extent to which utility infrastructure, including but not limited to wireless telecommunications facilities, as defined in Government Code section 65850.6, subdivision (d)(2), or Storage Group S or Utility and Miscellaneous Group U Structures, may be constructed on Undeveloped Ridgelines.
    8) Local Jurisdictions may approve Buildings on Strategic Ridgelines where Development activities such as mass grading will significantly alter the topography that results in the elimination of Ridgeline fire risks.
    9) The Local Jurisdiction may implement further specific requirements to preserve Undeveloped Ridgelines.

The County Fire Code also has requirements for setbacks adjacent to protected areas. Buildings and structures shall be setback a minimum of 100 feet from any property line adjacent to a national forest, state park or open space preserve. This setback may be reduced when existing permitted buildings and structures are located within 100 feet of the property line or additional mitigation measures are employed that are satisfactory to both the FAHJ and the building official.

CEQA

A CEQA mandatory "finding of significance" is required if the project has the potential to substantially change or degrade the quality of the environment, habitat, fish and wildlife, or plant populations, or substantially remove or restrict the range of threatened, endangered, or sensitive species, affect human beings either directly or indirectly, or eliminates important examples of California pre-history. The project must consider both direct impacts and the effects of area incremental development. (California Environmental Quality Act Public Resources Code, section 21000 et seq. CEQA).

In the opinion of the California Attorney General (CAG, 2022), CEQA requires an analysis of "any significant environmental effects the project might cause or risk exacerbation by bringing development and people into the area affected," including by locating development in wildfire risk areas and must consider whether a project will "expose people or structures, either directly or indirectly, to a significant risk of loss, injury or death involving wildland fires." The CAG indicates that three factors must be included in the analysis; project density, project location in the landscape, and water supply and associated infrastructure.

The following general guidance for siting a subdivision or development can reduce project significance relative to CEQA, as well as assist in mitigating wildfire risk:

- Avoid selecting a construction site along a gully or in a narrow canyon
- Avoid selecting a construction site in or adjacent to a saddle or narrow mountain pass
- Avoid impacts to nature reserves, conservancies, similar public lands
- Avoid constructing a new development adjacent to or on a steep slope. If a ridgetop site is selected, consider the following:
    - Choose an area that allows for a minimum 30–100-foot setback from wildland vegetation on the downslope side.
    - Increase the setback at sites with heavier fuels such as in a forested environment.
    - Develop a fuel modification and long-term vegetation management plan for the steep slopes proximate to the development site. Given specific topographic and vegetative conditions more than 100 feet of defensible space will likely be needed. In some jurisdictions, this can be as much as 200+ feet (e.g., Los Angeles County and Orange County).
- Avoid constructing a new development adjacent to an unmanaged open or wildland space where 50 to 100 feet of defensible space cannot be provided on the proposed site. If a site is selected that is proximate to an unmanaged open or wildland space, consider the following design features:
    - Integrate inherent fuel breaks such as fruit orchards, irrigated landscaping/greenbelts, golf course or other similar low-wildfire hazard features.
    - Consider providing increased structural hardening measures for structures proximate to the open or wildland space such as 6-foot non-combustible perimeter walls or 1-hour fire-resistant exterior walls and protected openings.
    - Consider other building-scale defenses, e.g., building orientation relative to fire flow paths, debris and ember accumulation, window number, and orientation.

BUILDING CONSTRUCTION

The County of San Diego Building Code and the San Diego County Consolidated Fire Code have enhanced and adopted California Building Code Chapter 7A requirements for life and property protection for properties and building within the Wildland-Urban Interface.
Large and destructive wildfires struck San Diego County in 2003 and 2007, with several factors identified leading to significant structural loss including:

- Vulnerable building construction
- Structures ignited by native and landscape vegetation
- Poor access and escape routes
- Inadequate water supplies
- Limited firefighting resources.

Following these wildfires, changes in the building and fire code were adopted that have hardened compliant structures from ignition, increasing their wildfire resilience more than 6x. The current code requirements are summarized below.

Requirements for Construction of Structures

- **Roofs*:*** Roofs shall have a minimum Class 'A' roof covering. For roof coverings where the profile allows a space between the roof covering and roof sheathing, the spaces shall be fire-stopped with approved materials to keep out flames and burning embers.
- **Exterior walls**: Exterior wall surfaces must be non-combustible (stucco, masonry, cement-fiber board, etc.), ignition-resistant, heavy timber or log wall construction. Stucco and cement plaster used as an exterior wall covering shall be minimum 7/8 inch thick. Noncombustible or fire-retardant-treated wood shake used as an exterior wall covering shall have an underlayment of minimum 1/2-inch fire-rated gypsum sheathing that is tightly butted, or taped and mudded, or an underlayment of other ignition-resistant material. As an exception, around door and window openings, maximum 3/4-inch thick combustible trim with an underlayment of ignition-resistant material.
- **Eaves*:*** Eaves, soffits and facias must comply with requirements for ignition-resistant construction. (See https://www.sandiegocounty.gov/content/dam/sdc/pds/docs/pds198.pdf for possible options.)
- **Unenclosed Underfloor Areas**: Homes built on stilts or using open post-and-beam construction are not permitted unless the underfloor area is enclosed to the ground with non-combustible construction.
- **Vents**: All vents (attic, underfloor, combustion air, etc.) must resist the intrusion of flames and burning embers into the structure. Ventilation openings for enclosed attics, eave soffit spaces, enclosed rafter spaces formed where ceilings are applied directly to the underside of roof rafters, underfloor ventilation openings, and vent openings in exterior walls and exterior doors shall be listed to ASTM E 2886 and comply with all of the following:
    - There shall be no flaming ignition of the cotton material during the Ember Intrusion Test.
    - There shall be no flaming ignition during the Integrity Test portion of the Flame

- Intrusion Test. The maximum temperature of the unexposed side of the vent shall not exceed 662 degrees Fahrenheit (350 degrees Celsius).

- **Windows (glazing):** Windows shall be dual-glazed units with a minimum of the inside pane tempered **or** shall be glass block units **or** shall have a fire-resistance rating of 20 minutes. Vinyl window frames must have welded corners to prevent glass from falling out with flame impingement and metal reinforcing in the interlock area to prevent the windows from opening or falling unexpectedly. In addition, vinyl windows must have a label showing they are certified to AAMA/WDMA/CSA 101/I.S.2/A440 structural requirements.
- **Skylights:** Skylights shall be tempered glass.
- **Insulation:** Paper faced insulation is not permitted in attics or ventilated spaces due to the potential of embers igniting the paper. Foil-backed or un-faced fiberglass batts and blankets are better suited to conditions of potential fire hazards. Use foil-backed insulation in areas where a vapor barrier is required.
- **Roof Gutters**: Roof gutters shall be provided with the means to prevent the accumulation of leaves and debris.
- **Exterior doors*:*** Exterior doors shall have an exterior surface or cladding of noncombustible or ignition-resistant material **or** be constructed of solid-core with stiles and rails wood not less than 1-3/8-inch thick **or** have a fire protection rating of not less than 20 minutes per NFPA 252 **or** meet SFM Standard 12-7A-1.
- **Decks, balconies, carports, patio covers, and exterior stairs (exposed structural members):** Exposed structural supports and framing members for decks, balconies, carports, patio covers, exterior stairs, and other projections and attachments must be one, or a combination, of the following:
  - Non-combustible construction (such as concrete or metal)
  - Fire-retardant treated wood (pressure-treated, listed for exterior use, installed per listing)
  - Modified heavy timber construction (minimum 2x exterior grade tongue-and-groove roof sheathing, 4x6 roof rafters/beams, 4x8 floor joists, 4x10 or 6x8 floor beams and stair stringers, 6x6 posts/columns, 3x blocking, 4x stair treads with steel angles)
  - One-hour fire-resistive construction

  Note: All other exposed surfaces must be enclosed with ignition-resistant materials such as stucco or cement-fiber material. There is no fire-resistive requirement for handrails and balusters.
- **Deck, balcony, porch, stair, and landing surfaces:** The surfaces of decks, balconies, and exterior stair treads/risers/landings must be one, or a combination, of the following:
  - Non-combustible construction (such as concrete or tile)
  - Fire-retardant treated wood (pressure-treated, listed for exterior use, installed per listing)
  - One-hour fire-resistive construction
  - Alternative decking materials passing the performance test requirements of State Fire Marshal standard 12-7A-4 and approved by the building official
- **Fences and other attachments*:*** Any portion of a fence or other structure less than five feet from any building shall be constructed of non-combustible material, pressure-treated exterior fire-retardant wood or meet the same fire-resistive standards as the exterior walls of the structure. The building official may allow vinyl fences when the construction conforms to guidance documents

The requirements above are minimums. Full scale testing conducted in 2022 identified several weaknesses in these adopted standards. Appendix A provides the most up-to-date ignition resistant construction features and is preferred. It may also be used as an AMM.

ACCESS AND EGRESS, EVACUATION PLANS, TEMPORARY SHELTER-IN-PLACE

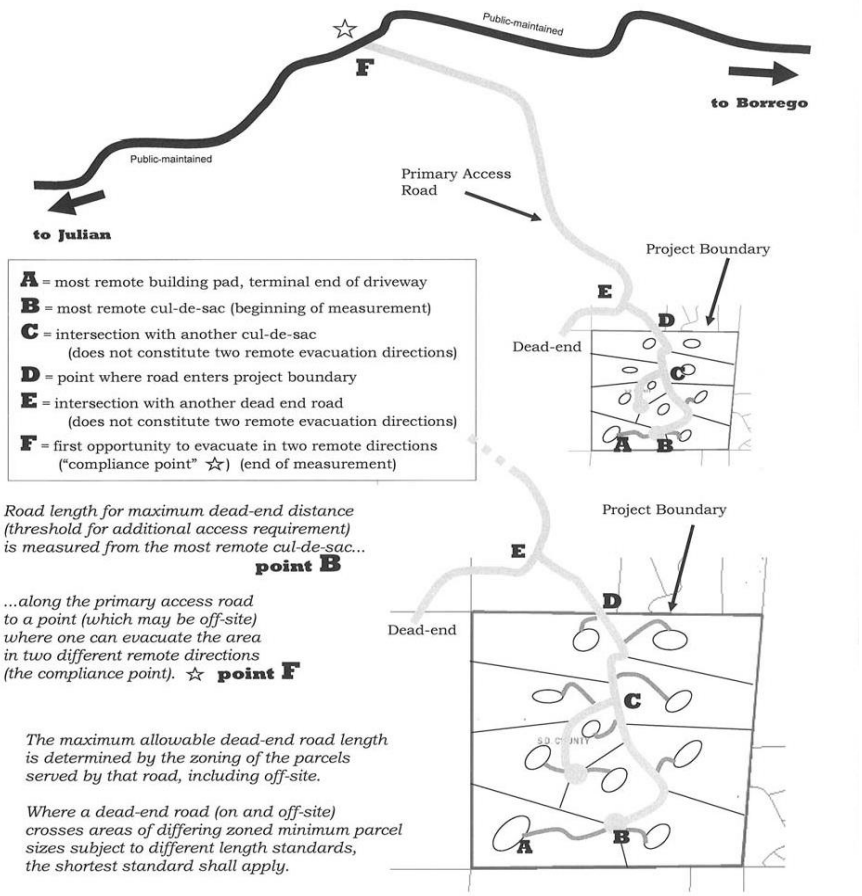
The analysis must include a description of the existing off-site and proposed on-site road network, including the following:

- Main/additional access
- Road widths, angles of approaches/departures, obstructions (gates), fire lane marking and turnarounds, including analysis of off-site roads from a public-way and all deviations from fire code requirements
- The maximum length of a dead-end roadways, including all dead-end roads accessed from that dead-end roadway, shall not exceed the cumulative lengths in Figure 5, regardless of the number of parcels served (Consolidated Fire Code Section 503).
    - Road length is measured from the beginning of the primary access road at a point where one can evacuate in two different directions (which may be off-site), measured to the end of the most remote cul-de-sac. Refer to Figure 6 for guidance on measuring dead-end roadway length.
    - Where a dead-end road crosses areas of differing zoned parcel sizes, requiring different length limits, the shortest allowable length shall apply. Where parcels are zoned 5 acres or larger, turnarounds shall be provided at a maximum of 1,320 foot intervals. Each dead-end road shall have a turnaround approved by the fire code official and constructed at its terminus.
- Road grades and surface improvements
- On-going road maintenance (identify entity responsible and private funding mechanism)

Figure 5: Maximum Length of Dead-End Roadways

Zoning for Parcel Served by Dead End Road(s)	Cumulative length of Dead End Road(s)
Parcels zoned for less than 1 acre	800 feet
Parcels zoned for 1 acre to 4.99 acres	1320 feet
Parcels zoned for 5 acres to 19.99 acres	2640 feet
Parcels zoned for 20 acres or larger	5280 feet

FIGURE 6: Length of Dead End Roads



The intent of limiting the allowable length of a dead-end road is to ensure that firefighters have access flexibility to deal with changing dynamics in wildfires and other emergencies, and that civilians have safe, reliable, and known evacuation alternatives during emergencies.

Dead-end road regulations also assist in limiting the number of persons attempting to evacuate on the road and to limit the time needed for safe evacuation. Steep, narrow, and winding roads delay evacuation. Long dead-end roads in rural wildland areas place people and emergency personnel at increased risk.

Projects with an access road that exceeds the regulations for dead-end roads should first consider providing an alternate means of access and egress before resorting to other possible alternatives. One acceptable AMM is to limit the number of homes accessed from that road as follows:

- 50 dwelling units where the restriction is designed to be permanent and the street or street system does not traverse a wildland area which is subject to hazard from brush or forest fire;

- 75 dwelling units where the restriction is designed to be permanent and the street or street system traverses a wildland area which is subject to hazard from brush or forest fire;
- 300 dwelling units, where the restriction is subject to removal through future development.

If the roadway paving on that portion of the street or street system forming the restriction is less than 36 feet in width and is not to be widened to 36 feet or more as a part of the development of the division of land, the permitted number of dwelling units shall be reduced by 25 percent if the pavement is 28 feet or more in width, and by 50 percent if the pavement is less than 28 feet in width. If the roadway paving on that portion of the street or street system forming the restriction is 64 feet or more in width and the restriction is subject to removal through future development, the permitted number of dwelling units may be increased to 600. In no event shall the pavement width be less than 20 feet.

The following conditions apply to roads serving new development:

Escape Routes:

Routes shall be designated as the principal means of evacuation from new development. These roads may be existing or newly constructed. Escape routes must meet the following standards:

a. At least two dispersed access routes shall be available for new development. (This condition may be waived for small projects by appeal to the Director, PDS). Additional routes may be required for larger developments.
b. Escape routes shall meet San Diego County paved public road standards and be available for public access on a constant basis. (https://www.sandiegocounty.gov/content/dam/sdc/pds/ceqa/Soitec-Documents/Final-EIR-Files/references/rtcref/ch3.1.8/2014-12-19_CountyofSanDiego2012_PublicRoadStandards.pdf
c. Any gating on escape routes must be either constantly staffed or immediately openable by approaching vehicles. Any unstaffed gate shall have assured power supply in case of utility public safety shutoff or failure. Any gating shall have emergency vehicle access accommodation. Gates may not have semi-permanent locking devices affixed.
d. Escape routes shall have continuous accessibility for incoming emergency response simultaneous to civilian evacuation use.
e. Any traffic calming feature located in escape routes shall be designed so as to accommodate emergency fire apparatus and large truck traffic, and not hinder response times or delay emergency evacuation traffic flows.

f. New development shall not detract from existing evacuation capacity or travel speeds of neighboring communities also using the same routes for evacuation. Traffic flow mitigation such as signaling, signage, additional traffic and turn lanes, center medians, or other installations may be considered for mitigation of traffic issues.

g. Contra flow, or the use of all traffic lanes, both in and out bound, as a temporary means of single direction traffic flow shall not be used as the primary evacuation method. This is due to a history of loss of life and severe congestion occurrence in the early stages of wildfire evacuation during major California wildfires. This method will be reserved for law enforcement discretion only. (This method requires extensive law enforcement prioritization and commitment, and may be difficult to achieve when limited law enforcement resources are heavily engaged in simultaneous public contact, evacuation notification, and initial traffic control).

Evacuation Plans:

a. San Diego County policy in the Safety element, Chapter 7 (65302 (g) (5) adopted through SB 99 (2019) requires identification of specified evacuation constraints associated with residential developments). The CAG has also stated that the California Environmental Quality Act (CEQA), Public Resources Code section 21000 et seq, requires detailed evacuation planning including timing, road capacity, impact to existing evacuation planning and routes, and traffic modeling. The project shall propose an evacuation plan that details emergency notification methods and procedure, mobilization, and complete community evacuation from wildfire risks. The plan shall include reliable routes of travel, the objective location of evacuations, and include both human and animal evacuation needs. Plans shall have a goal of evacuation of the community within 1-1.5 hours of public notification. Plans shall detail means and methods for infirmed or limited mobility populations such senior living facilities, or schools. The plan shall be consistent with the San Diego County Emergency Plan, Annex Q-Evacuation: https://www.sandiegocounty.gov/content/dam/sdc/oes/emergency_management/plans/op-area-plan/2018/2018-Annex-Q-Evacuation.pdf

b. Areas of safe refuge shall be designated for planned evacuations and shall be the objective of travel by designated escape routes. Evacuation plans shall describe any fire entrapment risks that evacuees may encounter in travels to safe refuge. (The project may be required to conduct mitigation of all or portions of these travel risks, as determined by the FAHJ or Director, PDS. Distances of travel and travel times to safe refuge shall be described in the evacuation plan. Safe refuge shall include sites where evacuees are safe from proximal exposure to fire behavior or effects, and which may accommodate large assemblages of evacuees and associated relief response.

c. The project shall detail in its FPP how the evacuation plan will be maintained and disseminated within the community.

Temporary Shelter-in-Place

a. The provision of temporary shelter in place within a community is driven by the fact that in cases where the origin of a wildfire is close to the community, not enough time may be available for safe evacuation, or, some residents may elect to not evacuate until it is no longer safe to do so. While evacuation will remain the primary means of public protection, accommodation for temporary safe within the community must also be developed and stated in the development's FPP.
b. Temporary Shelter-in-Place may occur at locations that offer separation from wildfire effects. These may include school yards, parking lots, landscaped parks of reasonable size, commercial centers, golf courses, ball fields, agricultural areas, community centers, churches, and similar sized facilities that have defensible space from wildfire, and safety within the site for temporary and significant public assemblage. Desirable characteristics for these sites include; immediately accessible to the public by foot or automobile, with opportunities for parking without creating traffic congestion, handicap accessible, pet or large animal accessible, and accessible for emergency responders to protect populations in-place. As an example, more than 8,000 residents who were unable to evacuate safely from the Camp Fire in 2018 in the Community of Paradise, CA took shelter in such sites and were protected in place by responding emergency services, surviving a wildfire that took 85 lives and burned 18,800 structures.
c. Projects shall detail in the FPP the location, capacity, and potential use of temporary Shelter-In-Place sites within the development. Guidance should be provided in the evacuation plan as to when and under what conditions it will be safer to occupy these sites rather than evacuate. The project shall ensure that designated Shelter-in-Place sites are absent life-threatening wildfire conditions and harden the sites through distance (such as road widths or green belts), installation of walls, fuel modification, or similar installations, when necessary.

TRAFFIC ENGINEERING, ROAD STANDARDS, AND CIRCULATION

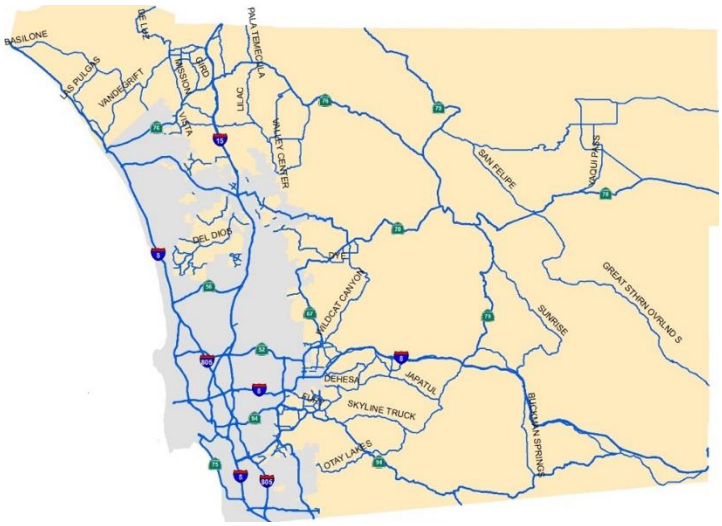
Traffic Engineering Study

A certified professional traffic engineer shall calculate traffic flows for emergency escape routes from the point of origin to safe refuge, and shall determine likely traffic speeds, impact to existing routes, impact of traffic calming features (if any time required for community evacuation, and recommend traffic engineering mitigations.

Traffic Engineering, Road Standards and Circulation

THE BALANCE OF THE SECTION IS RESERVED FOR FUTURE STUDY

FIGURE 7: Evacuation Routes



-- Major Roads & State Highways
Unincorporated San Diego
County Incorporated Cities

WATER REQUIREMENTS

A water tank is required where a project is not within a water district or not within 1500 feet of a water district line that could be extended for hydrants. The minimum size of the tank required for fire suppression is based on total area of the buildings to be protected:

Up to 1500 sq. ft. = 5,000 gallons
Over 1500 sq. ft. = 10,000 gallons
Recommended= 20,000 gallons

This general rule applies in most circumstances. An increase in required water supply may be necessary depending on the size of the structure.

For development within water districts having fire hydrants proximal to proposed development, the project shall submit calculation of hydrant fire flows, fire flow duration, reservoir capacity, and disclose any pump stations or hydraulic lift required to provide fire flows to the subject development. A minimum of 2,500 GPM fire flow with a duration of 4-hours shall be the minimum provided, or supplemental water tanks will be required.

Residential Fire Sprinkler Requirement

Residential fire sprinklers are required in conjunction with all new structures, regardless of use. Residential fire sprinklers are designed to protect occupants from fires that start inside the structure, giving them time to escape. They do prevent house fires from spreading to vegetation. They are not, however, intended to protect the home from wildfire (though there have been a few cases where radiant heat ignition of interior contents was stopped by a sprinkler). Far more people die in fires that start within dwellings than start anyplace else, including wildfires.

No recognized standard exists for fire sprinklers protecting the exterior of a home in a wildfire. Effective exterior building fire protection comes from non-combustible walls and eaves, restricted attic ventilation, class "A" roofs, fire-resistive decks, tempered dual-paned windows, fire-resistive doors – "defensible structures" – and from properly maintained vegetation – "defensible space".

Note**:** Greenhouses enclosed with translucent plastic or glass and located 30 feet or more from other buildings and all property lines **or** free standing, open-sided shade covers, sheds, gazebos, and similar non habitable accessory structures with less than 250 square feet of projected roof area, no utility connections, and located 30 feet or more from other buildings and all property lines are exempt from ignition-resistant construction requirements.

VEGETATION MANAGEMENT

The intent of vegetation management is to ensure all flammable vegetation or other combustible growth is managed to reduce the threat from wildfires. Reports on destructive fires contain common problem areas near structures, including:

- Overgrown or unmanaged vegetation
- Combustible mulches
- Woodpiles
- Trash and recycling receptacle storage locations
- Hazardous plants and vegetative debris
- Clustering of trees and shrubs

There are generally three levels of vegetation management: Community Fuel Modification (FM), Defensible Space around Structures (DS), and ornamental landscaping outside FM and DS zones.

Community Fuel Modification

State Minimum Fire Safe Regulations, Title 14, requires "fuel breaks" for new developments. These are considered synonymous with community "fuel modification" zones, based on application. Specifically, Section 1276.03 states:

(a) When Building construction meets the following criteria the need and location for Fuel Breaks shall be determined in consultation with the Fire Authority:

(1) the permitting or approval of three (3) or more new parcels, excluding lot line adjustments as specified in Government Code (GC) section 66412(d); or

(2) an application for a change of zoning increasing zoning intensity or density; or

(3) an application for a change in use permit increasing use intensity or density.

(b) Fuel Breaks shall be located, designed, and maintained in a condition that reduces the potential of damaging radiant and convective heat or ember exposure to Access routes, Buildings, or infrastructure within the Development.

(c) Fuel Breaks shall have, at a minimum, one point of entry for fire fighters and any Fire Apparatus. The specific number of entry points and entry requirements shall be determined by the Local Jurisdiction, in consultation with the Fire Authority.

(d) Fuel Breaks may be required at locations such as, but not limited to:

(1) Directly adjacent to defensible space to reduce radiant and convective heat exposure, ember impacts, or support fire suppression tactics;

(2) Directly adjacent to Roads to manage radiant and convective heat exposure or ember impacts, increase evacuation safety, or support fire suppression tactics;

(3) Directly adjacent to a Hazardous Land Use to limit the spread of fire from such uses, reduce radiant and convective heat exposure, or support fire suppression tactics;

(4) Strategically located along Ridgelines, in Greenbelts, or other locations to reduce radiant and convective heat exposure, ember impacts, or support community level fire suppression tactics.

(e) Fuel Breaks shall be completed prior to the commencement of any permitted construction.

(f) Fuel Breaks shall be constructed using the most ecologically and site appropriate treatment option, such as, but not limited to, prescribed burning, manual treatment, mechanical treatment, prescribed herbivory, and targeted ground application of herbicides.

(g) Maintenance mechanisms shall be established to ensure the fire behavior objectives and thresholds are maintained over time.

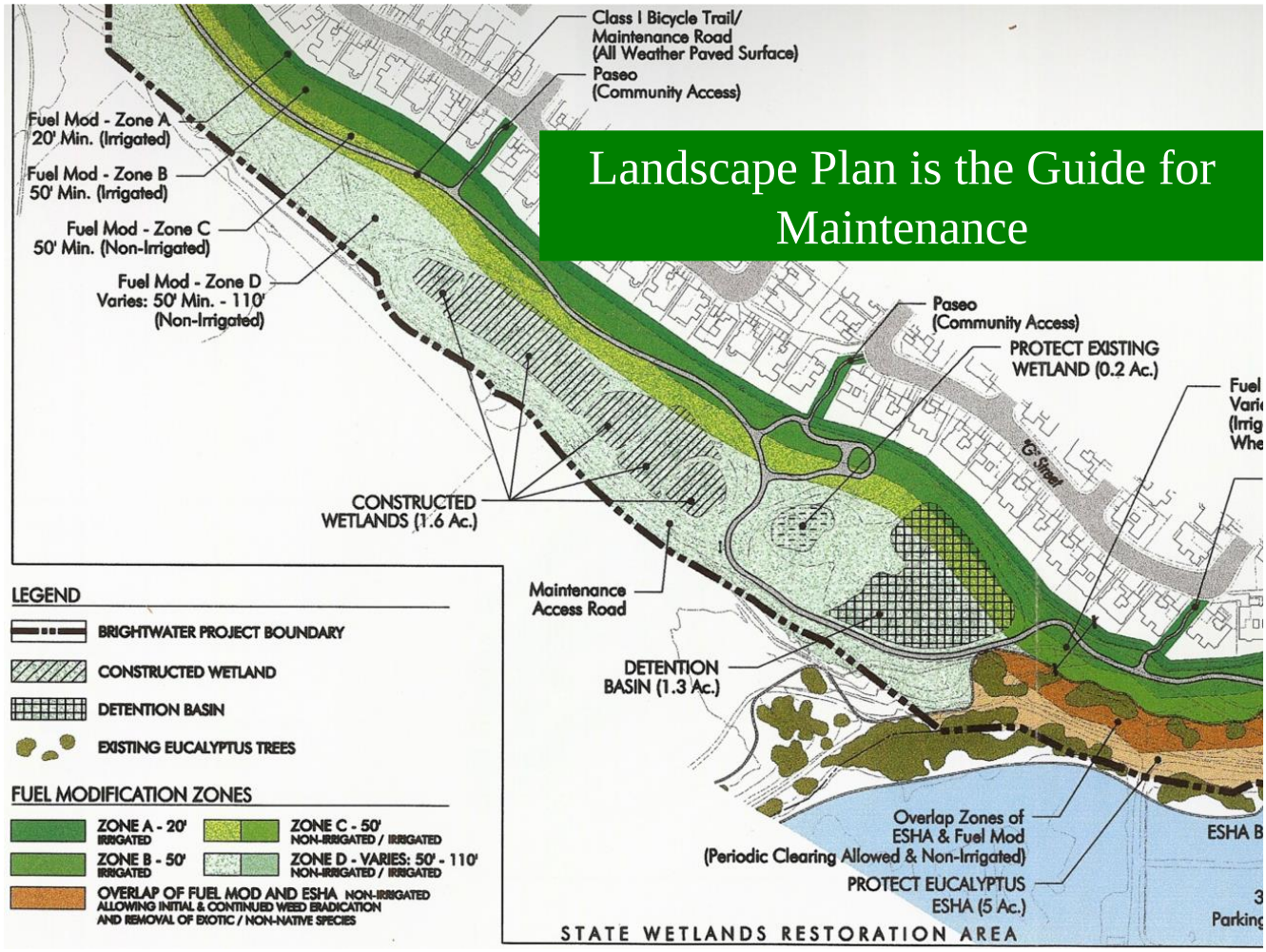
(h) The mechanisms required shall be binding upon the property for which the Fuel Break is established, shall ensure adequate maintenance levels, and may include written legal agreements; permanent fees, taxes, or assessments; assessments through a homeowners' association; or other funding mechanisms.

Fuel modification zones should be located to protect a community by reducing the fuel loads adjacent to *a community* and buildings within it. The width of zones shall be a minimum of 100 feet and may be wider based on the results of the fire modeling report. The developer shall assign the land on which any fuel modification zone is established to the association or other common owner group that succeeds the developer as the person responsible for common areas within the community.

Tracts and streets abutting the Wildland-Urban Interface must be considered “in-total” for their fuel modification requirement. In this case, structural fire defense will be evaluated by the FAHJ for protection of both individual structures and the exposed group of neighboring structures as a group.

Once a fuel modification zone has been established, the land on which the zone is located shall be under the control of an association or other common ownership established in perpetuity, for the benefit of the community to be protected.

FIGURE 8: Sample Community Fuel Modification Plan



Defensible Space for Structures

The County Fire Code requires defensible space around every building that is designed primarily for human habitation or use, or a building designed specifically to house farm animals. Decks, sheds, gazebos, freestanding open-sided shade covers and similar accessory structures less than 250 square feet and 50 feet or more from a dwelling, and fences more than 5 feet from a dwelling, are not considered structures for the establishment of a fuel modification zone.

Consistent with state regulations, the required defensible space area is 100-feet around structures (or to the property line, whichever is nearer to the structure). This includes the following:

1. Zone 0 “Immediate Zone” 0-5’ extends 5 feet on a horizontal plane from all exterior wall surfaces (and patios, decks or other attachments to buildings or structures). This zone shall be constructed of continuous hardscape or non-combustible materials (such as pavement, pavers, gravel, river rock, etc.). Combustible materials must be removed from this area (which includes but is not limited to removing combustible materials from roofs, gutters, decks, porches and stairways). Firewood and lumber are prohibited in this area. Dead branches that overhang roofs, are below or adjacent to windows, or which are adjacent to wall surfaces must be removed. All branches within ten (10) feet of any chimney or stovepipe outlet must be removed.
2. Zone 1 “Intermediate Zone” from Zone 0 to 50’ extends from the immediate edge of Zone 0 for 45 feet on a horizontal plane. This zone shall consist of planting of low growth, drought tolerant and fire resistive plant species. The height of the plants in this zone starts at 6” adjacent to Zone 0 and extending in a linear fashion up to a maximum of 18” at intersection with Zone 2. Dead or dying grass, plants, shrubs, trees, branches, leaves, weeds, and pine needles must be removed from the area. Other combustible materials must not be adjacent to or under combustible decks, balconies, and stairs. Vegetation in this zone shall be irrigated and not exceed 6’ in height and shall be moderate in nature as per Sec. 4907.6.4.1. Dead branches that overhang roofs, are below or adjacent to windows, or which are adjacent to wall surfaces must be removed. All branches within ten (10) feet of any chimney or stovepipe outlet must be removed.
3. Zone 2 “Extended Zone” from Zone 1 to 100’ extends from the immediate edge of Zone 1 for 50 feet on a horizontal plane. This zone consists of planting of drought tolerant and fire resistive plant species of moderate height. This area would be considered selective clearing of natural vegetation and dense chaparral by removing a minimum 50% of the square footage of this area. Horizontal and vertical spacing among shrubs and trees must be created using fuel separation, as follows: Dead and dying woody surface fuel and trees shall be removed. Loose surface litter (consisting of fallen leaves or needles, twigs, bark, cones, and small branches) shall be permitted to a maximum depth of three (3) inches. Annual grasses and forbs must be cut down to a maximum height of four (4) inches.

The area located within 50-feet of the structure must be cleared and planted with fire-resistant plants, and the landscaping must be irrigated. In the area between 50 to 100 feet around structures the native vegetation may remain but must be thinned by 50% and all dead and dying vegetation must be removed. In this area, grass and other vegetation less than 18 inches in height above the ground need not be removed where necessary to stabilize the soil and prevent erosion. The area between 0 and 5 feet from the structure shall be free of combustible materials.

Trees are allowed in the 100-foot defensible space area. The crowns of trees shall be a minimum of 10 feet from structures and the crowns of other trees and shall be pruned to remove limbs located less than 6 feet above the ground surface.

Defensible Space zones may, in selected circumstances, be required to be larger than 100 feet. These circumstances usually involve proximity of development to steep, elongated slopes and/or heavy fuels that are subject to extreme fire behavior. Such a determination shall be made by the FAHJ.

For more information on creating defensible space around homes and guidance regarding suggested ornamental planting material see the following guideline:

https://www.sandiegocounty.gov/pds/fire_resistant.html

Combustible vegetation can only be removed by mowing, cutting and grazing as long as the root structure is left intact. Any trees you remove shall have the stumps cut no higher than 8 inches above the ground. The only exception would be an orchard. Orchard trees may have their stumps completely removed. Commitment to maintenance standards and responsibilities will be required for approval of fuel modification plans.

If an open space easement is located on the property, you may legally clear the 100-feet from your structure, even if it takes you into that easement, upon written authorization of your fire protection district. No irrigated, or non-native landscaping is allowed within an open space easement.

FIGURE 9: Defensible Space Zones

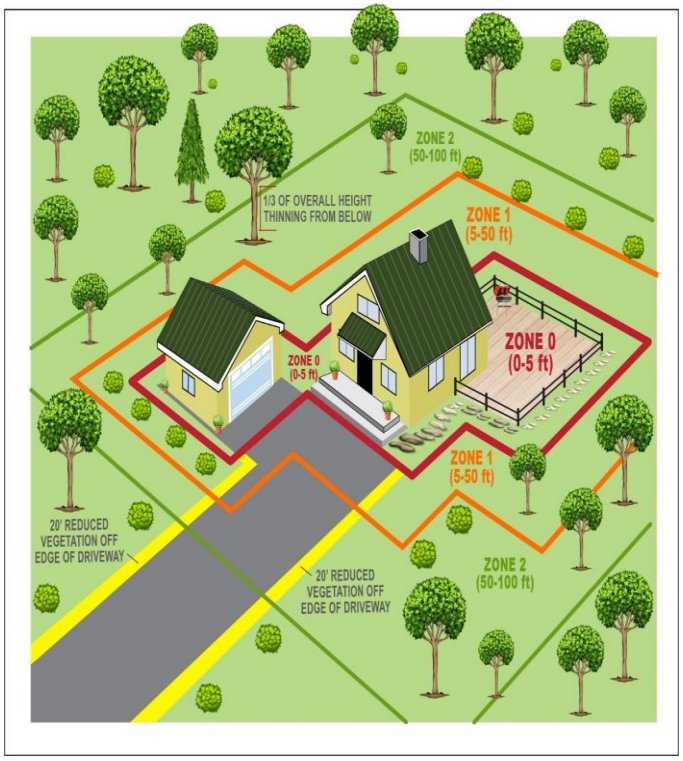
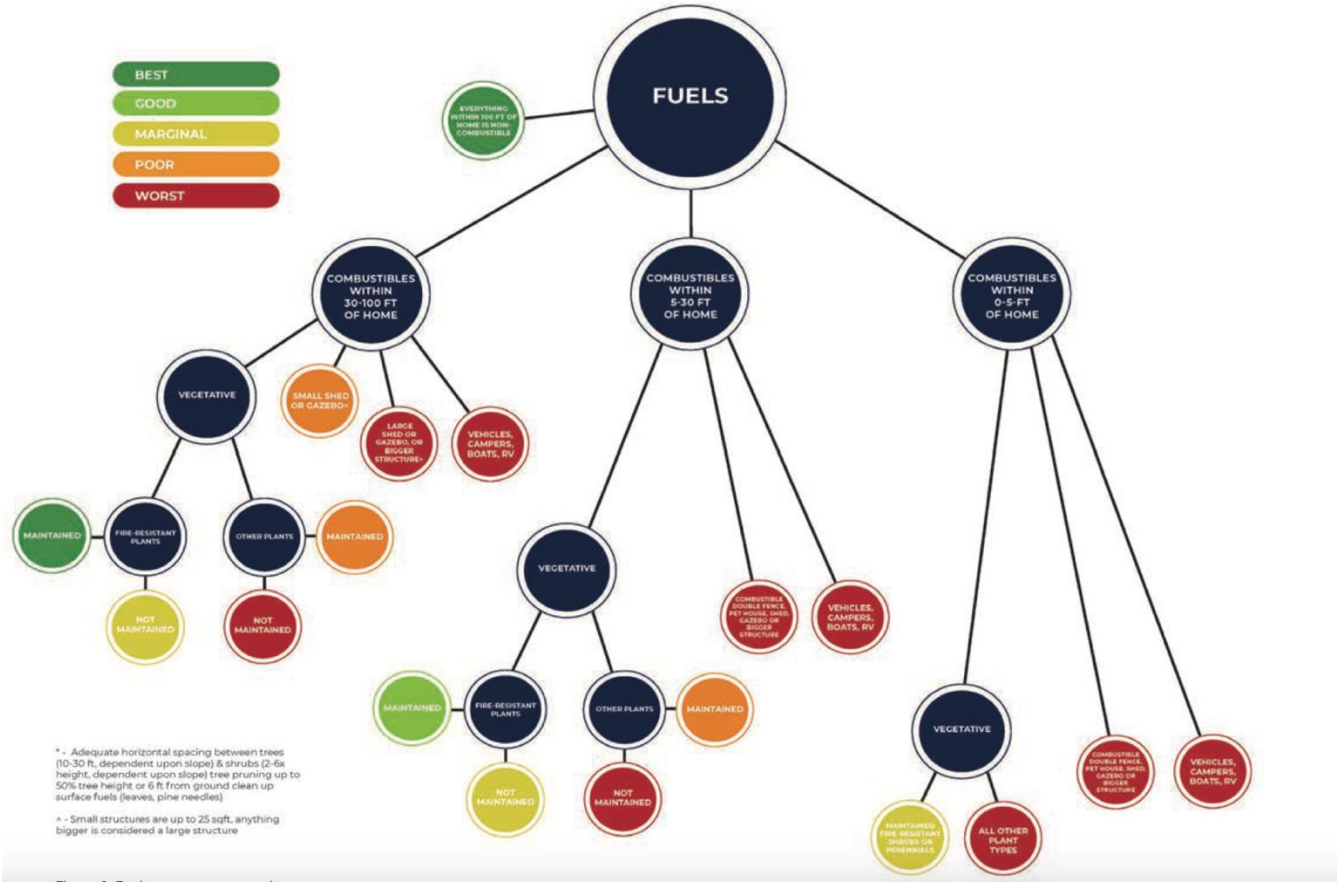


FIGURE 10: Defensible Space Guidance for Fuels



Location of Structures on Lots

Defensible Space is necessary for the life of the building. Fuel modification on neighboring property is not authorized by the County Fire Code. The defensible spaces zone may not extend beyond the lot being developed. Agreements with neighbors, while desirable, cannot be depended on; ownership and cooperation can change. Therefore, it is critical that the fire code regulate the minimum distance from structure to property line.

Where adequate setback distance is possible, the structure shall be located such that 100-foot fuel modification can be obtained on the property. This setback is particularly important where vegetation management is restricted such as an Open Space Easement or a where vegetation management may not take place (e.g. riparian areas, state or federal land.)

The absolute minimum setback is 30 feet. If the fire authority having jurisdiction [FAHJ], the planning authority having jurisdiction [PAHJ] and the County Fire Marshal identify the hazard in the area as “minimal”, they may allow less than 30 feet setback. When parcels are adjacent to national forest, state park or open space preserve, buildings and structures must be located a minimum of 100 feet from the property line adjacent the protected area.

Roadways

The FAHJ may require a property owner to modify combustible vegetation in the area within 20 feet from each side of the driveway or a public or private road adjacent to the property to establish a fuel modification zone.

Plants and Ornamental Landscaping

Specific plant types should be selected based on fire-resistance. Also be aware of plants to avoid. Invasive plants can have a higher potential for ignition than native vegetation because they often produce more flashy fuels which ignite and burn quickly. However, native vegetation can also be highly flammable. Common characteristics of prohibited plants include volatile resins and oils, generally aromatic when crushed (e.g., eucalyptus), narrow leaves or long, thin needles, waxy or fuzzy leave, accumulates dead leave and twigs on and/or under the plant (e.g., Italian Cypress), loose or papery bark, invasive species.

All new vegetation shall be *drought tolerant* and fire-resistant vegetation in accordance with the County Fire Code which also has height and spacing requirements for shrubs and trees. Characteristics of “fire-adapted” plants include: Drought-resistant, pest-resistant, native to area, noninvasive, slow-growing, wind-resistant, sustainable without supplemental fertilization. The following planting guidelines must be followed:

- Shrubs limited to 6’ in height.
- Grouping of shrubs limited to a maximum aggregate diameter of 10’.
- Separation of shrub groupings of a least 15’.
- Separation of groupings from structure of at least 30’.
- Shrubs located below or within a tree drip line shall be a separated from the lowest tree branch by a minimum of three times the height of the understory shrubs or 10 feet, whichever is greater.
- Tree driplines must be maintained at not less than 10 feet from any combustible structure.
- The horizontal distance between tree crowns must be not less than 10 feet.

All ornamental landscaping must also be consistent with County’s Landscape Ordinance and Landscape Design Manual. Projects requiring landscape plans should clearly identify the type of plant materials, locations and spacing of plant materials, and irrigated and non-irrigated landscaping. The landscape consultant may recommend in the text the inclusion or exclusion of specific varieties for review by the County landscape architect.

In addition to initial vegetation and landscape planning, ongoing vegetation management and maintenance is crucial. This includes all areas with vegetation in the development—both heavily landscaped open spaces and those dominated by native vegetation. Regular fire mitigation over the long-term should be required or performed.

Combustible vegetation can only be removed by mowing, cutting and grazing as long as the root structure is left intact. Use the San Diego County guidelines on acceptable and unacceptable plants. The building official and the FAHJ may provide lists of prohibited and recommended plants.

Plans

Landscape plans shall be provided to the FAHJ or a designated third party for any new construction and or addition for residential and commercial buildings or accessory thereof. Plans shall be submitted and approved prior to any framing inspection. In addition, plans shall be provided when modifications occur to any previously approved landscape plan or to the Home Ignition Zones.

Plans shall be prepared by a California Licensed Landscape Architect, Architect, or Civil Engineer. A landscape designer could prepare planting plans only (not irrigation) for a single-family residence but would need one of the above professionals to stamp the plans verifying compliance with the regulations. Plans shall include:

1. A readable (Engineer or Architect) scale.
2. Delineation of Fuel Modification Zones and Defensible Space/Home Ignition Zones with a general description of zone dimensions and character.
3. Describe and show existing vegetation on plan.
4. Include a Plant Legend with the plant-life form, scientific and common name, and expected height and width for mature growth.
5. Describe vegetation reduction around emergency access and evacuation routes.
6. Include quantities of trees and large shrubs being proposed.
7. Identify irrigated and non-irrigated areas on the plan.
8. Identify points of access for equipment and personnel to maintain vegetation.
9. Define all symbols, site amenities, features, and shaded areas, etc. used on the plans.
10. Legally binding statements regarding community responsibility for fuel modification zones
11. Legally binding statements to be included in covenants, conditions, and restriction regarding property owner's responsibilities for vegetation maintenance.

PROTECTION OF CRITICAL INFRASTRUCTURE

Communities rely on robust electric, water delivery, and telecommunications systems during emergencies. Power is required to receive emergency messaging, provide lighting, and to operate water delivery systems. Telecommunications systems such as telephone and cable services deliver critical emergency messaging, and digital operating coding for infrastructure. Water systems and delivery are critical for firefighting. Loss of these systems can contribute to loss of life and property.

Critical infrastructure protection (access/egress routes, communication systems, water supplies/infrastructure, electrical power infrastructure) from wildfire hazards, as well as limiting the potential sources of wildfire ignitions due to some of these features, is an important planning consideration where relevant to a new development or subdivision.

a. Discuss fire hardening of roadways, water, telecommunications, and electrical distribution, storage, node, and transfer facilities against wildfire damage or wildfire ignition
b. Discuss critical infrastructure maintenance responsibility, and fire defense methods, mitigations, and maintenance frequency to be undertaken by responsible parties
c. Discuss operating power resiliency for critical infrastructure to protect against domestic power supply loss. A minimum of 4 hours of power should be available.

The project shall also detail any proposed utilization of solar, wind, battery, or related green technologies, their siting within the project, and proposed fire risk mitigations.

Electrical

Where possible, place all electrical distribution equipment in conduit underground. Where underground distribution equipment is infeasible, consult any relevant fire safety ordinances for adequately designing overhead electrical distribution lines and associated equipment (e.g., transformers) to reduce the likelihood of this equipment providing a source for wildfire ignitions. Consideration should be given not only to the hardening of the equipment, but also in providing adequate vegetation clearance, appropriate plant selection such that fall-in, grown-in and lean-in of vegetation is minimized, and long-term management.

Fuel

Fuel tanks (e.g., propane) can present a significant hazard to both structures and first responders if they start off-gassing or explode during a wildfire. Exposed, fuel lines can also be vulnerable to wildfire damage (see NFPA 58). Bury or shield fuel lines to protect them from the effects of radiation, direct flaming, and ember exposure. Bury pressurized fuel-storage vessels underground, where possible. Where fuel storage tanks are stored or installed above ground, the following guidance should be considered:

- Install tanks a minimum of 30 feet from habitable structures.
- For cylindrical tanks, use vertical tank or orient horizontal tanks so that the circular ends are pointed away from residences or structures since the ends are weaker than the tank body.
- Install tanks on and surrounded by noncombustible surface.
- Provide a noncombustible masonry wall enclosure, where possible
- Avoid installing tanks near high-risk topographic features (e.g., steep slopes, drainages)

- Maintain at least 10 feet of clearance from other combustibles.
- Avoid installing tanks in proximity to primary or secondary egress routes.
- Ensure pressurized storage tanks have a pressure-relief valve and that the valve/vent is directed away from residences and structures.
- Provide signage or other form of notification of type and location of fuel-related utilities, where concealed or inconspicuous.
- Critical fire-protection equipment (e.g., water tanks, water supply pumps, pump houses) may necessitate fire-hazard reduction measures to protect this infrastructure from being damaged or lost during a wildfire incident.

Communication Towers & Renewable Energy Installation

Consider providing 30 feet of hardscaping or brush clearance around communication towers and associated equipment. Consult with local fire authorities for any local requirements, guidance, and best practices. Where no local guidance is provided, consult NFPA 1, NFPA 1140 or IWUIC.

NFPA 1 recommends a noncombustible base and clear area of 10' around ground-mounted photovoltaic installations.

Water

Water supply and water storage, including on-site storage, are components of critical infrastructure within a development.

The reliability of water storage and pumping facilities must be protected from wildfire. At a minimum, 30 feet of brush clearance should be maintained around critical fire protection equipment.

Essential Facilities/Community Refuges

Construct fire-resistant public facilities and create community refuges to provide safety for vulnerable populations and last-resort options for worst-case scenarios. Schools, nursing homes, hospitals on interior and ignition resistant. Different than "safety zones" which are typically large open areas sized based on vegetation height, slope steepness, and winds.

EMERGENCY SERVICES

Fire protection and emergency medical/rescue services are among the most vital and basic of community needs. Firefighters, who are generally the first responders to disasters, must be prepared to respond quickly and effectively to all types of emergencies, including wildland fires. For this reason, the provision of adequate facilities for fire protection and emergency services is fundamental to protecting the health, safety and general welfare of the residents of San Diego County. The following chart from the Safety Element of the San Diego County General Plan provides maximum travel times.

FIGURE 11: *Travel Time Standards from the Closest Fire Station

Travel Time	Regional Category (and/or Land Use Designation)	Rationale for Travel Time Standards**
5 min	■ Village (VR-2 to VR-30) and limited Semi-Rural Residential Areas (SR-1) ■ Commercial and Industrial Designations in the Village Regional Category ■ Development located within a Village Boundary	In general, this travel time standard applies to the County's more intensely developed areas, where resident and business expectations for service are the highest.
10 min	■ Semi-Rural Residential Areas (> SR-1 and SR-2 and SR-4) ■ Commercial and Industrial Designations in the Semi-Rural Regional Category ■ Development located within a Rural Village Boundary	In general, this travel time provides a moderate level of service in areas where lower-density development, longer access routes and longer distances make it difficult to achieve shorter travel times.
20 min	■ Limited Semi-Rural Residential areas (>SR-4, SR-10) and Rural Lands (RL-20) ■ *All* Commercial and Industrial Designations in the Rural Lands Regional Category	In general, this travel time is appropriate for very low-density residential areas, where full-time fire service is limited and where long access routes make it impossible to achieve shorter travel times.
>20 min	■ Very-low rural land densities (RL-40 and RL-80)	number of people potentially exposed to this hazard. Future subdivisions at these densities are not required to meet a travel time standard. However, independent fire districts should impose additional mitigation requirements on development in these areas.

* The most restrictive standard will apply when the density, regional category and/or village/rural village boundary do not yield a consistent response time standard.

** Travel time standards do not guarantee a specific level of service or response time from fire and emergency services. Level of service is determined by the funding and resources available to the responding entity.

Fire Agency Having Jurisdiction (FAHJ)

The following agencies provide fire services to non-Federal lands of San Diego County. Projects will need to confirm which agency provides emergency services to their proposed project to determine appropriate application of fire and building code, and to determine who will serve the proposed project area. **Highlighted agencies are those who enforce the County Consolidated Fire Code.** Project applicants need to contact the appropriate FAHJ for project processing. If the agency serving the project is not highlighted on this list, contact them for specific instructions regarding development of the FPP.

- **Alpine Fire Protection District**
- **Bonita-Sunnyside Fire Protection District**
- **Borrego Springs Fire Protection District** (Recently dissolved, now part of the San Diego County FPD)
- **CAL FIRE- San Diego Unit** (Cooperative fire protection with the San Diego County FPD)
- Carlsbad Fire Department
- Chula Vista Fire Department
- **Deer Springs Fire Protection District** (Served by the San Diego County FPD)
- Del Mar Fire Department

- Encinitas Fire Department
- Escondido Fire Department
- Heartland Fire and Rescue (Servings the Cities of El Cajon, La Mesa, and Lemon Grove)
- Imperial Beach Fire Department
- **Lakeside Fire Protection District**
- National City Fire Department
- North County Fire Protection District (Serving the unincorporated communities of Fallbrook, Bonsall, Rainbow, Pala Mesa, De Luz, and Winterwarm)
- Oceanside Fire Department
- Poway Fire Department
- **Ramona Municipal Water District** (Unincorporated community of Ramona fire services provided by the San Diego County FPD)
- **Rancho Santa Fe Fire Protection District** (including communities of Elfin Forest and Harmony Grove)
- **Rincon Del Diablo Fire Protection District** (Served by City of Escondido FD)
- San Diego City Fire-Rescue Department
- **San Diego County Fire Protection District** (Contract staffed by CAL FIRE, serving County unincorporated area and the Deer Springs FPD, Ramona Municipal Water Dist., and former Borrego Springs FPD)
- **San Marcos Fire Department**
- **San Miguel Fire Protection District** (Serving unincorporated communities of Bostonia, Casa De Oro, Crest, Grossmont/Mt. Helix, La Presa, Rancho San Diego, Spring Valley, and Cities of El Cajon and La Mesa unincorporated area
- Santee Fire Department
- Solana Beach Fire Department
- **Valley Center Fire Protection District**
- **Vista Fire Protection District**

Fire Departments Serving Tribal Lands

- Barona Fire Department
- Campo Reservation Fire Protection District
- La Jolla Reservation Fire Department
- Pala Fire Department
- Pauma Fire Department
- Rincon Fire Department
- San Pasqual Reservation Fire Department
- Sycuan Fire Department
- Viejas Fire Department

Services Analysis and Assessment

Proposed development shall detail the ability of current emergency services to meet both fire and emergency medical demand for the proposed development area. This appraisal shall summarize available fire/rescue/medical station locations, assigned apparatus types, facility and apparatus age and condition, staffing, response times to the project site, currently assigned mission (wildland or structural), and annual call capacity/demand.

The project will need to consult with the FAHJ to determine these conditions. The results of this evaluation shall be summarized in the project's FPP. Should the appraisal determine insufficiencies to serve the proposed project in comparison with this standard, the project must work with the FAHJ to determine appropriate mitigations. Adopted mitigations shall be approved by the Director, Land Use and Planning and adopted into development agreements.

Specifically, the analysis shall:

a. Identify the five closest fire stations available for response
b. Identify the apparatus and staffing assigned to these stations
c. Ascertain the mission of these stations and availability for response to the development's demand
d. Determine the response time of these stations to the development site
e. Determine the age and condition of fire station facilities and apparatus
f. Determine the availability, number, and location of paramedics and ambulances
g. Determine the call and service demands of the development and contrast to available emergency services
h. Propose mitigations related to fire service provision of service to the development, if any

Travel Time Standards

Projects must comply with the emergency travel time requirements specified in the County General Plan. Travel time is defined as the estimated time it will take for a responding agency to reach the furthest structure in a proposed development project. Travel time is determined by measuring the safest, most direct, appropriate and reliable route between the fire station(s) and the project with consideration given to safe operating speeds for heavy fire apparatus. Travel time does not include alarm activation, reflex or reaction time, or on-scene size-up and set-up prior to attacking the fire, all of which are critical precursors to actual firefighting. Travel time may be calculated by using NFPA 1142 Table C.11(b), SANDAG layering, PDS-GIS software travel time mapping, actual emergency travel time run data or actual driving tests. If the travel time determined in the FPP is less than the travel time determined by the FAHJ, the travel time determined by the FAHJ shall take precedence.

Stations that are seasonal (not open all year), have strictly a wildland fire protection mission, or staffed with volunteers without legal responsibility to respond to emergencies, should not be used for determining consistency with travel time requirements of the County General Plan.

Difference in Fire/Rescue Apparatus Types

When evaluating staffing and fire apparatus availability vs. new development service needs, it is important to identify the type of fire apparatus currently available in the project area. In urban/suburban areas, larger structural fire engines are needed to provide the types of firefighting equipment, hose, ladders, and pumping capacity necessary for fire suppression in structures. These engines are typically referred to as "Type 1 Engine Companies". Additionally, larger apparatus which primarily carry ladders, salvage, smoke management, and heavy rescue equipment are referred to as "Truck Companies". Engines are generally available at most fire stations while Trucks are needed more regionally and are placed about every third fire station. These types of fire apparatus are the principal means for provision of structural fire response.

Wildland fire engines (frequently referred to as "Type 3 Engines Companies"), are typically all that may be available at rural fire stations. While these smaller units can assist in structural fire attack, they are principally configured for the wildland mission and are absent the full complement of needed tools and capability for the structural fire mission. While they will be counted upon as part of a contingent for rural response, the need for structural fire response may require structural equipment be added to nearby fire stations to meet new development needs, or new stations with structural fire apparatus created to serve a project specifically.

With regard to emergency medical response, the availability of Paramedic and Ambulance services are critical to this mission. Projects must also detail emergency medical resources available or needed to serve new project demand. In San Diego County, Paramedic services are frequently cross-staffed with engine company staffing.

The San Diego County Fire Protection District has established Fire and Medical Emergency Response time standards utilizing four regional categories identified by land use designation and population density: Urban, Rural, Outlying, and some hard to serve area or extreme outlying areas are defined as Desert. These Regional Categories are consistent with the San Diego County General Plan for Safety definition for travel time standards for fire protection services. (For projects served by other FAHJ, projects should confirm that these standards specifically apply). The goal of County fire services is to meet or exceed the response standards 80% of the time.

REGIONAL CATEGORY	POPULATION PER SQ. MILE	RESIDENTIAL PROPERTIES	DESCRIPTION
URBAN	> 2000	3-20+ DUAC	Village Designation, Residential, Commercial, Industrial
RURAL	500 -2000	1-2 DUAC	Semi-Rural Designation, 2 Acre Residential, Light Commercial, Agriculture

OUTLYING	< 500	< 1 DUAC	Rural Designation, 10 Acre Lots, Open Space, Agriculture, Tourism
DESERT	Very few, transient	< 1 DU40AC	Hard to Serve Areas, Recreational Areas, Seasonal Fluctuations, Open Space, Public Lands

Proposed development projects should first be evaluated for their applicable "regional category", then further evaluated as to whether emergency services available for the area of proposed development currently meets the FAHJ Standards of Cover. The project will need to work with the FAHJ to determine the service capabilities at fire stations near the proposed development. A list of Fire Stations of the San Diego County Fire Protection District may be found at : ***h***ttps://www.sandiegocounty.gov/content/sdc/sdcfa/sdcfa/fire-stations.html

For emergency medical incidents, response may be provided by a mix of paramedic, emergency medical technical, and basic first aid capable responders assigned to various fire apparatus, rescue units, and ambulances . Paramedic level of care is the highest level of field medical response and is provided to all areas of San Diego County. Projects should work with the FAHJ and evaluate available and needed levels of emergency medical service for the area of proposed development.

A response time study for fire/emergency medical response should be conducted for current services to determine services delivery to the proposed project. This appraisal must include response times, apparatus types, staffing, mission of the available resources (wildland, structural, etc.), and current annual call capacity and demand. Appraisal results should be completed for engine and truck companies, paramedic and ambulance service, and summarized in the project's FPP.

After determination of currently available resources, a comparison should be conducted to determine response times to the proposed project. Within the jurisdiction of the San Diego County Fire Protection District, the response time standard is for fire and emergency medical response is:

FIRE DEPARTMENT FIRST DUE RESPONSE STANDARD Fire and Emergency Medical Response				
RESPONSE CATEGORY	CALL PROCESSING TIME	STATION ALERTING AND TURNOUT TIME	TRAVEL TIME	TOTAL RESPONSE TIME
URBAN	1:20	1:40	5:00	**08:00**
RURAL	1:20	1:40	10:00	**13:00**
OUTLYING	1:20	1:40	20:00	**23:00**

DESERT	1:20	1:40	45:0 0	**48:00**

TRUCK / RESCUE COMPANY RESPONSE STANDARD *Where Truck service has been implemented				
RESPOSE CATEGORY	CALL PROCESSING TIME	STATION ALERTING AND TURNOUT TIME	TRAVEL TIME	TOTAL RESPONSE TIME
URBAN	1:20	1:40	8:00	**11:00**
RURAL	1:20	1:40	16:00	**19:00**
OUTLYING	1:20	1:40	30:00	**33:00**

Multiple Station Response

Response to fires within structures and other complex calls typically requires response from multiple fire stations to achieve minimum staffing requirements as detailed by the California Occupational Safety and Health Administration, the County General Plan, and County fire organization policy. These standards also require a mix of fire apparatus types and staffing to respond to reported structure fire within a prescribed minimum time frame. This standard for the San Diego County Fire Protection District is as follows: (Projects served by other FAHJ shall confirm the project meets that agency's Standard of Cover)

TOTAL FULL ALARM RESPONSE STANDARD				
RESPONSE CATEGORY	FIRST DUE ENGINE	FIRST DUE TRUCK	TOTAL PERSONNEL	TOTAL TIME FOR ENTIRE RESPONSE TO ARRIVE
URBAN	08:00	11:00	19	**19:00**
RURAL	12:00	19:00	13	**30:00**
OUTLYING	23:00	33:00	10	**51:00**

Minimum staffing for fire apparatus detailed in this standard as follows:

- Type 1 Structural fire engines: 3 firefighters (at least one being a Paramedic)
- Truck companies: 4 firefighters
- Miscellaneous and support apparatus at the discretion of the FAHJ

Project's Call Demand

When calculating the potential emergency service demand created by new development, The San Diego County formula for new call demand is as follows:

- 2.5 emergency calls per day for every 1,000 new residents, or per 250,000 square feet of new commercial development.(. Smaller developments may pro-rate this projected call volume according to project size).

Extraordinary Fire Risk

The FPP shall detail any existing or proposed use involving high risk occurring within 1 mile of the project perimeter that may impact local fire services delivery, cause extraordinary risk during wildfires, or affect evacuations. (examples: any storage or processing of explosives or explosively reactive materials, bulk hazardous materials, hazardous industrial processes, or facilities of large public use or assemblage).

Emergency Service Mitigations

If emergency services analysis determines that current response times or service demands are exceeded, or service delivery factors required for new development are not met by existing emergency services, the Director of PDS may, upon concurrence with the FAHJ, accept mitigation measures. Acceptable mitigation may include, but is not limited to:

- Alternative construction methods and measures not otherwise required;
- Automatic Aid agreement(s);
- Upgrading existing fire station facilities or infrastructure;
- Constructing new fire station facilities; or
- Implementing a long-term binding agreement aimed at reducing the response time to acceptable limits
- Adding fire or medical staffing
- Adding new fire or medical apparatus

County policy S-7-2 through 4 (San Diego County Safety Element, Chapter 7) requires development to contribute its fair share towards funding the provision of appropriate fire and medical services as determined necessary to adequately serve the project. The policy further requires that new development demonstrate that adequate fire services can be provided that meet the minimum staffing and personnel, and that meet the minimum travel times identified (see travel time standards), and that fire protection staffing, facilities, and equipment required to serve the development are operating prior to, or in conjunction with, the development.

If a modification is proposed, the requirements of the County Consolidated Fire Code specific to modifications apply. Documentation of mitigation should appear not only in the FPP, but also in the files of the FAHJ as prescribed in the Fire Code. Failure to mitigate emergency services deficiencies may result in a court finding of project violation of the California Environmental Quality Act.

Mitigation Driven Timing and Costs

The project proponent must propose a schedule for FAHJ acceptance that implements acceptable emergency services mitigations prior to delivery of the 150th occupancy permit in a development. Smaller developments may negotiate with the FAHJ regarding the phasing of mitigations. Costs for required mitigation shall be borne by the project/new development. In some cases, mitigations are expected to exist in perpetuity. Examples of these may include new fire station staffing or operation. Frequently, initial property tax revenue is insufficient during the early phases of tract occupancy to fully fund significant mitigations such as new fire stations, however FAHJ's must staff to meet project created risks before tax revenues cover costs. If new development property tax revenue is insufficient to fully support required mitigations, the project may be responsible for additional mitigation financial support until property tax for the service area becomes reliably sufficient. The FAHJ shall notify the project when such a condition applies and will negotiate with the project proponent for appropriate mitigation delivery and compliance.

WILDFIRE BEHAVIOR ASSESSMENT

A summary narrative of wildfire behavior must be included within the FPP. This short narrative should include discussion of wind, spotting potential, fire trajectory, fuel beds, topographical influences, and major fire history for the site and nearby areas. In addition, a more technically detailed Fire Behavior Model should be completed for the project area in accordance with the requirements listed below. The Fire Behavior Report is a tool for fire authorities to estimate the behavior of fire that may threaten the proposed development and surrounding area. The Fire Behavior Report will be further reviewed by fire service experts with wildland expertise within FAHJ.

Report

Requirements for inclusions within the fire behavior report include:

- A summary of fire behavior modeling results indicating what modeling methods were used, what inputs were calculated, and fire behavior output results.
- The identity and qualifications of the person completing the wildfire modeling, and their training and competency to complete and review wildfire modeling must be stated
- Modeling origins and trajectories must be specific to the development site and reflect average-worst-case wildfire behavior. The following criteria reflects the minimum number of wildfire trajectory projections required and size of the modeling sample
    1. Point-source modeling tools (Behave, et. al): At least 3 projections for every 640 acres/1 square mile, selecting runs that capture the worst-case geographic, vegetative, and wind exposure within the development and surrounding site.
    2. Landscape-scale modeling tools (Farsite, Flammap, Technoslyva etc.): At least one projection which incorporates the most likely average-worst-case fire behavior and spread for the majority of the development and surrounding site. (Site resolution, detail, and accuracy are higher in landscape models and they are the preferred source of data).
    3. Size of modeling area: The modeled site shall consider the entire development perimeter and surrounding vegetated area within 1-mile of the outer development perimeter.
- The following wildfire modeling results shall be reported:

1. Projected fireline intensity for the leading edge of the fire's trajectory, as expressed in "flame lengths". **(**Flame Lengths are measured from the average flame tip to the middle of the active flaming zone at the base of the fire. It is measured on a slant when the flames are tilted due to effects of wind and slope. It is highly indicative of fire line intensity and thermal output.
2. Average and maximum "Rate of Spread" for wildfires. Rate of Spread shall be expressed in feet-per-hour or miles-per-hour.
3. Spotting distance (distance of ember cast ahead of the fire front), expressed in feet/miles downwind.
4. Wind direction: Fire modeling shall be completed for the most Commonly experienced wind vector for the site, and a second model completed for Santa Ana wind conditions on the site. Wind vectors shall be stated by compass heading. (Example: NE, SSW, etc.)
5. Fuel Type: The types of fuels models used for modeling shall be reported using the National Surface Fuels Classification System (https://www.nwcg.gov/publications/pms437/fuels/surface-fuel-model-descriptions
6. Slope: Modeled slopes shall be identified by location on a site map and include a description of steepness, in percent (%) slope.
7. Fuel Moisture: Model inputs shall include typical/average fuel conditions for San Diego County (Example for 10 hr. fuels: Live Fuel Moisture- 80% or less, Dead Fuel Moisture- fully cured and 6% or less).

Technical Review

Given the complexity and variability of fire behavior, modeling is recommended to be completed, reviewed and interpreted by a certified Wildfire Behavior Analyst or GeoSpatial Analyst. To effectively use fire modeling, users must have enough fire experience and training in fire behavior to recognize if whether input values are appropriate, outputs are reasonable, and which adjustments are needed to correctly model the forecasted fire behavior.

- Typical average flame lengths; level terrain, mid-summer, San Diego County
  Knee-High Grass: 4-8 feet
  Tall Grass: 8-12 feet
  Coastal Sage Scrub: 10-20 feet
  Chaparral: 20-40 feet
  Timber: (Yellow Pine species): 30-60 feet

Modeled Flame Length outputs are an important indicator of fire line intensity. The following chart details this relationship:

FIRELINE INTENSITY				
Flame Length (ft.)	*Energy Output- BTU/Ft/Sec.*	*Rate of Spread (Ft/Hr)*	*Rate of Spread (MPH)*	*Notes*
0-1'	0-3	0-132	<0.25	Campfire heat intensity
1-4'	3-145	132-330	<0.25	Large bonfire heat intensity

4-8’	145-578	330-1320	<0.25	Max. human skin exposure without injury
8-12’	578-1156	1320-3300	0.25-0.62	Radiant ignition of nearby combustibles possible
12-25’	1156-2891	3300-9900	0.62-1.87	Radiant ignition of nearby combustibles probable
25’+	2891+	9900+	1.87+	Very high wildfire intensity
25’-60’	2891+	15,840+	3.00+	Critical Rate of Spread Extreme fire behavior

* Source: Fire Behavior Field Reference Guide, PMS 437, National Wildfire Coordinating Group

Limitations

Some limitations exist within Fire Behavior Models, including the following:

1. Most models are unable to predict the behavior and continuity of wildfire once it significantly involves or moves into structural development or ornamental vegetation. Rates of spread for structural involvement in these cases will require professional fire expertise and judgement.
2. Older, point source models lose accuracy in predicting sustained extreme wildfire behavior moving through tree crowns. If crowning potential exists, more advanced fire behavior modeling may be required.
3. The effects of ember cast after development of high intensity wildfire is difficult to model due to the uptake and transport downwind of embers and burning material high into a thermal column. These materials are lifted by convection and frequently deposited at extended distance from the flaming front causing spot fires. (Accurate determination may require use of advanced fire modeling for more accurate prediction). Similar modeling difficulties exist for geographic aided spotting conditions, such as when wind-driven fire crosses ridgelines.
4. Significant structural ignition during a wildland-urban interface fire increases wildfire behavior and dynamics throughout the fire area due to increased energy release into the thermal column. (Accurate determination requires use of advanced fire modeling and fire expertise for accurate prediction).

MODELING TOOLS *A selected List of Wildfire Behavior Prediction Tools (others are available)*	
Behave Plus	Windows based application available for non-licensed users. Creates a spot/point source origin basic forecast with an overall accuracy of +/- 15%. Outputs are achieved for a single line of fire trajectory. Versions may be downloaded for use on PC’s, tablets, or cell phones.
FlamMap	A federal fire behavior prediction suite capable of complex fire behavior forecasting over time on a landscape scale basis. Highly accurate with a +/-

Farsite	1-3% accuracy. The system includes crown fire modeling capability. Requires a license and certification as a Fire Behavior Analyst to access. This is the current National standard fire behavior system. It is often used in conjunction with the "Landfire" biota database.
Technosylva-Wildfire Analyst	A cloud-based subscription service which provides advanced, high-resolution wildfire spread prediction and probability on a landscape scale. The system requires a license and certification as a Wildfire Geographic Information Specialist for access and effective use. This is currently a developing standard utilized by CAL FIRE.

Fire Behavior Modeling Samples

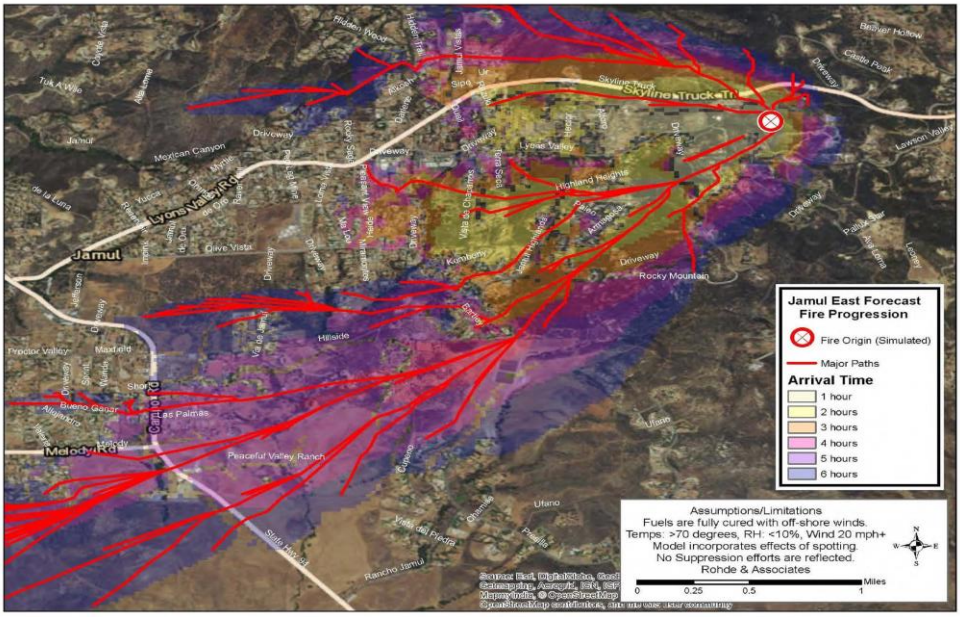
While a number of wildfire prediction tools are available to determine wildfire intensity and trajectory, a commonly used basic assessment tool is "BehavePlus". The system was developed and is maintained by the U.S. Government and may be accessed at: https://www.frames.gov/behaveplus/home

BehavePlus is an application which may be utilized by lay practitioners without a license. It creates a fire behavior forecast for a single line of fire trajectory and factors fuel type, slope, winds, and other related basic wildfire behavior that is directly input by the user. Since it develops fire behavior outputs for a single line of fire trajectory, multiple runs are often needed to fully characterize a development site. BehavePlus produces results which have a general accuracy of +/- 15%. Because of this variability, modeling results for BehavePlus should be reviewed by a qualified wildfire professional for accuracy.

Charts have been developed in this section that offer BehavePlus outputs for areas of San Diego County as a reference (see below) and may in some Cases offer alternatives to using the modeling application, but may be inadequate for complex fuel and terrain conditions.

Other fire models are available that develop high resolution, landscape scale fire models which generally have a technical accuracy of +/- 1-3%. They also produce stronger forecast of spotting potential and extreme fire behavior. Most of these models require a license for use, and expertise in inputting and interpreting resulting data. (See fire models, below).

Example of advanced fire modeling product- Farsite/FlamMap Models, Jamul CA.



Using BehavePlus

The BehavePlus fire behavior modeling system is the least complex to use and does not require a license to access applications. As such, it is the most likely system many users will select. It may be downloaded for use on most computers, tablets, or cell phones. It should be understood that the system offers basic rather than advanced fire behavior outputs. Users of the BehavePlus prediction system must be careful to input accurate data into the system so that accurate fire behavior forecasting is created. Current weather data may also be retrieved at http://famweb.nwcg.gov/weatherfirecd/ for input into the application.

BehavePlus Charts

As an alternative to using the BehavePlus application, charts (see below) have been prepared which indicate average BehavePlus outputs for San Diego County. These charts reflect 20 years of average weather (Months of April-December,2000-2020) and associated rates of spread and fireline intensity data. The data has been validated by National Fire Danger Rating System and Remote Automated Weather Station data, and U.S.D.A. Forest Service records.

Users of BehavePlus should plot and report two trajectory runs for each calculated site. One for daytime summer condition using the most prevalent (onshore) wind vector, and a second projection using Santa Ana wind conditions, those offshore winds typically occurring in the fall of the year producing Southern California's worst case fire behavior. Since BehavePlus is limited to a single line of fire trajectory as its output, users are cautioned to complete several trajectories for every square mile under consideration using the most favorable sites of wind, topography, and fuels for wildfire development, and to average those outcomes for summer and Santa Ana period average conditions to more accurately determine wildfire behavior over a larger spatial area.

The Burning Index (BI) output calculated by BehavePlus is included for reference in the attached charts. The "BI" represents the relative difficulty of controlling a wildfire and is calculated from the collective impacts of temperature, wind, relative humidity, and fuel (vegetation) moisture. The Burning Index may be roughly translated to expected flame lengths (FL) by dividing the BI by 10. (Example: BI =125/10= FL or 12.5 feet in flat terrain).

Outputs from BehavePlus should be plotted on a topographic map displaying the line of trajectory and other data used in the calculation, along with the outputs of Rate of Spread and Fire Line Intensity (Flamelengths) produced.

<u>Example of Behave Use</u>

Use BehavePlus to calculate fire spread in directions likely fire trajectory, as shown by arrows on map to right. (plot these on a map)

Example inputs:

-Summer winds (interior),

-Fuel Model 4 (heavy brush),

-50% slope

Example Outputs:

- Rate of Spread: 620 ft./min.
- Flame Lengths: 56 feet

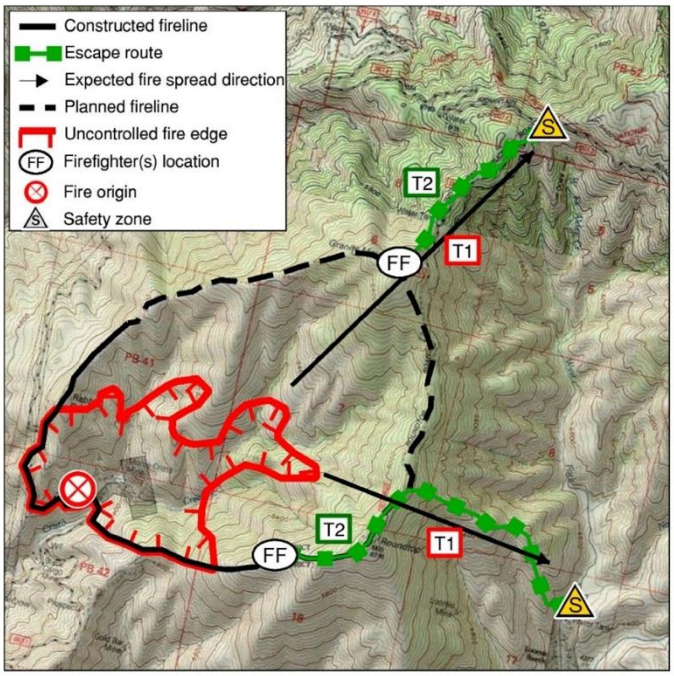


Table 1: BEHAVE Plus 5.0.1

Average-Worst case sustained winds (10 min. average and peak) Fuel Model 1 (knee high grass) at 50% slope

Zone	Period	Temperature	Relative Humidity	Sustained Wind Speed	Burning Index (99%)	Rate of Spread Feet/min	Flame length
Maritime	Summer	70-89°F	30-34%	17 mph	41	300	8
	Santa Ana	90-109°F	5-9%	18 mph	64	470	10
	Peak	90-109°F	5-9%	22 mph	-	550	11
Coastal	Summer	90-109°F	10-14%	19 mph	57	430	9
	Santa Ana	90-109°F	0-4%	21 mph	112	600	12
	Peak	90-109°F	0-4%	26 mph	-	730	13
Transitional	Summer	90-109°F	10-14%	19 mph	119	430	9
	Santa Ana	90-109°F	5-9%	28 mph	145	730	13
	Peak	90-109°F	5-9%	41 mph	-	730	13
Interior (Use for Coastal Sage/Grass mix, any region)	Summer	90-109°F	5-9%	18 mph	153	540	15
	Santa Ana	90-109°F	5-9%	24 mph	183	839	18
	Peak	90-109°F	5-9%	56 mph	-	839	18
Desert	Summer	90-109°F	5-9%	18 mph	153	470	10
	Santa Ana	90-109°F	5-9%	24 mph	168	730	13
	Peak	90-109°F	5-9%	56 mph	-	730	13

Table 2: BEHAVE Plus 5.0.1

Average-worst case sustained winds (10 min. average and peak, Fuel Model 4 (heavy chaparral shrub) at 50% slope

Zone	Period	Temperature	Relative Humidity	Sustained Wind Speed	Burning Index (99%)	Rate of Spread Feet/min	Flame length
Maritime	Summer	70-89°F	30-34%	17 mph	41	480	47
	Santa Ana	90-109°F	5-9%	18 mph	64	620	56
	Peak	90-109°F	5-9%	22 mph	-	700	60
Coastal	Summer	90-109°F	10-14%	19 mph	57	989	50
	Santa Ana	90-109°F	0-4%	21 mph	112	740	61
	Peak	90-109°F	0-4%	26 mph	-	870	65
Transitional	Summer	90-109°F	10-14%	19 mph	119	615	54
	Santa Ana	90-109°F	5-9%	28 mph	145	1100	73
	Peak	90-109°F	5-9%	41 mph	-	1600	87
Interior	Summer	90-109°F	5-9%	18 mph	153	620	56
	Santa Ana	90-109°F	5-9%	24 mph	168	870	66
	Peak	90-109°F	5-9%	56 mph	-	2400	105
Desert Chaparral	Summer	90-109°F	5-9%	18 mph	153	620	56
	Santa Ana	90-109°F	5-9%	24 mph	168	870	66
	Peak	90-109°F	5-9%	56 mph	-	2400	105

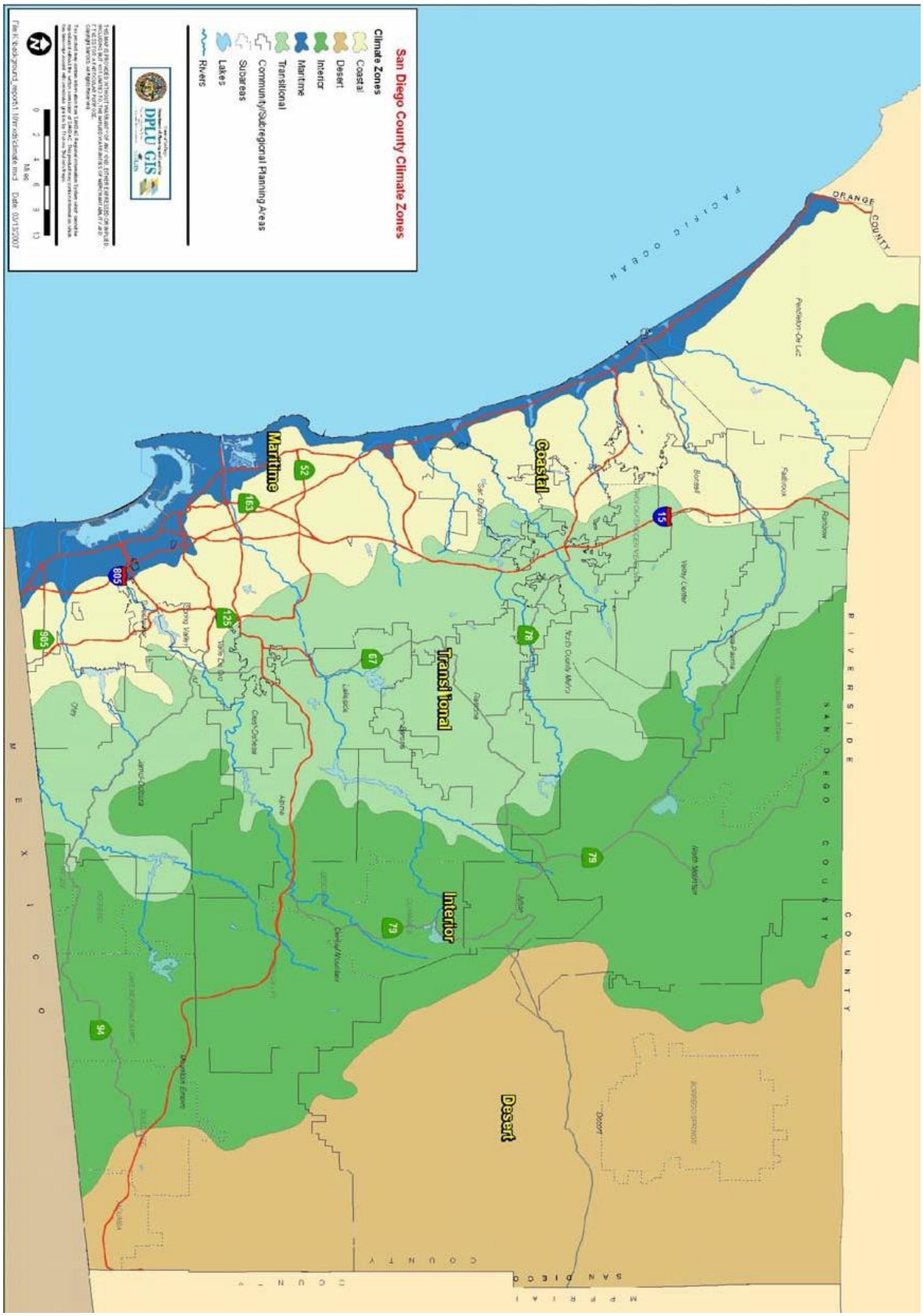
Table 3: BEHAVE Plus 5.0.1

Average-worst case sustained winds (10 min. average and peak, Fuel Model 10 (mature timber with understory) at 50% slope

* Surface Fire Only. Behave does not model crown fires in timber ** Fuel type occurs only in the interior zone of San Diego County

Zone	Period	Temperature	Relative Humidity	Sustained Wind Speed	Burning Index (99%)	Rate of Spread Feet/min*	Flame length*
Interior	Summer	90-109°F	5-9%	18 mph	153	30	10
	Santa Ana	90-109°F	5-9%	24 mph	168	40	11
	Peak	90-109°F	5-9%	56 mph	-	100	17

FIGURE 12: Climate Zones in San Diego County



LIST OF PREPARERS & PERSONS/ORGANIZATIONS CONTACTED

Provide a list of preparers, noting each person included on the County list of approved consultants. Note that the principal author must be on the County list or the report will not be accepted.

REFERENCES

Include a list of all technical references used in the report

TECHNICAL APPENDICES

The Table of Contents for the Appendices must list each document attached to the report in the order in which it is included. The following documents must be included in the report, either in the text (if size is appropriate) or as an appendix:

- Site Map/Plot Plan with topography overlay
- Aerial photo of site and immediate vicinity – with property lines shown
- Photos of the site at ground level
- Fire Modeling
- Completed and signed form "PDS #399F – Project Facility Availability Form for Fire" (if required for the specific permit application)

FPP LETTER REPORT OUTLINE

The FPP – Letter Report is for project applicants who are processing minor projects that have little to no anticipated risk of loss, injury or death involving wildland fires. Discretionary permits that may qualify for a FPP – Letter Report include projects that are located within the State Responsibility Areas and are "infill" projects with virtually no wildlands in the immediate vicinity. The FPP – Letter Report may be prepared by the applicant or the applicant's representative, instead of a fire consultant. However, the applicant may employ the services of a fire consultant to prepare a Letter Report FPP. The FPP Letter Report preparer does not have to be on the County's approved list of consultants.

If upon review of the completed FPP - Letter Report, the County determines that code issues are unresolved or inadequately addressed or the project cannot comply with required conditions that are specified in the "Project Exposure to Wildland Fires" section below, the project does not qualify for a FPP – Letter Report, and a FPP – Full Report will be required. The FPP must be prepared by a consultant currently approved by the County for such reports, and must follow the prescribed format.

The FPP – Letter Report must be written in the following format. Guidance on how to complete certain sections of the report is shown in *(italics)*. Questions on how to complete the form can be directed to (858) 694-2960.

(Date)

County of San Diego
Planning & Development Services (PDS)
5510 Overland Avenue, Suite 310
San Diego, CA 92123

(Local Fire Agency/District Having Jurisdiction)
(Address)

(City, State, Zip)

SUBJECT: FIRE PROTECTION PLAN – LETTER REPORT
(Project Common Name)

(Project Application Number – e.g. TPM ####)
(Assessor Parcel Numbers e.g. ###-###-##-00)

This FPP – Letter Report is submitted pursuant to the County Consolidated Fire Code, to address the adverse environmental effects that a proposed project may have from wildland fire and to provide mitigation of those impacts to ensure that the project does not expose people or structures to a significant risk of loss, injury or death involving wildland fires.

PROJECT DESCRIPTION

(Briefly describe the project being proposed – acreage, parcel size range (e.g."24.5 acre parcel in A-72 zone divided into four 4.0 to 6.5 acre residential lots")

ENVIRONMENTAL SETTING

1. **Location:** *(give the community where the project is located [e.g. Fallbrook] and describe the character of the area that surrounds the subject property , i.e. how it is currently developed)*
2. **Topography:** *(generally identify the terrain of the site and adjacent properties (e.g. land is generally flat immediately off Access Street for 100 yards followed by rolling hills. Unusually high steep terrain can be found in the northwestern corner of the site and beyond)*
3. **Geology:** *(describe any geological features that might affect access roads or building pad design, or increase or reduce wildfire potential on the site.)*
4. **Flammable Vegetation:** *(discuss the type and density of vegetation – this information is typically available in the project Biology Report. If a Biology Report is not required for your project, generally describe the types of plants that are found on the property and the density of vegetation.)*
5. **Climate:** *(identify general climate and seasonal events – e.g. "coastal or west sloping valley or mountainous or desert climate – subject to Santa Ana wind events, flash flooding", etc.)*

PROJECT EXPOSURE TO WILDFIRES

1. **Water Supply:** *(Describe how water is going to be supplied to the project. NOTE: If the project is outside the boundaries of a water district, include the following language in this*

section of the FPP – Letter Report: "All proposed structures shall have a water tank, with size, location and fire department connection (FDC) consistent with the County and Consolidated Fire Code."

If the project is inside the boundaries of a water district, a copy of the Service Availability Form for water must be attached to this FPP – Letter Report. Furthermore, include the following language in this section of the FPP – Letter Report: "Hydrants shall be located along fire access roadways as determined by the Fire Marshal to meet operational needs, at intersections, at cul-de-sacs, and at intervals pursuant to the County Consolidated Fire Code. Required fireflow in water main is 2500 gallons per minute

2. Fire Access Roads

Location. *(Describe the location of all access roads and the number of parcels that will access each road, include development pads and driveways). Explain how the primary access road complies with the distance thresholds specified under the County Consolidated Fire Code.*

Width: *(Describe the width of all access roads. NOTE: All fire access roads including driveways must be improved to a minimum 16' width all-weather surface suitable for travel by 50,000 lb. fire apparatus. Fire access roads serving more than two single- family dwellings shall be a minimum 24' wide with all-weather surface suitable for travel by 50,000 lb. fire apparatus.*

Vertical Clearance: *(Include a statement that "minimum vertical clearance of 13 feet 6 inches must be maintained for the entire required width of fire access roads".)*

Grade: *(Describe the maximum grade in percent for the roads and driveways. NOTE: Grades greater than 15% are not permitted without mitigation; grades greater than 20% are prohibited.)*

Surface: (Describe the surface improvements for all roads and driveways. Be specific rather than quoting this entire code section).

3. **Setback from Property Lines:** *(The minimum setback from any property line in high hazard areas is 30 feet (even though Zoning Setback may be less). Exceptions may be allowed if parcels are smaller than one acre, upon review and approval from the FAHJ and County. Minimum setback from property lines abutting national forests, open space preserves, and designated riparian areas is 100 feet. The applicable statement must appear in this section, and any such forest, preserve or riparian areas must be identified.)*

4. **Building Construction:** *(The Report must include the following statement: "All structures shall comply with the ignition-resistive construction requirements: Wildland-Urban Interface areas of Chapter 7A of the County Building Code.")*

5. **Fire Protection Systems:** *(The Report must include the following statement: "All habitable structures and attached garages shall have residential fire sprinklers per County Code or County Consolidated Code requirements.")*

6. **Defensible Space:** *(The Report must include the following statement: "A minimum 100-foot Fuel Management Zone will be established and maintained around all structures over 250 square feet in size. No off-site clearing is required or authorized.")*

7. **Vegetation Management:** *(The Report must include the following statement: "Prescribed Defensible Space (fuel management zones) will be maintained by the property owners at least annually or more often as needed. Boundaries of fuel*

management zones will be clearly and permanently marked. Plants used in the Defensible Space will be from an approved fire resistant planting materials list that is maintained by County of San Diego, Department of Planning & Development Services.")

8. **Fire Behavior Computer Modeling:** Based on preliminary evaluation by the County Fire Marshal, Computer Fire Behavior Modeling is not required for this **FPP** – **Letter Report** *(Note: Contact the Fire Authority Having Jurisdiction [FAHJ] to confirm).*

Prepared By (Signature)[1]	Date	Printed Name	Title

Property Owner (Signature)[1]	Date	Printed Name

[1] The FPP – Letter Report will not be accepted without original signatures.

ATTACHMENT A:

Building Materials and Components – Baseline, Enhanced, & Optimum Scenarios

Table 5.2. Building materials and components in the Baseline, Enhanced, and Optimum scenarios.

	BASELINE		ENHANCED		OPTIMUM	
	Northern California	Southern California	Northern California	Southern California	Northern California	Southern California
Roof						
Fascia	Wood	Wood	Wood	Wood	Fiber-cement	None
Gutter	Vinyl	Vinyl	Vinyl	Vinyl	Metal with metal gutter guards	Metal with metal gutter guards
Roof surface	Asphalt composition shingle	Asphalt composition shingle	Asphalt composition shingle	Asphalt composition shingle	Steel roof panels, metal drip edge	Clay tiles, noncombustible end caps, metal drip edge
Underlayment	None	None	None	None	Synthetic, fire-resistant	Mineral-surfaced roll roofing
Under-Eave Area						
Soffit	Open eaves (no soffit)	Open eaves (no soffit)	Open eaves (no soffit)	Open eaves (no soffit)	Fiber-cement	Stucco
Under-eave vent	Circular metal vents between rafters	Circular metal vents between rafters	Circular metal vents between rafters	Circular metal vents between rafters	Metal strip vents	Metal strip vents
Exterior Walls						
Door	Solid-core birch wood; vinyl-clad wood-framed sliding glass door; fiberglass garage door	Solid-core birch wood; vinyl-clad wood-framed sliding glass door; fiberglass garage door	Solid-core birch wood; vinyl-clad wood-framed sliding glass door; fiberglass garage door	Solid-core birch wood; vinyl-clad wood-framed sliding glass door; fiberglass garage door	Galvanized steel with insulated glass panel; aluminum-framed tempered-insulated-glass sliding door; metal garage door	Galvanized steel with insulated glass panel; aluminum-framed tempered-insulated-glass sliding door; metal garage door
Dryer vent	Plastic, louvered	Plastic, louvered	Plastic, louvered	Plastic, louvered	Metal	Metal
Siding	Wood composite cladding, gypsum wallboard (ending six inches above grade)	Wood composite cladding, gypsum wallboard (ending six inches above grade)	Wood composite cladding, gypsum wallboard (ending six inches above grade)	Wood composite cladding, gypsum wallboard (ending six inches above grade)	Fiber-cement lap siding	Stucco
Trim	Wood composite	Wood composite	Wood composite	Wood composite	Fiber-cement	Stucco
Attached Deck						
Deck surface	Redwood (non-fire-retardant-treated)	Plastic composite, uncapped	Redwood (non-fire-retardant-treated)	Plastic composite, uncapped	Plastic composite, capped; metal grate at deck-to-wall junction	Metal decking; metal grate at deck-to-wall junction
Fascia	Redwood	Plastic composite	Redwood	Plastic composite	Plastic composite, capped	Metal
Railing	Redwood	Plastic composite	Redwood	Plastic composite	Plastic composite	Metal
Structural support system	Preservative-treated wood	Preservative-treated wood	Preservative-treated wood	Preservative-treated wood	Foil-faced bitumen tape on top and sides of supporting joists	Metal
Underdeck area	Not enclosed	Not enclosed	Enclosed with 1/8 inch metal mesh	Enclosed with 1/8 inch metal mesh	Enclosed with 1/8 inch metal mesh	Enclosed with 1/8 inch metal mesh
Near-Home Landscaping						
Fencing and gate	Cedar	Cedar	Metal chain-link	Metal chain-link	Metal chain-link	Metal chain-link
Mulch	Bark mulch	Bark mulch	Pea gravel and landscaping fabric	Pea gravel and landscaping fabric	Pea gravel and landscaping fabric	Pea gravel and landscaping fabric

ATTACHMENT B:

OUTLINE FOR THE FPP

1.0 Cover Page
2.0 Table of Contents
3.0 Introduction
- 3.1 Summary of proposed project
- 3.2 Reference any alternate means and methods used for compliance
- 3.3 List of those involved, e.g., developers, consultants, etc.

4.0 Vicinity, Site And Project Detail And CEQA Impacts
- 4.1 Vicinity Description
- 4.2 Site Description
- 4.3 Project Description
- 4.4 Anticipated Fire Behavior
- 4.5 CEQA Determination of Significance

5.0 Building Construction
- 5.1 Methodology for compliance with Fire and Building Code
- 5.2 Identification of ignition resistant construction methods and practices, including hardening against ember cast and ignition.
- 5.3 Discussion of site layout and placement of structural development in relation to topography
- 5.4 Inclusion of additional enhancements to mitigate severe fire hazards, as required.
- 5.5 Discussion of development and yard limitations required for fire safety.
- 5.6 Discussion of structural spacing and density and any means utilized to prevent fire transmission between structures.

6.0 Vegetation Management
- 6.1 Identification of native fuel conditions for site and within one mile of the project perimeter
- 6.2 Discussion of fuel modification to protect the community.
- 6.3 Discussion of defensible space for structural development, including design
- 6.4 Detail of defensible space for structure within 0-5 feet, 5-50 feet, and from 50-100 feet of all proposed structures.
- 6.5 Discussion of fuel modification necessary to protect principle transit/evacuation routes and temporary safe refuge sites
- 6.6 Detail of approved fire resistive plant pallet for ornamental planting and landscapes (fuel modification and defensible space)
- 6.7 Discussion of maintenance methods, frequency and responsibility for fuel modification and defensible space

7.0 Community Critical Infrastructure
- 7.1 Discussion of fire hardening of water, telecommunications, and electrical distribution, storage, and transfer systems
- 7.2 Discussion of utilities maintenance responsibility and targets for fire risk mitigation
- 7.3 Discuss the proposed development or utilization of any alternate energy technologies including solar, wind, battery, or other power supply, and associated fire risk mitigation.

8.0 Access and Egress

8.1 Detail of availability for simultaneous access and egress by emergency responders and evacuees

8.2 Presentation of at least two routes of emergency access egress (unless condition is waived by FAHJ/Director-PDS/LUEG

8.3 Identification of proposed gating, gate staffing, and emergency access controls,

8.4 Discussion of dimensions, grades, and design of principle circulation and roads, cul-de-sacs, turn-arounds, parking controls and ensure emergency vehicle access.

8.5 Identification of any traffic calming features and potential impacts to emergency response and/or evacuation

8.6 Identification of principal escape routes (must be built to County road standards and have 24hr. civilian Access, and assured power supply if gated

8.7 Discussion of proposed evacuation routing is shared with any adjacent communities and identify potential impacts from joint and simultaneous use

9.0 Community Evacuation Plan and Temporary Safe Refuge

9.1 Plan for communicating wildfire emergency alerting

9.2 Plan for management of infirmed or disabled populations

9.3 Plan for Temporary safe refuge if evacuation cannot be completed safely, including location, access, and capacity.

9.4 Plan for maintenance and dissemination to community of evacuation plan

9.5 Identification of evacuation target locations and distances from the proposed development. Discuss wildfire entrapment potential on these routes, if any

9.6 Identification of community internet and cellular access for emergency notification

10.0 Water Supply

10.1 Detail of fire suppression water supply distribution systems, reservoirs, and relate facilities.

10.2 Description of fuel modification and facility hardening for critical water facilities

10.3 Identification of any development areas that require pumping or lift to obtain fire flows and emergency redundancies.

10.4 Identification of water sources (groundwater, regional water systems, desalination, etc.

10.5 Identification and map of water pressure, and hydrant placement and spacing,

10.6 Identification capacity of reservoirs and duration of fire flow

10.7 Verification of a minimum of 2,500 GPM fire flow from all fire hydrants

11.0 Emergency Services

Analysis of existing fire and emergency medical services capability to serve new development, and identification of new, development driven needs and proposed mitigations (if any)

12.0 Traffic Engineering, Road Standards, and Circulation (reserved)

13.0 Alternative Means and Methods

13.1 Identification the specific location, intent, and mitigation provided by any requested “Alternate Means and Methods”, cite the fire or building code requirement involved, and discuss why strict compliance may not be achieved.

13.2 Description of preferred alternatives proposed

13.3 Inclusion of a site map demonstrating the placement of the AMM

13.4 Presentation of AMM requests on a site specific or lot-by lot basis only

14.0 Wildfire Behavior Assessment

14.1 Description of wildfire history and trajectory within 5 miles of the development site
14.2 Description of 20-year average weather and climate conditions affecting wildfire behavior, including analysis of dominant weather conditions and Santa Ana wind episodes
14.3 Description of native fuels condition on the site both pre and post development
14.4 Description of the geographic features within and adjacent to the development site affecting wildfire behavior
14.5 Completion of fire behavior modeling for the development site to include vegetated areas up to one-mile from the project perimeter. Complete modeling per this document's guidance

15.0 **LIST OF PREPARERS & PERSONS/ORGANIZATIONS CONTACTED**
16.0 **REFERENCES**
17.0 **TECHNICAL APPENDICES**

San Diego County Fire Protection District /

County of San Diego- Land Use & Environmental Group, Planning & Development Services

County of San Diego
Fire Protection Plan Staff Report
DRAFT 10/14/23

ROHDE & ASSOCIATES
WILDFIRE RISK MITIGATION

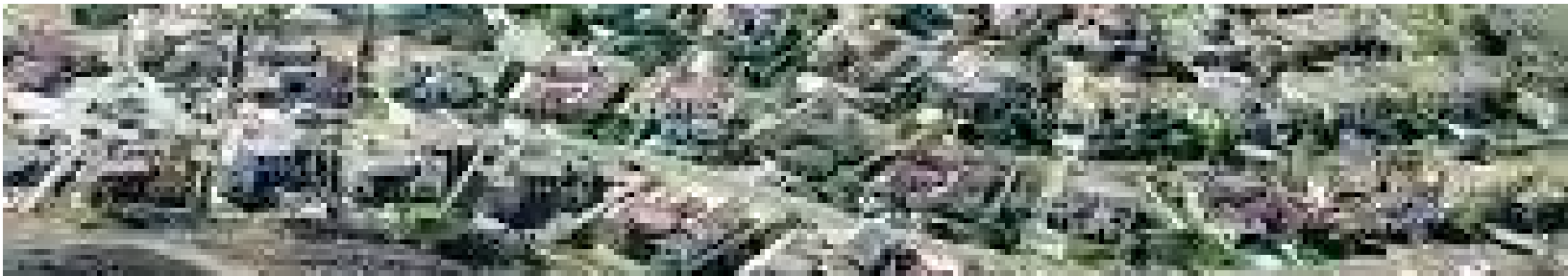


Table of Contents

Executive Summary

SECTION I: PROJECT OVERVIEW

Purpose and Background
- The Challenge

Considerations for Building Community Resilience
- Significant State and Local Planning
- Legal Authorities and Regulations
- Tools
- Technology

SECTION II: BEST PRACTICES
- Plan Development
- Regulations Integration
- Implementation: Tools & Technology

Findings & Recommendations
- Findings
- Recommendations

Stakeholder Input

LIST OF FIGURES

Figure 1: Best Practices in Plan Development
Figure 2: Best Practices in Regulation Integration
Figure 3: Best Practices in Implementation: Tools

SECTION III: FIRE PROTECTION PLAN GUIDELINES FOR PLANNING TEAM

SECTION IV: FIRE PROTECTION PLAN GUIDELINES FOR CONSULTANTS

Executive Summary

Land-use planning decisions determine where communities are built and influence how vulnerable they are to wildfire. Planners and fire officials are well positioned to address wildfire concerns during all phases of community planning and development—from creating community visions that incorporate safety and resilience goals to implementing regulations that specify construction materials and plant selections on a site.

Recognizing this, San Diego County is updating their Fire Protection Plan guidance to ensure it is consistent with current regulations and best practices. This report and the subsequent guidelines, incorporates plans, regulations, tools, and technology related to wildfire risk and mitigation. Fire behavior modeling opportunities and limitations are also examined. Finally, best practices are reviewed and where feasible, incorporated into the guidelines. Additional best practices are documented as findings and recommendations for consideration.

SECTION 1: PROJECT OVERVIEW

PURPOSE & BACKGROUND

Rohde & Associates LLC was retained by the San Diego County Fire and County Planning and Development Services to update the County "Guidelines for Determining Significance and Report Format and Content Requirements for Wildland Fire and Fire Protection" (FPP Guidance document). The FPP provides guidance to planners, applicants, consultants, fire professionals and other interested parties for evaluating adverse environmental effects that a proposed project may have from wildland fire and establishes standards to ensure that development projects do not unnecessarily expose people or structures to a significant risk of loss, injury or death involving wildland fires.

The revised document meets requirements of the County of Board of Supervisors and staff including:

- Addressing guidelines of the California Environmental Quality Act (CEQU)
- Incorporating current regulations and standards
- Evaluating and updating fire access road, fuel modification, water supply and construction standards
- Creating a new standard for emergency evacuation (on hold per staff)
- Incorporating best practices, where feasible
- Discussing Fire Hazard Severity Zones, mapping, and update
- Evaluating and recommending fire modeling software and considering pre-identified weather inputs for modeling

Implementation of these guidelines will assist San Diego County in reducing a new community's vulnerability to wildfire and establishing resilient communities.

The Challenge

Cities and counties are frequently challenged to accommodate both current and future residents in need of safe and affordable housing. In California, approximately 180,000 homes need to be constructed annually to meet demand (Department of Housing and Community Development). Over the past few decades, communities across the state have approved many new housing units. These are often placed within or adjacent to wildland areas, creating "wildland-urban interface" (WUI) conditions. Today, approximately one third of all homes in California are located in the WUI (Mowery et al, 2019).

According to CAL FIRE's 2018 Strategic Plan for California, "since the turn of the century there has been a steep increase in structures lost compared to the 1990s". This rise in destroyed assets is not only because of increasing housing demand and development in the WUI; it is also correlated to an increase in average fire size and severity. Land management efforts have yet to be employed at the scale required to address the continued overgrowth and environmental health impacts caused by 100+ years of fire suppression, making wildfires more difficult to contain.

In addition, Earth's changing climate— specifically rising temperatures and the resulting shifts in wind and water patterns—is exacerbating the situation, substantially increasing wildfire risk in certain areas of the state. The frequency of extreme fire weather during the autumn months has more than doubled in California since the 1980s and, factoring in climate change, this frequency is projected to increase in the future (Goss et.al, 2020). According to California's Fourth Climate Change Assessment, if greenhouse gas emissions continue to rise, California is likely to see a 50% increase in fires larger than 25,000 acres as well as a potential 77% increase in average area burned by 2100. According to some experts, we are now entering an era of "mega-fires" or "mega-disturbances" (Stephens et.al., 2014).

Wildfires in California not only cause direct damage, but also produce indirect impacts on ecosystem services and the built environment (Hill et al., 2020). For example, following the Tubbs fire, benzene—a toxic chemical—was released from melted plastic piping and entered Santa Rosa's drinking water system. As a result, the city implemented a water advisory that lasted for 11 months (City of Santa Rosa, n.d.). Additionally, with less vegetation in place, destructive floods and landslides pose serious risks to fire-impacted communities. Following the 2017 Thomas fire, a debris flow caused severe structural damage and took the lives of at least 23 people (County of Santa Barbara Office of Emergency Management, 2018).

Wildfire events also increase pressure on safety net services such as unemployment, food stamps, educational assistance (Deryugina, 2017). The impacts of California wildfires even extend beyond state borders. In 2020, wildfire smoke not only blanketed large swaths of California, but also worsened air quality across the United States (NASA, 2020).

Moreover, as energy utilities responded to the growing threat and severity of catastrophic wildfire events and the potential risk of ignitions by electrical transmission and distribution facilities and equipment, communities across the

state were affected by public safety power shutoff (PSPS) events. In 2019, about 2.7 million people experienced extended power outages during PSPS events as utilities responded to risky weather conditions (Botts, 2019). Utility credit downgrades are also resulting in higher customer rates, thereby reducing access to affordable electricity (Office of Planning and Research, 2019).

Recent trends have shown an increase in the number of ignitions, area burned, and impacts to ecosystems. Ignitions, which are correlated to increased workload, have been on the rise since 2007 after decades of reductions. While this increase in ignitions is indicative of an increased fire suppression workload for the fire service, it also highlights the continued need for a robust fire prevention program.

Several concurrent trends—climate change, fire exclusion policies, and increasing home development in wildfire-prone lands—are accelerating wildfire risks to people and homes. As the risks rise, so do the costs and impacts to communities.

Understanding where wildfire is likely to occur, how it behaves under extreme weather conditions, and where people live in relation to areas of high risk is critical in reducing wildfire risk. Tools such as land use planning, zoning ordinances, building codes, and subdivision regulations can mitigate wildfire risk by influencing the location, design, and maintenance of homes and property.

Planning a community with wildfire in mind requires integrating risk-reduction strategies into the design, layout, and development of homes and neighborhoods.

CONSIDERATIONS FOR BUILDING COMMUNITY RESILIENCE

Plans and regulations assist jurisdictions in building communities that are less vulnerable to wildfire and other natural and manmade disasters. Tools and technology can improve the effectiveness of these plans and regulations, as well as the efficiency of implementation.

Significant State And Local Planning

All cities and counties in California are required by state law to adopt a general plan, which sets forth a long-term vision of a community's future. The format and content of general plans can vary, and there is no mandatory structure or maximum number of "elements" or topics that a general plan must include. However, California law requires each general plan to address a minimum set of mandatory elements: land use, circulation, housing, conservation, open space, noise, and safety (California Government Code [GC] § 65302). Additional elements

may also be required; for example, cities and counties that have identified disadvantaged communities must also address environmental justice in their general plans.

Senate Bill 1241 (2012) revised general plan safety element requirements such that all cities and counties whose planning area is within the designated state responsibility area (SRA), or in a very high fire hazard severity zone (VHFHSZ), must address and incorporate specific information on wildfire hazards and risk and adopt policies to address and reduce unreasonable risks associated with wildfire.

San Diego County incorporates wildfire hazards and risks in several elements, as well as the County General Plan itself. Wildfire measures in the Land Use, Housing and Safety Elements are included in the guidelines.

Other Plans implement the goals and policies of the general plan. Importantly, all of these plan types provide an opportunity to integrate wildfire hazard into their contents. For example, specific plans, which are useful for planning large projects whose development may be phased over time, can set a schedule for infrastructure improvements, fuel modification and landscape maintenance requirements, or other development standards or requirements to address and mitigate wildland fire hazards and associated risks throughout the phases of each development.

Many of these plan types are subject to environmental review under the California Environmental Quality Act (CEQA). The level of detail required in an Environmental Impact Report (EIR) will vary based on the plan type. The following list of plans were not included in the guidelines but should be consistent with General Plan elements that address the wildfire risk.

Specific Plans

A specific plan is the most detailed of these plan types and acts as a tool for systematic implementation of the general plan within all or a portion of a local agency's planning area. Specific plans may deal with one or more general plan policies and may also address subjects not included in the general plan. These plans are regulated by the State (GC § 65450) and must include a minimum set of requirements related to land use regulations and development standards, public works projects, implementation measures, and financing measures. These plans can be adopted within a zoning ordinance, as part of the general plan, or as a standalone planning document. Jurisdictions may have many specific plans—an example of a specific plan in San Diego County is the Alpine Specific Plan, which

proposes and guides community growth in the Alpine region for a period of decades.

Precise Plans

Similar to a specific plan in terms of its detail but typically remains under the umbrella of a jurisdiction's general plan and does not necessarily include financing mechanisms or a capital improvements program.

Community Plans

A policy document that sets forth a vision for growth within a defined area, such as a particular community or neighborhood. These plans contain goals, objectives, and programs for implementation to help meet the broad objectives of the general plan. Unlike a specific plan or precise plan, they do not include zoning regulations or development standards.

Neighborhood Plans

Similar to a community plan or master plan, but the level of detail and scope can vary significantly based on the needs of the plan and neighborhood area.

Master Plans

Varies significantly depending on how a local jurisdiction defines its purpose or use. Master plans may focus on one or more planning topics, such as infrastructure, facilities, recreation, open space, etc. in combination with the needs of a defined geographic area, such as a utility district, university campus, community area (e.g., downtown, creek way), or jurisdiction. Similar to community plans, master plans are typically designed to be comprehensive and set forth a long-range vision to guide growth and development.

Open Space and Recreation Plans

This broad category can encompass plans for parks, open space, recreation, sensitive lands, and similar land management topics. These plans can address wildfire in many ways, such as assessing how open space should be managed to reduce hazardous vegetation, identifying opportunities for park features to be used as fuel breaks, or analyzing the potential for recreational facilities to act as evacuation centers or temporary areas of refuge.

Local Hazard Mitigation Plans

Local hazard mitigation plans (LHMPs) are voluntary plans that help communities prevent or minimize risks within their jurisdiction to reduce response and post-disaster costs. The federal government requires local governments to develop and maintain LHMPs to receive FEMA mitigation project assistance. These plans must be revised by local/tribal governments, reviewed by the State Mitigation Officer, and approved by FEMA once every five years.

The LHMP and general plan safety element can share similar hazard planning data and analyses. Local governments can work with their local emergency management agencies, local fire authorities, Cal OES, California Department of Forestry and Fire Protection (CAL FIRE), and Fire Safe Councils to ensure effective, integrated, and consistent wildfire prevention and hazard mitigation programs across numerous plans, including LHMPs, CWPPs, and general plans.

Community Wildfire Protection Plans

A Community Wildfire Protection Plan (CWPP) is a planning and funding prioritization tool created by the Healthy Forests and Restoration Act of 2003 that requires communities to define their wildland-urban interface and create actions to reduce wildfire risk to landscapes and the built environment. These plans also incentivize communities by enabling them to influence where and how federal agencies implement fuel reduction projects on federal land and how federal or state funds may be distributed for projects on non-federal lands.

Climate Mitigation and Adaptation Plans

Climate mitigation and adaptation plans help communities assess their vulnerability to the local impacts of climate change and create strategies to either mitigate or adapt to these changes. Climate mitigation plans, also known as climate action plans (CAPs), typically focus on strategies to lower greenhouse gas (GHG) emissions, while climate adaptation plans focus more on adapting to the adverse impacts associated with climate change.

Climate plans have a strong linkage to wildfire as they can consider how a community must adapt to changing conditions such as increased temperature, unpredictable precipitation, and extreme weather events, and shifts in flora and fauna.

Resiliency and Post-Disaster Recovery Plans

Resiliency and post-disaster recovery plans typically guide short and long-term recovery processes for communities who are planning for or recently experienced a disaster. These plans often include topics such as re-establishing critical infrastructure, rebuilding damaged or destroyed homes and businesses, supporting a just economic recovery, and improving resilience to the impacts from future disasters. They may also include a number of other topics such as capacity building, disaster preparedness, and hazard profiles.

Wildfire Mitigation and Safety Plans

SB 901 (2018) expanded existing laws related to electrical corporations' responsibilities to plan for and minimize risks associated with overhead electrical lines and equipment. Public Utilities Code § 8386 now requires each electrical corporation to annually prepare and submit a wildfire mitigation plan for review and approval by the Office of Energy Infrastructure Safety within the California Natural Resources Agency. Plans must include a description of the preventive strategies and programs that the electrical corporation will adopt to minimize the risk of its electrical lines and equipment causing catastrophic wildfires (including consideration of dynamic climate change risks), plans for vegetation management, procedures for customer notifications, plans for inspections, roles and responsibilities for plan execution, metrics for measuring performance, and more.

While the primary focus of these wildfire mitigation plans is to address wildfire risks for the electrical grid, these plans typically align with the objectives of other community-based plans.

Legal Authorities and Regulations

While myriad plans serve as the policy foundation for addressing the WUI, regulations provide communities with the legal means to implement these policies. WUI regulations can address both existing and future development in the WUI, including structures and attachments, roads and other infrastructure, landscaping, current and future land uses, and additional development features.

Communities have a variety of regulatory options for addressing the WUI and related wildfire hazard conditions. Similar to plans, there are some state regulations, such as building codes, that must be adopted by local communities when tied to specific fire hazard severity zones or SRA. Other regulations are adopted voluntarily at the local level. Collectively, these tools can be implemented at a range of scales: from the larger community-level scale, through the

neighborhood or subdivision scale, down to the individual building or lot scale. They provide planners with options for reducing risk through different interventions, such as locating specific uses away from wildfire hazard areas, creating effective landscaping ordinances that are compatible with multiple objectives, and ensuring communities have safe evacuation routes. Development of the FPP guidelines included a review of the following regulations and incorporated several as applicable.

CEQA Compliance

The California Environmental Quality Act (CEQA), Public Resources Code section 21000 et seq. requires lead agencies to detail specific risks for development in wildfire-prone areas as part of the environmental review process, and to adopt all feasible mitigation measures. Those areas mapped by CAL FIRE as "High" or Very High" Fire Hazard Severity Zone, or related high-fire risk areas as designated by local ordinance must comply with these CEQA requirements.

California State Attorney General Opinion

The California State Attorney General (CAG) has litigated against development projects where the CEQA review was judged inadequate. (Some of these cases have been in San Diego County). The CA-AG has published "Best Practices for Analyzing and Mitigating Wildfire Impacts of Development Projects Under the California Environmental Quality Act" in October or 2022, as guidance in application of CEQA to development.

A synopsis of this report and general guidance, including lead agency responsibilities, is included in the guidelines which also establish a base for the development of an evacuation standard.

Building and Fire Codes

Minimum wildfire requirements and referenced performance-based test standards for building construction are found in different parts of the CBSC: Part 2 - California Building Code, Chapter 7A Materials and Construction Methods for Exterior Wildfire Exposure (typically referred to as "Chapter 7A") and Chapter 15 Roof Assemblies and Rooftop Structures; Part 2.5 - California Residential Code; Part 9 - California Fire Code; and Part 12 - California Referenced Standards Code. Similar wildfire protection requirements for mobile homes and other types of manufactured buildings are regulated by the California Department of Housing and Community Development (HCD) (CCR Title 25).

The Office of the State Fire Marshal (OSFM) is responsible for promulgating wildfire safety regulations based on Health and Safety Code § 13108.5. State law designates where CBSC wildfire requirements shall apply based on fire hazard severity zone classifications in the SRA and Local Responsibility Area (LRA). Recent legislation (SB 63, 2021) requires the OSFM and HCD, in consultation with interested stakeholders, to consider expanding the application of WUI building standards to moderate fire hazard severity zones, as defined in GC § 51178.

The County of San Diego significantly amends and adopts the wildfire chapters and articles of the building and fire codes. A review was conducted, and a discussion is included in the guidelines.

Fire Safe Regulations

Public Resources Code § 4290 requires the California State Board of Forestry and Fire Protection to adopt regulations for minimum fire safety standards related to defensible space, road standards for fire equipment access, standards for signs identifying streets, roads, and buildings, minimum private water supply reserves for emergency fire use, fuel breaks and greenbelts, and measures to preserve undeveloped ridgelines to reduce fire risk and improve fire protection. These regulations are known as the Fire Safe Regulations and are codified in CCR, Title 14 (Natural Resources), Division 1.5 (Department of Forestry), Chapter 7 (Fire Protection) under Subchapter 2. The Fire Safe Regulations apply to the perimeters and access to all residential, commercial, and industrial building construction within State Responsibility Areas (approved after January 1, 1991) and lands classified and designated as VHFHSZs (approved after July 1, 2021).

The State Board of Forestry and Fire Protection is also required to periodically update regulations for fuel breaks and greenbelts for greater fire safety. These regulations do not supersede local regulations which equal or exceed minimum regulations adopted by the State.

The April 2023 update of these regulations was reviewed to ensure regulations and guidelines adopted by San Diego are at least as restrictive as state law.

Subdivision Ordinances

Subdivision ordinances describe the conditions and procedures under which land may be subdivided. The Subdivision Map Act (GC § 66410, et seq.) establishes the basic subdivision procedures, while giving local government the authority to regulate the design and improvement of subdivisions, require dedications of public

improvements, require payment of impact fees, and require compliance with the objectives and policies of the general plan. These regulatory powers can promote land use, circulation, open space and safety element objectives, policies, and implementation measures.

Regulation of subdivision design can address wildfire safety by incorporating measures such as emergency access, adequate infrastructure and facilities, separation between buildable lots and wildland areas, fuels reductions and fire protection measures such as residential sprinkler systems in homes abutting open space or where there is inadequate water for structural fire suppression. Local governments can also require dedication of public improvements and land (through fee title or easements) to serve the subdivision.

A tentative subdivision map or parcel map cannot be approved unless the county finds that the subdivision, together with design and improvement conditions, is consistent with all aspects of the general plan or any applicable specific plan (GC § 66474). Two of the findings that can cause a subdivision to be denied are (1) that the site is physically ill-suited for the proposed type or density of the development or (2) that the subdivision's design or improvements are likely to cause substantial environmental damage or cause public health or safety problems (GC § 66474). These are important considerations for counties who are reviewing subdivision proposals in areas that are subject to wildland fire hazard.

Zoning Ordinances

Cities and counties are required to adopt zoning ordinances (also referred to as zoning codes, land use codes, or development regulations) as a means of implementing their general plans (GC § 65860). Zoning ordinances control and regulate land use and development by establishing the types of uses allowed in legally designated geographic areas, the quality and quantity of site characteristics and development standards (e.g., building envelope, setbacks, parking, site access, landscaping, and signage), and procedures for evaluating different types of development applications.

Landscaping, Defensible Space, & Hazard Abatement Ordinances

Current state law requires that all property within the SRA and Local Responsibility Area VHFHSZ must maintain 100 feet of defensible space (GC § 51182, PRC § 4291). Recent legislation also focuses more attention on future requirements and guidance on the management of the "ember- resistant zone"—an area within five

feet of a structure that can have combustible features (e.g., fencing) or landscaping that increases a structure's susceptibility to ignitions from embers (AB 3074).

In addition to state laws, local communities can adopt standards to further regulate landscaping, defensible space, brush or hazardous/flammable vegetation management, weeds, and other risk factors and features (e.g., fences, walls, gates) that are deemed to cause a fire hazard to people and property. These regulations may be adopted as a standalone ordinance, such as a landscaping ordinance, or within a chapter of municipal code— for example, a health and safety code, public nuisance code, or zoning ordinance (when tied to a designated land use zone or zones).

A discussion of San Diego County's vegetation management regulations and guidelines is included in the FPP guidelines. This includes adoption of 5' ember resistant zone, a best practice, and clarification of fuel modification for a community and defensible space for a specific (occupied) structure.

Tools

Although not applicable to the FPP Guidelines, a review of tools available to *implement* the guidelines is included in this report.

Development Agreements

Any city, county, or city and county may enter into a development agreement with any person having a legal or equitable interest in real property for the development of the property (GC § 65864 et seq.). Development agreements are legally binding contracts that establish a specific set of standards for a proposed development. In some cases, requirements for the developer may be more stringent than otherwise allowed under the zoning code, such as higher design standards or dedication of additional public facilities. Development agreements can also provide more flexibility for the developer, such as density bonuses or expedited review times. Communities may also use development agreements to set forth conditions and restrictions for subsequent discretionary actions. For example, a city or county agency may require dedication of emergency access easements, dedication of land for firefighting facilities, on-going maintenance of those facilities, and subsequent review of fire safety plans before later phases of development can begin.

Joint Powers Agreements

California Government Code § 6500 et seq. authorizes two or more public agencies to jointly exercise any power common to the contracting parties, including, but not

limited to, the authority to levy a fee, assessment, or tax. This is established through a joint powers agreement (JPA) and must be authorized by the agencies' legislative or other governing bodies. A JPA can also result in the formation of a new entity created by the public agencies.

Special Taxes & Assessment Districts

Communities and fire authorities can create dedicated sources of local funding for wildfire prevention activities through voter-approved measures that adopt special taxes and fees. These taxes are tied to designated parcels within districts or other identified assessment areas. This can result in predictable funding to enable proactive planning for activities such as fire mitigation, infrastructure improvements, and increased services.

Regional Wildfire Management Programs

Regional wildfire management programs are established by cities and/or counties to work across jurisdictional boundaries to implement coordinated activities for wildfire resilience. These programs typically focus on regional planning and implementation activities, such as landscape- scale fuel management projects, homeowner risk reduction projects (e.g., defensible space, evacuation preparedness), and outreach and education activities, and may include many other wildfire resilience and risk reduction activities. A key ingredient of regional programs is a collaboration among many stakeholders and the public.

Growth Management & Land Acquisition Tools

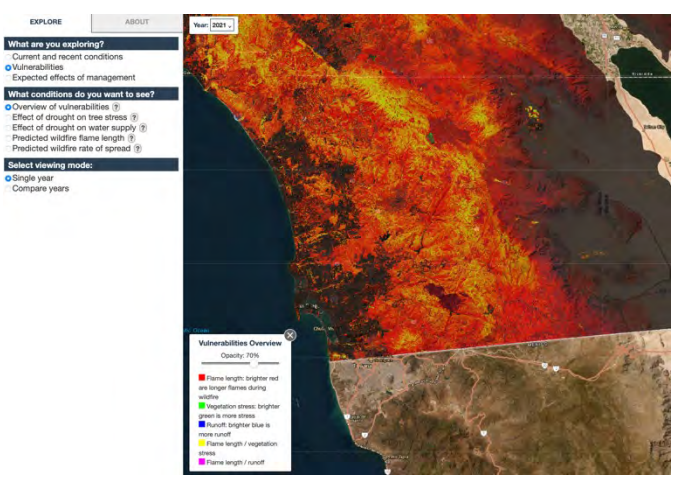
Communities can employ various growth management and land acquisition strategies to direct development away from wildfire hazard areas. These approaches can be implemented by general plan policies, land use regulations, or as part of open space, land acquisition, or conservation management programs.

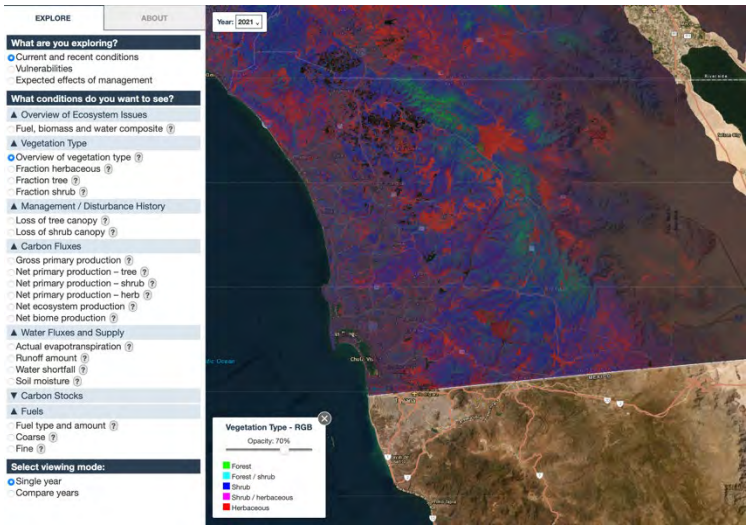
Technology

The technology around wildfire risk and mitigation is quickly evolving. A brief discussion is included for awareness.

- Center for Ecosystem Climate Solution: Natural Climate Solutions Toolbox - a suite of powerful ecosystem data tools, to help land managers, scientists, and other interested stakeholders better evaluate and compare land management options for climate mitigation and adaptation in California. Link to Data Atlas Toolhttps://cecs.ess.uci.edu/data-atlas/
- Planscape is a wildfire resilience decision support tool for planners designed to bring the best available state and federal data and science together in a

user-friendly, accessible format. Planscape helps regional planners prioritize landscape treatments to mitigate fire risk, maximize ecological benefits, and help California's landscapes adapt to climate change. https://www.planscape.org/faqs#h.7kua4s8p5kg6





- The Natural Climate Solutions Data Atlas is a web-based visualization tool to showcase the geospatial data generated by the Center for Ecosystem Climate Solutions (CECS) for California's terrestrial ecosystems. The Atlas consists of annual records of disturbance, water balance, vegetation stress, carbon dynamics, fuels, and ignition probability spanning a timeframe from 1986 to 2021, at 30-m to statewide resolution. Data layers are sourced from Landsat (30-m grids) and transformed into ecosystem services with transparent physical units using our natural ecosystem modeling Data Engine to track water, vegetation stress, fire, and carbon as a wholistic web of tightly linked ecological conditions. This allows for apples-to-apples comparisons across space and time. CECS data products are created with scientific software on the leading edge of reproducibility, rapid refresh, and continuous improvement. https://cecs.ess.uci.edu/data-atlas/
- The Interagency Fuel Treatment Decision Support System (IFTDSS) is a web-based application designed to make fuel treatment planning and analysis more efficient and effective. IFTDSS provides access to data and models through one simple user interface. It is available to all interested users, regardless of agency or organizational affiliation. IFTDSS is designed to address the planning needs of users with a variety of skills, backgrounds, and needs. A simple and intuitive interface provides the ability to model fire behavior across an area of interest under a variety of weather conditions and

easily generate downloadable maps, graphs, and tables of model results. Additionally, the application provides a step-by-step process for testing a variety of fuel treatment impacts (thin, clear cut, prescribed burn) on fire behavior and comparing results to determine which modeled treatment best achieves desired results in terms of reduced fire behavior potential. It can be used at a variety of scales from local to landscape level. IFTDSS hosts a complete set of reference data available for the entire US including LANDFIRE fuels information, SILVIS Wildland Urban Interface, Agency Ownership, as well as a modern map interface allowing users to create or upload their own data. https://iftdss.firenet.gov/landing_page/whats-new.html

Section II: BEST PRACTICES

A comprehensive review of best practices was conducted to identify potential improvements to the FPP Guidelines. The review resulted in no guidelines more comprehensive or user-friendly than those development by San Diego County. However, best practices in related wildfire risk mitigation are included for consideration. Best practices relative to plan development, regulation integration and implementation are summarized in the following figures:

Figure 1: Best Practices in Plan Development

Plan Type	Jurisdiction	Best Practice	Link
General	San Bernadino County	Updated and expanded GP to a Countywide Plan discussing wildfire through land use, housing, transportation, and mobility elements	https://countywideplan.com
Neighborhood	Santa Barbara County	Eastern Goleta Valley Community Plan has a PA with mapped Very High and High Fire Hazard Severity Zones. Wildfire considerations incorporated: landscaping, special design, road connectivity and ingress/egress, etc.	https://content.civicplus.com/api/assets/c045b531-6a10-4bf5-9f34-d03284a623ae
Open Space	Hillsborough	Open Space Vegetation Management Strategy & Guidelines: mapped sensitive species and conducted and mapped fuel load and wildfire risk. Received $800k FEMA grant to manage open space near homes.	https://www.hillsborough.net/DocumentCenter/View/202/Open-Space-Vegetation-Management-Strategy-and-Guidelines?bidId=
Master	Mariposa County	Recreation & Resiliency Master Plan integrating wildfire resiliency as theme in countywide plan.	https://www.mariposacounty.org/2347/Recreation-and-Resiliency-Master-Plan
GP/LHMP/CWPP	Marin County	Multi-Jurisdictional Local Hazard Mitigation Plan describe natural hazards faced and priorities for mitigation. 	https://emergency.marincounty.org/pages/lhmp
GP & LHMP	Rolling Hills	Safety Element references the city's local hazard mitigation plan and community wildfire protection plan incorporating key strategies, such as veg management, utility undergrounding, and roofing and structure hardening.	https://cms5.revize.com/revize/rollinghillsca/Goverment/Planning%20And%20Community%20Services/General%20Plan/SafetyElement/PL_GPN_221024_Safety%20Element_Amended_AB2140_LHMP_FINAL.pdf

CWPP	Mariposa County	Overarching framework for local communities to plug into plan with customized action plans.	https://www.mariposacounty.org/DocumentCenter/View/88105/FINAL-ADOPTED-2021-CWPP-BOARD-Resolution2021-080
Disaster Recovery	Ventura County	Created after 2017 Thomas Fire and refined after Hill and Woolsey.	http://bosagenda.countyofventura.org/sirepub/cache/2/uv5dmldvfl1mxbiugyfqj1dc/14308380816 2023020403702.PDF
Ad Hoc	Laguna Beach	The Wildfire Mitigation and Fire Safety Report identified 47 mitigation strategies to address emergency alert systems, evacuation plans and improvement, fuel modification, infrastructure improvement and undergrounding of utilities.	https://www.lagunabeachcity.net/home/showpublisheddocument/10278

Figure 2: Best Practices in Regulation Integration

Regulation	Jurisdiction	Best Practice	Link
California Building Code	Portola Valley	Urgency ordinance to amend and add home hardening for all new buildings and applicable additions/alterations/repairs jurisdiction-wide	https://library.municode.com/ca/portola_valley/codes/code_of_ordinances?nodeId=TIT15BUCO_CH15.04BUCO
California Codes	Rancho Cucamonga	The Fire District's Board adopted a map designating the Wildland-Urban Interface Fire Area (**WUIFA**) for application of codes. The designated area includes the High and Very High Fire Hazard Severity Zones in the State Responsibility Area (SRA), fire hazard severity zones within the Local Responsibility Area (LRA) identified by CalFIRE, and portions of the City the Fire District has identified as having a high wildfire hazard or risk based on wildland fire history.	https://www.dropbox.com/sh/86zjfacfxqh8oeo/AABYEQ81w5vL7WZ7e1zBiu25a?dl=0&preview=49-1+Wildland-Urban+Interface+Fire+Area+-+Interim.pdf
California Codes *Plus*	N/A	Full-scale fire testing by the Insurance Institute for Business and Home Safety resulted in best practices for hardened homes. Headwaters Economics used research results to recommend improvements to Chapter 7A of the California Building Code.	https://headwaterseconomics.org/wp-content/uploads/2022_HE_IBHS_WildfireConstruction.pdf
Fire Safe Regs	Del Norte	Webpage to facilitate compliance with regulations was created.	https://www.co.del-norte.ca.us/departments/EngineeringSurveying/SMFSR
Subdivision Ordinance	LA County	Restricts number of dwelling units allowed based on type of street system and proximity to wildland areas	https://library.municode.com/ca/los_angeles_county/codes/code_of_ordinances?nodeId=TIT21SU_CH21.24DEST_PT1AC

Zoning Ordinance	San Bernadino County	Fire Hazard Overlay Zone with use restriction or development standards for fire safety in addition to development requirement of base zone, e.g., Residential and density criteria that limit the number of dwelling units per gross acre based on slope percentage	https://www.sbcounty.gov/Uploads/lus/DevelopmentCode/Chapter8213FireSafetyOverlay.pdf
Landscape Guides & Plant Lists	Orange County	The Orange County Fire Authority developed guidelines that distinguish between community fuel modification and defensible space of individual structures and requirements of each, inclusive of acceptable and prohibited plans.	https://ocfa.org/Uploads/CommunityRiskReduction/OCFA%20Guide-C05-Fuel%20Modification.pdf

Figure 3: Best Practices in Implementation: Tools

Tool	Jurisdiction	Best Practice	Link
Development Agreement	Orange County	The Ranch Plan Fire Protection Program, a negotiated agreement with the developer documents community-wide requirements related to fuels management and defensible space, building materials and landscaping rules, access to hydrants, road standards, and more. Good performance-based tool to implement when prescriptive requirements do not result in best mitigation or requested design elements.	https://ocds.ocpublicworks.com/sites/ocpwocds/files/import/data/files/45303.pdf
Joint Powers Authority	Marin County	In 2019, Marin County, along with numerous local fire districts, cities, and other member agencies, established the Marin Wildfire Prevention Authority, tasked with planning, financing, implementing, managing, owning, and operating a multi- jurisdictional and countywide agency to prevent and mitigate wildfires in Marin County. The need arose from multiple fires and lessons learned that identified an urgent need for a coordinated wildfire prevention program.	https://www.marinwildfire.org/collaborations/fire-adapted-marin
Special Assessment	Santa Barbara Truckee	Santa Barbara's Wildland Fire Suppression Assessment District is funded by annual fees from residents within the designated high fire hazard areas and supports FD positions and projects. Voters in the Truckee Fire Protection District passed Measure T, which levies a special tax of $179 per parcel each year to create an annual Community Wildfire Prevention Fund of $3.7 million annually to conduct fuel reduction and wildfire prevention projects.	https://santabarbaraca.gov/government/departments/fire-department/wildland-fire/wildland-fire-suppression-assessment-district https://www.truckeefire.org/coc

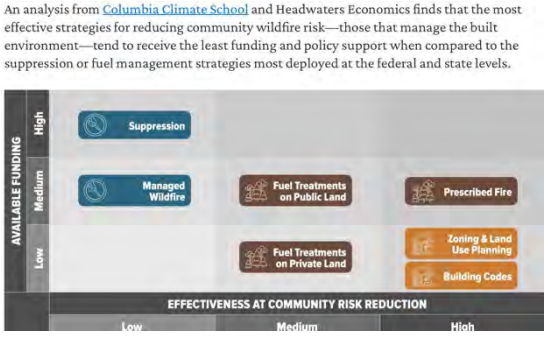
Home Retrofit & Special Assistance Programs	Mendocino	The Mendocino Fire Safe Council defensible space assistance program helps low- income seniors and physically disabled persons adhere to defensible space regulations. The DSAFIE program services include brush and tree trimming, raking, chipping, on- site education, and more.	https://firesafemendocino.org/dsafie/
Growth Management	Windsor	The Town of Windsor Growth Control Ordinance established an urban growth boundary that meets multiple objectives, including preserving open space land for agricultural uses, protecting natural resources, and protecting development from natural hazards by monitoring the Town's residential development. When the 2019 Kincade Fire threatened the town, some advocates attributed the Town's urban growth boundary as helping firefighters better position themselves to effectively respond and protect neighborhoods near the fire front.	https://library.municode.com/ca/windsor/codes/code_of_ordinances?nodeId=TITXVIDEAGSUFEDESEZOGRMA_CH4GRCO_16-4-122AG

Findings & Recommendations

A list of findings and recommendations based on best practice research follows.

Findings

1. Shortcomings associated with hazard maps can be a barrier to adopting effective regulatory measures. Since many wildfire zoning strategies begin with a map that helps planners identify where risk is highest, the maps themselves become sources of controversy. California's FHZ maps depict hazard only and risk becomes subjective. In addition, the maps are infrequently updated. Current maps were created in 2007 and the latest (2022) update has yet to be implemented. Therefore, they do not accurately account for fuels reduction work that may have occurred, recent fires that can have profound effects on the behavior of future fires, the complex influences associated with climate change, and other elements that define risk at a local level. Despite decades of investment and technological advancement, scientists are still unable to produce reliable parcel-scale risk data. Research concludes maps are functionally out of date the instant they are published. Recent fires in Louisville, CO, and Santa Rosa, CA, showcased the shortcomings of risk maps, as the areas that burned were far outside what maps had flagged as highest risk.
2. The most effective policies for reducing community wildfire risk tend to be those that manage the built environment, including mandated building codes and home hardening. Those policies are also among the least funded or supported. Managing fuels, especially on private lands near homes, was also found to be effective, as it can reduce risks to communities, but is similarly underfunded. Meanwhile, policies such as broad wildfire suppression are regularly funded but do little to reduce risk to communities and actually contribute to increasing risk over time. *Missing the Mark: Effectiveness and Funding in Community Wildfire Risk Reduction, June 2023*
https://headwaterseconomics.org/wpcontent/uploads/HE_2023_Missing-the-Mark-Wildfire.pdf



3. Embers and radiant heat from other burning structures (not burning brush) are the main threat to structures, rendering homes themselves as fuel. Applying rules to wildfire risk zones, including where and how people can build, offers a potentially

powerful leverage point for moving the needle toward reduced risk. With growing pressure from state policymakers to increase housing, many communities are left with few options but to build in high-hazard areas. In higher-density development, where homes are close together, incorporating wildfire-resistant, near-building details is critical. A series of CAL FIRE-funded "structure separation experiments" is being conducted by the National Institute of Standards and Technology (NIST) and the Insurance Institute for Business & Home Safety (IBHS). These experiments will lead to better guidance regarding home-to-home spacing (and other smaller building-to-home distances) in wildfire-prone areas. Outcomes from this research may ultimately influence building code amendments and understanding regarding high-density developments alongside increasing wildfire risks. The NIST and IBHS experiments are scheduled to be completed in 2024. For decades, researchers have argued for a reframing of the wildfire crisis as a home-ignition problem and not a wildland fire problem. Reducing impacts to communities and increasing home survivability requires a multipronged approach that considers ignition vulnerabilities to the home, neighborhood, and community. Success requires deliberate consideration and planning of housing arrangements, property vegetation management, nearby wildland fuels, and the materials, design, and near-home landscaping of the home itself.

4. NIST, CAL FIRE, and IBHS developed a Hazard Mitigation Methodology (HMM) to reduce the vulnerability of structures and parcels in a cost-efficient and implementable way. The HMM was conceived to allow structures in the WUI to "stand alone" and survive fire and ember exposures without contributions from first responders as field data has demonstrated that wildfire progression can quickly outpace the efforts of first responders during large and/or concurrent WUI fires. In the WUI, structures can experience two distinct fire exposure problems/hazards—embers and fire. Research and testing identified three sets of technical principles specific to fire, embers, and parcel/community hazard mitigation implementation.

   Embers

   a. Ember exposures to the residence/parcel to be protected can originate from adjacent and/or far field parcels and are beyond the control of the owner of the parcel being protected.
   b. Increased ignition resistance of features and specific combustion considerations can decrease ember generation.
   c. Large surface area combustibles (e.g., combustible roof) contribute significantly to the ember ignition hazard.
   d. Large ember exposures can be generated and observed in WUI fire incidents. Ember exposures can vary significantly in space and time.
   e. The potential for high ember exposures drives the need to harden structures against ember exposures completely.
   f. Partial structure hardening for embers does not relate linearly to hazard reduction. 90 % ember hardening does not translate to 90 % risk reduction.
   g. In high ember exposures, complete ember hardening (100 % compliance) is necessary to significantly reduce the structure ignition potential from embers.

Fire

h. Fire represents a direct and indirect exposure hazard to residences, commercial structures, and infrastructure in the WUI. Direct exposures occur when a source (item burning) directly impacts a target, in this case a residence or commercial structure. Indirect exposures occur when a source ignites a secondary fuel, impacting the target.
i. Fire exposure increases via fuels agglomeration. Increased fire exposures can then potentially impact the residence/commercial structure. Increased exposure also negatively impacts defensible space, making it more hazardous for first responders to conduct firefighting and rescue operations.
j. A property owner can control and reduce fire exposures to their residence/commercial structure by managing their parcel-level combustibles.
k. A property owner may not be able to control fire exposures from adjacent parcels.

Parcel/Community

l. The parcel size and placement of structure(s) will determine structure-to-structure exposures within the parcel and to adjacent parcels.
m. Structure separation distances have significant impact on fire propagation in the WUI.
n. Fuel relocation, reduction, and/or removal should be considered when addressing parcel hardening independent of WUI housing density.
o. Even if certain parcel-level combustible features are seen as expendable/disposable in the context of parcel hardening, the impact of these features must be considered in the context of fuels agglomeration and exposures to structures and other nearby combustibles.
p. In high-density WUI communities, fuel removal may be necessary to comply with the HMM and reduce structural losses.

5. The HMM outlines a detailed structure hardening strategy to resist ignitions from ember exposures. The 40 identified structure ignition vulnerabilities illustrate how detailed structure hardening must be for a structure to stand alone. Structures in the WUI need to be protected against ember exposures independent of WUI Type and housing density. The list goes significantly beyond what is outlined in many best practice documents currently available to WUI residents. The spatial analysis used in the HMM was developed specifically to address fire (radiation and convection) exposures within and across parcels. The latest science and expert knowledge combining decades of field observations were used to develop the spatial relationships outlined in the HMM. The HMM was developed based on how fire spreads between and across parcels, as fire behavior does not respect parcel boundaries. HMM was developed utilizing the principles of fuel reduction, relocation, and removal.
6. Given the magnitude of California's wildfire risks and increasing home development in wildfire-prone areas, constructing a home beyond 2022 CBC Chapter 7A requirements may be needed to ensure greater wildfire resistance.

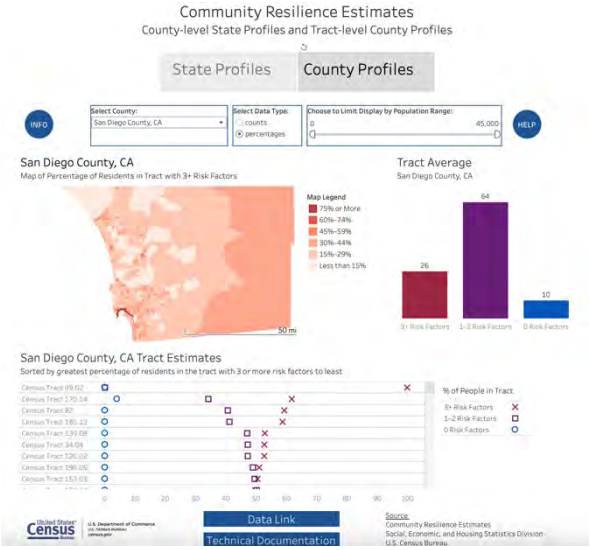
Table ES.1. Summary of Baseline, Enhanced, and Optimum Scenarios.

	Baseline	Enhanced	Optimum
Summary	Compliant with California's Building Code Chapter 7A.	Compliant with Chapter 7A, plus enclosed deck and noncombustible near-home zone.	Beyond Chapter 7A compliance to highest wildfire-resistant measures.
Description	Home meeting the minimum standard of Chapter 7A and current Public Resource Code (PRC) requirements. It does not include a 0-5 foot ember-resistant zone.	Baseline home requirements with the addition of noncombustible near-building landscaping and enclosed under-deck area. Consistent with IBHS's Wildfire Prepared Home™ designation.	Home meeting the most stringent and restrictive options for compliance with Chapter 7A and current PRC requirements. It includes additional building materials and design features beyond what is required in the code ("Code plus"), or preferential selection of building materials and design features that meet the most restrictive requirements in the code. Consistent with IBHS' Wildfire Prepared Home™ Plus designation.
Costs	$	$	$$$

Construction Costs for a Wildfire-Resistant Home | California Edition 3

7. Climate Change. The increase in prolonged droughts and warmer conditions associated with changing climate creates a recipe for fire disaster in the WUI, resulting in the loss of human lives and the cascading effects of environmental and socioeconomic devastation to communities for years to come (EPA, 2020). Throughout much of the United States and worldwide, wildfires are growing in intensity, size and destructiveness. Climate scientists are beginning to correlate the increasingly destructive nature of wildfires with warming global temperatures. In the western U.S., the annual acreage burned could increase 2 to 6 times from the current numbers by the middle of the century because of the effects of climate change. The southeastern U.S. has the potential for larger fires (greater than 12,000 acres) to increase by 300% to 400% by midcentury (USGCRP, 2017).
8. Socioeconomic impact. When wildfire enters the WUI, communities are impacted in many ways. Typically, fire agencies only track the cost to suppress wildfires as well as structures lost. These agencies usually do not evaluate the cascading economic and environmental impacts associated with wildfire and related smoke in the WUI. Examples include municipal watershed loss, transportation and utility disruption, business and job loss, loss of community tax base, the hidden cost of health-related issues from wildfire smoke, and the psychological stress associated with these very traumatic events.
9. Wildfires in the United States inflict an economic loss of $63 billion to $285 billion each year. This includes everything from fire suppression to evacuations to property loss and recovery efforts (Thomas et al., 2017). A community's ability to respond to a wildfire and protect itself can be a socioeconomic indicator of its ability to recover fully from the impacts of wildfire. Research indicates that low-income households are more likely to have lower to no fire response capabilities than higher-income households (Lynn & Gerlitz, 2005).

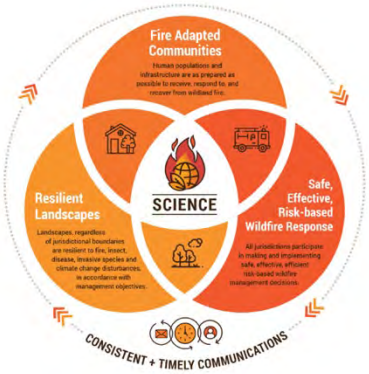
10. San Diego County Resilience



11. CalPoly is developing a Plan Integration Resilience Scorecard (PIRS) as a method for increasing wildfire resilience through assessing and managing local land use, mitigation and adaptation plans. PIRS is a methodology that spatially evaluates networks of plans produced by various agencies (e.g. Safety Element of the General Plan, Hazard Mitigation Plan, and Community Wildfire and Protection Plan) to help reduce vulnerability to hazards. It provides a pathway to adjust multiple policies to improve and strengthen resiliency at the spatial level. Plan integration is the process of harmonizing a jurisdictions network of plans to support community priorities. PIRS+WUI is a three-part process:
    - Hazard zones are defined and mapped creating neighborhood scale units for improved analysis. For PIRS+WUI a combination of CA Fire Hazard Severity maps is combined with census block groups and parcel data.
    - Content analysis is used on documents from the jurisdictions “network of plans” to organize a “policy set” related to the hazard that is scored relative to impact on vulnerability, and influences on land use.
    - Physical and social vulnerability are determined for each of the districts and compared to the policy scores. The phases to a PIRS include: creating the scorecard, analyzing the scorecard, analyzing scorecard results, and advancing resilience. The scorecard shows which policies contribute most to building WUI resilience for the jurisdiction.

Recommendations

1. The National Wildland Fire Management Cohesive Strategy should be used to outline plans and guidelines for consistency and funding opportunities. The tenants: executing safe and effective wildfire response, building resilient landscapes, and creating fire-adapted communities support the shared vision of *"Safely and effectively extinguish fire, when needed; use fire where allowable; manage our natural resources; and collectively, learn to live with wildland fire."*



2. Consider results of fire modeling for identification of wildfire hazard and risk areas to augment State FHZs as local WUI areas as permitted in state law. All state designated FHZs should be subject to all requirements, without distinction.
3. Consider creating an FHZ/WUI map overlay for all maps used in the planning process. The overlay can be the basis for additional requirements related to development in this high-risk area.
4. Integrate all County plans and regulations to focus on goals and priorities. Consider including local CWPPs.



5. Consider implementing the HMM discussed in the Findings to significantly reduce structure losses from future WUI fires. Addressing the 40 identified structure ignition vulnerabilities, as well as the spatial relationships will assist in structure survival regardless of fire department intervention.
6. Update separate but concurrent processes to uniformly reference the FHSZs and eliminate gaps in timing, communication, and coordination across departments. Incorporate defensible space requirements during the Subdivision Committee review. Strengthen Fire Hazard Severity Zone Development Conditions - A decision support process that provides guidance to staff on identifying development conditions can help determine the number of units and lots that are appropriate for approval in the FHSZ.
7. Consider changes to Subdivision regulations to (a) better integrate evaluation of fire risk factors into the County's existing subdivision review and approval process, (b) improve the clarity and objectivity of fire risk evaluation criteria, and (c) address questions and potential risks that arise because of the State's recent legislation limiting local government authorities regarding ADUs.
    - Develop a transparent, formalized decision support process that provides guidance to staff and applicants on identifying development conditions that can help determine the number of units and lots that are appropriate for approval in the FHSZ.
    - Subdivision regulations should limit the number of lots that can be located on a single point of access to control the number of County residents who may be placed at risk and who may need to evacuate the area if a public emergency occurs, and to limit the number of structures that may be destroyed and the risks to firefighters created in defending those structures (even if they are vacant at the time). This is particularly important in limiting the development of new primary dwelling units in FHSZs. Recent California legislation permitting up to two ADUs on many single-family lots significantly increases the existing risks by increasing the potential number of County residents that may be at risk when wildfire emergencies occur. In short, any increase in occupancy in FHSZs creates significant additional risk, regardless of whether occupancy occurs in primary dwelling units or ADUs.
    - The County's ADU ordinance should amend the Zoning Code to prohibit new ADUs on lots in the VHFHSZ that do not have two independent points of access, as well as limiting the creation of new developable lots in the VHFHS. In addition, the ADU ordinance should address whether the likely increased occupancy on lots should influence the County's willingness to create new residential lots in FHSZs. The regulation should reflect the increased risks to public safety that come with the creation of new residential lots and the likely increased occupancy of those lots, by reducing the number of residential lots that can be located on a single point of access. Doing so would significantly reduce the risks to human life, the difficulty of evacuating residents in case of wildfire, and the number of structures that need to be defended when wildfires occur in the future.

8. Consider revising County Road Standards to address the following:
    - **Determination of adequacy.**
        - Each street providing access to lots within a division of land shall connect directly or through one or more other streets to a highway which is shown on the Public Roads Plan, and which is maintained and open to public travel. Each route of access to a highway which is shown on the Roads Plan shall be adequate to accommodate the composition and volume of vehicular traffic generated by the land uses which it serves.
        - In determining the adequacy of a route of access, the advisory agency shall consider the potential for blockage of the route by flood, fire or landslide and the effect of such blockage on the safe evacuation of future users and occupants of the division and on the deployment of fire equipment or other services under emergency conditions. The advisory agency may disapprove a design which makes use of a residential street as a route of access to industrial, commercial or other divisions of land generating traffic which would conflict with the residential character of the street.
        - In determining the adequacy of a route of access, the advisory agency shall consider the potential for blockage of the route by flood, fire or landslide and the effect of such blockage on the safe evacuation of future users and occupants of the division and on the deployment of fire equipment or other services under emergency conditions. The advisory agency may disapprove a design which makes use of a residential street as a route of access to industrial, commercial or other divisions of land generating traffic which would conflict with the residential character of the streets.
    - **Restricted residential access**
        - If a street or street system is restricted to a single route of access to a road shown on the Roads Plan, except for a limited secondary highway, which is maintained and open to public travel, whether at the point of intersection with the highway or at some point distant from the highway, the street or street system shall serve not more than:
            - 150 dwelling units where the restriction is designed to be permanent, and the street or street system does not traverse a wildland area which is subject to hazard from brush or forest fire;
            - 75 dwelling units where the restriction is designed to be permanent, and the street or street system traverses a wildland area which is subject to hazard from brush or forest fire;
            - 300 dwelling units, where the restriction is subject to removal through future development.
        - If the roadway paving on that portion of the street or street system forming the restriction is less than 36 feet in width and is not to be

widened to 36 feet or more as a part of the development of the division of land, the permitted number of dwelling units shall be reduced by 25 percent if the pavement is 28 feet or more in width, and by 50 percent if the pavement is less than 28 feet in width. If the roadway paving on that portion of the street or street system forming the restriction is 64 feet or more in width and the restriction is subject to removal through future development, the permitted number of dwelling units may be increased to 600. In no event shall the pavement width be less than 20 feet.

- **Wildland Access**
  - The advisory agency may disapprove a design of a division of land which utilizes a cul-de-sac or branching street system or other single-access street or street system as the sole or principal means of access to lots within the division, where the forester and fire warden advises:
    - That the street or street system will traverse a wildland area which is subject to extreme hazard from brush or forest fires;
    - That the lack of a second route of access would unduly hinder public evacuation and the deployment of fire-fighting and other emergency equipment in the event of a brush or forest fire.
- **Modifications to access and frontage requirements.**
  The advisory agency may modify the requirements where it finds that topographic conditions, title limitations, or the pattern of ownership or the state of development of parcels in the immediate vicinity of a division of land make the strict application of the provisions of these sections impossible or impractical and that the public health, safety and general welfare will not be adversely affected.

9. Revise definitions to be consistent across all plans.
10. Distinguish between community fuel modification and defensible space in guidelines and plans. The developer should provide an engineered community fuel modification around a development of three or more homes. Defensible space is at the parcel level and should abut the fuel modification. If no fuel modification is provided, lor size and/or configuration should allow for a minimum of 100’ defensible space.
11. Consider prohibiting undesirable trees from anywhere in any high fire hazard zone e.g., pines, conifers, palms, etc.
12. Consider integrating IBHS findings related to the effectiveness of current California/County Building Code Chapter 7A into the next code adoption process. The results of current NIST/IBHS structure ignition test should also be also available for consideration.
13. Modeling used in FPP should be reviewed for currency and best practice. Currently, San Diego County allows non-professionals to interpret anticipated wildfire behavior using the Behave+ Software suite. This program is dated and does not provide high resolution fire behavior prediction outcomes, sometimes experiencing as much as much as +/- 25% variance from actual outcomes. More contemporary programs

however require wildfire expertise and qualification to access and operate but have finer resolution, producing results with +/- 1-2% accuracy from actual outcomes. Consideration should be given to upgrading the required technology and accuracy of fire behavior reporting completed by applicants.

14. Evacuation planning should include robust analysis of traffic flows for not only the project but it's regional impacts, especially on regional evacuation routes. Traffic routes should be studied for maximum capacity and flows, and if the road infrastructure is sufficient to permit timely evacuation of new development, or if traffic flow improvements are needed.

Stakeholder Input

From: Dan Silver <dsilverla@me.com>
Sent: Tuesday, September 26, 2023 11:23 AM
To: Slovick, Mark <Mark.Slovick@sdcounty.ca.gov>
Subject: [External] Follow up on fire guidelines conversation

Hi Mark:
Thank you again for your time today. Much appreciated.

EHL again stresses the land use policy component, specifically using the Village boundaries as a way to stop expanding the wildland-urban interface via GPAs while allowing ample housing within Villages. I've enclosed the LA County motion that uses this concept and an article (Radeloff) on the extent of WUI expansion and scientists' recommendations against it. Large lot ("intermix") development is a particular problem.

Otherwise, sticking to CalFire guidance for 100 ft of defensible space is ample, unless there are site-specific issues identified by the Fire Authority. Within chaparral and coastal sage scrub ecosystems, thinning or clearing beyond this is only justified for strategic fuel breaks for access and staging purposes. Clearing in shrublands leads to "type conversion" and replacement by flammable grasses. Let me know if you would like more references on type conversion, as I've enclosed just one. Forests are more complicated and outside my expertise. EHL favors construction standards, noting that they are not a panacea. I've enclosed several references on factors in structure loss. Syphard 2014 is the key one on amount of defensible space. All this is called the "house out" approach, and is increasingly gaining favor.

As we discussed, "same practical effect" waivers for egress and dead end road lengthy are vague, subjective and fraught with problems. To say, for example, that increasing vegetation clearance compensates for lack of egress is mixing apples and oranges. We recommend eliminating these waivers and sticking with strong standards that everyone understands.

I understand that evacuation will be a subsequent step, but again enclose the state bill that, to my knowledge, is state-of-the-art on this.

If convenient, I'm more than happy to continue to coordinate. Please let me know if 8 files did not transmit.

From: "Slovick, Mark" <Mark.Slovick@sdcounty.ca.gov>
Subject: RE: FW: [External] Follow up on fire guidelines conversation
Date: September 28, 2023 at 11:32:48 AM PDT
To: Mike Rohde <michaelsrohde@gmail.com>
Cc: "Sibbet, David" <David.Sibbet@sdcounty.ca.gov>, "Nissen, Dave" <Dave.Nissen@sdcounty.ca.gov>, "Truong, Angelica" <Angelica.Truong@sdcounty.ca.gov>, "Silva, Ryan" <Ryan.silva@fire.ca.gov>, "laurab@goinnative.net" <laurab@goinnative.net>, "Benner, Julie" <Julie.Benner@sdcounty.ca.gov>

Wanted to update you on another stakeholder meeting I had yesterday with some members of the Elfin Forest Town Council, which is an area near Harmony Grove Village in north county. They had some suggestions and wanted to get the groups thoughts on it. See list below… maybe we can discuss at our next meeting. They also mentioned someone named Cova that did a report for San Luis Obispo? They're going to send me some follow up info and suggested we review the information. Thanks!

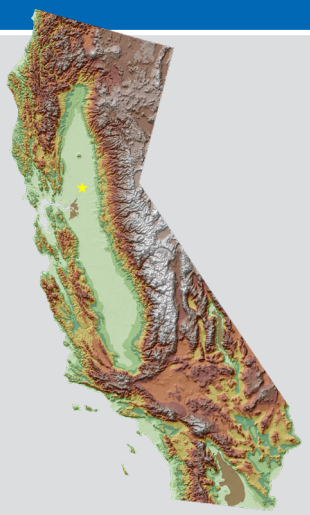
- Add a requirement that a third-party independent review be prepared by the County (on consultant) for large scale projects at applicant's expense (not hired by applicant but done by County or County consultant) This practice is already a part of the Fire District's review, based upon fire marshal determination of project complexity. Cost is currently managed by negotiation with the project proponent by the fire marshal. For example, our firm has completed eight community development project reviews for fire protection concerns. In my opinion, additional codification of this practice through inclusion in the document wouldn't hurt, especially for cost assignment purposes, but it may be advantageous to leave the determination for such review as discretionary to the County, as not all projects require this level of sophisticated review.
- Requiring more analysis/resolution of major issues like dead end road length up front before a project moves forward through the process to avoid the complaint that the applicant has invested too much money to stop the project The fire district believes the current document draft includes best practices in this regard and addresses development concerns fairly and adequately.
- One main concern was regarding waivers and making sure the findings are concrete and objective… they brought up the Harmony Grove Village South project and mitigation for dead end road length as example of something they

don’t think meets the intent of the code (adding hydrants and an additional lane) The issue of Dan's concern occurred during the consideration of the Harmony Grove South project, and the issue received extensive review by fire services, including a third party review of risk and mitigation concerns. The determination of the road length was a factor in that review. A determination for use of this road included increased road width, additional fuel modification, and positioning of a primary safety zone (large park) at the edge of this road. Additional community mitigations including use of pressurized attic ventilation rather than passive roof venting for control of ember intrusion as part of the mitigation. Traffic studies were also performed that considered how emergency traffic flows would impact escape routes through use of this road. Dan has an apparent lack of complete understanding of the process and decisions applied, and the Fire District does not agree with his assessment of this particular mitigation acceptance process. We believe best practices were involved in these decisions and the course of action followed is what Dan has suggested would be best practices in this regard.

- Lots of concerns about evacuation, but they were very focused on requiring the developer to look at impact on existing residents and community, not just the projects residents The goal of evacuation management in the document is to look at both the planned development and existing community and to conduct analysis on accomplishment of timely evacuation, and to not deter from existing greater community evacuation capacity through new development. Mitigations are sought if impacts occur. (only partial address to evacuation issues has been completed in this report, the County intends to contract for a second study on evacuation requirements that will shape this issue).
- Requirements need to be stringent and based on objective requirements and science The current draft is consistent with best available technologies and science and is believed to be objective, citing contemporary recommendations by best available sources.
- “Same practical effect” waivers for egress and dead end road lengthy are vague and subjective

Only partial address to evacuation issues has been completed in this report, the County intends to contract for a second study on evacuation requirements

CALIFORNIA



Key Messages

Temperatures in California have risen almost 3°F since the beginning of the 20th century. The six warmest years on record have all occurred since 2014. Under a higher emissions pathway, historically unprecedented warming is projected during this century.

California snowpack plays a critical role in water supply and flood risk. Projected earlier melting of the snowpack due to rising temperatures could have substantial negative impacts on water-dependent sectors and ecosystems.

Global sea level is projected to rise, with a likely range of 1–4 feet by 2100. This will increase coastal flooding and impact management of water supplies and transportation.

California, the most populous and third-largest U.S. state, has a diverse climate. The deserts in the south are some of the Nation's hottest and driest areas, while higher elevations can experience low temperatures and heavy snowfall. **The North Pacific High, a semipermanent high-pressure system off the Pacific Coast, and the mid-latitude jet stream play dominant roles in California's seasonal precipitation patterns**. During summer, the North Pacific High and the jet stream move northward, keeping storms north of the state and resulting in dry summers. In winter, this system moves southward, allowing storms to bring precipitation to the state. Due to the moderating effect of the Pacific Ocean, coastal locations experience mild year-round temperatures, while inland locations experience a wider range of temperatures. Annual average (1991–2020 normals) temperatures vary from less than 40°F at the highest mountain elevations to less than 50°F in the northeast and greater than 70°F in the southeast. Because of its large north–south extent and the existence of several mountain ranges, extreme climate events often affect only a portion of the state. For example, strong El Niño events often cause excessive precipitation in Southern California, but the effects in Northern California are inconsistent.

Temperatures in California have risen almost 3°F since the beginning of the 20th century (Figure 1). In the 126-year period of record (1895–2020), the six warmest years have all occurred since 2014 (2014, 2015, 2016, 2017, 2018, and 2020). The 2015–2020 period saw the highest number of extremely hot days, slightly exceeding the record set in the early 1930s, and included the years with the second- and third-highest values (2017 and 2020; Figure 2a). The greatest number of very warm nights has occurred since 2005, including the six years with the highest values (2006, 2013, 2015, 2017, 2018, and 2020; Figure 3). The number of cold nights has been below average since 1995 (Figure 4).

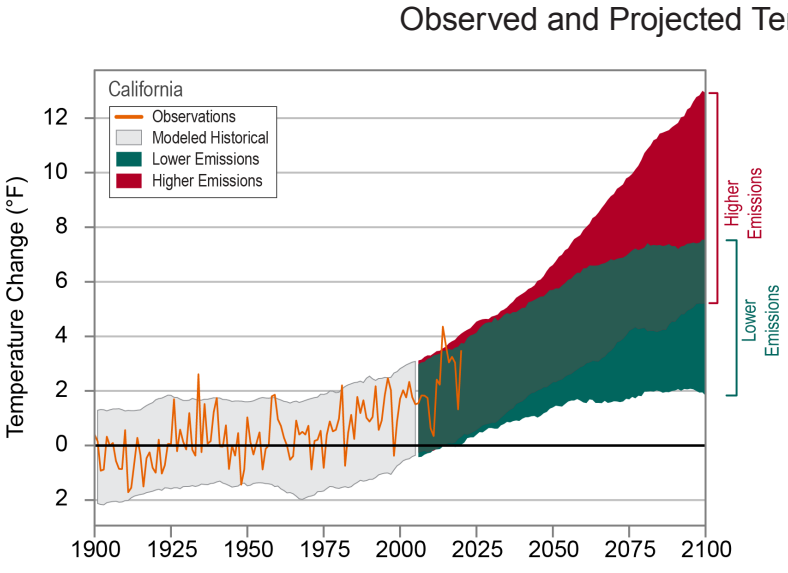


Figure 1: Observed and projected changes (compared to the 1901–1960 average) in near-surface air temperature for California. Observed data are for 1900–2020. Projected changes for 2006–2100 are from global climate models for two possible futures: one in which greenhouse gas emissions continue to increase (higher emissions) and another in which greenhouse gas emissions increase at a slower rate (lower emissions). Temperatures in California (orange line) have risen almost 3°F since the beginning of the 20th century. Shading indicates the range of annual temperatures from the set of models. Observed temperatures are generally within the envelope of model simulations of the historical period (gray shading). Historically unprecedented warming is projected during this century. Less warming is expected under a lower emissions future (the coldest end-of-century projections being about 1°F warmer than the historical average; green shading) and more warming under a higher emissions future (the hottest end-of-century projections being about 9°F warmer than the hottest year in the historical record; red shading). Sources: CISESS and NOAA NCEI.

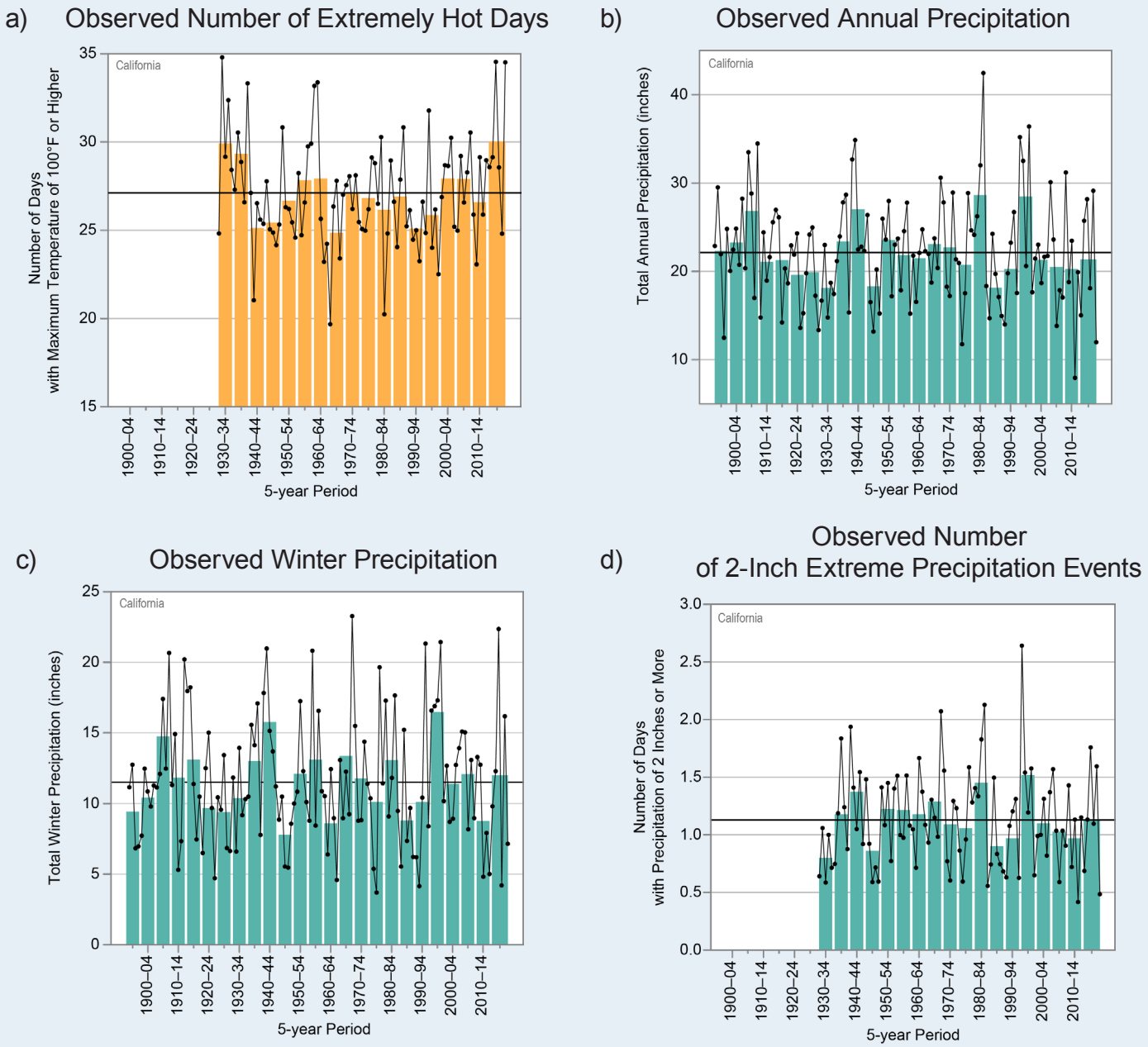


Figure 2: Observed (a) annual number of extremely hot days (maximum temperature of 100°F or higher), (b) total annual precipitation, (c) total winter (December–February) precipitation, and (d) annual number of 2-inch extreme precipitation events (days with precipitation of 2 inches or more) for California from (a, d) 1930 to 2020 and (b, c) 1895 to 2020. Dots show annual values. Bars show averages over 5-year periods (last bar is a 6-year average). The horizontal black lines show the long-term (entire period) averages: (a) 27 days, (b) 22.1 inches, (c) 11.5 inches, (d) 1.1 days. (Note that for Figures 2a and 2d, the average for individual reporting stations varies greatly because of the state's large elevation range.) The greatest number of extremely hot days occurred during the 2015–2020 period. Annual precipitation shows wide variability but has been below average since 2000. There is no long-term trend in winter precipitation. Two-inch extreme precipitation events also show no overall trend; a typical station experiences 1 event per year. Sources: CISESS and NOAA NCEI. Data: (a) GHCN-Daily from 75 long-term stations; (b, c) nClimDiv; (d) GHCN-Daily from 104 long-term stations.

Annual precipitation varies from less than 3 inches in Death Valley in the southeast to more than 100 inches near Eureka in the northwest. Precipitation is also highly variable from year to year, with statewide totals ranging from 7.9 inches in 2013 to 42.5 inches in 1983. The driest multiyear periods were in the early 1930s, late 1940s, late 1980s, and early 2010s, and the wettest were in the early 1940s, early 1980s, and late 1990s (Figure 2b). The driest consecutive 5-year interval was 1928–1932, and the wettest was 1979–1983. Winter precipitation, which accounts for about half of total annual precipitation, has also been highly variable (Figure 2c).

One of California's most serious climate hazards is flooding. Extreme precipitation events resulting in damaging flooding occur periodically. In particular, atmospheric rivers, a weather phenomenon in which a narrow band of very moist air is transported from tropical latitudes of the Pacific Ocean to the West Coast, are capable of causing torrential rainfall. From December 1996 to January 1997, heavy rains and snow fell in northern California. Precipitation was particularly heavy between December 26 and January 3, with some weather stations reporting as much as 25 inches. In addition to the large amounts of rainfall, unusually warm temperatures caused tremendous snowmelt. Lake Tahoe reached its highest level since 1917. Notable locations that experienced massive flooding included Yosemite Valley (first time since 1861–62) and areas along the Russian, Klamath, and San Joaquin Rivers. The late 1990s had the highest number of 2-inch extreme precipitation events because of this and other events (Figure 2d). The 2016–17 winter was the second-wettest on record. The resulting flooding caused more than $1 billion in losses and damaged the Oroville Dam spillway; however, the precipitation also recharged reservoirs depleted by years of drought.

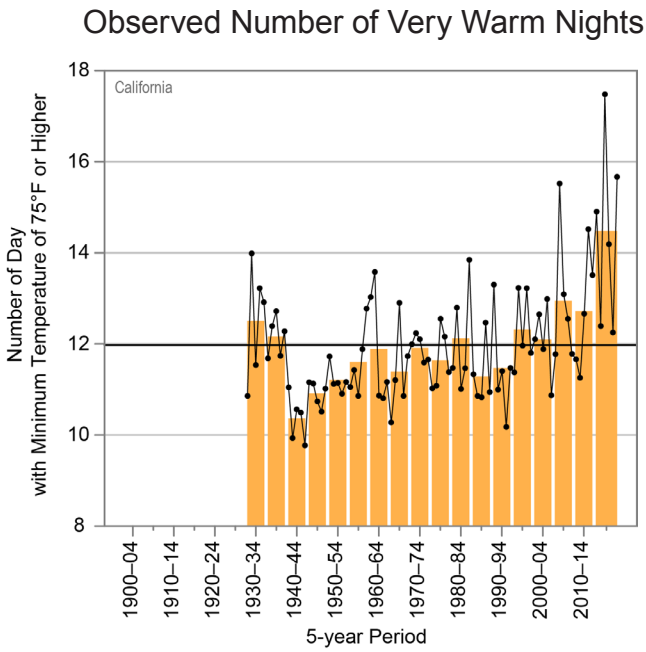


Figure 3: Observed annual number of very warm nights (minimum temperature of 75°F or higher) for California from 1930 to 2020. Dots show annual values. Bars show averages over 5-year periods (last bar is a 6-year average). The horizontal black line shows the long-term (entire period) average of 12 nights (note that the average for individual reporting stations varies greatly because of the state's large elevation range). The highest number of very warm nights has occurred since 2005. Sources: CISESS and NOAA NCEI. Data: GHCN-Daily from 75 long-term stations.

Drought is another serious climate hazard. Because snowpack plays an important role in the management of California's complex water system, some of the most impactful droughts have coincided with years of abnormally low snowpack accumulation during the winter months. The historical record indicates periodic prolonged wet and dry periods (Figure 5). Drought conditions can be exacerbated by warm temperatures. The record warmth in 2014 and 2015, in combination with multiple years of below average precipitation (Figure 2b), led to one of California's most severe droughts.

California is the most productive agricultural U.S. state. Its agricultural industry relies heavily on reservoir water supplied by snowmelt and rainfall runoff. Yearly variations in snowpack depths, and the resulting snowmelt that feeds a network of reservoirs, have implications for water availability. Spring snowpack at Donner Summit reached record-low levels in 2014, which were exceeded in 2015 by a remarkable April 1 snow water equivalent (SWE) value of only 5% of average (Figure 6). The same drought contributed to near-record-low storage levels in the Shasta Dam

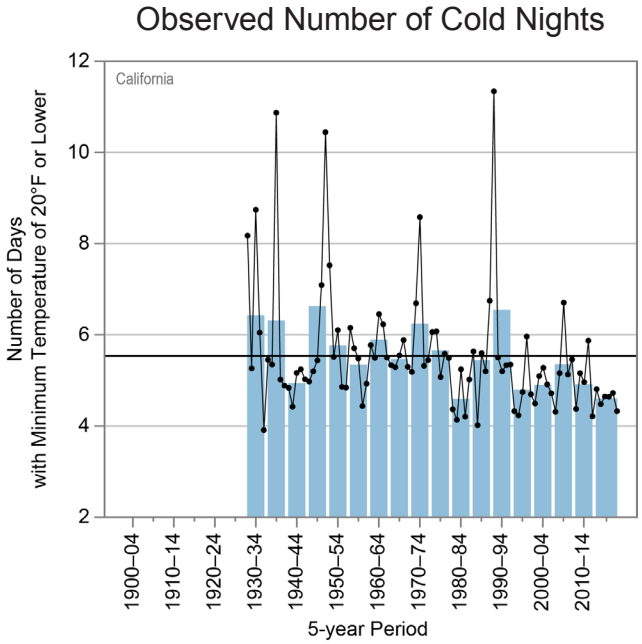


Figure 4: Observed annual number of cold nights (minimum temperature of 20°F or lower) for California from 1930 to 2020. Dots show annual values. Bars show averages over 5-year periods (last bar is a 6-year average). The horizontal black line shows the long-term (entire period) average of 5.5 nights (note that the average for individual reporting stations varies greatly because of the state's large elevation range). The number of cold nights has been below average since 1995, indicative of warming in the region. Sources: CISESS and NOAA NCEI. Data: GHCN-Daily from 75 long-term stations.

Reservoir in 2014 (Figure 7). Low reservoir levels force many agricultural producers to turn to groundwater. The recent dry years and resulting groundwater pumping have caused large drops in groundwater levels in some areas of the Central Valley.

Because summer is the dry season, wildfires are a common occurrence, particularly toward the end of summer. Downslope winds, such as the Santa Ana winds of Southern California that can gust to 80 mph, are often associated with the most destructive wildfires. Because they usually occur after the summer dry season, when there is ample dry vegetation for fuel, they can cause small fires to quickly burn out of control. These Santa Ana winds have been associated with some of the state's largest fires, including those in October 2003 and October 2007, when more than 800,000 and 1,000,000 acres burned, respectively. In the San Francisco Bay area, the comparable Diablo winds can be equally devastating, as evidenced by the Oakland Firestorm of 1991, which killed 25 people and caused more than $1 billion in damages. The year 2020 saw a record number of acres burned and several of the largest fires, including the largest single fire and the largest fire complex in the state's history. The denuding of vegetation by wildfires increases the risks of mudslides and flooding when heavy rain occurs.

Under a higher emissions pathway, historically unprecedented warming is projected during this century (Figure 1). Even under a lower emissions pathway, annual average temperatures are projected to most likely exceed historical record levels by the middle of the century. However, a large range of temperature increases is projected under both pathways, and under the lower pathway, a few projections are only slightly warmer than historical records. Overall, warming will lead to increased heat wave intensity but decreased cold wave intensity. Future heat waves could particularly stress coastal communities that are rarely exposed to extreme temperatures and therefore are not well adapted to such events, such as San Francisco.

Winter precipitation projections range from slight decreases in Southern California to increases in Northern California, but these changes are smaller than natural variations (Figure 8). **Projected rising temperatures will raise the snow line—the average lowest elevation at which snow falls**. This will increase

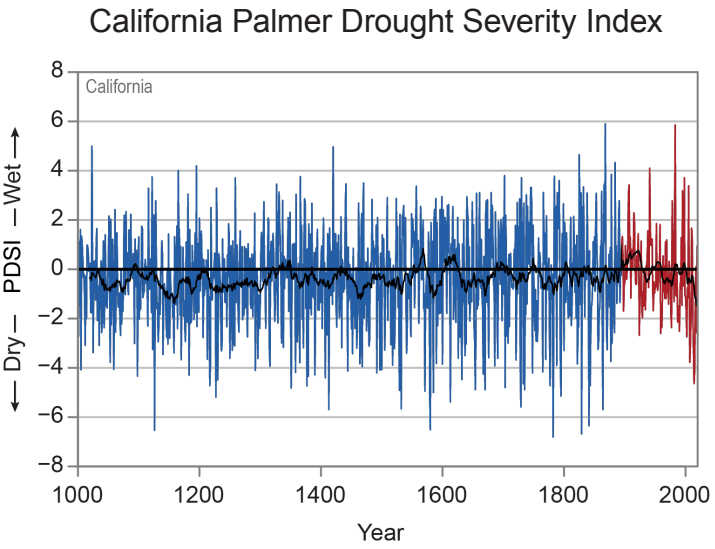


Figure 5: Time series of the Palmer Drought Severity Index for California from the year 1000 to 2020. Values for 1895–2020 (red) are based on measured temperature and precipitation. Values prior to 1895 (blue) are estimated from indirect measures such as tree rings. The fluctuating black line is a running 20-year average. The extended record indicates periodic prolonged wet and dry periods. In the modern era, the wet period of the 1900s and the recent dry period of the 2000s are clearly evident. Sources: CISESS and NOAA NCEI. Data: nClimDiv and NADAv2.

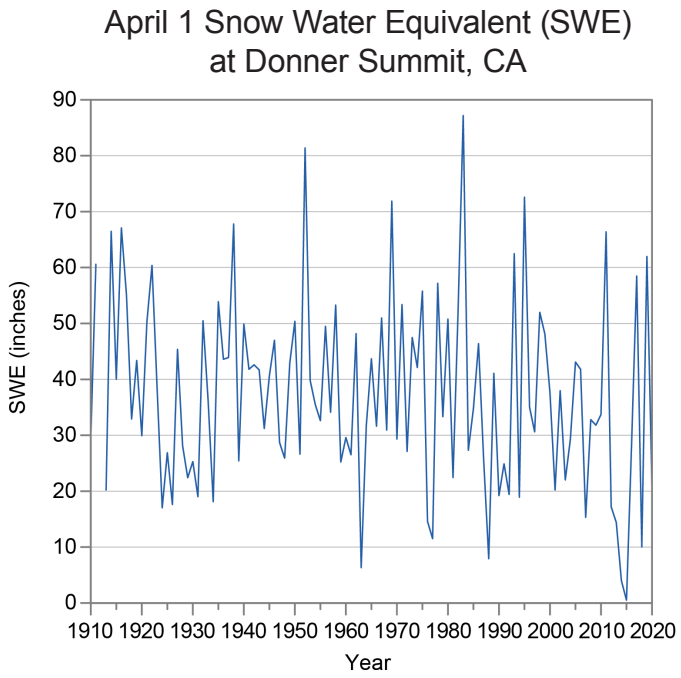


Figure 6: Variations in the April 1 snow water equivalent (SWE) at the Donner Summit, California, snow course site. SWE, the amount of water contained within the snowpack, varies widely from year to year. Snowpack levels decreased between 2011 and 2015 due to unusually low precipitation and warm temperatures during the first three months of the year, reaching record lows in 2014 and 2015. The 2015 value was only 5% of the long-term average, a dramatic indication of the severity of the drought. Source: NRCS NWCC.

the likelihood that precipitation will fall as rain rather than snow, reducing water storage in the snowpack, particularly at those lower mountain elevations that are now on the margins of reliable snowpack accumulation. Higher spring temperatures will also result in earlier melting of the snowpack. This shift in snowmelt timing has critical implications for California's water supply because of flood control rules requiring that water be allowed to flow downstream and prohibiting the storage of water in reservoirs for use in the dry season. A new management strategy called Forecast-Informed Reservoir Operations is being tested to address such challenges.

Naturally occurring droughts are expected to become more intense. Even if precipitation increases in the future, rising temperatures will increase the rate of soil moisture loss during dry spells, further reducing streamflow and water supplies. **As a result, wildfires are projected to become more frequent and severe**.

Rising temperatures also raise concerns for sea level rise in coastal areas. **Since 1900, global average sea level has risen by about 7–8 inches. It is projected to rise another 1–8 feet, with a likely range of 1–4 feet, by 2100** as a result of both past and future emissions from human activities (Figure 9). Sea level rise has caused an increase in tidal floods associated with nuisance-level impacts. Nuisance floods are events in which water levels exceed the local threshold (set by NOAA's National Weather Service) for minor impacts. These events can damage infrastructure, cause road closures, and overwhelm storm drains. As sea level has risen along the California coastline, the number of tidal flood days (all days exceeding the nuisance-level threshold) has also increased. La Jolla experienced its highest number of tidal flood days (8) in 2008 and 2015, and San Francisco recorded its highest number (6) in 1982 (Figure 10). **Continued sea level rise will present major challenges to California's water management system**. The Sacramento–San Joaquin delta is the hub of California's water supply system. Water from reservoirs in Northern California flows through the delta, where it is then pumped into aqueducts to Central and Southern California. As a result of sea level rise, salty ocean water will intrude into the delta through San Francisco Bay, requiring increased releases of water from upstream reservoirs to keep the salty water out of the delta. This, in turn, will reduce water supply amounts.

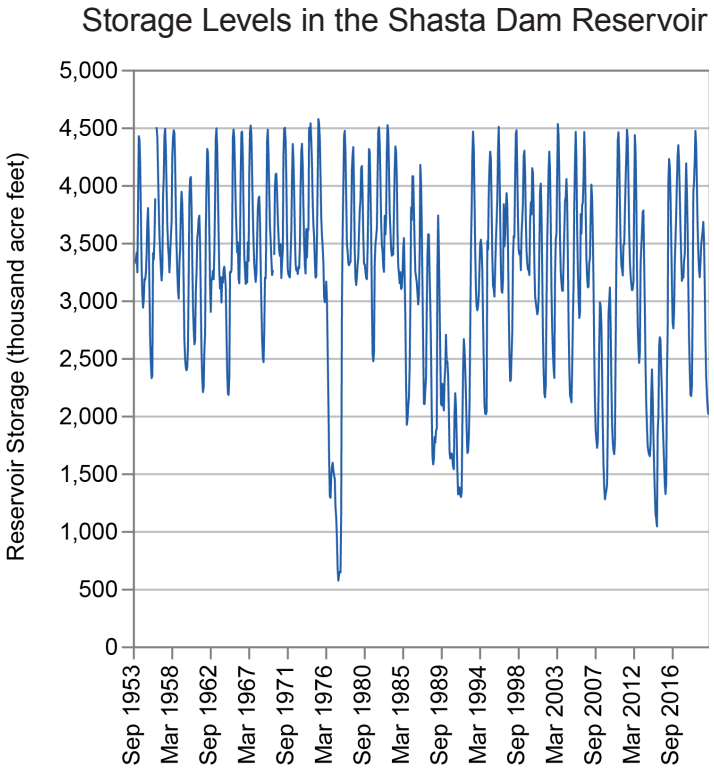


Figure 7: Monthly time series of the average water storage levels in the Shasta Dam Reservoir, California, from September 1953 to December 2020. The Shasta Dam Reservoir generally experiences similar seasonal cycles in water levels from year to year. However, water levels have dropped significantly several times over the past 68 years. In 2014, the reservoir reached its second-lowest levels, surpassed only by extremely low levels during the 1977 drought. Source: California DWR.

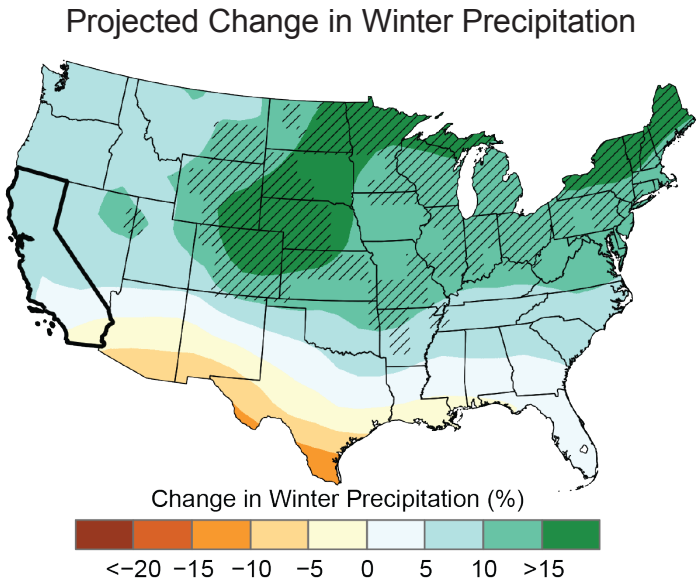


Figure 8: Projected changes in total winter (December–February) precipitation (%) for the middle of the 21st century compared to the late 20th century under a higher emissions pathway. Hatching represents areas where the majority of climate models indicate a statistically significant change. Winter precipitation is projected to increase slightly in the central and northern parts of the state and decrease in the south, but these changes are small relative to the natural variability in this region. Sources: CISESS and NEMAC. Data: CMIP5.

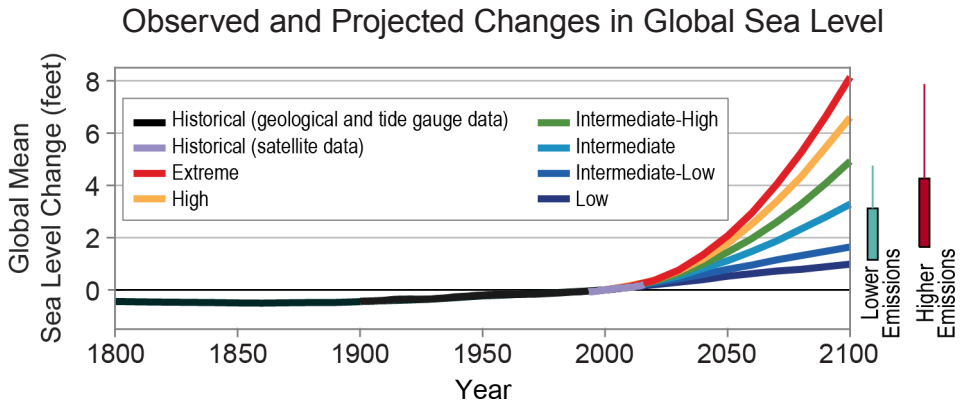


Figure 9: Global mean sea level (GMSL) change from 1800 to 2100. Projections include the six U.S. Interagency Sea Level Rise Task Force GMSL scenarios (Low, navy blue; Intermediate-Low, royal blue; Intermediate, cyan; Intermediate-High, green; High, orange; and Extreme, red curves) relative to historical geological, tide gauge, and satellite altimeter GMSL reconstructions from 1800–2015 (black and magenta lines) and the very likely ranges in 2100 under both lower and higher emissions futures (teal and dark red boxes). Global sea level rise projections range from 1 to 8 feet by 2100, with a likely range of 1 to 4 feet. Source: adapted from Sweet et al. 2017.

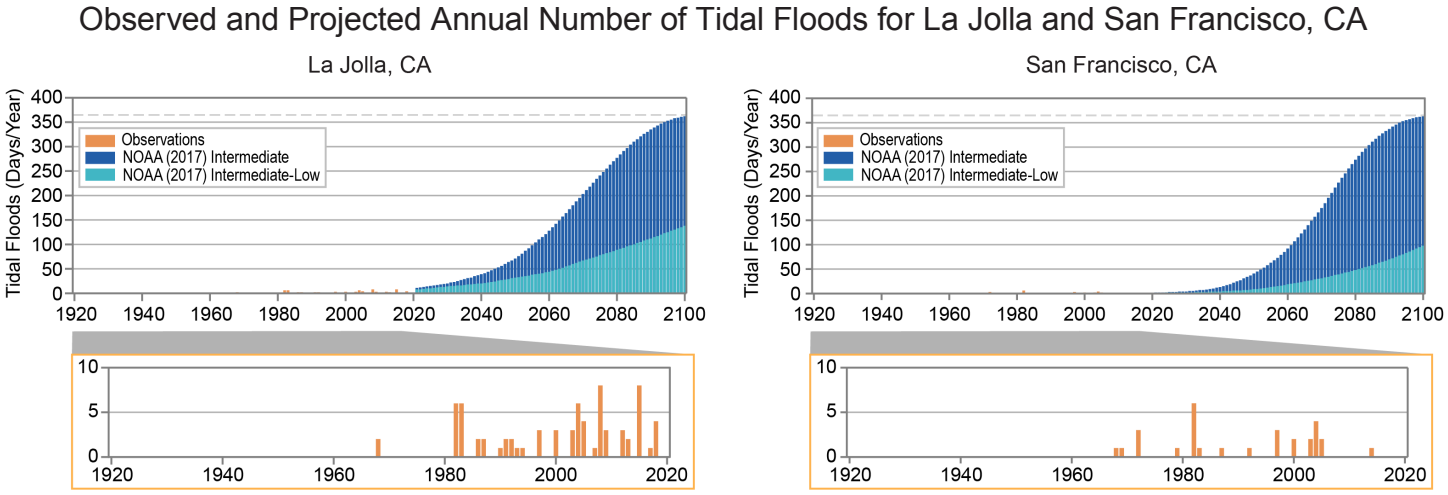


Figure 10: Number of tidal flood days per year at La Jolla and San Francisco, California, for the observed record (1925–2020 for La Jolla and 1920–2020 for San Francisco; orange bars) and projections for two NOAA (2017) sea level rise scenarios (2021–2100): Intermediate (dark blue bars) and Intermediate-Low (light blue bars). The NOAA (2017) scenarios are based on local projections of the GMSL scenarios shown in Figure 9. Sea level rise has caused a gradual increase in tidal floods associated with nuisance-level impacts. The greatest number of tidal flood days (all days exceeding the nuisance-level threshold) occurred in 2008 and 2015 at La Jolla and in 1982 at San Francisco. Projected increases are large even under the Intermediate-Low scenario. Under the Intermediate scenario, tidal flooding is projected to occur nearly every day of the year by the end of the century. Additional information on tidal flooding observations and scenarios is available at https://statesummaries.ncics.org/technicaldetails. Sources: CISESS and NOAA NOS.

Technical details on observations and projections are available online at https://statesummaries.ncics.org/technicaldetails.