THE Ember Alliance

2022

CRYSTAL LAKES
COMMUNITY WILDFIRE PROTECTION PLAN

LARIMER COUNTY, COLORADO

Funded by Crystal Lakes Road and Recreation Association

Crystal Lakes
Community Wildfire Protection Plan
2022 Update

Prepared for Crystal Lakes Road and Recreation Association

300 Tami Rd, Red Feather Lakes, CO 80545

Crystal Lakes

Road & Recreation Association

Prepared by The Ember Alliance

1631 E Lincoln Ave, Fort Collins, CO 80524

THE Ember Alliance

This Community Wildfire Protection Plan (CWPP) was developed in response to the Healthy Forest Restoration Act of 2003 and complies with CWPP standards set forth by the Colorado State Forest Service in 2022. The CWPP is a collaborative effort to guide our wildfire protection. Where possible, we intend to apply the recommended practices to improve our community and increase public safety.

This CWPP is a voluntary, recommended plan and imposes no obligations of the signatories. Executing this document in no way obligates the Crystal Lakes Road and Recreation Association to take any action requiring the commitment of funds to accomplish the recommendations presented herein.

The following individuals and organizations were engaged in developing the Crystal Lakes CWPP and approve the 2022 update:

Cheryl Poage, President
Crystal Lakes Road and Recreation Association

Signature: Cheryl Poage

Date: 11/19/2022

Evan Rau, Fire Chief
Crystal Lakes Fire Protection District

Signature:

Date: 11/17/2022

Paige Niederer, Vice President
Crystal Lakes Road and Recreation Association

Signature: Paige Niederer

Date: 11/19/2022

Derek Rosenquist, Sergeant
Larimer County Sherriff's Office Emergency Services

Signature:

Date: 11/17/22

Kellie Sponberg, Community Member
Greenbelt Management Committee

Signature: Kellie Sponberg

Date: 11-17-2022

Max Erickson, Supervisory Forester
Colorado State Forest Service

Signature:

Date: 11/21/22

Table of Contents

Appendices are available as a separate document.

How to use this CWPP Document

This document is designed for everyone that lives, works, and manages land within and around the Crystal Lakes Fire Protection District. Different sections will be most helpful to different people; please use this guide to direct you to the resources most relevant to you.

I want to learn the basics about wildfires, my local fire districts, and what a CWPP is.	**Look for:** •Section 1.a to learn about CWPPs •Section 2 to learn about wildfire threats in your local fire district •Section 3.a to learn what your next steps can be •Appendix A for an introduction to fire behavior
I'm a resident / homeowner and want to learn about protecting my family, home, and property from wildfires.	**Look for:** •Section 3.a to learn about the actions you can take, including detailed recommendations and research-backed guidance for protecting your home and family •Section 3.b to find detailed hazard ratings and recommendations for your neighborhood
I want to learn about community-led wildfire mitigation actions for the CLRRA.	**Look for:** •Sections 3.c, 3.d, and 3.e to learn about the actions communities can take together to better protect everyone, including funding opportunities •Section 3.b to find detailed hazard ratings and recommendations for your neighborhood
I'm with a government agency or cross-boundary organization and want to learn about landscape-scale wildfire mitigation.	**Look for:** •Section 2.d and 2.e to learn about fire history and treatment history in the area •Section 4.b to learn about priority fuel treatment projects for this community •Sections 4.c and 4.d for general recommendations for stand-level and roadside fuel treatments •Section 4.d to learn about pros and cons of different slash management options
I want to learn about the science behind these recommendations and how priorities were made.	**Look for:** •Appendix B to learn about modelling methodology for fire behavior and evacuation modelin, on-the-ground hazard assessments, and treatment prioritization

Acronyms

CLRRA	Crystal Lakes Road and Recreation Association
CLFPD	Crystal Lakes Fire Protection District
CR	County Road
CSFS	Colorado State Forest Service
CWDG	Community Wildfire Defense Grant
CWPP	Community Wildfire Protection Plan
DFPC	Division of Fire Prevention and Control
FAC	Fire Adapted Community
FEMA	Federal Emergency Management Agency
GBC	Greenbelt Management Committee
HIZ	Home Ignition Zone
IIBHS	Insurance Institute for Business & Home Safety
IRPG	Incident Response Pocket Guide
ISO	Insurance Services Office
LCD	Larimer Conservation District
LCSO	Larimer County Sherriff's Office
NCFC	Northern Colorado Fireshed Collaborative
NFPA	National Fire Protection Association
NWCG	National Wildfire Coordinating Group
PODs	Potential Operational Delineations
RAWS	Remote Automatic Weather Stations
TEA	The Ember Alliance
USFS	U.S. Forest Service
WUI	Wildland-Urban Interface

Refer to the **Glossary** on page 151 for definitions of the words and phrases used throughout this document.

1. Introduction

1.a. Purpose and Need for a Community Wildfire Protection Plan

Community Wildfire Protection Plans (CWPPs) help communities assess local hazards and identify strategic investments to mitigate risk and promote preparedness (**Figure 1.a.1**). Assessments and discussions during the planning process can assist fire protection districts with fire operations in the event of a wildfire and help property owners prioritize mitigation actions. These plans also assist with funding gaps for fuel mitigation projects since many grants require an approved CWPP.

Figure 1.a.1. Elements of a holistic and actionable CWPP.

The Crystal Lakes Road and Recreation Association (CLRRA) is a subdivision that resides within the Crystal Lakes Fire Protection District (CLFPD) near Red Feather Lakes in Larimer County, Colorado. Due to their high wildfire risk, the CLRRA identified the need to update their 2008 CWPP and contracted The Ember Alliance to carry out this project. The CLFPD is the response agency for CLRRA and surrounding subdivisions including Pearl Creek Estates, Elkridge Ranches, and Poudre Meadows (**Figure 1.a.2**). Fire risk is shared across the landscape and does not stop at the boundary of the CLRRA, so including the entire Fire Protection District as well as the surrounding landscape in this CWPP is important for protecting property owners within CLRRA.

The 2022 CWPP for CLRRA is a robust update to the 2008 CWPP that takes advantage of recent advances in fire science and addresses changes to fire risk, home construction, and other characteristics of the community that have occurred since the original CWPP was prepared. The CWPP includes a wildfire risk analysis, prioritization of mitigation activities, and implementation recommendations. This document is a tool for the fire district, land managers, property owners, communities, and the CLRRA to begin prioritizing projects that will make the entire CLFPD a safer and more resilient community to wildfire. The objectives of this project are to:

- Produce an actionable CWPP based on robust analyses of fuel hazards, burn probability, evacuation routes, and community values across the fire district.
- Provide recommendations, including prioritization, for reducing fire hazards, hardening homes, and increasing evacuation safety.
- Engage community members during the CWPP process to address local needs and concerns.
- Set the stage for planning and implementation by property owners, CLRRA, CLFPD, and agency partners to mitigate hazards and promote community preparedness.

Complex interactions among wildland fuels, weather, and topography determine how wildfires behave and spread. Many aspects of wildfires are predictable based on known scientific research on the physical processes driving fire. Much of the work in this CWPP is based on scientific research and computer models of wildfire behavior. A basic understanding of fire behavior aids in interpreting the findings and recommendations reported herein. See **Appendix A. Introduction to Wildfire Behavior and Terminology** and the **Glossary** for the definition of key terms. Several maps presented throughout this document are provided in an interactive online format so you can zoom in and explore output from this CWPP. Visit the CLRRA CWPP Map Experience and see figure legends throughout this document for an indication of which maps are available online.

Why is the CWPP relevant to me?

Becoming a fire adapted community that can safely coexist with wildland fire takes a concerted, ongoing effort by everyone who lives, owns property, protects, or manages land in and around this community. Conditions in CLRRA and surrounding neighborhoods in the CLFPD share some risk factors common to past catastrophic wildfires across the country. This CWPP provides recommendations for how to prepare your family to safely evacuate during a wildfire, how to mitigate your home ignition zone to give your house a fighting chance at surviving wildfires and protect the lives of firefighters engaged in protecting your community.

Even if you do not have a permanent home on your property, you can take steps to protect your camper and other assets, including the value of your property; areas that are heavily burned have less aesthetic and monetary value. More importantly, work you do to reduce fire risk on your property can amplify the work that your neighbors do on theirs, resulting in greater protection for everyone. Removing trees from along roadways can increase the visibility of your property to firefighters, increase the accessibility of your property for fire engines, and reduce the chance that non-survivable conditions can develop and entrap residents and first responders during wildfires.

This CWPP is a call to action to do your part to continue making CLRRA a beautiful and safe community. Land management partners, CLRRA, and CLFPD are here to support your individual efforts, and they are committed to taking action to reduce wildfire risk and increase emergency preparedness for the benefit of this amazing community.

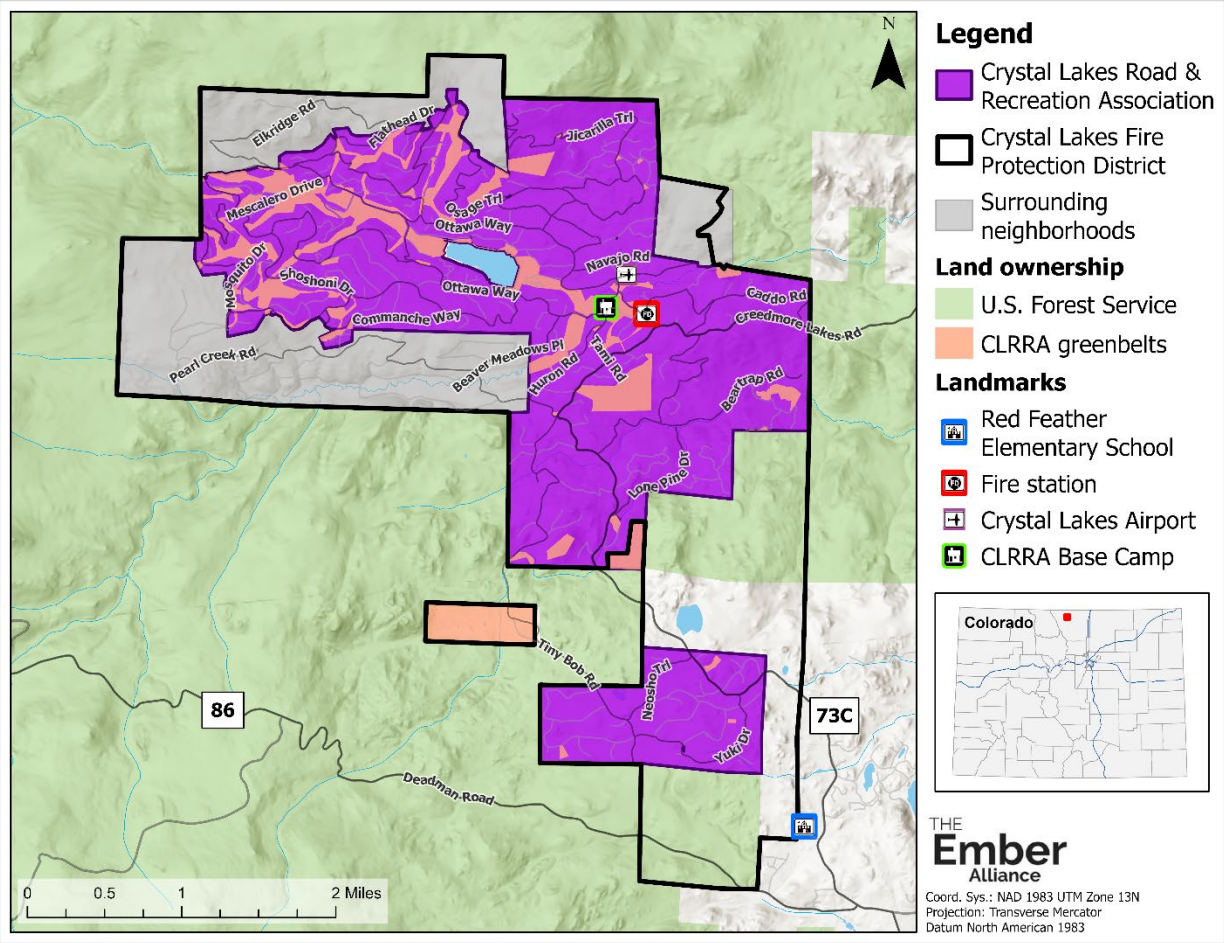


Figure 1.a.2. *Boundary of the CLRRA, which is within the CLFPD along with Pearl Creek Estates, Elkridge Meadows, and Poudre Meadows. The CLFPD is surrounded by the Arapaho-Roosevelt National Forest. Source: Colorado Department of Local Affairs, OpenStreetMap, U.S. Geological Survey, Protected Areas Database of the United States, and CLRRA.*

1.b. Community and Partner Engagement

Collaboration is an essential part of CWPPs. Community engagement, partner commitment, and follow through are what make a CWPP successful. The Ember Alliance (TEA)—a Colorado nonprofit dedicated to fire management and community engagement—worked with the CLRRA and CLFPD to write the CWPP. TEA and representatives from the CLFPD and CLRRA engaged property owners and partners from across the district to develop the recommendations set forth in this CWPP. They incorporated lessons learned from the challenging 2020 wildfire season in Colorado and considered valuable insights shared by community members and other partners.

TEA and CLRRA would like to thank the following partners for their time and effort in developing, providing data, providing feedback, and planning implementation projects for this CWPP:

- Crystal Lakes Fire Protection District
- Crystal Lakes Greenbelt Management Committee
- Crystal Lakes Water and Sewer Association
- Poudre Valley REA
- Larimer County Sherriff's Office
- Larimer County Office of Emergency Management
- Larimer County Road and Bridge
- Larimer Conservation District
- Larimer County Conservation Corps
- Colorado State Forest Service
- Colorado Forest Restoration Institute
- Arapaho-Roosevelt National Forest
- Coalition for the Poudre River Watershed
- The Nature Conservancy, Colorado
- Northern Colorado Fireshed Collaborative

Community Engagement:

On June 11, 2022, members of The Ember Alliance attended the CLRRA annual meeting. Over 75 property owners attended in-person and over 50 attended virtually. We provided an overview of the CWPP process, wildfire risk in the CLFPD, and potential actions for homeowners to mitigate their wildfire risk. We stayed after the meeting and distributed Home Ignition Zone Guides from the Colorado State Forest Service and asked property owners to indicate locations on a map of CLFPD that are especially concerning to them in terms of wildfire hazards.

We also passed out a survey at the meeting and made the survey available online for all property owners. The survey gauged property owner knowledge and concerns about wildfire, barriers and needs for conducting mitigation on their property, and preferred means of communication. Questions developed by the Wildfire Research group (WiRē) were instrumental in designing the survey. 119 property owners responded to the survey and their feedback informed the development of recommendations and priorities for the 2022 CWPP.

On September 10, 2022, we hosted a community field tour to demonstrate different types of forestry treatments that address both wildfire mitigation and ecological restoration. We visited private properties in CLRRA that have implemented defensible space and home hardening, as well as a site that the Larimer Conservation District (LCD) worked at to do mechanical thinning and ecological restoration. Fourteen community members attended the field tour, along with representatives from the USFS and LCD.

A community-wide meeting was held on October 5, 2022, to share the results of the CWPP and give community members an opportunity to ask questions and share resources. About 30 community members were in attendance in person or remotely, as well as partners representing the CLRRA, CLFPD, CSFS, LCD, USFS, DFPC, Northern Colorado Fireshed, LCSO Emergency Services, and CPRW. The CWPP document was then open for public review for a two-week period from October 24 - November 4, 2022. Community feedback was incorporated into the final version of the document.

Partner Engagement:

Representatives from the organizations listed above participated in the CWPP prioritization process and were consulted on the identification of project areas. The first partner prioritization meeting on July 12, 2022, had 15 attendees. We presented the first iteration of the prioritization maps based on our fire behavior analyses, evacuation modeling, and fuel treatment database. We discussed how CLRRA's priority areas align with those of the other organizations and incorporated feedback into the final prioritization maps.

A virtual meeting was held with partners on August 9, 2022, to discuss treatment options in the lodgepole pine forest type that is prevalent across the CLFPD. There were 6 participants in this meeting, and discussions resulted in recommendations for homeowners that have homes in lodgepole stands to reduce their wildfire risk.

Individual meetings to discuss project areas were held with the Arapaho-Roosevelt National Forest (September 7, 2022), the CLRRA Greenbelt Management Committee (September 7, 2022), and with Larimer County Emergency Services and Road & Bridge Department (September 29, 2022). These meetings informed the final project areas that are identified in this CWPP.

Kristin Leger with The Ember Alliance talks about evacuation preparedness with community members during a CWPP meeting for the CLFPD on October 5, 2022. Photo credit: The Ember Alliance.

1.c. Accomplishments Since the Previous CWPP

Crystal Lakes Road and Recreation Association

- Installation of six emergency sirens throughout the community.
- Posting of evacuation routes in the community.
- Completion of a shaded fuelbreak project in Filing 15.
- Colorado Youth Corps fuels mitigation north of the Community Center.
- Mitigation on over 60 acres between 2016-2018 through a FEMA grant, and volunteers have continued to mitigate small areas since then.

Crystal Lakes Fire Protection District

- Installation of "dry hydrants" at several area lakes and ponds that enable quick, safe connection of 5" draft hose to established underwater inlets.
- Extensive fire station renovation and expansion, adding extra room to fit larger apparatus, as well as two additional apparatus bays and high-efficiency lighting.
- Ramp-up of successful grant-writing program, securing thousands of dollars each year to help pay for equipment and supplies.

Fuels mitigation project to promote aspen regeneration and reduce wildfire risk in CLRRA Filing 13. Photo credit: The Ember Alliance.

2. Community Description and Wildfire Context

2.a. General Description

CLRRA was established in 1969 and contains approximately 1,600 lots (half of which have permanent structures on them) distributed across 4,800 acres that are surrounded by the Arapaho-Roosevelt National Forest. This area was the ancestral land of the Sioux, Eastern Shoshone, Arapaho, and Cheyenne Nations. The CLFPD is the response agency for CLRRA and surrounding subdivisions including Pearl Creek Estates, Elkridge Ranches, and Poudre Meadows. Fire risk is shared across the landscape and does not stop at the boundary of the CLRRA, so including the entire Fire Protection District as well as the surrounding landscape in this CWPP is important for protecting property owners within CLRRA.

Compared to the general population of the United States, property owners in CLFPD and the surrounding area are slightly older than average (38.5 vs 62.2 years old, respectively) (U.S. Census Bureau, 2020). Many property owners live in mobile and temporary housing on undeveloped land during the summer months. Most property owners in the Fire Protection District, but not all, live within the CLRRA.

CLFPD is bordered by the Red Feather Lakes Fire Protection District to the east and the Poudre Canyon Fire Protection District to the south. CLFPD often coordinates with these districts to provide mutual aid and respond to calls near the borders of the district.

In the CLFPD, there is an airport, fire station, landfill, and offices for local water, sewer, and recreation organizations on the east center area of the district. Three dams are located at the major water bodies, and communications towers and recreational facilities are spread throughout the district. Beaver Meadows is the only restaurant (**Figure 2.a.1**).

Approximately 880 acres of land (11%) of the CLFPD is publicly managed land. The USFS Arapaho-Roosevelt National Forest owns and maintains 880 acres of land within the CLFPD, and the ARNF completely surrounds the FPD on all sides except the southeast corner at Red Feather Lakes, which is privately owned (**Figure 1.a.2**).

Elevations in the CLFPD range from 8,000-9,500 feet above sea level. The district lies within the Poudre River Watershed and water from here serves property owners of the district as well as downstream users in Fort Collins. Vegetation across the CLFPD changes dramatically from east to west as elevation increases. Ponderosa pine, conifer-hardwood, and mixed-conifer forests occur in the eastern portion of the CLFPD with some shrublands in the center. Lodgepole pine and aspen forests dominate the western portion. Spruce-fir forests are found at higher elevations to the west of the CLFPD (**Figure 2.a.2**). Black bear, elk, moose, mule deer, mountain lion, and bald and golden eagles are some of the large wildlife found in the CLFPD.

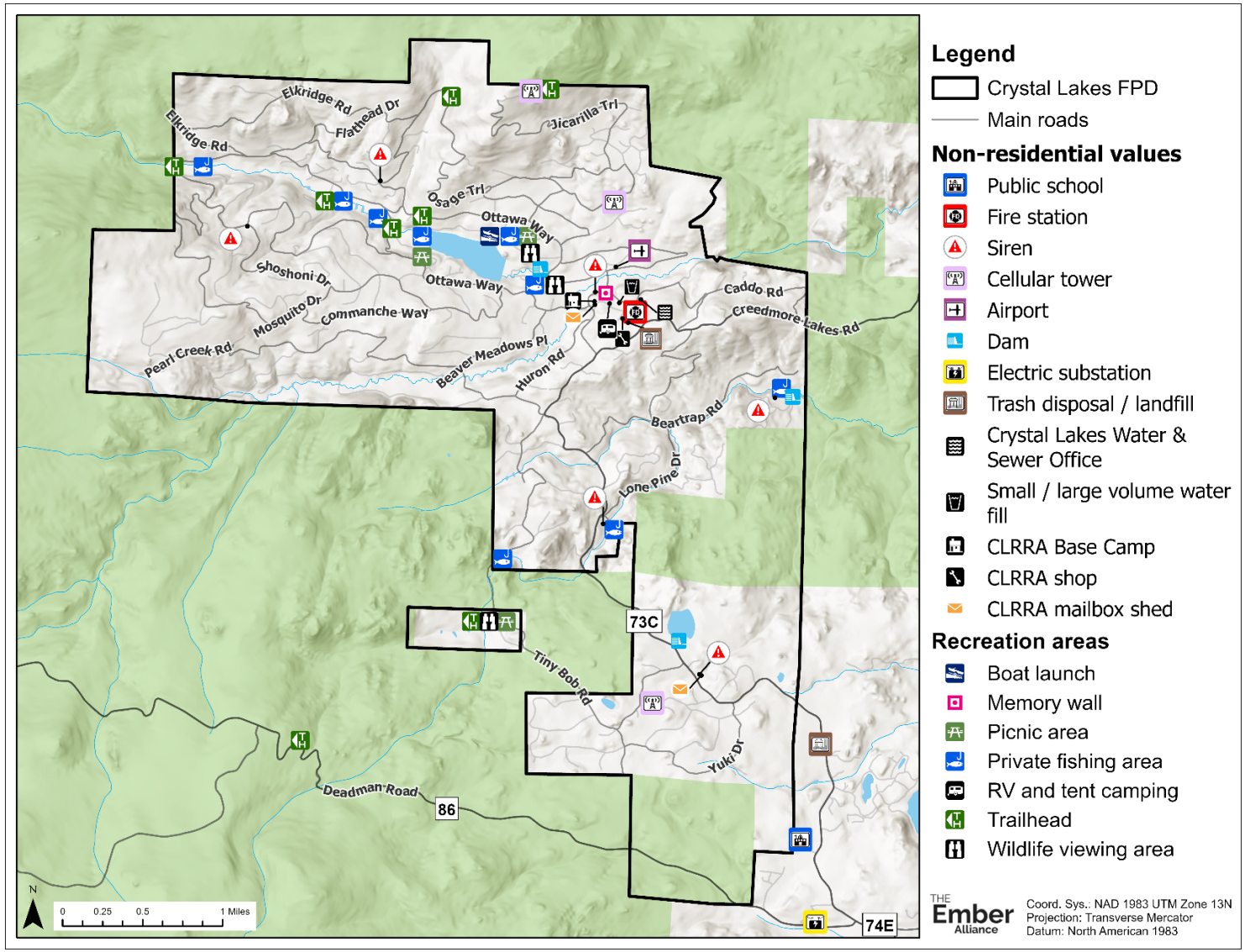


Figure 2.a.1. *Non-residential values within and around the CLFPD. Sources: CO Division of Water Resources, Homeland Infrastructure Foundation-Level Data, U.S. Geological Survey, National Center for Education Statistics, and CLRRA.*

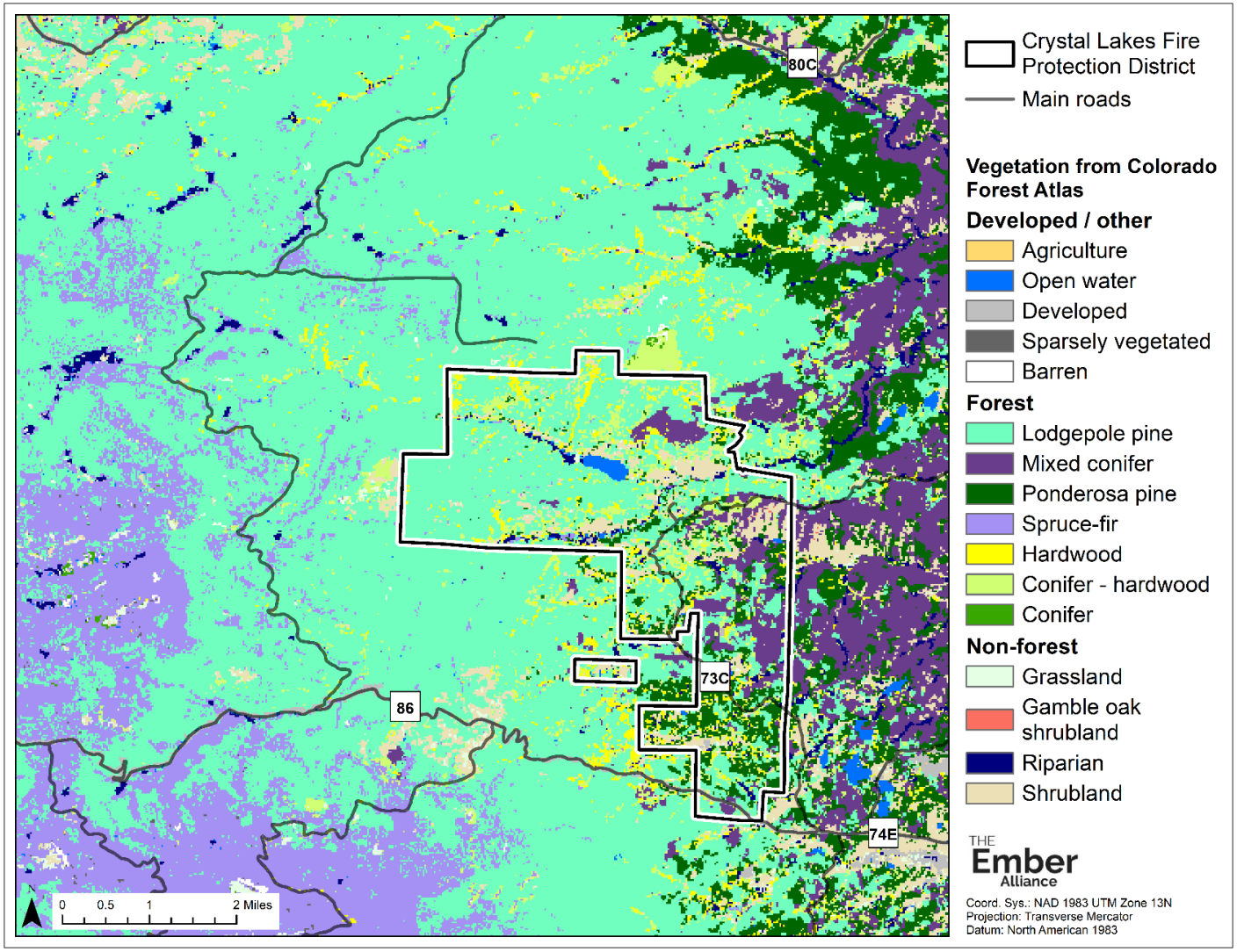


Figure 2.a.2. *Map of vegetation in and around the CLFPD. Source: Colorado State Forest Service, [Colorado Forest Atlas](#).*

2.b. District Capacity

CLFPD has been an all-volunteer department since it was founded in 1995. It includes 14 volunteer firefighters and 10 special duty responders that provide incident-responding support, such as traffic control, mutual aid lead-in, and logistics. CLFPD is headed by the following leadership positions, all occupied by dedicated volunteers:

- Fire Chief
- Assistant Chief of Logistics and Communication
- Assistant Chief of Operations
- Training Officer
- Safety Officer
- Administrative Officer
- Head Special Duty Responder

CLFPD has the following vehicles, located at the 237 Blackfoot Road station, which is staffed on an as-needed basis:

- One 4x4 Type 3 engine with a 500-gallon tank (structure fire engine)
- Two Type 6 engines (brush trucks)
- One 4x4 tender with a 2,000-gallon capacity for firefighting water delivery
- One squad vehicle with a snowplow
- One squad vehicle for initial response
- One support vehicle (decommissioned ambulance)
- One 2-3 person inflatable watercraft

The Insurance Services Office (ISO) rating is 9 for Crystal Lakes Volunteer Fire Department. ISO ratings range from 1 (highest) and 10 (lowest) and are provided to fire departments and insurance companies to reflect how prepared a community is for fires in terms of local fire department capacity, water supply, and other factors.

Visit the CLFPD website to sign up for newsletters about fire department activities, local events, fire conditions, fire bans, and safety information. You can also contact the CLFPD for property assessments to determine what steps you need to take to increase your property's survivability. See the CLFPD community page on their website for more information.

Station 1, headquarters CLFPD. Photo credit: The Ember Alliance.

2.c. Wildland-Urban Interface

Every year, wildfires result in billions of dollars in fire suppression costs and destroy thousands of homes across the United States. Some of the most destructive, deadly, and expensive wildfires have occurred in the past several years, partly due to construction of additional homes in the wildland-urban interface (WUI). Wildfire risk in the WUI is further exacerbated by severe fire weather perpetuated by climate change (Caton et al., 2016). Some examples include the 2013 Black Forest Fire that destroyed 511 structures, the 2020 East Troublesome Fire that destroyed at least 366 structures, and the 2021 Marshall Fire that destroyed over 1,000 structures. See **Appendix A. Introduction to Wildfire Behavior and Terminology** for a discussion about how wildfires can threaten and destroy homes.

The WUI is any area where the built environment meets wildfire-prone areas—places where wildland fire can move between natural vegetation and the built environment and result in negative impacts on the community (Forge, 2018). People that live and work in the WUI must be aware of the effect that ecosystem processes and disturbances, such as wildland fire, have on their lives. WUI exists along a continuum of wildland to urban densities (**Figure 2.c.1**). Wildland-urban intermix refers to areas where housing and wildland vegetation intermingle, while wildland-urban interface refers to areas where housing is in the vicinity of a large area of dense wildland vegetation (Martinuzzi et al., 2015).

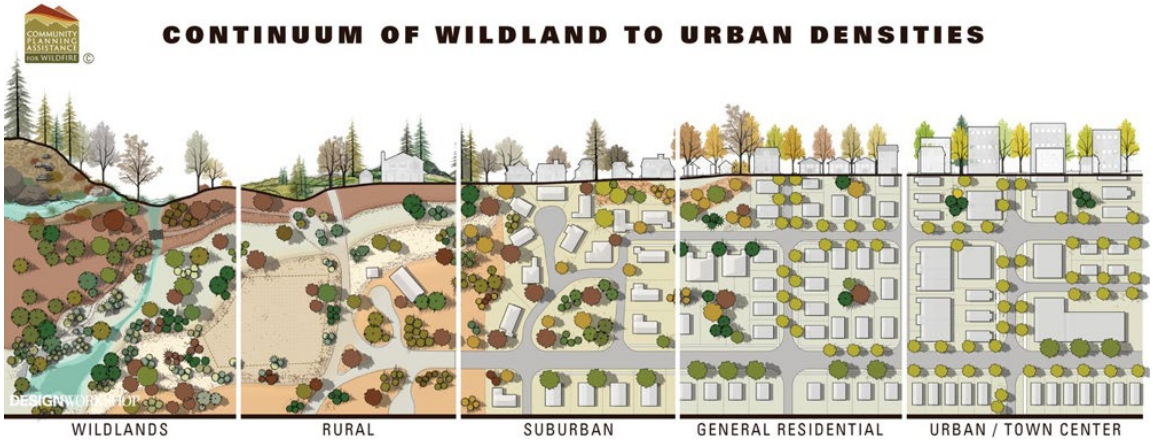


Figure 2.c.1*. The wildland-urban interface exists along a continuum of wildland to urban densities. Source: Community Planning Assistance for Wildfire.*

Every single property within the CLFPD is within the WUI and exposed to wildfire risk. According to the 2020 Wildfire Risk to Communities analysis by the U.S. Forest Service, homes in the CLFPD and the surrounding areas have a higher risk of fire than 92% of the communities in the state of Colorado (USFS, 2021a). Over the past 50 years, immigration to the mountains along the Colorado Front Range has increased the number of occupied structures within this historically forested landscape. This population change has increased not only the density and size of the WUI, but also increased the risk of structure loss from wildfire and the likelihood of fire starts.

For the purpose of this CWPP, the WUI boundary includes all of the CLFPD and the surrounding landscape that could transmit wildland fire into the CLFPD as well as the area along important evacuation routes (**Figure 2.c.2**; see methodology in **Appendix B**). Strategic wildfire mitigation across the WUI can increase the safety of property owners and wildland firefighters and reduce the chances of home loss.

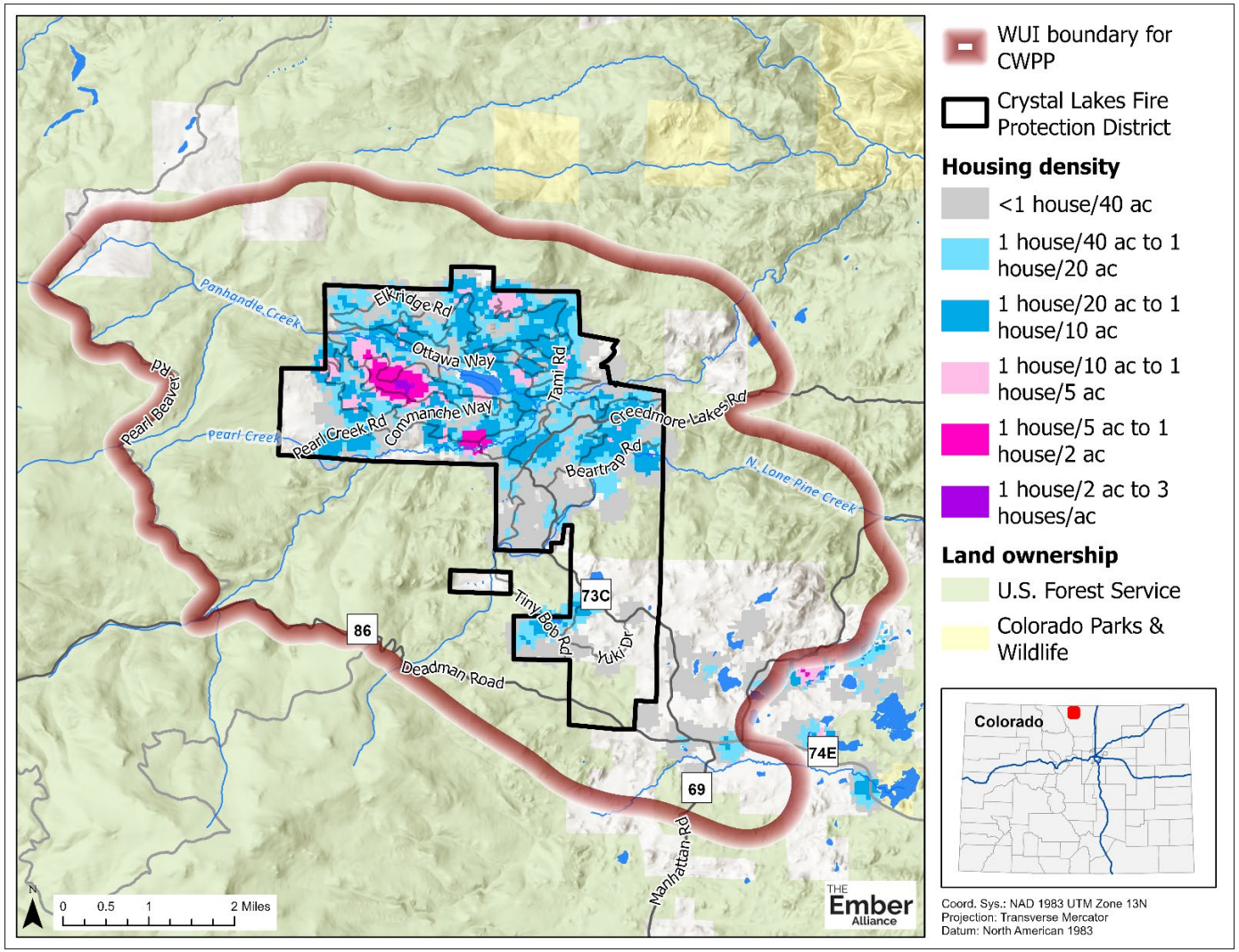


Figure 2.c.2. *All property owners of the CLFPD live in the Wildland-Urban Interface and/or Intermix and are exposed to elevated wildfire risk. For the purpose of this CWPP, the WUI boundary includes all of the CLFPD and the surrounding landscape that could transmit wildland fire into the CLFPD and the area along important evacuation routes (see methodology in* ***Appendix B****). Visit the CLRRA CWPP Map Experience for an interactive version of this map.*

2.d. Firefighting in the WUI

One of the standard firefighter orders is to "fight fires aggressively, having provided for safety first" (NWCG, 2018a). Firefighters are committed to protecting lives and property, but firefighting is particularly dangerous in the WUI. The firefighter community is increasingly committed to safety of wildland firefighters, which can require the difficult decision to cease structure protection when conditions become exceedingly dangerous, particularly around homes with inadequate defensible space, safety zones, and egress routes.

High-intensity, fast-moving wildfires in the WUI can quickly overwhelm firefighting resources when homes begin igniting each other (Caton and others 2016). Firefighters are often forced to perform structure triage to effectively allocate limited resources during an incident, and more importantly, to protect the lives of firefighters. The Incident Response Pocket Guide (IRPG), which is carried by all firefighters certified under the National Wildfire Coordinating Group, explicitly states, "**Do not** commit to stay and protect a structure unless a safety zone for firefighters and equipment has been identified at the structure during sizeup and triage" (NWCG, 2018a). The IRPG outlines four categories of structure triage: (1) defensible – prep and hold, (2) defensible – stand alone, (3) non-defensible – prep and leave, and (4) non-defensible – rescue drive-by.

Do not count on firefighters staying to defend your home—your home should be able to survive a wildfire on its own. There are never enough firefighters to stay and defend every single home during large incidents. Section **Mitigate the Home Ignition Zone** of this CWPP provides recommendations for how property owners can increase the chance of their homes surviving wildfires and enhance the safety of wildland firefighters.

2.e. Fire History Along the Colorado Front Range

Colorado's Front Range was influenced heavily by fire before the era of fire suppression. This land is the ancestral land of the Sioux, Cheyenne, Eastern Shoshone, and Arapaho Nations. Many Indigenous peoples utilized fire as a land management tool. Lightning-ignited fires were common in ponderosa pine and mixed-conifer forests before European settlement in the 1850's.

Ponderosa pine and mixed-conifer forests are fire-adapted ecosystems and very resilient to wildfires. Low- to mixed-severity fires occurred every 7 to 50 years and occasional severe, stand-replacing fires (**Figure 2.e.1**). Frequent fires would kill many tree seedlings and saplings, thereby preventing the accumulation of ladder fuels and reducing the potential for surface fires to transition into crown fires. Fire spread was more rapid through understory grasses but released far less heat, which allowed many larger trees to survive unscathed. Occasionally, dense clumps of trees would experience mortality from passive crown fire, further increasing the diversity of habitat in these ecosystems, which included a mosaic of widely spaced trees and small tree clumps interwoven with grasslands and shrublands, particularly on drier south-facing slopes. North-facing slopes often supported denser forest stands (Addington et al., 2018). Ponderosa pine ecosystems with fewer trees support more abundant and species-diverse understories of grasses, forbs, and shrubs and provide habitat for a variety of wildlife that prefer more open forest structure (Kalies et al., 2012; Matonis and Binkley, 2018; Pilliod et al., 2006).

As the initial ranching and logging activities of Euro-American settlers subsided in the region and government-mandated fire suppression began in the late 1800's, trees grew back in a single age class, resulting in many dense forest stands (**Figure 2.e.2**) (Addington et al., 2018). Although many property owners consider dense forest as "natural," these conditions are vastly different from the wildfire-resilient ecosystems that existed before. Tree densities in ponderosa pine forests along the Colorado Front Range average 4.5 times higher today than they were in the mid-1800s (Battaglia et

al., 2018). Landscapes of continuous, dense forests are more prone to high-severity fires that are difficult to suppress and can result in catastrophic losses to lives and property (Haas et al., 2015).

Lodgepole pine forests are part of fire-adapted ecosystems that are resilient after infrequent, stand-replacing wildfires. Research on historical conditions in lodgepole pine forests suggest they experienced high-severity wildfires every couple of centuries in northern Colorado and southern Wyoming (Higuera et al., 2021) (**Figure 2.e.1**). Lodgepoles grow dense and tall, which leaves little light that reaches the understory. They have relatively high canopy base height because they drop their lower branches as they grow and few ladder fuels exist in the understory, meaning they typically burn with high-severity crown fires. They have serotinous cones that open after the heat of a wildfire, creating a dense seedbed that will grow into a new even-aged stand and replace the burned previous stand. Young stands that are in recovery and regeneration stages after wildfires do not have the resources to regenerate after a second wildfire event, so frequent stand-replacing fires can have detrimental effects on this ecosystem (Dennis et al., 2009; Turner et al., 2019). Fires are becoming more common in high elevation lodgepole pine and wet mixed-conifer forests due to climate change (Higuera et al., 2021).

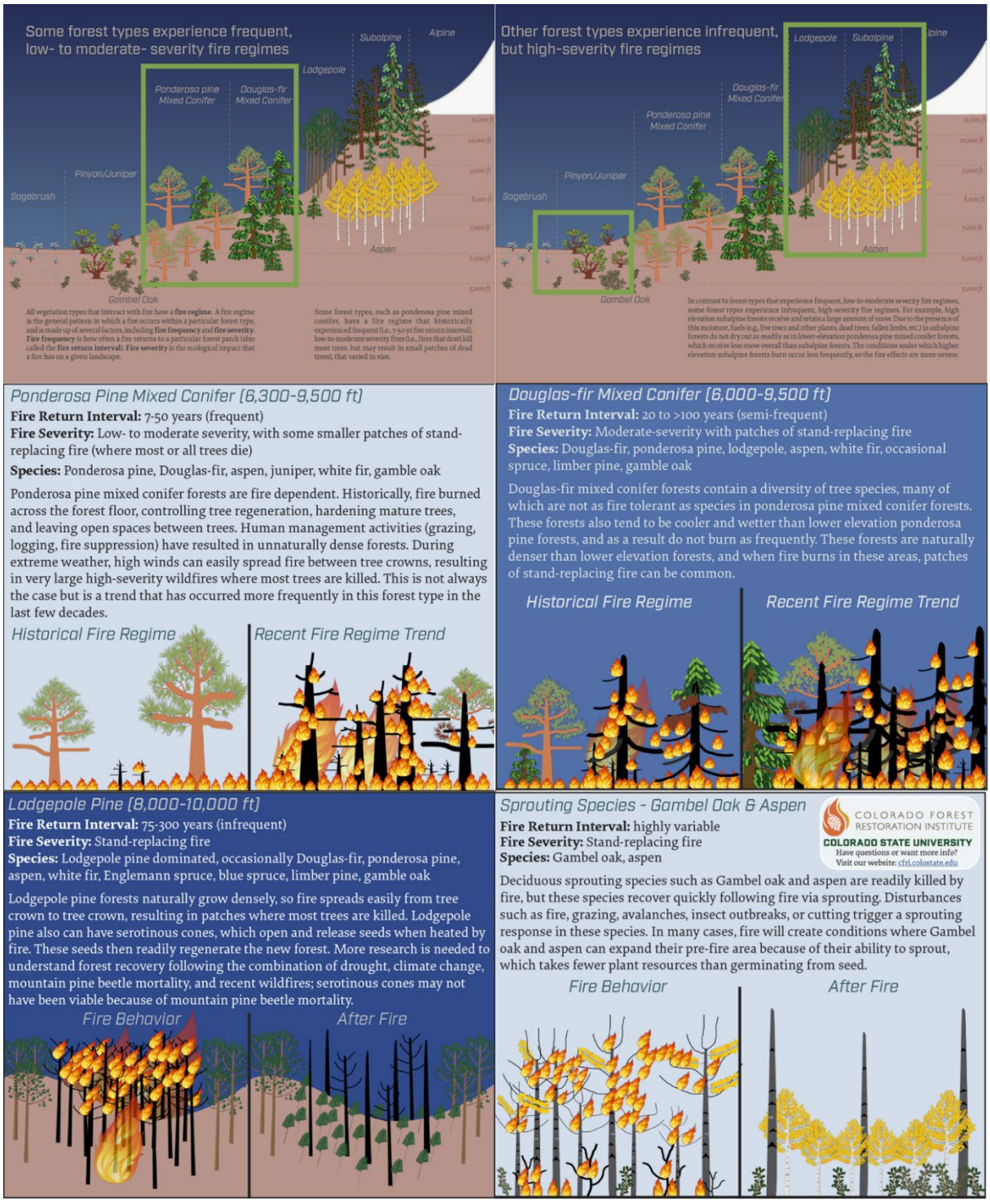


Figure 2.e.1. *Lodgepole pine forests historically experienced infrequent fires every 75-300 years. Fire suppression in the west began around the 1850s, so these forests may not have experienced fire for 150 to nearly 500 years. They may be overly dense and ready for a stand-replacing disturbance. Ponderosa pine forests along the Colorado Front Range historically experienced frequent fires every 7-50 years and mixed-conifer forests experienced semi-frequent fires every 20 to >100 years, resulting in less dense forest conditions than we see today. Source: Colorado Forest Restoration Institute.*

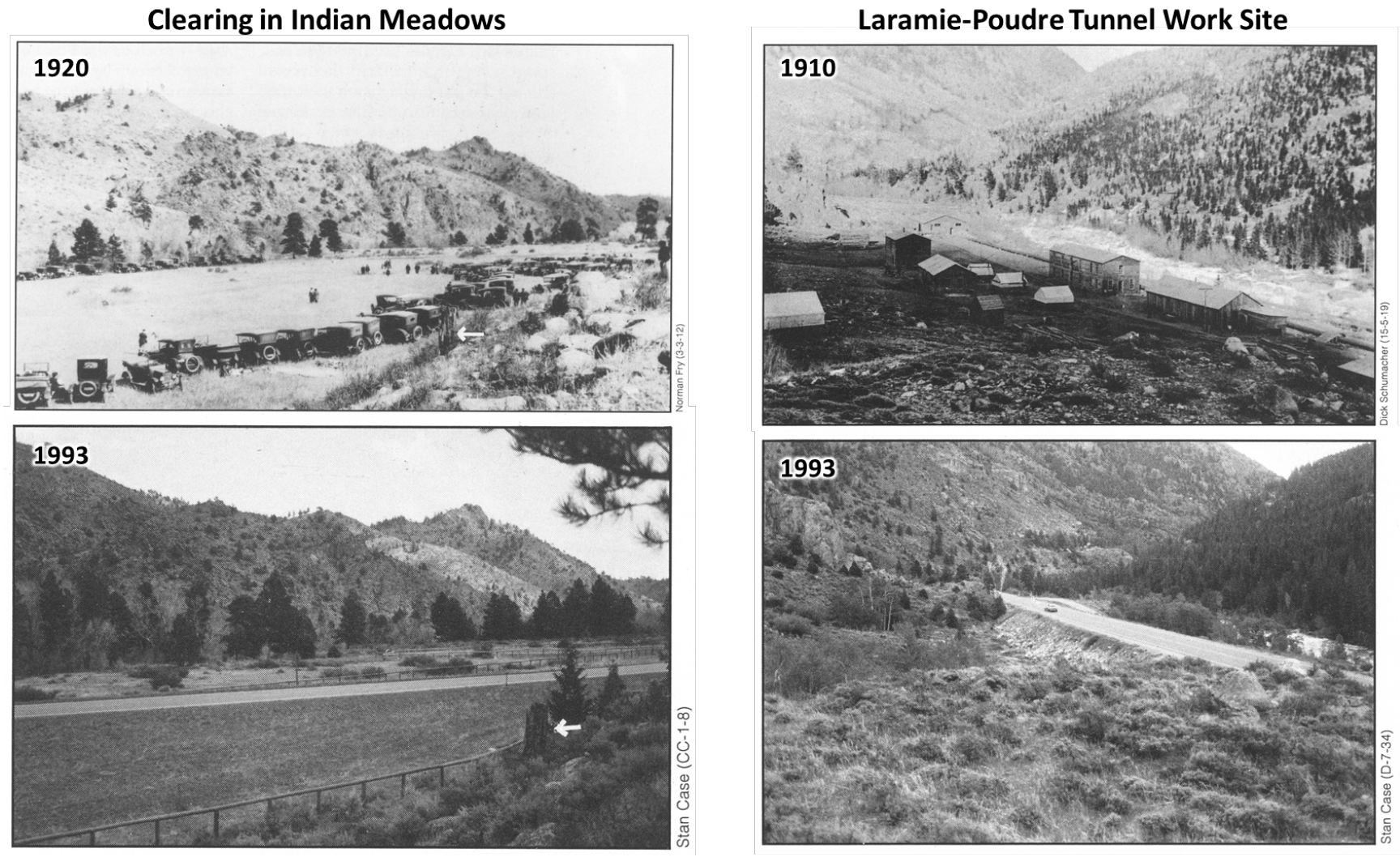


Figure 2.e.2. *Tree densities have remained low in some ponderosa pine savannas areas (photos at left), but in other ponderosa pine and mixed-conifer forests, particularly north-facing slopes, tree densities are substantially higher today than they were historically in part due to fire suppression (photos at right). Photo credits: Norman Fry, Stan Case, and Dick Schumacher. Source: Case, 1995.*

Along the Front Range of Colorado, a combination of extreme fire weather conditions (extreme heat and high winds), unplanned ignitions, and dry, unmitigated wildland vegetation can create catastrophic wildfire scenarios in the WUI. Climate change is further increasing wildfire risk and lengthening fire seasons (Parks et al., 2016). Many catastrophic wildfires in Colorado's history have occurred on dry and windy days, resulting in rapid fire spread over short periods of time. On the Front Range, wind can gust over 60 miles/hour, which makes wildfire suppression nearly impossible (Haas et al., 2015).

Days with red flag warnings indicate severe fire weather and require extra vigilance by fire departments and property owners (see **Table 2.e.1** for red flag warning criteria). The occurrence of red flag warnings is highly variable from year to year due to regional weather patterns and weather anomalies such as El Niño and La Niña. The CLFPD experienced between 0 and 32 red flag warnings per year from 2006 to 2020 (**Figure 2.e.3**). The greatest number of red flag warnings occurred in 2012 and 2020, which were the years of the High Park and Cameron Peak Fires. Red flag conditions are most common in March, June, September, and October. Climate change is expected to cause 12-15 more red flag warning days each year in the coming fifty years, making fire adaptation now even more important to the community. See the climate change assessment in **Appendix B** for more information on climate change and wildfire risk.

The 2020 Cameron Peak fire came within 1.1 miles of the CLFPD (**Figure 2.e.4**). The most notable wildfire in the district was the Bear Trap Fire in 1980, which was ignited by the crash of a light plane and reached 2,050 acres. The 1980 Bear Trap Fire was fanned by 40 mph winds and resulted in high mortality of lodgepole pine in the northwestern part of the CLFPD. Two homes were lost and about 150 people were evacuated during the wildfire. The burned area has subsequently regenerated and is now blanketed in short, dense lodgepole pine.

Table 2.e.1*. Red flag days are warnings issued by the National Weather Service using criteria specific to a region. A red flag day must meet all criteria under Option 1 or all criteria under Option 2.*

National Weather Service – Denver/Boulder Forecast Office Red Flag Warning Criteria	
Option 1	**Option 2**
Relative humidity less than or equal to 15%	Widely scattered dry thunderstorms
Wind gusts greater than or equal to 25 mph	Dry fuels
Dry fuels	

During red flag warnings, all property owners need to be prepared for evacuations in the case of a wildfire, just as the fire department will be preparing for wildfire response.

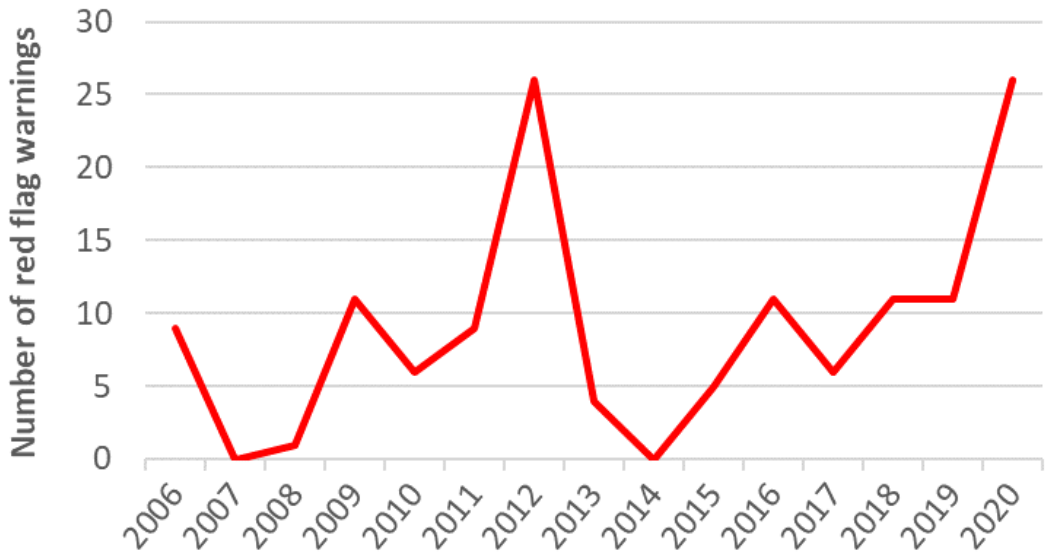


Figure 2.e.3. *Total number of red flag days by year from 2006 to 2020. March, June, September, and October are the most common months for experiencing red flag weather. Source: Iowa State University, Iowa Environmental Mesonet.*

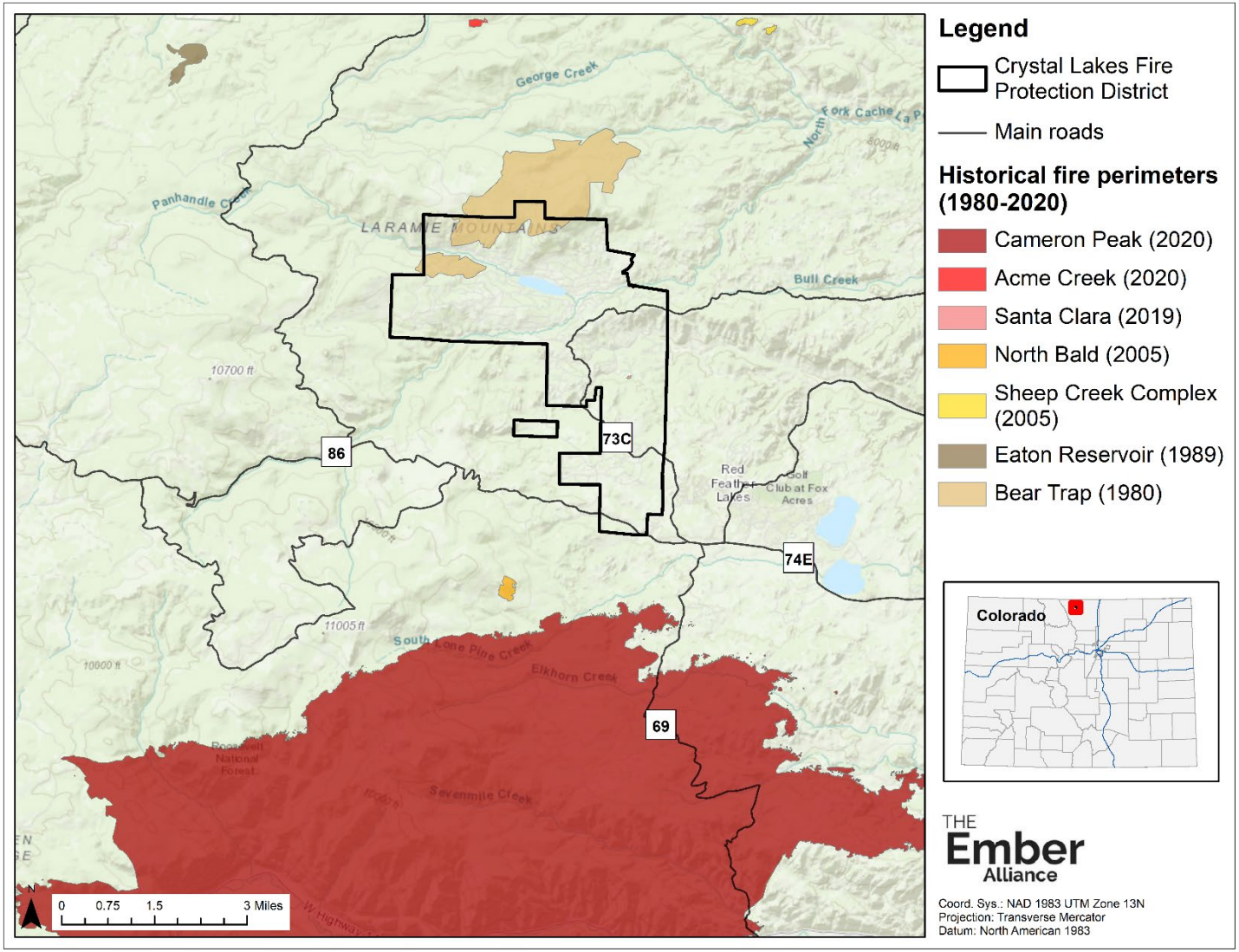


Figure 2.e.4. *Wildfires occurring in and around the CLFPD between 1980-2020. The 2020 Cameron Peak fire came within 1.1 miles of the CLFDP, and fires of this size could easily overwhelm CLFPD's capacity to respond. Source: National Interagency Fire Center. Visit the CLRRA CWPP Map Experience for an interactive version of this map.*

2.f. Potential Fire Behavior in the CLFPD

Many neighborhoods in the CLFPD could experience extreme fire behavior that could put the lives of residents, visitors, and firefighters at risk **There is an immediate need for this community to undertake proactive measures to mitigate wildfire risk to protect lives and property.**

Under moderate fire weather conditions—conditions typical of a summer day in CLFPD—27% percent of the CLFPD could experience high to extreme fire behavior. This percentage increases to 50% under less common but more extreme, hot, dry, and windy conditions (**Figure 2.f.1**).

Important Considerations for Fire Behavior Predictions

Fire behavior models can provide reasonable estimates of relative wildfire behavior across a landscape. However, wildfire behavior is complex, and models are a simplification of reality. It is recommended to use fire behavior analyses to assess relative risk across the entire CLFPD. Models cannot produce specific and precise predictions of what will occur in the vicinity of an individual home during a wildfire incident.

Exceptional hot, dry, and windy conditions are increasingly common due to climate change and could result in even more extreme fire behavior across the CLFPD than predicted by this analysis.

See **Appendix B** for details on fire behavior modeling used for this CWPP.

High to extreme fire behavior includes ember production that ignites additional fires away from the main fire and the movement of high-intensity fire from treetop to treetop. Such fires are extremely challenging if not impossible to control until winds die down and fuel moistures increase. Fire growth could be extensive across the CLFPD if wildland firefighters cannot engage due to dangerous conditions from extreme fire behavior (**Figure 2.f.2**).

High to extreme fire behavior can also create non-survivable conditions along roadways, which is of particular concern in a community like CLFPD where there are few points of egress for an evacuation. Under moderate fire weather conditions, 3% of the roads in the CLFPD could experience non-survivable conditions, but this percentage rises to 67% under extreme fire weather conditions (**Figure 2.f.3**).

Topography and fuel conditions are highly variable across the CLFPD (**Figure 2.f.4**), and patterns in these factors, plus alignment between wind patterns and topography, help explain the patterns in potential fire behavior across the CLFPD and surrounding landscape. If wind is pushing wildfire up a steep slope, it can result in more extreme fire behavior than if a fire is backing down the leeward side of a slope. Northwest-facing slopes are likely to have dense forest conditions and a greater quantity of fuel available to burn if conditions are dry enough. However, south-facing slopes are usually drier than north-facing slopes, and grasses present in moderately dense forests and shrublands can dry out very quickly on hot days and support rapidly moving fires with high flame lengths.

Lodgepole pine forest that are abundant in the western part of the CLFPD have the potential to burn in high-severity wildfires with extreme flame lengths and active crown fire, but only when fuels are very dry and winds are strong, such as during the 2020 East Troublesome Fire. When lodgepole pine forest ignite under these conditions, they are difficult if not impossible for firefighters to contain. However, under milder conditions, particularly with lower wind speeds, these forests experience mild fire behavior because of the distance between surface fuels and tree branches and the lack of understory vegetation, resulting in low-intensity, creeping, surface fires (Lotan et al., 1985).

The central-eastern portion of the CLFPD, which includes private and National Forest Service land, could experience high to very high fire behavior even under moderate fire weather conditions. This

area includes steep, south-facing slopes that support dry mixed-conifer forests and shrublands. Shrubs and small regenerating trees can carry surface fires into treetops, creating additional challenges for firefighters.

Meadows with willows and aspen in the bottom of valleys across the CLFPD are less likely to experience extreme fire behavior. However, even areas along streams can burn following summer drought and on days with hot, dry, and windy conditions.

Under extreme fire weather conditions, at least some portion of each CLRRA filing contains fuel and topographic conditions that could support high to extreme fire behavior. On days with extreme fire weather conditions, all homes within the CLFPD could be exposed to embers from burning vegetation, regardless of vegetation in the immediate vicinity of the home (**Figure 2.f.**). Homes serve as an additional source of fuel that could produce high-intensity flames, emit embers, and initiate home-to-home ignitions. Potential exposure to radiant heating and embers is widespread across the CLFPD, and this awareness should encourage property owners to create defensible space and complete home hardening practices to reduce the risk of ignition.

Property owners in the CLFPD are highly concerned about wildfire risk. Top concerns include damage to property, damage to wildlife habitat, loss of insurance coverage, post-fire erosion and flooding, decreased beauty of the landscape, and loss of life (**Figure 2.f.**). Fortunately, these concerns can be addressed through concerted effort across the community to mitigate wildfire risk and increase emergency preparedness. **Implementing recommendations in this CWPP will go a long way towards helping the CLFPD become a fire adapted community.**

Take Away Message

Portions of the CLFPD are at risk for large, high-severity wildfires due to dense forest conditions, dry and hot weather, and strong, gusty winds. Increasing drought and warming temperatures exacerbate wildfire risk in the area. **The CLFPD and property owners in the CLFPD must prepare for large wildfire events. Proactive work is imperative to protect lives and property.**

Airtanker drops retardant near the Manhattan Road south of Red Feather Lakes during the 2020 Cameron Peak Fire on August 27, 2020. Photo credit: NWCG InciWeb.

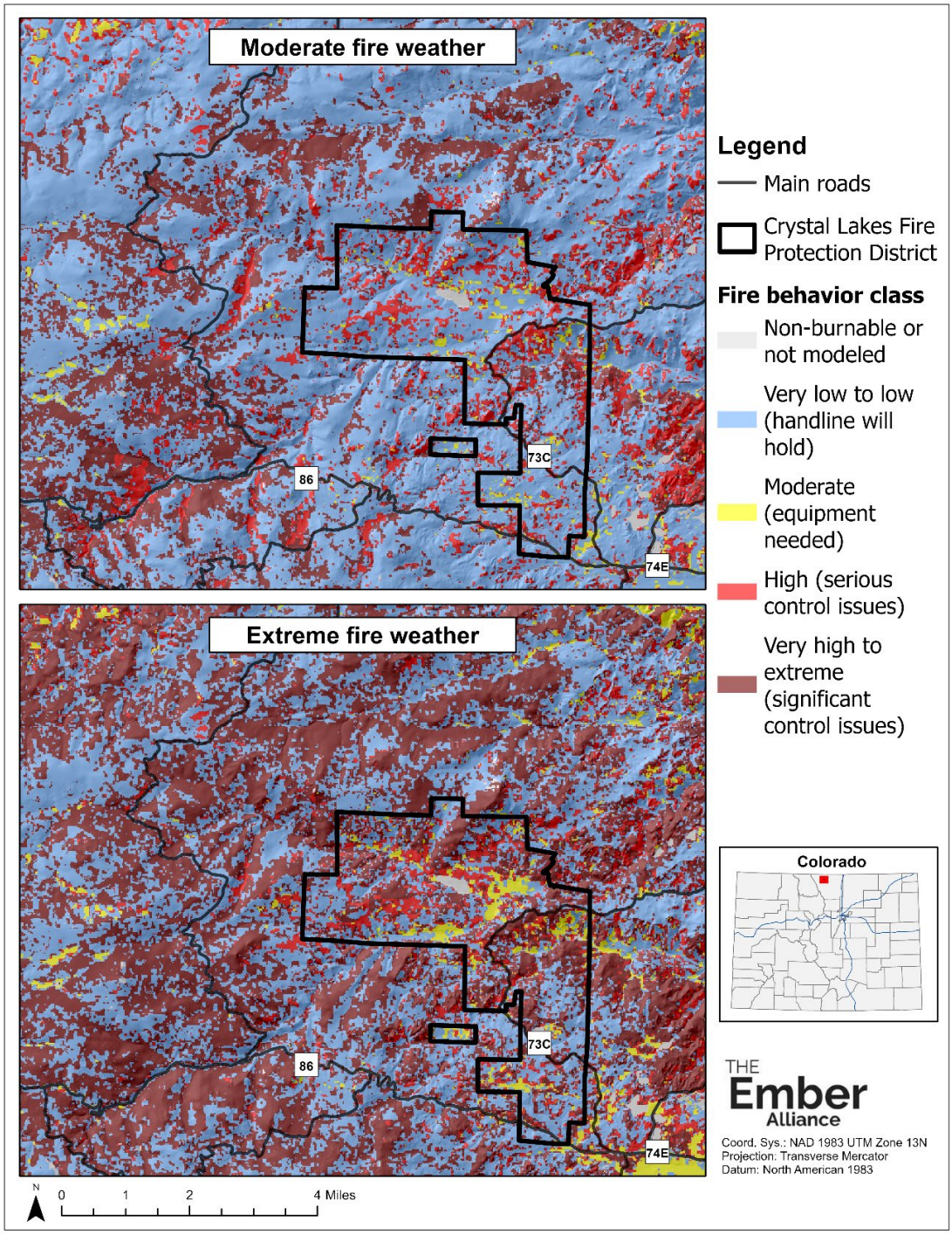


Figure 2.f.1. *Under moderate fire weather conditions—conditions typical of a summer day in CLFPD—27% percent of the CLFPD could experience high to extreme fire behavior, and this percentage increases to 50% under less common but more extreme, hot, dry, and windy conditions. High to extreme fire behavior includes ember production that ignites additional fires away from the main fire and the movement of high-intensity fire from treetop to treetop. Such fires are extremely challenging if not impossible to control until winds die down and fuel moistures increase. Variations in shading correspond to topography. Visit the CLRRA CWPP Map Experience for an interactive version of this map.*

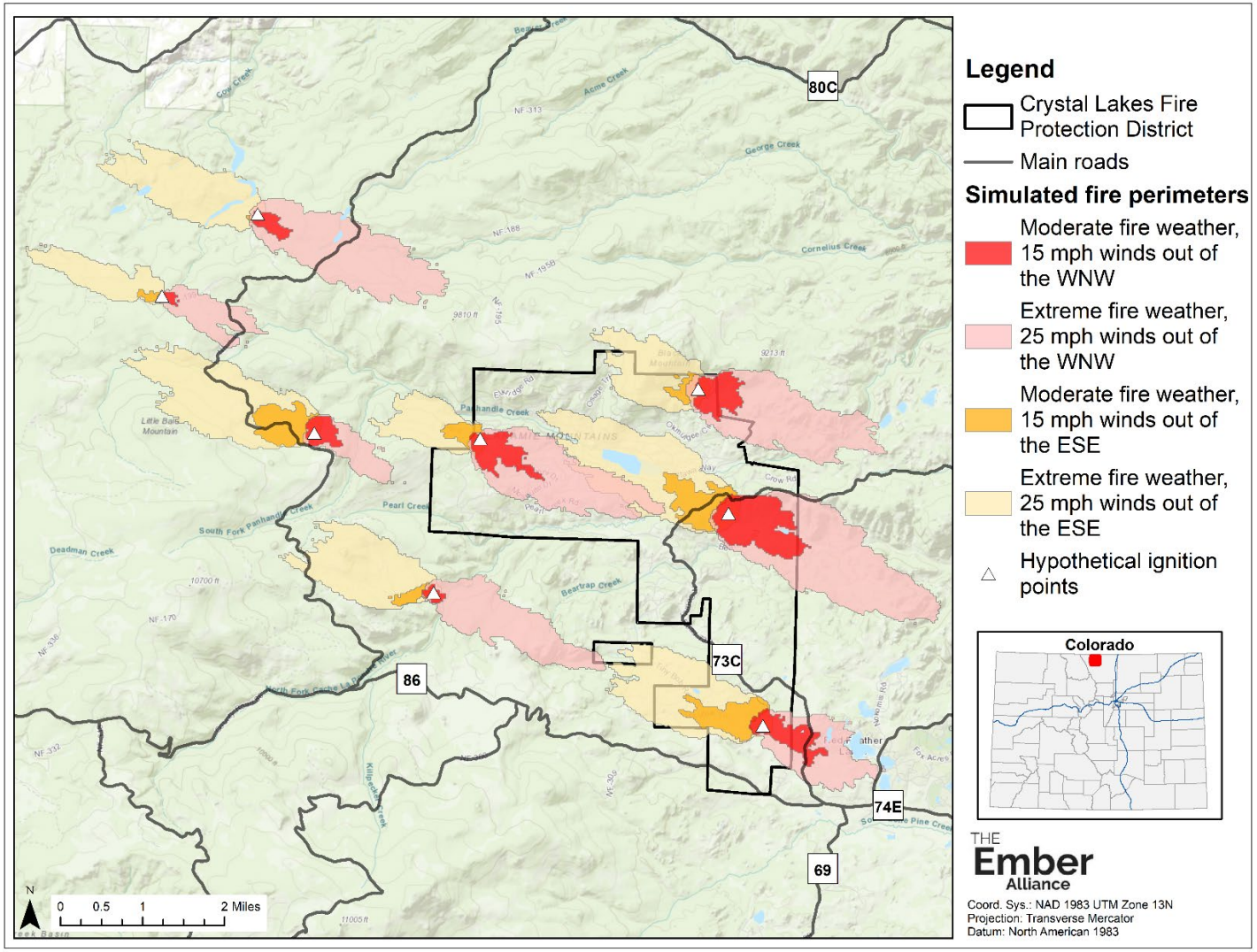


Figure 2.f.2*. Fire growth could be extensive across the CLFPD under extreme fire weather conditions if wildland firefighters cannot engage due to dangerous conditions from extreme fire behavior. Simulated fire perimeters were based on fire behavior predictions after 4-hours of fire growth without suppression activities from hypothetical ignition locations. Multiple fire perimeters are shown to demonstrate the variety of fire sizes, shapes, and travel paths that could happen in and around the CLFPD under different fire weather conditions and wind directions.*

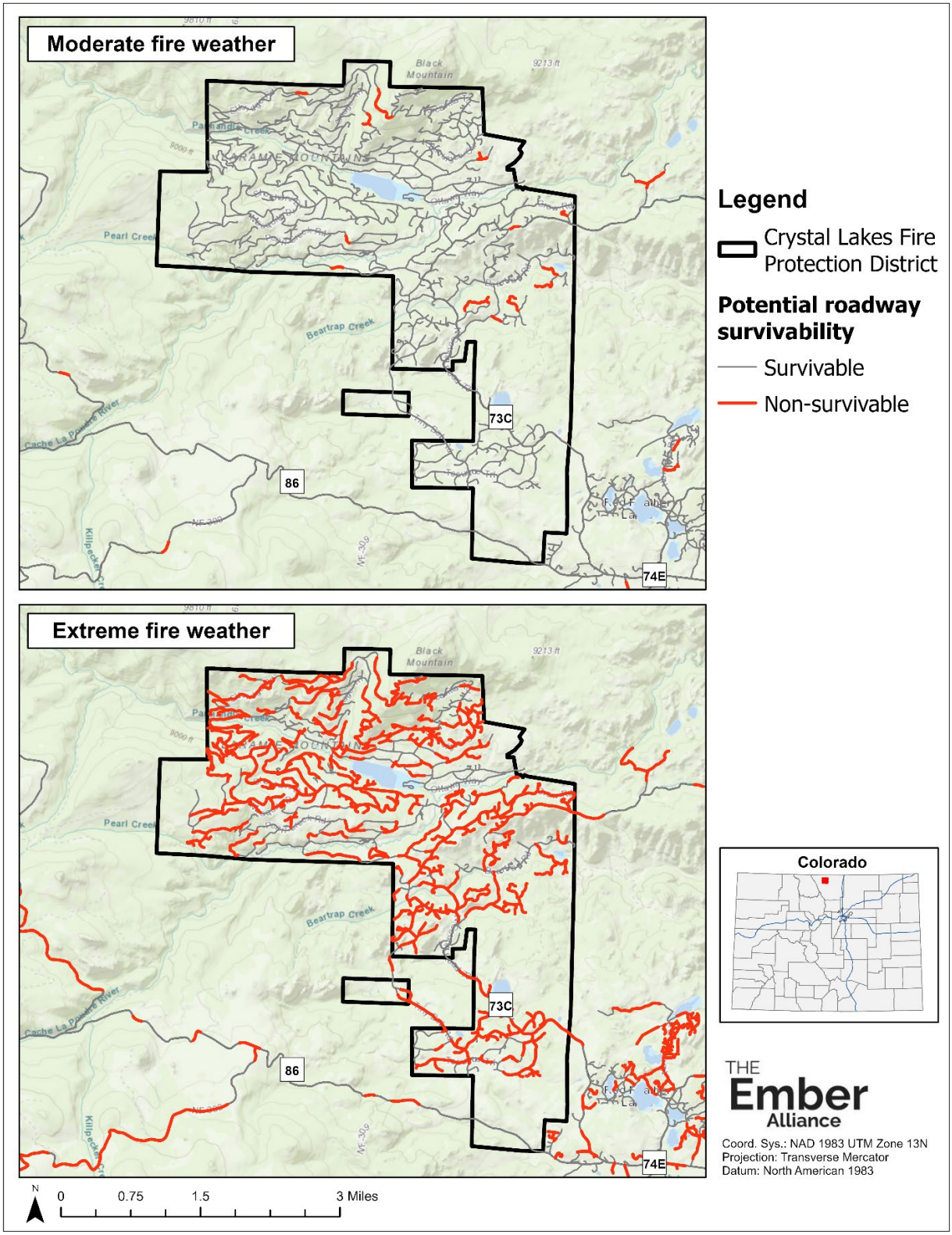


Figure 2.f.3. *Under moderate fire weather conditions, 3% of roads and driveways in the CLFPD could potentially experience non-survivable conditions during wildfires (i.e., flame lengths over 8 feet). This percentage rises to 67% under extreme fire weather conditions.*

Figure 2.f.4. *Fuel loads are variable across the CLFPD and can result in different types of fire behavior. Wildfires burning in dense lodgepole and wet mixed-conifer forests with abundant ladder fuels (A and B) can spread from treetop to treetop and are difficult if not impossible to suppress. Wildfires burning in open ponderosa pine forests with widely spaced trees and few ladder fuels (C) are less likely to transition into treetops but can experience rapid rates of spread where grasses are continuous and dry. The presence of shrubs and low branches in ponderosa pine (D) increases the chance of fire transitioning into treetops. Wildfires are less likely to ignite and spread in aspen forests (E) and wet riparian areas with willow (F) unless they are exceptionally dry from prolonged drought. Photo credit: The Ember Alliance.*

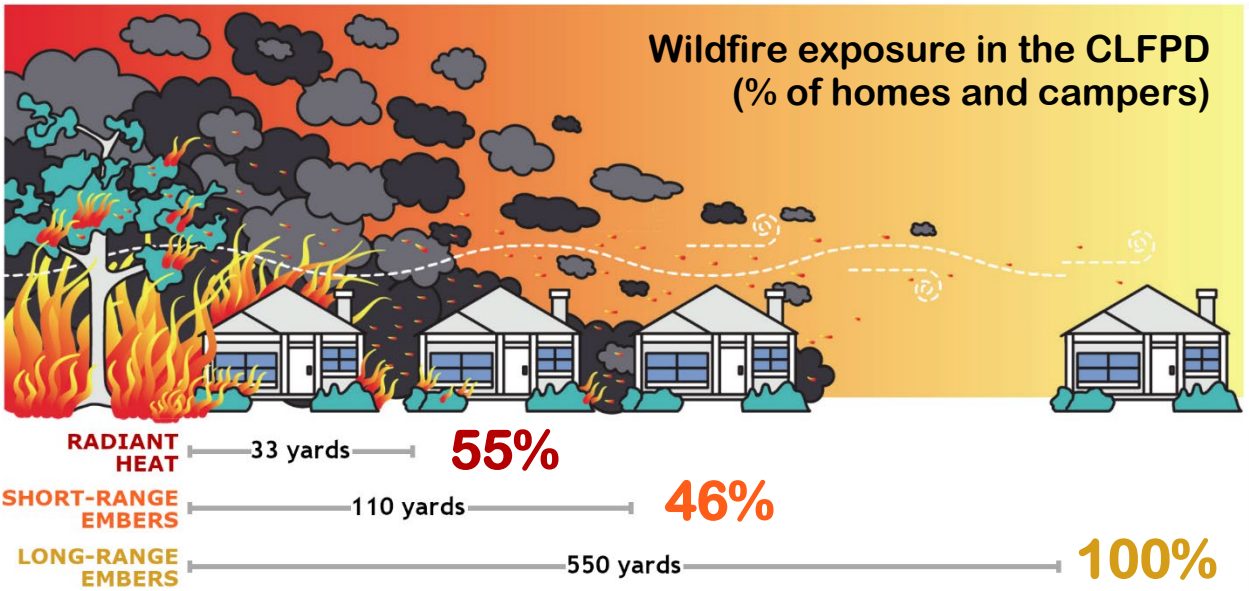


Figure 2.f.5. *Percentage of homes and campers in the CLFPD with different types of exposure to wildfire under extreme fire weather conditions. Radiant heat from burning vegetation can ignite nearby homes, and embers emitted from burning vegetation or other homes can travel long distances and ignite vegetation and homes away from the main fire. Analysis based on research by Beverly et al. (2010) (see* ***Appendix B*** *for details). Image modified from Reducing Brushfires Risks by the Victorian Auditor-General's Office.*

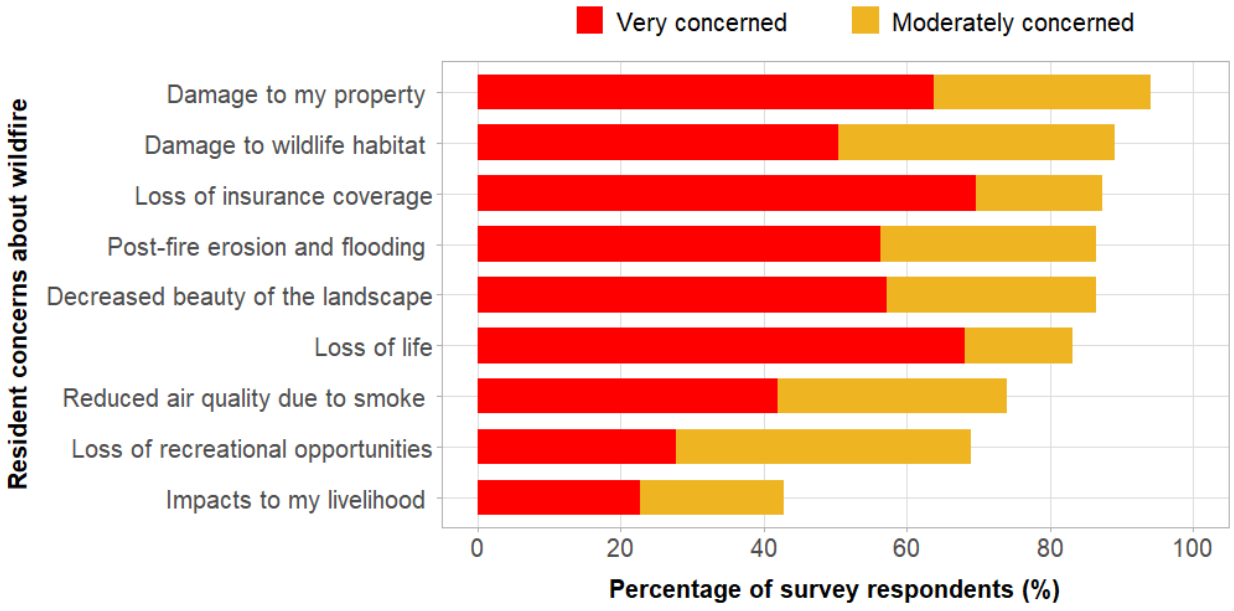


Figure 2.f.6. *Percentage of CFLPD property owners who responded the CWPP survey as being moderately concerned or very concerned about different impacts of wildfire in the community. See* ***Appendix C*** *for a full summary of survey findings.*

2.g. Fuel Treatment History in and Around the CLFPD

Fuel treatments reduce the amount of fuel in strategic locations, reducing fire risk to nearby communities and creating tactical opportunities for wildland firefighters to engage with wildland fires. Fuel treatments were important tactical features during the Cameron Peak Fire by reducing the potential for extreme fire behavior in strategic locations, including around the Drala Mountain Center outside Red Feather Lakes (Avitt 2021). In 1980, fuel treatments helped firefighters protect CLFPD during the Bear Trap Fire (Dennis, 2005).

The U.S. Forest Service (USFS) treated almost 12,500 acres between 2005-2021 within and around the CLFPD using broadcast burning, pile burning, and/or mechanical thinning (**Figure 2.g.1**). Notable projects around the CLFPD include thinning and pile burning for the Crystal Lakes Fuel Reduction Project from 2005-2012, thinning, pile burning, and broadcast burning for the Red Feather Fuel Reduction Project from 2009-2019, and thinning and broadcast burning for the Sheep Creek 2 Project from 2008-2011.

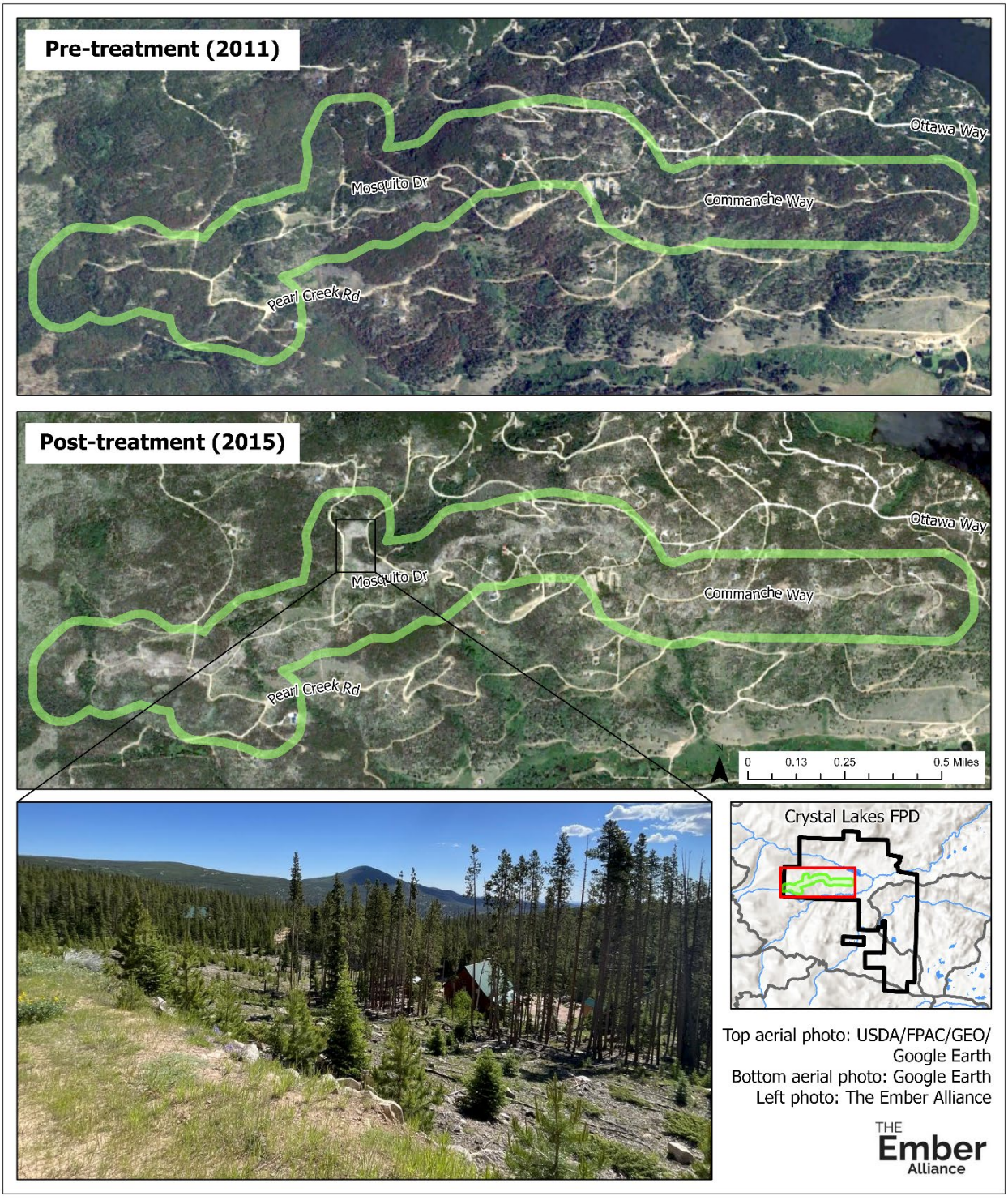
In 2012, the USFS and Colorado State Forest Service (CSFS) created shaded fuelbreaks within 140 acres along roadways in the western portion of the CLFPD to create safer conditions for citizens evacuating during wildfires and for wildland firefighters. Treatments were funded by a $180,000 Community Assistance for Adjacent Lands grant from the CSFS, with additional funding from CLRRA, Crystal Lakes Water and Sewer Association, and private donations. Some of the treatments occurred on private land that abutted roadsides.

Some property owners found the 2012 roadside fuel treatments aesthetically displeasing because of the removal of so many trees, but these treatments are vital for increasing the safety of property owners and firefighters in this community. Roadside treatments must dramatically reduce fuel loads to effectively reduce the risk of non-survivable conditions developing during wildfires.

The USFS safely conducted broadcast prescribed burns on about 8,350 acres and pile burns on about 1,930 acres of the Arapaho-Roosevelt National Forest between 2008-2019. Broadcast prescribed burning can be an extremely effective method to reduce hazardous fuels and restore ecological conditions across a variety of grassland, shrubland, and forest ecosystems (Paysen et al., 2000; Stephens et al., 2009). It is extremely uncommon for prescribed burns to escape containment lines (Weir et al., 2019), and when they do, the wildland fire community soberly reviews those escapes to produce lessons learned and make improvements (Dether, 2005).

CLRRA was awarded a grant from the Federal Emergency Management Agency (FEMA) in August 2022 to mitigate wildfire risk on 250 acres of CLRRA green spaces over the next 3 years using hand or mechanical treatments. The work will be funded by CLRRA, CSFS, and FEMA. In summer 2022, the Larimer County Sherriff's Office Initial Attack Module treated 4-acres on a CLRRA greenbelt in the western part of the CLFPD to mitigate wildfire risk.

An important component of this CWPP was identifying locations for additional fuel treatments to protect the community. **Section 4** outlines these priority locations and the land management agency that will lead these efforts in the coming years.



In 2012, the Colorado State Forest Service conducted roadside fuel treatments in the western part of CLFPD to dramatically reduce fuel loads and reduce the risk of non-survivable conditions developing along roadways. Some of these areas need retreatment due to regeneration of lodgepole pine.

Firefighters with the U.S. Forest Service and collaborators conducted a broadcast burn on the Arapaho-Roosevelt National Forest east of the CLFPD in June 2021 to reduce fuel loads and protect communities in the area. Photo credit: NWCG Inciweb.

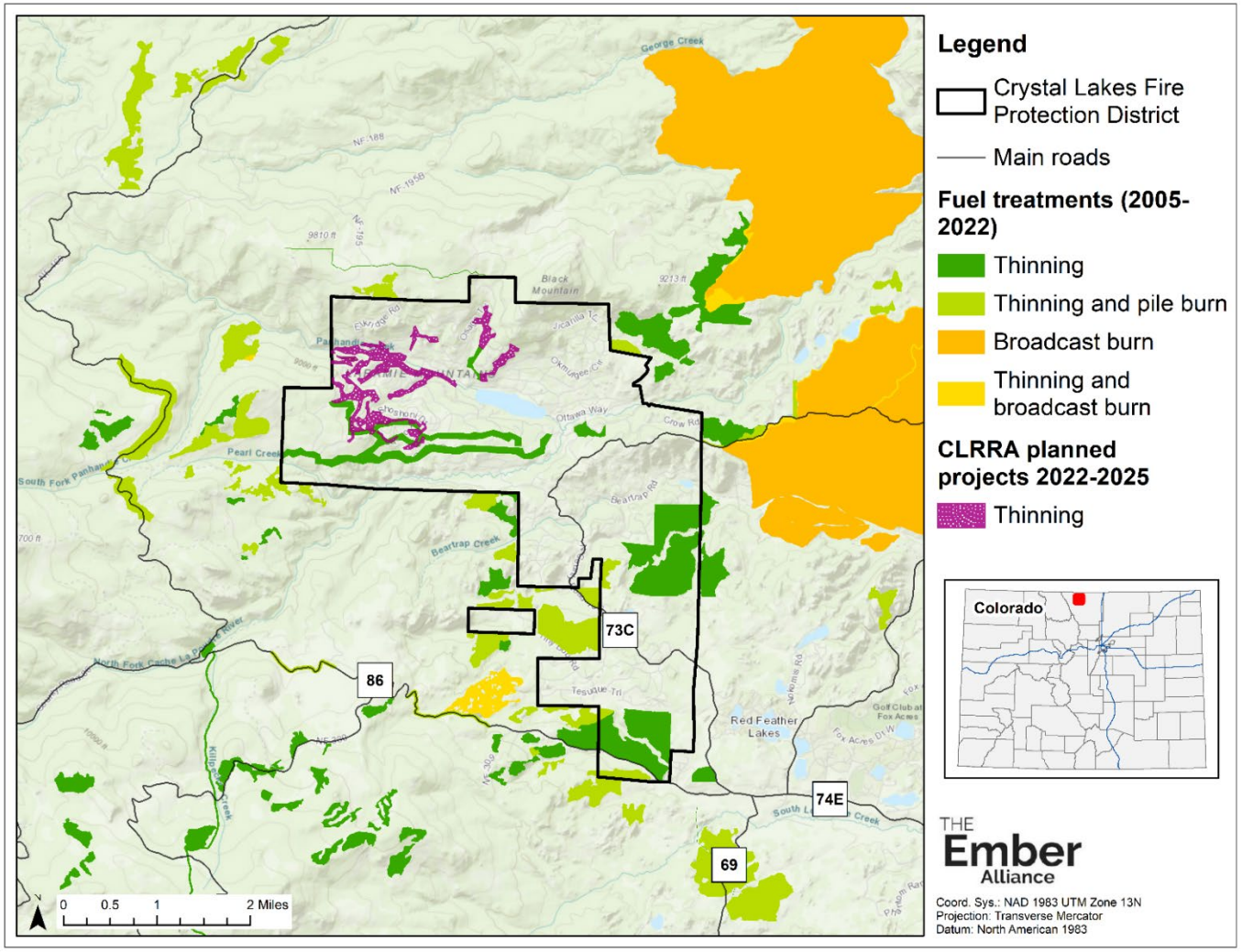


Figure 2.g.1. *Locations of forest management treatments and wildfires in and around the CLFPD from 2005-2018 by the CO State Forest Service and from 2005-2021 by the U.S. Forest Service. CLRRA received a grant from FEMA in August 2022 for fuel mitigation projects in 250 acres of CLRRA greenbelts. Sources: Colorado Forest Restoration Institute, data available through 2018; U.S. Forest Service, data available through 2021; Larimer County Sherriff's Office, data available for 2022. Visit the CLRRA CWPP Map Experience for an interactive version of this map.*

3. Becoming a Fire Adapted Community

It is recommended that that CLFPD, CLRRA, and property owners embrace the concept of Fire Adapted Communities (FAC), which is defined by the National Wildfire Coordinating Group as "a human community consisting of informed and prepared citizens collaboratively planning and taking action to safely coexist with wildland fire". This concept can guide property owners, fire practitioners, and communities through a holistic approach to become more resilient to fire (**Figure 3.1**).

Your community's CWPP sets the stage for fire adaptation, and the next step is on-the-ground action and an ongoing commitment to risk mitigation at all levels of the community, from individual homeowners to CLRRA filings and the entire CLRRA to the CLFPD to land managers and other partners. This section of the CWPP includes recommendations and resources for mitigating wildfire risk and enhancing emergency preparedness. The CLFPD and public land managers have an important role to play in implementing the recommendations in this CWPP, and they have made commitments to take on-the-ground action as outlined in **Section 4.**

Individual homeowners, CLRRA filings, and the entire CLRRA also have a vital role to play in addressing shared wildfire risk. Action and community-building centered around mitigation have reduced wildfire risk and increased community resilience across the mountain west. Mitigation work by property owners can spur mitigation by their neighbors (Brenkert-Smith et al., 2013). The cumulative impact of linked defensible space across private properties can improve the likelihood of home survival and protect firefighters during wildfire events (Jolley, 2018; Knapp et al., 2021).

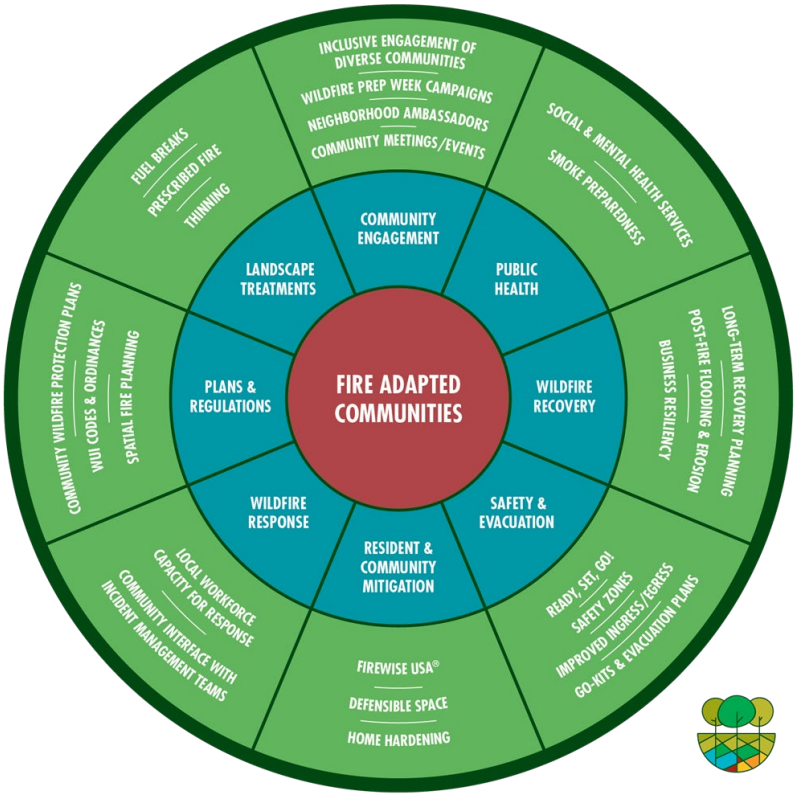


Figure 3.1. *The Fire Adapted Communities graphic provides specific programs and activities that communities can take to reduce their wildfire risk and increase their resilience. Source: [Fire Adapted Community Learning Network](#).*

3.a. Individual Recommendations

Mitigate the Home Ignition Zone

During catastrophic wildfires, property loss happens mostly due to conditions in the **home ignition zone** (HIZ). The HIZ includes your home and other structures (e.g., campers, sheds and garages) and area within 100 feet of each structure. Firefighter intervention, adequate defensible space, and home hardening measures are common factors for homes that survive major wildfires (IIBHS, 2019; Maranghides et al., 2022). Research following the 2018 Camp Fire showed that homes were more likely to burn down when they were close to other structures that had also burned, when they had vegetation within 100 meters of the home, and when they had combustible materials (firewood or propane tanks) near the home (Knapp et al., 2021).

You can increase the likelihood that your home will survive a wildfire and help protect the safety of firefighters by creating defensible space, replacing, or altering building materials to make your home less susceptible to ignition, and taking steps to increase firefighter access along your driveway.

It is important for property owners to work together as a community to mitigate shared wildfire risk in the HIZ. Structure-to-structure ignition is a major concern in WUI communities and can cause substantial property loss. Neighbors can increase their homes' chances of survival during a wildfire if they work together to reduce hazards in their overlapping defensible space.

Even if you do not have a permanent home on your property, you can take steps to protect your camper and other assets, including the value of your property; areas that are heavily burned have less aesthetic and monetary value. More importantly, work you do to reduce fire risk on your property can amplify the work that your neighbors do on theirs, resulting in greater protection for everyone. Removing trees from along roadways can increase the visibility of your property to firefighters, increase the accessibility of your property for fire engines, and reduce the chance that non-survivable conditions can develop and entrap residents and first responders during wildfires.

Defensible space is the area around a structure where vegetation, debris, and other types of combustible fuels have been treated, cleared, or reduced to slow the spread of fire and reduce exposure to radiant heat and direct flame. It is encouraged that property owners develop defensible space so that during a wildfire their home or camper can stand alone without relying upon limited firefighter resources due to the great reduction in hazards they have undertaken.

Defensible space allowed firefighters to protect this home during the 2016 Cold Springs Fire near Nederland, CO. Photo credit: Wildfire Partners.

Home hardening is the practice of making a home less likely to ignite from the heat or direct contact with flames or embers. It is important to remember that embers can ignite homes even when the flaming front of a wildfire is far away. Home hardening involves reducing this risk by changing building materials, installation techniques, and structural characteristics of a home. Home hardening measures are particularly important for WUI homes; 50 to 90% of homes ignite due to embers rather than radiant heat during wildfires (Babrauskas, 2018; Gropp, 2019).

Fortunately, many property owners in the CLFPD have already started taking actions to mitigate their HIZ (**Figure 3.a.1**). Over 90% of property owners have removed trees or low limbs on their property and about two thirds of property owners annually remove debris from around their homes or campers. Only a third have replaced their roofs with less flammable materials, but most newer homes in the CLFPD already have flame-resistant roofs. Property owners should follow the defensible space and home hardening recommendations outlined below to continue increasing their home's chances of surviving a wildfire.

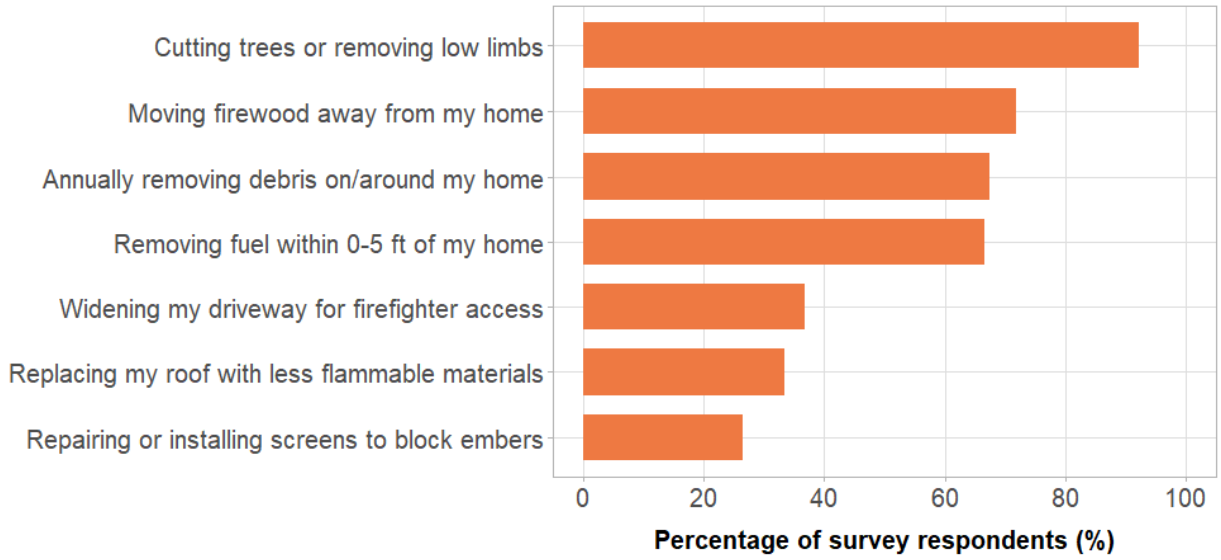


Figure 3.a.1. *Percentage of CLFPD property owners who have completed different actions to mitigate risk in their HIZ. See* ***Appendix C*** *for a full summary of survey findings.*

Defensible Space

Defensible space creates a buffer between your home or camper and grass, trees, and shrubs that could ignite during a wildland fire. Defensible space can slow the spread of wildfire, prevent direct flame contact, and reduce the chance that embers will ignite material on or near your home (Hakes et al., 2017). Substantially reducing vegetation within the HIZ and removing vegetation that overhangs decks and roofs can reduce structure loss, especially for homes on slopes (Syphard et al., 2014).

Do not count on firefighters staying to defend your home—your home should be able to survive a wildfire on its own. There are never enough firefighters to stay and defend every single home during large incidents. Properties that are not defensible will not often receive firefighter resources due to unsafe conditions and the higher likelihood of home loss.

Defensible space is divided into multiple zones around a home, and recommended practices vary among zones. The Colorado State Forest Service (CSFS) defines zone 1 (HIZ 1) as 0 to 5 feet from the home, zone 2 (HIZ 2) as 5 to 30 feet from the home, and zone 3 (HIZ 3) as 30 to about 100 feet from the home (**Figure 3.a.2**). Some organizations call HIZ 1 the "noncombustible zone" (0 to 5 feet from the home) and HIZ 2 the "lean, clean, and green zone" (5 to 30 feet from the home).

Property owners should establish defensible space around each structure on their property, including campers / RVs, detached garages, storage buildings, barns, and other structures. RVs are highly flammable and can emit embers that might ignite nearby homes and vegetation. Removing all vegetation under and around campers in HIZ 1 is crucial. Campers / RVs, boats, detached garages, storage buildings, barns, and other large structures should be placed at least 50 feet away from primary structures to prevent structure-to-structure fire spread (Maranghides et al., 2022).

Some properties in the CLFPD have exemplary defensible space with mowed grass near structures, trees limbed and not overhanging roofs, and non-flammable barriers within HIZ 1. Mitigating fuels under and around campers is important for reducing their chance of igniting and emitting embers that might catch nearby vegetation and homes on fire. Photo credit: The Ember Alliance.

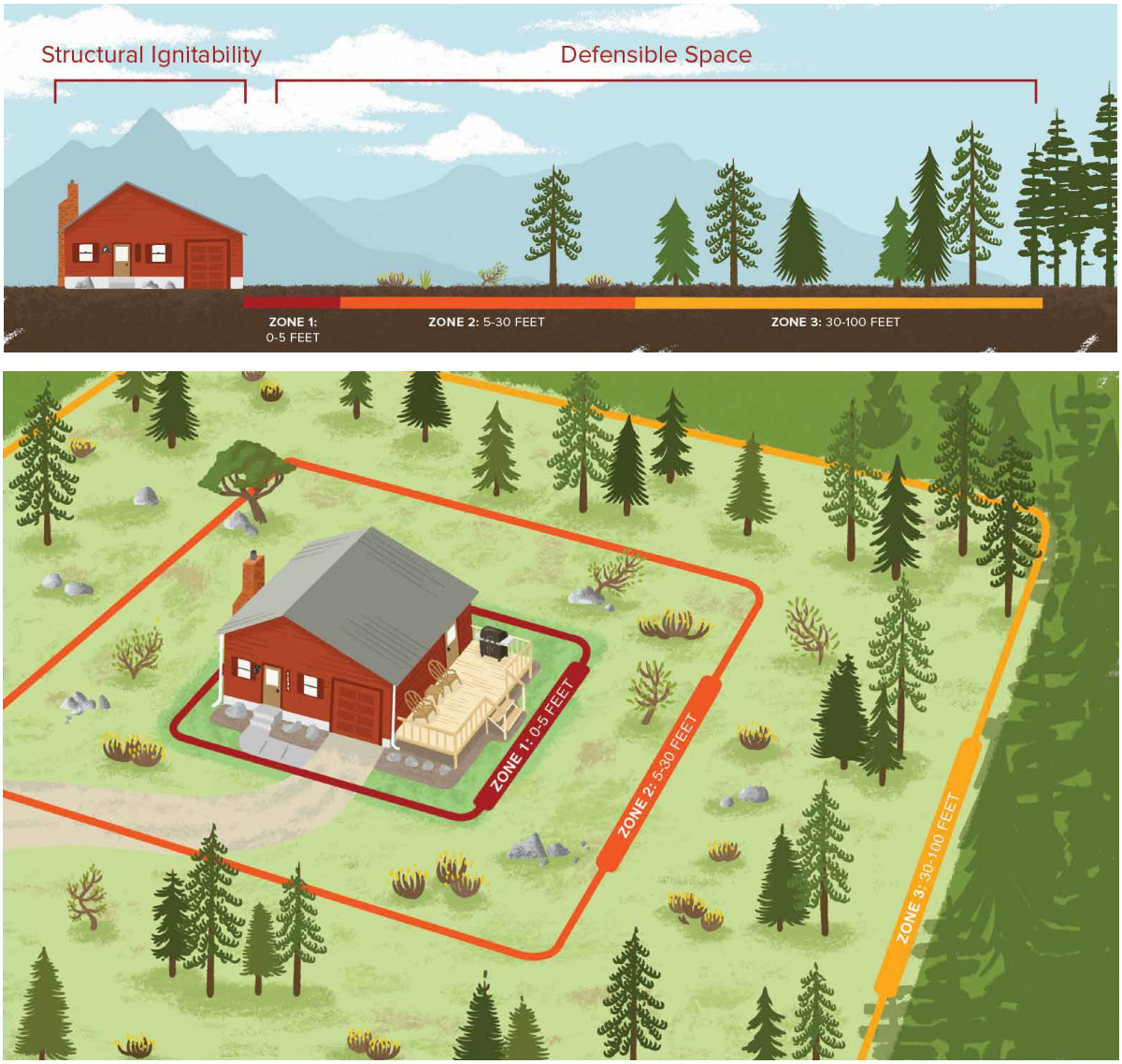


Figure 3.a.2. *Defensible space zones recommended by the Colorado State Forest Service. Creating defensible space around primary structures, outbuilding such as sheds, and campers / RVs is crucial for increasing your home's chance of surviving a wildfire and creating safe conditions for wildland firefighters. Source: Colorado State Forest Service, The Home Ignition Zone.*

A 2021 study from the University of Colorado-Boulder showed that homeowners living in the WUI in Bailey, CO typically underestimated the level of risk their home is at due to wildfire, and tended to overestimate the amount of work they have done to protect their property (Simpkins, 2021). Make sure you are informed about best practices for protecting your home. See **Table 3.a.1** and the CSFS publication The Home Ignition Zone for recommendations. **Section 4.c** includes specific defensible space recommendations by forest type for HIZ 3. You can also contact the CLFPD for property assessments to determine what steps you need to take to increase your property's survivability. See the CLFPD community page on their website for more information.

Some homeowners in the WUI are concerned that removing trees will destroy the forest and reduce the aesthetic and monetary value of their property. In fact, many dense ponderosa pine forests are unhealthy and greatly diverged from historical conditions that were maintained by frequent wildfires, and lodgepole and mixed conifer forests are adapted to burn in stand-replacing events that have been suppressed for well over a century (**Figure 2.e.1**). The reality is that nothing will decrease

the aesthetic and monetary value of your home as much as a high-severity wildfire burning all the vegetation in the community, even if your home survives the fire. Forest management can look messy and destructive in the first years following treatment; however, grasses, shrubs, and wildflowers will respond to increased light availability after tree removal and create beautiful ecosystems with lower fire risk (**Figure 3.a.3**). It might even be said that the more trees you cut, the more trees you save from wildfire.

Many property owners enjoy their land even more after conducting effective fuel treatments. Removing trees can open incredible views of mountains, rivers, and rock formations, and wildlife are often attracted to forests with lower tree densities and a greater abundance of understory plants. Reducing fuel loads and increasing the spacing between trees increases the chance that your home and your neighbors' homes will survive a wildfire, and most importantly, it increases the safety of wildland firefighters working to protect your community**.**

Figure 3.a.3. *Grasses, shrubs, and wildflowers recovered quickly after tree removal in this ponderosa pine forest at the Drala Mountain Center near Red Feather Lakes, CO. This beautiful and restored ecosystem is less susceptible to high-severity crown fire and can help reduce risk of wildfire damage to surrounding communities. Diverse understory plants can recover within 1-3 years of removing trees and increasing light availability in ponderosa pine ecosystems. Photo credit: Larimer Conservation District (https://www.fortcollinscd.org/before-and-after.html).*

Table 3.a.1. *Defensible space recommendations for homes in the WUI based on the CSFS publication The Home Ignition Zone. This is not an all-inclusive list of activities. Specific measures will depend on the placement and condition of your property.* ***Section 4.c*** *includes specific defensible space recommendations for HIZ 3 by forest type.*

HIZ 1: 0 to 5 feet from your home – the noncombustible zone.
Goal: Prevent flames from having direct contact with your home.
• Create a noncombustible border 5 feet around your home (aka, hardscaping). Replace flammable wood chips with alternatives like dirt, stone, or gravel. • Remove branches that hang over your roof and drop needles onto your roof and remove all fuels within 10 feet of the chimney. • Remove combustible materials (dry vegetation, wooden picnic tables, juniper shrubs, etc.) from underneath, on top of, or within 5 feet of decks, overhangs, windows, and doors. • Annually remove dead or dry leaves, pine needles, and dead plants withing 5 feet of your home and off your deck, roof, and gutters. Farther than 5 feet from structures, raking material will not significantly reduce the likelihood of ignition and can negatively affect other trees. • Move firewood or other combustible materials to HIZ 3. • Do not use space under decks for storage.

HIZ 2: 5 to 30 feet from your home – the lean, clean, and green zone.
Goal: Slow the movement of flames approaching your home and lower the fire intensity.
• Mow grasses to 4 inches tall or less. Since irrigated lawns are not permitted in the CLRRA, consider replacing dry grasses with Firewise Plant Materials that are more drought tolerant and less flammable. • Remove any accumulated surface fuels such as logs, branches, slash and mulch • Remove all common junipers because they are highly flammable and tend to hold a layer of flammable material beneath them. Landscape with plants that have more fire-resistant attributes, like short-statures, deciduous leaves, and higher moisture content. See Firewise Plant Materials from Colorado State University Cooperative Extension for suggestions. • Remove enough trees to create at least 10 feet* of space between crowns. Measure from the outermost branch of one tree to the nearest branch on the next tree. Create even more space between trees if your home is on a slope (**Table 3.a.2**). See **Figure 3.a.3** for how to measure crown spacing. • Favor the retention of aspen trees because this species naturally has high fuel moisture, no low branches, and smooth bark, making them less likely to ignite than conifer trees. • Remove ladder fuels under remaining trees. This is any vegetation that can bring fire from the ground up into taller fuels. • Remove limbs so branches do not hang below 6 feet above the ground, ideally not below 10 feet above the ground. See **Figure 3.a.3** for a depiction of how to measure limb height. • Keep spacing between shrubs at least 2-3 times their height. • Relocate wood piles and propane tanks to HIZ 3. • Remove stressed, diseased, dead, or dying trees and shrubs. This reduces the amount of vegetation available to burn and improves forest health. • Keep shrubs at least 10 feet* away from the edge of tree branches.

HIZ 3: 30 to 100 feet from your home
If you live on a slope, this zone may be larger to gain the full benefits of defensible space.

Goal: Slow movement of flames, move fire to the ground, reduce ember production.

- Store firewood and propane tanks at least 30 feet away and uphill from your home and away from flammable vegetation. Store even farther away if your home is on a slope.
- Move campers / RVs, boats, detached garages, storage buildings, barns, and other large structures at least 50 feet away from your home.
- Mow or trim grasses to maximum height of 6 inches. Grasses can be taller in HIZ 3 than HIZ 2 because of the greater distance from your home, but shorter grass is always better for reducing potential flame lengths and therefore radiant heat exposure.
- Remove enough trees to create at least 6- to 10-foot spacing* between the outermost branches of remaining trees. Create even more space between trees if your home is on a slope (**Table 3.a.2**). See **Figure 3.a.3** for a depiction of how to measure crown spacing.
- Favor the retention of aspen trees because this species naturally has high fuel moisture, no low branches, and smooth bark, making them less likely to ignite than conifer trees.
- Remove limbs so branches do not hang below 6 feet above the ground, ideally not below 10 feet above the ground. See **Figure 3.a.3** for a depiction of how to measure limb height.
- Remove shrubs and saplings that can serve as ladder fuels.
- Remove heavy accumulations of dead trees and branches and piles of fallen leaves, needles, twigs, pinecones, and small branches. Thin trees to increase spacing and remove ladder fuels to reduce the likelihood of torching, crown fires, and ember production.
- Consult with a qualified forester to develop a plan to manage your property to achieve fuel reduction and other goals, such as creating wildlife habitat. Follow principles of ecological restoration as outlined in **Section 4. Implementation Recommendations for Fuel Treatments and Ecological Restoration**.

*Spacing recommendations are a general guideline and should be increased for properties on steeper slopes. Reach out to the CSFS, Larimer County Conservation District, or other forestry professionals to develop a plan for mitigating wildfire risk on your property.

Aspen trees naturally have high fuel moisture, no low branches, and smooth bark, making them less likely to ignite than conifer trees. Retaining small groups of aspen trees is acceptable in HIZ 2—just remember to rake up dry leaves that fall onto your roof or on the ground within 5 feet of your home. Photo credit: Fire Adapted Colorado.

Table 3.a.2. *Minimum recommended spacing between tree crowns and shrubs is greater for properties on steeper slopes due to the exacerbating impact of slope on fire behavior (Dennis, 2003).*

Percent slope	Minimum spacing between tree crowns	Minimum spacing between shrubs / small clumps of shrubs
0 to 10 %	10 feet	2.5 x shrub height
11 to 20%	15 feet	3 x shrub height
21 to 40%	20 feet	4 x shrub height
>40%	30 feet	6 x shrub height

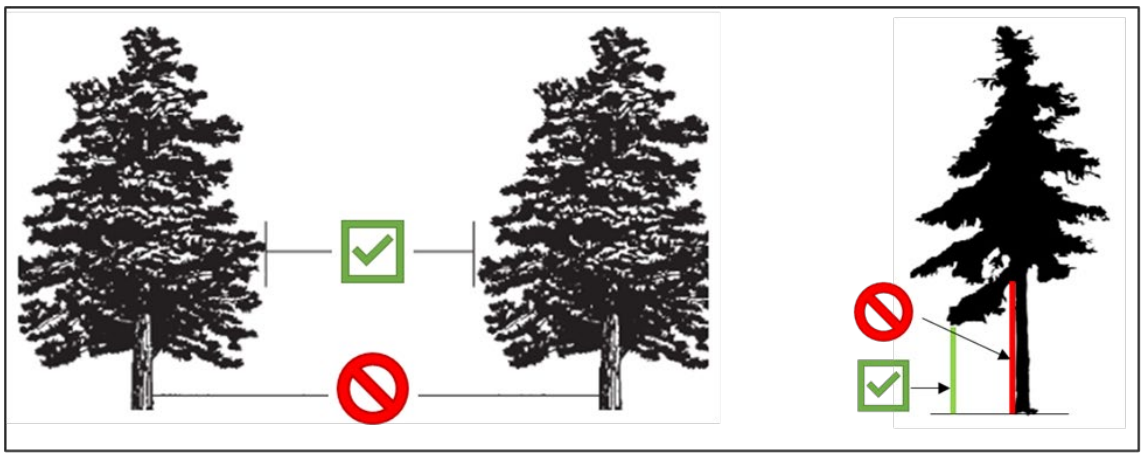


Figure 3.a.4. *Spacing between tree crowns is measured from the edge of tree crown to tree crown, NOT from tree stem to tree stem (left). Height of limbs above the ground is measured from the ground to the lowest point of the limb, NOT from where the limb attaches to the tree (right).*

Home Hardening

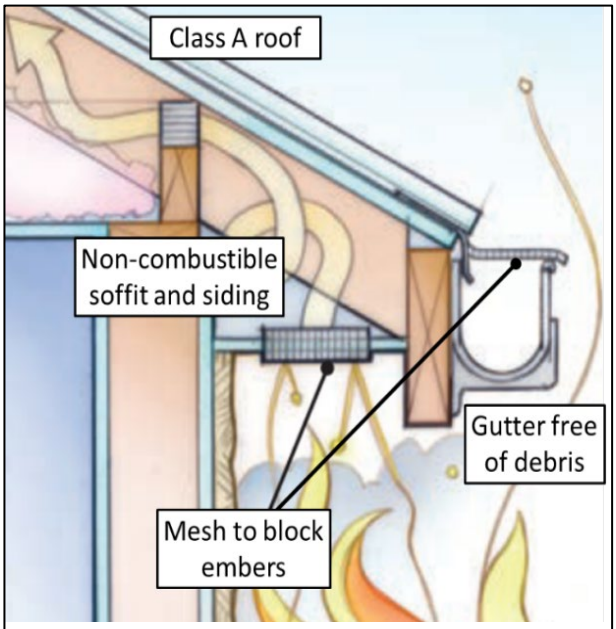
Home hardening involves modifying your home to reduce the likelihood of structural ignition. All homes in the CLFPD are at risk of long-range embers, and about 55% are at risk of radiant heat from burning vegetation under severe fire weather conditions (**Figure 2.f.4**). Risk to ignition from radiant heating is likely higher than estimated by this analysis due to the abundance of vegetation in many HIZs around the community. Homes in denser neighborhoods are also at risk of short-range embers from nearby homes, which could lead to structure-to-structure ignitions.

Buildings cannot be made fireproof, but the chance of your home surviving wildfires increases when you reduce structural ignitability through home hardening in tandem with the creation and maintenance of defensible space. Figure 3.a.5 depicts important home hardening measures.

Roofs, vents, windows, exterior siding, decks, and gutters are particularly vulnerable to wildfires. Research on home survival during wildfires demonstrates that enclosed eaves and vent screens can reduce the penetration of wind-born embers into structures (Hakes et al., 2017; Syphard and Keeley, 2019). **Very few property owners in the CLFPD have installed screens to reduce ember penetration into their home (Figure 3.a.1), and this is a low-cost action that all property owners should consider.**

Multi-pane windows have greater resistance to radiant heat. Windows often fail before a home ignites, providing a direct path for flames and airborne embers to enter a home (CSFS, 2021).

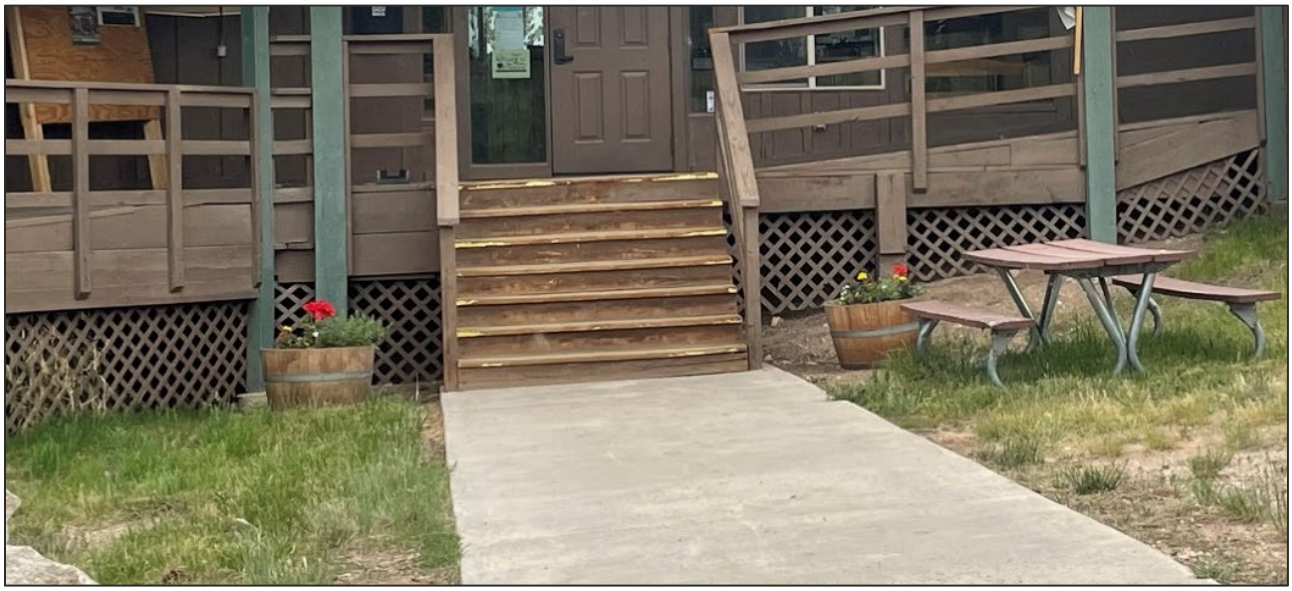
It is important to replace wood or shingle roofs with noncombustible materials [1] such as composite, metal, or tile. Ignition-resistant or noncombustible siding and decking further reduce the risk of home ignition, particularly when homes also have a 5-foot noncombustible border of dirt, stone, or gravel. Non-wood siding and decking are often more durable and require less routine maintenance.



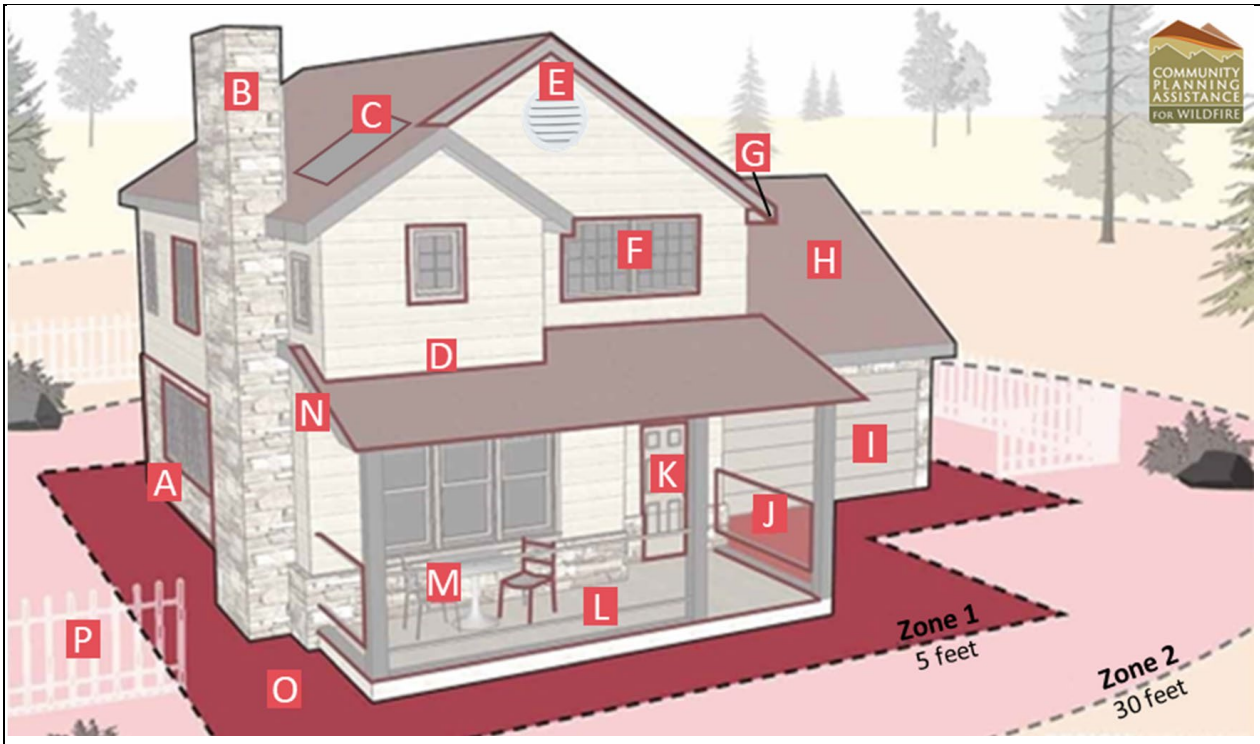
Property owners can increase their homes' chance of survival by making it harder for embers to enter and ignite their homes (image from Healthy Building Science).

There are many low-cost actions you can start with to harden your home (see **Table 3.a.3**). Keep home-hardening practices in mind and use ignition-resistant materials if you replace a hail-damaged roof or remodel your home. Effective as of February 2019, Many home hardening practices are required in Larimer County per building construction regulations for homes within the Wildfire Hazard Area. New construction and expansions adding 50% or more area must comply with the new building standards.

[1] See the **Glossary** on page 143 for the definition of terms used the describe the performance of building materials when exposed to fire (e.g., wildfire-resistant, ignition-resistant, and noncombustible).



Several homes in CLFPD have wooden lattice paneling around their decks. This is a fire hazard because embers can easily get trapped underneath the deck and cause the structure to ignite. Wooden lattice should be removed from all homes throughout the district and replaced with metal mesh and noncombustible lattice. Photo credit: The Ember Alliance.



Low-cost actions:

- **B.** Cover chimneys and stovepipes with 3/8th to ½ inch corrosion-resistant metal mesh.
- **C.** Minimize debris accumulation under and next to solar panels.
- **E.** Cover vent openings with 1/16th to 1/8th inch corrosion-resistant metal mesh. Install dryer vents with metal flappers and keep closed unless in use.
- **G.** Clear debris from roof and gutters regularly.
- **I.** Install metal flashing around and under garage doors that goes up at least 6 inches inside and outside the door.
- **J.** Use noncombustible lattice, trellis, or other decorative features.
- **K.** Install weather stripping around and under doors.
- **L.** Remove combustible materials from underneath, on top of, or within 5 feet of deck.
- **M.** Use noncombustible patio future.
- **N.** Cover all eaves with screened vents.
- **O.** Establish and maintain a 5-foot noncombustible buffer around the home.

Actions to plan and save for:

- **A.** Use noncombustible or ignition resistant siding and trim (e.g., stucco, fiber cement, fire-retardant treated wood) at least 2 feet up around the base of your home.
- **C.** Use multipaned glass for skylights, not materials that can melt (e.g., plexiglass), and use metal flashing.
- **D.** Install a 6-inch vertical noncombustible surface on all gables above roofs.
- **F.** Install multi-pane windows with at least one tempered-glass pane and metal mesh screens. Use noncombustible materials for window frames.
- **G.** Install noncombustible gutters, gutter covers, and downspouts.
- **H.** Install ignition-resistant or noncombustible roofs (composite, metal, or tile).
- **I.** Install 1-hour fire rated garage doors.
- **K.** Install a 1-hour fire rated doors.
- **L.** Use ignition-resistant or noncombustible decking. Enclose crawl spaces.
- **N.** Use noncombustible eaves.
- **P.** Replace wooden fences with noncombustible materials and keep at least 8 feet away from the home. Keep double fences at least 20 feet away from the home.

Figure 3.a.5. *A home can never be made fireproof, but home hardening practices decrease the chance that flames, radiant heat, and embers will ignite your home. Infographic by Community Planning Assistance for Wildfire with modifications to include information from CALFIRE 2019 and Maranghides et al. 2022.*

Annual Safety Measures and Home Maintenance in the WUI

Reviewing safety protocols, creating defensible space, and hardening your home are not one-time actions, but part of *annual* home maintenance when living in the WUI. During a wildland fire, homes that have clear defensible space are identified as sites for wildland firefighters to engage in structure protection, and homes that are not safely defensible will not usually receive firefighter resources.

The **Colorado State Forest Service** provides the following recommendations for annual activities to mitigate risks and increase your wildfire preparedness:

- ✓ Check fire extinguishers to ensure they have not expired and are in good working condition.
- ✓ Review your family's evacuation plan and practice family fire and evacuation drills.
- ✓ Verify that your home telephone number, cell phone, and/or email are properly registered through the NOCO Alert website.
- ✓ Review the contents of your "go-bag" and make sure it is packed and ready to go. Visit the Larimer County Emergency Preparedness page to learn about go-bags and evacuation planning, including tips for preparing your pets and livestock for evacuation. Your go-bag should include supplies to last at least three days, including cash, water, clothing, food, first aid, and prescription medicines for your family and pets. Keep important documents and possessions in a known and easily accessible location so you can quickly grab them during an evacuation.
- ✓ Pay attention to red flag-day warnings from the National Weather Service and stay vigilant. Ensure your family is ready to go in case of an emergency.
- ✓ Walk your property to identify new hazards and ways to maintain and improve current defensible space. Take pictures of your defensible space to help you monitor regrowth and determine when additional vegetation treatments are necessary.
- ✓ Clear roofs, decks, and gutters of pine needles and other debris. Remove all pine needles and flammable debris from around the foundation of your home and deck. Remove trash and debris accumulations within 30 feet of your home. Repeat throughout the year as necessary.
- ✓ Properly thin and prune trees and shrubs that have regrown in HIZ 1 and 2 (0-5 feet and 5-30 feet from your home). Remove branches that overhang the roof and chimney. Prune trees and shrubs that are encroaching on the horizontal and vertical clearance of your driveway.
- ✓ Mow grass to a height of 4 inches or less within 30 feet of your home, camper / RV, sheds, and barns. Since irrigation is not permitted in the CLRRA, consider replacing dry grasses with Firewise Plant Materials that are more drought tolerant and less flammable.
- ✓ Check the visibility of your address and remove vegetation that obscures it.
- ✓ Dispose of leaves, needles, and branches at the CLRRA slash depot on CR 73C.
- ✓ Check screens over chimneys, eaves, and vents to make sure they are in place and in good condition.
- ✓ Ensure that an outdoor water supply is available for responding firefighters. Put a hose and nozzle in a visible location. The hose should be long enough to reach all parts of your home.

Mitigation Barriers and Opportunities

Homeowners and property owners in the WUI share concerns about creating defensible space and maintaining a defensible HIZ. **Table 3.a.3** proposes several opportunities to address these challenges.

Table 3.a.3. *Common concerns from property owners in the WUI, and potential solutions to encourage mitigation measures in the HIZ.*

Concern	Potential solutions
I don't know where to start with creating defensible space.	Review **Figure 3.a.2**, **Table 3.a.1**, and read the CSFS publication The Home Ignition Zone: A guide for preparing your home for wildfire and creating defensible space for mitigation recommendations. Visit the Colorado State Forest Service for useful information and tips about defensible space creation. Reach out to the CLFPD, Colorado State Forest Service, or Larimer County Conservation District to learn about defensible space and home hardening tactics from their qualified specialists.
I do not have a permanent structure on my property in CLRRA, so I don't know how HIZ applies to me.	Even if you do not have a permanent home on your property, you can take steps to protect your camper and other assets, including the value of your property; areas that are heavily burned have less aesthetic and monetary value. Removing all vegetation from under and within 0-5 feet of your camper / RV and keeping grass mowed in HIZ 2 are crucial to reduce your camper's potential exposure to radiant heat. Limbing and thinning out trees in HIZ 2 and 3 can also reduce your camper's potential exposure to radiant heat and embers, thereby reducing the risk of your camper burning and generating embers that can ignite nearby homes and vegetation. Work you do to reduce fire risk on your property can amplify the work that your neighbors do on theirs, resulting in greater protection for everyone. Removing trees from along roadways can increase the visibility of your property to firefighters, increase the accessibility of your property for fire engines, and reduce the chance that non-survivable conditions can develop and entrap residents and first responders during wildfires.
I don't have the resources to invest in defensible space.	Creating adequate defensible space can take years and a significant financial investment. Fortunately, there are **effective, low-cost measures** that property owners can start with: ✓ Annually remove leaves, needles, and other vegetation from roofs, gutters, decks, and around the base of homes. ✓ Use hand tools like a pole saw to remove tree branches that hang less than 10 feet above the ground. ✓ Remove combustible materials (dry vegetation, wooden picnic tables, juniper shrubs, etc.) from underneath, on top of, or within 5 feet of decks. ✓ Remove vegetation and combustible materials within 5 feet of windows and doors.

	✓ Replace wood mulch within 5 feet of all structures with dirt, stone, or gravel. ✓ Remove downed logs and branches within 30 feet of all structures. ✓ Utilize the CLRRA slash depot on CR 73C. ✓ Apply for cost-sharing grants with your neighbors to subsidize the creation of defensible space (see **Section 3.e. Funding Opportunities for Wildfire Hazard Mitigation and Emergency Preparedness**). ✓ Research tax credits that will offset the costs or the work you want to do from the Colorado Department of Revenue.
I don't have the resources to invest in home hardening.	Retrofitting an existing home to be wildfire-resistant can be expensive, particularly actions like replacing flammable roofs and siding. Some of these costs can be divided and prioritized into smaller projects. If you are building a new home, the cost of using wildfire-resistant materials is roughly the same as using traditional building materials (Quarles and Pohl, 2018). Wildfire-resistant features often come with additional benefits, such as greater durability and reduced maintenance. Many home hardening practices are required in Larimer County per building construction regulations effective as of February 2019 for homes within the Wildfire Hazard Area. New construction and expansions adding 50% or more area must comply with the new building standards. Fortunately, there are effective, low-cost measures from CAL FIRE's 2020 Low Cost Retrofit List that property owners can start with to harden their homes: ✓ Install noncombustible metal gutter covers. ✓ Cover vent openings with 1/16th- to 1/8th-inch corrosion-resistant metal mesh. ✓ Cover chimney and stovepipe outlets with 3/8th- to ½-inch corrosion-resistant metal mesh to prevent embers from escaping and igniting a fire. ✓ Caulk and plug gaps greater than 1/16th-inch in siding or around exposed rafters. ✓ Install weather stripping around and under garage doors to reduce gaps to less than 1/16th-inch. ✓ Remove combustible materials from underneath, on top of, and within 5 feet of a deck. ✓ Replace wood mulch within 5 feet of all structures with noncombustible products like dirt, stone, or gravel. ✓ Store all combustible and flammable liquids away from potential ignition sources. ✓ Keep a fire extinguisher and tools such as a shovel, rake, bucket, and hose available in your garage for fire emergencies.

I am afraid that removing trees will destroy the forest and reduce the aesthetic and monetary value of my property.	The reality is that nothing will decrease the value of your home as much as a high-severity wildfire burning all the vegetation in the community, even if your home survives the fire. Drive around the community and look for homes that have followed the guidelines in **Figure 3.a.2** and **Table 3.a.1**. Some properties in the CLFPD have exemplary defensible space and beautiful landscaping at the same time. Read Firewise Plant Materials from Colorado State University Cooperative Extension and Firescaping from FIRESafe MARIN for suggestions on beautiful, fire-resistant landscaping. As an added benefit, fire-resistant landscape is often more drought tolerant. Learn about the ecology of frequent-fire forests along the Colorado Front Range by reading *Back to the future: Building resilience in Colorado Front Range forests using research findings and a new guide for restoration of ponderosa and dry-mixed conifer landscapes* (Miller, 2018). Restored ecosystems can be aesthetically pleasing, benefit wildlife and light-loving wildflowers and grasses, and protect your home from high-severity wildfires.
CLRRA rules hinder my ability to establish defensible space around my home.	Contact CLRRA board members to ask questions about regulations. You might perceive barriers to mitigation that do not exist or are easily addressed. Serve on CLRRA working teams and speak with CLRRA leadership to support community-wide action around wildfire mitigation. Advocate for CLRRA regulations that align with home hardening practices and Firewise landscaping. Firewise plants are less flammable and drought tolerant, so they require less watering during the summer. This is especially important for homeowners in the CLRRA because irrigated lawns and landscaping are not permitted. Ask the CLFPD for assistance communicating the need for homeowner mitigation in the neighborhood.
My neighbors haven't mitigated risk on their property.	Some property owners in the CLFPD are rightfully concerned about high hazards on their neighbors' properties and CLRRA open space. Your HIZ might overlap with your neighbor's property. Given the high fire risk in the area, it is important that property owners across the CLFPD create defensible space and harden their homes. Ideas to inspire action by your neighbors include: • Working with CLRRA, and other community groups to help educate your community about the benefits of defensible space and home hardening. • Organizing walking tours to visit the property of property owners with exemplary defensible space. Witnessing the type of work that can be done, and seeing that a mitigated property can still be aesthetically pleasing, can encourage others to follow suit.

- Inviting your neighbors over for a friendly conversation about the risk assessment in this CWPP. Review resources about defensible space together, discuss each other's concerns and values, and develop joint solutions to address shared risk.

Fire-resistant landscaping in zone 1 can be aesthetically pleasing and more drought tolerant, requiring less watering during the summer. Limbed and thinned trees in HIZ 2 (as seen in the background of this photo) can create beautiful, open conditions that allow understory vegetation to flourish under higher light conditions and provide habitat for wildlife. Photo credit: Washington State University Master Gardener Program.

Evacuation Preparedness

The best way to get out quickly and safely during an evacuation is to be prepared. Prepare a go-bag and have a family emergency plan **before** the threat of wildfire is in your area. Talk to children and elderly family members about what they would be expected to do. Visit the Larimer County Emergency Preparedness page to learn about go-bags and evacuation planning, including tips for preparing your pets and livestock for evacuation. Property owners should register their cell phones and email addresses on the NOCO Alert website.[2]

Evacuation preparedness is the responsibility of each property owner in the CLFPD. Unfortunately, only 53% of respondents to the CWPP survey have evacuation plans for their family and only 38% have go-bags at the ready. These are simple and crucial actions that can save lives.

Understand the differences between voluntary and mandatory evacuations. The following definitions are provided by the Larimer County Sherriff's Office:

Voluntary Evacuation	Mandatory Evacuation
When to leave: Leave if you are concerned for your safety, you need additional time to exit the area, or you have health conditions that may be aggravated by the incident.	**When to leave:** Immediately! You are ordered to leave due to an imminent or immediate threat to your safety.
What to do: Gather essential items to add to an Emergency go-bag such as medications and items you may need if away for an extended period.	**What to do:** Grab your go-bag and leave the area immediately.
Other considerations: Create a plan for transporting animals out of the area if needed.	**Other considerations:** You may not be allowed to return until the emergency is resolved.

Some property owners have family members or neighbors with physical limitations who might struggle to evacuate in a timely manner. Family members or individuals living alone also need to address the unique needs and vulnerabilities that arise from mobility or hearing impairments during an evacuation. Other property owners are concerned about school-aged children who might be home alone during an evacuation. Parents should work with their neighbors to develop a plan for how their children would evacuate if home alone. Families with these concerns should put extra time into having go bags ready and using the earliest evacuation warnings to leave in the event of a wildfire, rather than waiting for mandatory evacuation orders. Having a plan in place ahead of time can ensure prompt evacuations and save lives during wildfires.

Property owners with livestock trailers or large camper vehicles should plan to leave during voluntary evacuation notices to allow time for their preparations and create more space on the roads for other property owners during a mandatory evacuation. It is important to have a plan for where to take livestock to reduce some of the chaos and uncertainty created by wildfire evacuations.

[2] NOCO Alert is the official emergency notification system for Larimer County as of the writing of this CWPP for CLFPD in 2022.

Follow evacuation etiquette *to increase the chance of everyone exiting the CLFPD in a safe and timely manner during a wildfire incident:*

- Register for Larimer County Emergency Alerts to receive evacuation notifications.
- Leave as quickly as possible after receiving an evacuation notice.
- Have a go-bag packed and ready during the wildfire season, especially on days with red flag warnings.
- Leave with as few vehicles as necessary to reduce congestion and evacuation times across the community.
- Drive safely and with headlights on. Maintain a safe and steady pace. Do not stop to take pictures.
- Yield to emergency vehicles.
- Follow directions of law enforcement officers and emergency responders.

Property owners in the CLFPD experienced mandatory and voluntary evacuations during the 2020 Cameron Peak Fire. Following orders of the Larimer County Sheriff's Office during evacuations is critical to keep property owners and first responders safe. Photo credit: Denver7 News (left) and Blaine Howerton/North Forty News (right).

Accessibility and Navigability for Firefighters

Address signs

Installing reflective address numbers can save lives by making it easier for firefighters to navigate to your home at night and under smokey conditions. Reflective signs are available from the CLFPD, making is an easy and inexpensive action you can accomplish to protect firefighters and your family. Mount reflective address signs on noncombustible posts, not on stumps, trees, wooden posts, or chains across driveways. Chains across driveways might be removed during wildfire suppression to facility access to your property. Make sure the numbers are clearly visible from both directions on the roadway.

An example of a reflective address sign that you can get from the Crystal Lakes Fire Department. The homeowner has mounted it on a noncombustible post that is visible from the road, which will make it easier for emergency responders to navigate to this home. Photo credit: The Ember Alliance.

Driveways

It is important to ensure emergency responders can locate and access your home. Narrow driveways without turnarounds, tree limbs hanging over the road, and lots of dead and down trees by the road may make firefighters choose to not defend your home during a wildfire event (Brown, 1994).

Some roads in the CLFPD have accessibility and navigability issues, such as narrow widths, inadequate vertical clearance for engines, and heavy fuel loading on the sides of the road. These unsafe road and driveway conditions could turn firefighters away from attempting to defend homes. According to the National Fire Protection Association, driveways and roads should have a minimum of 20 feet of horizontal clearance and 13.5 feet of vertical clearance to allow engines to safely access the roads (O'Connor, 2021).

Many driveways within the CLFPD do not meet current access requirements and pose safety issues that are difficult to mitigate. Long, narrow, steep driveways lacking turnarounds, and dense trees on the sides of the road can create challenges for emergency response vehicles during wildfires. Home hardening and fuel mitigation are particularly important to reduce wildfire risk around homes with accessibility issues. Photo credit: The Ember Alliance.

Where possible, property owners should improve roadway access, and where this is not feasible, it is vital that homeowners take measures to harden their home and create defensible space. Some actions to increase access to your home are simple, such as installing reflective address numbers, and others take time and investment, such as widening driveways to accommodate fire engines.

Private Water Resources

Water resources to fight fire in the foothills can be scarce, especially during the fire season in late summer and fall. Firefighters are skilled at determining the most beneficial ways to use water to protect structures from an approaching fire. Providing clear access to suitable water resources around your home or neighborhood can help them defend your home.

Do not turn sprinklers on around your home as you evacuate. This is counterproductive to protecting your home because continuous use of water before a flame front approaches can drain local wells and cisterns long before the fire reaches your neighborhood. This can leave firefighters with less resources to defend your home, putting their lives and your property at higher risk. Leaving sprinklers out but **turned off** allows the firefighters to determine whether they will be useful or not.

Prepare personal water resources by making them easily accessible and clearly labelling how to access them. Unlock pump house doors and remove vegetation or other obstructions. If you have a generator, leave it in an accessible location in case power is turned off. Notify the fire department of community cisterns or tanks and ensure they are compatible with their firefighting equipment. CLFPD can use an unpressurized cistern with at least 1.5" draft pipe or connector.

Most importantly, create defensible space around your home and buildings so that water resources can be used effectively. Water is not a reliable resource in the Colorado mountains. Maintaining a property that requires less water and resources to defend is more likely to survive a fire. See **Table 3.a.1** and **Figure 3.a.5** for guides on defensible space and home hardening recommendations.

Steps to enhance firefighter safety and access to your home:

- ✓ Install reflective address numbers on the street to make it easier for firefighters to navigate to your home under smokey conditions and at night. Make sure the numbers are clearly visible from both directions on the roadway. Use noncombustible materials for your address sign and sign supports. **Installing reflective address numbers can save lives and is inexpensive and easy to accomplish.**
- ✓ Address roadway accessibility for fire engines. Long, narrow, steep, and curving private drives and driveways without turnarounds significantly decrease firefighter access to your property, depending on fire behavior.
- ✓ Fill potholes and eroded surfaces on private drives and driveways.
- ✓ Increase fire engine access to your home by removing trees along narrow private drives and driveways so the horizontal clearance is 20 feet wide, and prune low-hanging branches of remaining trees so the unobstructed vertical clearance is at least 13.5 feet per the National Fire Protection Association (O'Connor, 2021).
- ✓ Park cars in your driveway or garage, not along narrow roads, to make it easier for fire engines to access your home and your neighbors' homes.
- ✓ Clearly mark septic systems with signs or fences. Heavy fire equipment can damage septic systems.
- ✓ Clearly mark wells and water systems. Leave hoses accessible for firefighters to use when defending your home, but **DO NOT** leave the water running. This can reduce water pressure to hydrants across the community and reduce the ability of firefighters to defend your home. Read this post by FIRESafe Marin about why it is dangerous to leave water running when you evacuate during a wildfire.
- ✓ Post the load limit at any private bridges or culverts on your property.
- ✓ Leave gates unlocked during mandatory evacuations to facilitate firefighter entrance to your property.
- ✓ Leave exterior lights on to increase visibility.
- ✓ If time allows, leave a note on your front door confirming that all parties have evacuated and providing your contact name and phone number.

3.b. Neighborhood Recommendations

The CWPP is a useful planning document, but it will only affect real change if property owners, neighbors, CLFPD, CLRRA, and agency partners come together to address shared risk and implement strategic projects. This section of the CWPP discusses the concept of linked defensible space and mosaic landscapes and provides relative hazard ratings and specific recommendations for the CLRRA filings, Pearl Creek Estates, Elkridge Ranches, and Poudre Meadows, which all reside within the CLFPD. We encourage property owners within the aforementioned areas to organize and support each other to effectively reduce wildfire risk and enhance emergency preparedness.

Linked Defensible Space

The HIZ of individual property owners can overlap that of their neighbors, so wildfire hazards on one property can threaten adjacent properties. Structures that are on fire can emit significant radiant heat and embers and endanger homes and structures near them**.** A vast majority of homes in the CLFPD (80%) could be exposed to short-range ember cast from at least one neighboring home (**Appendix B, Figure B.9**).

Neighbors can increase their homes' chances of survival during a wildfire if they work together to create linked defensible space. Linked defensible space also creates safer conditions and better tactical opportunities for wildland firefighters. According to James White, the Prescribed Fire and Fuels Specialist for the Arapaho-Roosevelt National Forests, "Broadcast burning, mechanical thinning, and other treatments are proven to mitigate wildfire risk, but they are even more effective when we work together to integrate treatments across the landscape, across borders and ownerships" (Avitt, 2021). Defensible space projects that span ownership boundaries are better candidates for grant funding due to their strategic value.

How can you help inspire action by your neighbors? Start by creating defensible space and hardening your own home. Then try the ideas below:

- Invite your neighbors over for a friendly conversation about the risk assessment in this CWPP. Review resources about defensible space together, discuss each other's concerns and values, and develop joint solutions to address shared risk.
- Volunteer with CLRRA working groups to help educate your community about the benefits of defensible space and home hardening.
- Help organize walking tours in your neighborhood to visit properties with exemplary defensible space. Witnessing the type of work that can be done, and seeing that a mitigated property can still be aesthetically pleasing, can encourage others to follow suit.

Mosaic Landscapes

Varied fuel types are known to slow the spread of fire, and heterogeneous landscapes (landscapes with multiple fuel types and trees of different sizes and ages) are more typical of historical forest conditions (Duncan et al., 2015). Creating a mosaic landscape in neighborhoods can help slow fire spread by changing the fuel types as it moves across a hill or valley. A mosaic landscape can be created many ways. For example, a neighborhood could have a few acres of old growth conifer trees next to a couple acres of aspen stands, and a few acres of young regenerating conifer trees by a large grassy meadow. This can be arranged in many ways for aesthetic and tactical purposes, and will resemble a patchwork quilt or mosaic art (**Figure 3.b.1**).

The homes in these patches still need to have adequate defensible space, but this would create a more diverse landscape where fire may move slower as it transitions between forest types and unforested locations like shrublands or meadows. Slower fire movement means firefighters have time to defend more homes in the neighborhood. It also creates a diversity of biomes that both property owners and wildlife enjoy.

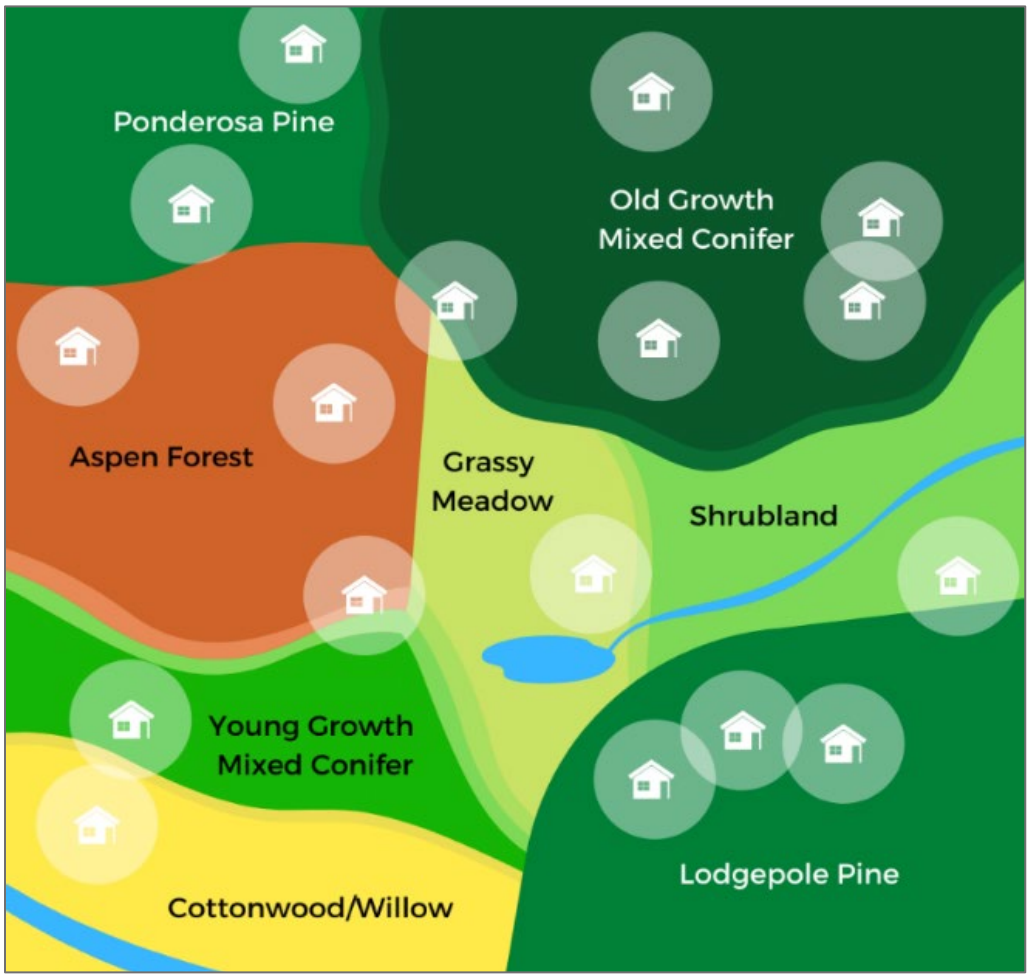


Figure 3.b.1. *Example of a mosaic landscape in a neighborhood. Each home has defensible space around it, and the landscape is varied throughout, providing tactical opportunities for firefighters working to defend homes.*

Relative Risk Ratings

Colorado CWPPs must include relative risk ratings within fire protection districts to help prioritize action. TEA combined on-the-ground observations and summary output from our fire behavior and evacuation analyses to assess relative risk within CLRRA filings, Pearl Creek Estates, Elkridge Ranches, and Poudre Meadows. Due to the limited number of homes in Poudre Meadows, this neighborhood was combined with CLRRA Filing 5 for the purpose of assessing relative risk.

Hazards were assessed in four categories: fire risk, fire suppression challenges, evacuation hazards, and HIZ hazards. See **Appendix B** for a description of hazard rating methodology. Relative risk ratings are specific to the CLFPD and not suitable for comparing this fire protection district to other communities in Colorado or the United States.

The potential for wildfires to pose a threat to lives and property is high across the CLFPD, but risk is relatively higher in some parts of the district than others. Filings with higher relative risk are strong candidates for immediate action to mitigate hazardous conditions. However, filings with moderate relative risk still possess conditions that are concerning for the protection of life and property in the case of a wildfire.

Filings with extreme relative risk are scattered across the CLFPD. Filings 8, 12, and 15 could experience extreme fire behavior due to steep slopes with dense lodgepole pine and wet mixed-conifer forests, and filings 1, 2, and 3 could experience extreme fire behavior due to steep south-facing slopes with shrubs that could carry fire into the tops of ponderosa pine forests. Despite the concerning potential for extreme fire behavior in filing 8, the relative risk rating is high because many homes have adequate home hardening and defensible space. Additional work in this filing to mitigate hazards in greenbelts will go a long way in reducing wildfire risk in this filing.

Filings 9 and 4 have a moderate relative risk and filing 14 has a high relative risk rating due to the lower potential for extreme fire behavior in these areas. However, HIZ hazards are extreme in these filings due to the abundance of older homes with flammable siding, roofs, and decks and abundant hazards in HIZ 1 and 2.

Evacuation hazards are high to extreme in most filings and neighborhoods due to the abundance of narrow roads that can only handle one-way traffic and have no pullovers, potential for non-survivable conditions to develop along roadways during wildfires, and a road network that funnels many property owners onto two main points of egress. Section **3.c Community-Wide Recommendations** provides suggestions for addressing evacuation hazards in this community.

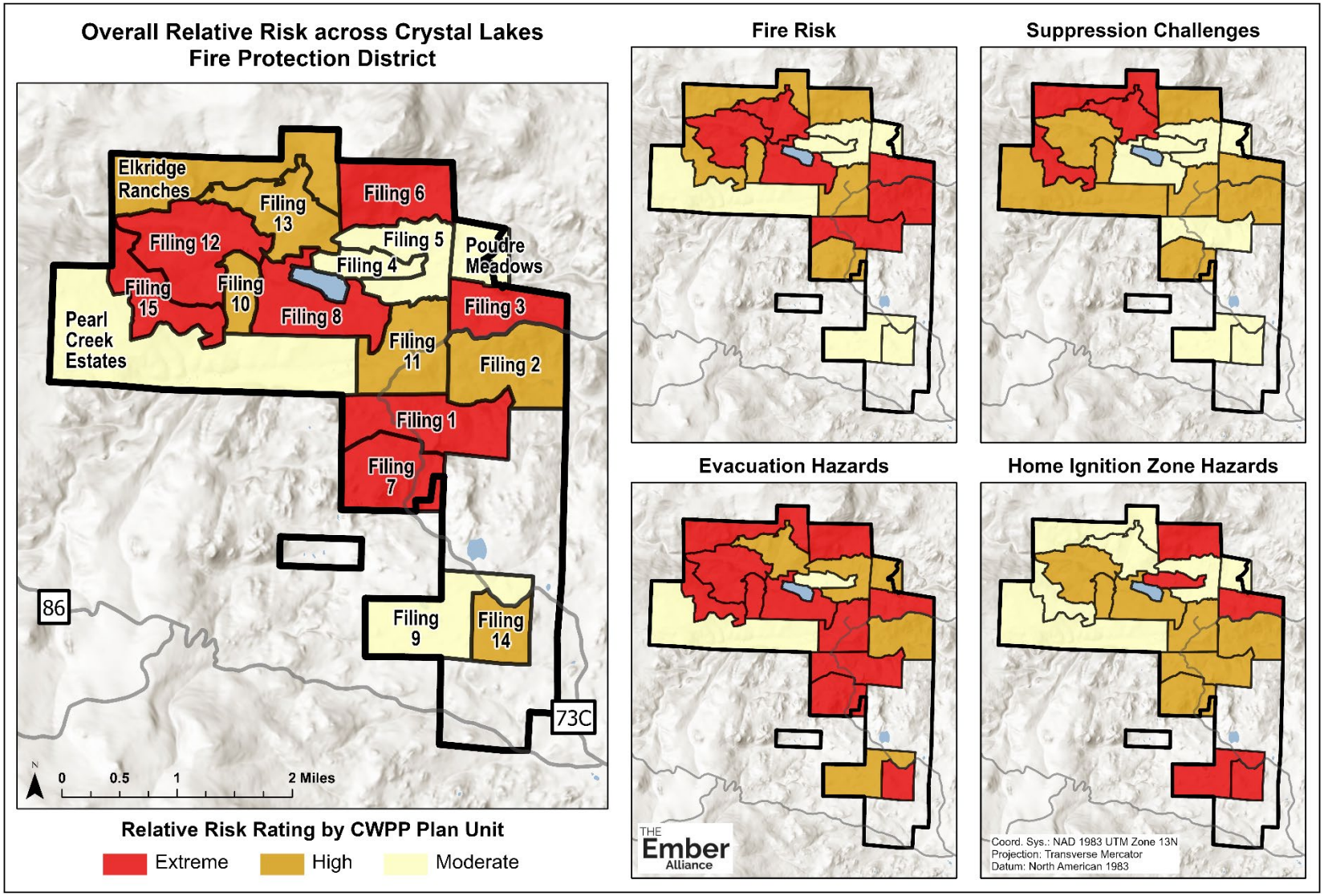


Figure 3.b.2. *Relative risk rating for CLRRA filings and neighborhoods across the CLFPD. "Moderate" risk is a relative term – all property owners in the CLFPD are exposed to elevated fire danger due to topography and fuels in this part of Colorado and should take recommended actions in this CWPP seriously. Visit the CLRRA CWPP Map Experience for an interactive version of this map.*

Priority Action for CLRRA Filings and CLFPD Neighborhoods

Here we describe conditions in each CLRRA filings, Pearl Creek Estates, Elkridge Ranches, and Poudre Meadows from our on-the-ground relative risk rating assessment and include a summary of predicted fire behavior, roadway survivability, and home exposure to radiant heat and short- and long-range embers from burning vegetation (see **Appendix B** for methodology). Due to the limited number of homes in Poudre Meadows, this neighborhood was combined with CLRRA Filing 5 for assessment purposes. Photos of representative vegetation in each filing were taken by TEA during the CLFPD community assessment.

We also provide priority recommendations for collective action by homeowners to address shared risk and magnify the impact of individual mitigation actions. Guidelines for priority action could be spearheaded by neighborhood ambassadors in each filing with support from fellow property owners (see **Section 3.d. Outreach and Education** for a description of a neighborhood ambassador program recommended for CLRRA).

Filing 1 – Extreme relative risk rating

Predicted wildfire exposure under extreme fire weather in filing 1:

72% non-survivable roadways	61% of homes exposed to short-range embers from burning vegetation
74% of homes exposed to radiant heat from burning vegetation	100% of homes exposed to long-range embers from burning vegetation

Vegetation in filing 1 is highly variable with ponderosa pine overstories and grass and shrub understories on flat and south-facing slopes, dense mixed-conifer on north-facing slopes, and aspen and willow in drainages. There is a high potential for extreme fire behavior in dense forests on steep slopes on hot, dry, and windy days. Areas with grass-shrub understories can support fast rates of fire spread.

Several homes are located mid-slope, which increases their potential exposure to extreme fire behavior. In general, homes are older in this filing and have more flammable construction materials, including wooden decks. Unfortunately, many homes have older asphalt roofs that are less flame resistant than metal, composite, or new asphalt roofs. Most homes have abundant hazards in HIZ 1 and 2. Tree branches overhang roofs, pine needles are accumulated in gutters, and tall grass abuts many homes. Many homes have hazards such as old wooden sheds, wood piles, and other flammable material within 30 ft of the home.

Over two-thirds of roads in this filing could experience non-survivable conditions during wildfires. Most roads are accessible for Type 3 engines, except for several roads with tight switchbacks. Most roads can only accommodate one-way traffic. Wooden street signs across the filing could burn during a wildfire and would be illegible at night or through heavy smoke.

Recommendations for collective action in filing 1:

- Remove vegetation along roadways to reduce the risk of non-survivable conditions during wildfires, particularly along Tiny Bob Road, Lone Pine Drive, Commanche Court, Commanche Circle, Delaware Court, and Teton Court (see **Figure 3.c.2**). Treatments along Tiny Bob Road are called out as priority project areas for this CWPP (see **Section 4.b**).
- Work with neighbors to create linked defensible space. Projects that span multiple properties are more effective at reducing wildfire risk and more attractive to grant funders. Contractor costs can sometimes be shared among homeowners, reducing the cost for everyone involved. See **Section 4.c** for implementation recommendations and pictures of effective stand-scale treatments to protect communities and restore ecosystems.
- Speak with the USFS about the potential to coordinate treatments on private land when work begins in the priority project area in the eastern part of the CLFPD on the Arapaho-Roosevelt National Forest (see project area in **Section 4.b**).
- Conduct walking tours to demonstrate home hardening and defensible space practices. Every homeowner in filing 1 should review and consider actions outlined in **Section 3.a. Individual Recommendations**. Even homes in the interior of this filing have the potential for ignition from long-range ember cast during wildfires.
- Encourage all property owners to develop evacuation plans for their family, sign up for emergency notifications from Larimer County, and coordinate with neighbors who might need additional support during evacuations.
- Replace wooden street signs with metal, reflective signs to make it easier for firefighters to locate homes through heavy smoke and at night.

Filing 2 – High relative risk rating

Moderate to steep south-facing slopes in filing 2 are covered in low to moderate density ponderosa pine with grass and shrub understories. Aspen is present along valley bottoms. Grasses could support fast rates of fire spread up steep, dry slopes, and shrubs could support long flame lengths that could cause overhead trees to ignite.

Numerous homes are located mid-slope and several on ridgetops, which increases their potential exposure to extreme fire behavior. In general, homes are older in this filing and have more flammable construction materials, including wooden decks. Some homes have non-burnable barriers within HIZ

1 and adequate defensible space in HIZ 2. Some homes have hazards such as old wooden sheds, wood piles, and other flammable material within 30 ft of the home. Fortunately, many homes have metal or new asphalt roofs.

Over two-thirds of roads in this filing could experience non-survivable conditions during wildfires. Almost all roads are accessible for Type 3 engines, but at least half of roads can only accommodate one-way traffic. Reflective street signs are present along CR 73C, but wooden street signs along sideroads could burn during a wildfire and would be illegible at night or through heavy smoke.

Predicted wildfire exposure under extreme fire weather in filing 2:	
69% non-survivable roadways	25% of homes exposed to short-range embers from burning vegetation
58% of homes exposed to radiant heat from burning vegetation	100% of homes exposed to long-range embers from burning vegetation

Recommendations for collective action in filing 2:

- Remove vegetation along roadways to reduce the risk of non-survivable conditions during wildfires, particularly along CR 73C and Caddo Road (see **Figure 3.c.2**). Treatments along CR 73C are called out as priority project areas for this CWPP (see **Section 4.b**).
- Work with neighbors to create linked defensible space. Projects that span multiple properties are more effective at reducing wildfire risk and more attractive to grant funders. Contractor costs can sometimes be shared among homeowners, reducing the cost for everyone involved. See **Section 4.c** for implementation recommendations and pictures of effective stand-scale treatments to protect communities and restore ecosystems.
- Speak with the USFS about the potential to coordinate treatments on private land when work begins in the priority project area east of the CLFPD boundary on the Arapaho-Roosevelt National Forest (see project area in **Section 4.b**).
- Conduct walking tours to demonstrate home hardening and defensible space practices. Every homeowner in filing 2 should review and consider actions outlined in **Section 3.a. Individual**

Recommendations. Even homes in the interior of this filing have the potential for ignition from long-range ember cast during wildfires.

- Encourage all property owners to develop evacuation plans for their family, sign up for emergency notifications from Larimer County, and coordinate with neighbors who might need additional support during evacuations.
- Replace wooden street signs with metal, reflective signs to make it easier for firefighters to locate homes through heavy smoke and at night.
- Widen roads and create pullouts to facilitate two-way traffic during emergencies.

Filing 3 – Extreme relative risk rating

Predicted wildfire exposure under extreme fire weather in filing 3:

95% non-survivable roadways	74% of homes exposed to short-range embers from burning vegetation
81% of homes exposed to radiant heat from burning vegetation	100% of homes exposed to long-range embers from burning vegetation

Vegetation in filing 3 is varied with mixes of ponderosa pine, Douglas-fir, lodgepole pine, and aspen. Some forests have low to moderate tree densities and grass and shrub understories, and others are dense and have abundant ladder fuels. Much of the filing is on a steep north-facing slope, but the northern portion is on a south-facing slope. There is a high potential for extreme fire behavior in dense forests on steep slopes on hot, dry, and windy days. Areas with grass-shrub understories can support fast rates of fire spread.

Numerous homes are located on ridgetops, and several are mid-slope, which increases their potential exposure to extreme fire behavior. In general, homes in this filing have newer, flame-resistant siding and roofs. Several homes have old wooden decks enclosed in flammable, wooden lattice. Unfortunately, most homes have abundant hazards in HIZ 1 and 2. Tall grasses and shrubs abut

homes and abundant ladder fuels could carry wildfire into trees near homes. Some homes have hazards such as old wooden sheds, wood piles, and other flammable material within 30 ft of the home.

Almost all roads in this filing could experience non-survivable conditions during wildfires. Most roads are accessible for Type 3 engines, but Crow Road and side roads can only accommodate one-way traffic. Reflective street signs are present along CR 73C, but wooden street signs along sideroads could burn during a wildfire and would be illegible at night or through heavy smoke.

Recommendations for collective action in filing 3:

- Remove vegetation along roadways to reduce the risk of non-survivable conditions during wildfires, particularly along CR 73C, Caddo Road, Pueblo Road, and Blackfoot Road (see **Figure 3.c.2**). Treatments along CR 73C are called out as priority project areas for this CWPP (see **Section 4.b**).
- Work with neighbors to create linked defensible space, building on momentum started by several property owners in this filing who have already created defensible space on their properties. Projects that span multiple properties are more effective at reducing wildfire risk and more attractive to grant funders. Contractor costs can sometimes be shared among homeowners, reducing the cost for everyone involved. See **Section 4.c** for implementation recommendations and pictures of effective stand-scale treatments to protect communities and restore ecosystems.
- Conduct walking tours to demonstrate defensible space practices. Much work needs to be done around home hardening and defensible space creation in this filing. Every homeowner in filing 3 should review and consider actions outlined in **Section 3.a. Individual Recommendations**. Even homes in the interior of this filing have the potential for ignition from long-range ember cast during wildfires.
- Encourage all property owners to develop evacuation plans for their family, sign up for emergency notifications from Larimer County, and coordinate with neighbors who might need additional support during evacuations.
- Replace wooden street signs with metal, reflective signs to make it easier for firefighters to locate homes through heavy smoke and at night.
- Widen roads and create pullouts to facilitate two-way traffic during emergencies.

Filing 4 – Moderate relative risk rating

Filing 4 is mostly in a valley bottom and relatively flat. Most forests have ponderosa pine overstories with occasional aspen and grass and shrub understories. There are some lodgepole pine stands with moderate tree densities, but these are intermixed with aspen and meadows. There is a lower potential for extreme fire behavior in this filing, but a potential for fast rates of spread in areas with grass-shrub understories.

Homes in this filing have highly varied construction material and defensible space. Some homes have newer, flame-resistant siding and roofs and others have older, flammable siding and roofs. Some homes have trees immediately adjacent to homes, and most homes have flammable vegetation within HIZ 1. Many homes have hazards such as wood piles, propane tanks, and other flammable material within 30 ft of the home.

Predicted wildfire exposure under extreme fire weather:

72% non-survivable roadways

74% of homes exposed to radiant heat from burning vegetation

61% of homes exposed to short-range embers from burning vegetation

100% of homes exposed to long-range embers from burning vegetation

Only about a third of roads in this filing could experience non-survivable conditions during wildfires. Almost all roads are accessible for Type 3 engines and can accommodate two-way traffic. Wooden street signs across the filing could burn during a wildfire and would be illegible at night or through heavy smoke.

Predicted wildfire exposure under extreme fire weather in filing 4:

37% non-survivable roadways

12% of homes exposed to radiant heat from burning vegetation

26% of homes exposed to short-range embers from burning vegetation

100% of homes exposed to long-range embers from burning vegetation

Recommendations for collective action in filing 4:

- Conduct walking tours to demonstrate home hardening and defensible space practices. Much work needs to be done around home hardening and defensible space creation in this filing. Every homeowner in filing 4 should review and consider actions outlined in **Section 3.a. Individual Recommendations**. Even homes in the interior of this filing have the potential for ignition from long-range ember cast during wildfires.
- Encourage all property owners to develop evacuation plans for their family, sign up for emergency notifications from Larimer County, and coordinate with neighbors who might need additional support during evacuations.
- Replace wooden street signs with metal, reflective signs to make it easier for firefighters to locate homes through heavy smoke and at night.
- Create pullouts to facilitate emergency traffic.

Filing 5 and Poudre Meadows – Moderate relative risk rating

The southern part of filing 5 and Poudre Meadows has low to moderate density of ponderosa pine and shrub understories. Other parts of the filing have ponderosa pine and Douglas-fir overstories with occasional aspen, high tree densities, and abundant ladder fuels. Slopes are mostly shallow to moderate. There is a lower potential for extreme fire behavior in this filing, but a potential for fast rates of spread in areas with grass-shrub understories and for passive crown fire in areas with ladder fuels.

In general, homes in this filing have newer, flame-resistant siding and roofs and non-burnable barriers within HIZ 1. Several homes have old wooden decks enclosed in flammable, wooden lattice. Some homes in the northern part of the filing have a high density of trees within HIZ 2. Many homes have hazards such as wooden sheds, wood piles, and other flammable material within 30 ft of the home.

Predicted wildfire exposure under extreme fire weather:

61% non-survivable roadways

43% of homes exposed to radiant heat from burning vegetation

20% of homes exposed to short-range embers from burning vegetation

100% of homes exposed to long-range embers from burning vegetation

Over half of roads in this filing could experience non-survivable conditions during wildfires. Almost all roads are accessible for Type 3 engines, but at least half of roads can only accommodate one-way traffic. Wooden street signs across the filing could burn during a wildfire and would be illegible at night or through heavy smoke.

Predicted wildfire exposure under extreme fire weather in filing 5 / Poudre Meadows:

61% non-survivable roadways

43% of homes exposed to radiant heat from burning vegetation

20% of homes exposed to short-range embers from burning vegetation

100% of homes exposed to long-range embers from burning vegetation

Recommendations for collective action in filing 5 / Poudre Meadows:

- Remove vegetation along roadways to reduce the risk of non-survivable conditions during wildfires, particularly along Muskogee Trail, Pottawatomie Trail, and Okmulkee Circle (see **Figure 3.c.1**).
- Work with neighbors to create linked defensible space, building on momentum started by several property owners in this filing who have already created defensible space on their properties. Projects that span multiple properties are more effective at reducing wildfire risk and more attractive to grant funders. Contractor costs can sometimes be shared among homeowners, reducing the cost for everyone involved. See **Section 4.c** for implementation recommendations and pictures of effective stand-scale treatments to protect communities and restore ecosystems.
- Conduct walking tours to demonstrate defensible space practices, particularly in HIZ 2. Every homeowner in filing 5 and Poudre Meadows should review and consider actions outlined in **Section 3.a. Individual Recommendations**. Even homes in the interior of this filing and neighborhood have the potential for ignition from long-range ember cast during wildfires.
- Encourage all property owners to develop evacuation plans for their family, sign up for emergency notifications from Larimer County, and coordinate with neighbors who might need additional support during evacuations.
- Replace wooden street signs with metal, reflective signs to make it easier for firefighters to locate homes through heavy smoke and at night.
- Widen roads and create pullouts to facilitate two-way traffic during emergencies.

Filing 6 – Extreme relative risk rating

Predicted wildfire exposure under extreme fire weather in filing 6:

64% non-survivable roadways

45% of homes exposed to radiant heat from burning vegetation

27% of homes exposed to short-range embers from burning vegetation

100% of homes exposed to long-range embers from burning vegetation

About half of filing 6 is on a steep southeast-facing slope with a mix of ponderosa pine and Douglas-fir overstories with occasional limber pine and aspen. Higher elevation areas have lodgepole pine and Douglas-fir forests. Some forests have low to moderate tree densities and grass and shrub understories, and others are dense and have abundant ladder fuels. There is a moderate potential for extreme fire behavior in dense forests on steep slopes on hot, dry, and windy days.

Numerous homes are located mid-slope and several on ridgetops, which increases their potential exposure to extreme fire behavior. Homes in this filing have highly varied construction material. Some have newer, flame-resistant siding and roofs and others have older, flammable siding and roofs. Several homes have old wooden decks enclosed in flammable, wooden lattice. Most homes have abundant hazards in HIZ 1 and 2, including trees and ladder fuels abutting homes. Many homes have hazards such as wood piles, propane tanks, and other flammable material within 30 ft of the home.

Over two-thirds of roads in this filing could experience non-survivable conditions during wildfires, and property owners could experience particularly long evacuation times in this filing due to the road network and distance from primary points of egress out of CLFPD. Most roads are accessible for Type 3 engines, except for several roads with tight switchbacks. Most roads can only accommodate one-way traffic. Wooden street signs across the filing could burn during a wildfire and would be illegible at night or through heavy smoke.

Recommendations for collective action in filing 6:

- Remove vegetation along roadways to reduce the risk of non-survivable conditions during wildfires, particularly along Pottawatomie Trail, Okmulkee Circle, Jicarilla Trail, and Chickasaw Court (see **Figure 3.c.1**).
- Work with neighbors to create linked defensible space. Projects that span multiple properties are more effective at reducing wildfire risk and more attractive to grant funders. Contractor costs can sometimes be shared among homeowners, reducing the cost for everyone involved. See

Section 4.c for implementation recommendations and pictures of effective stand-scale treatments to protect communities and restore ecosystems.

- Collaborate with the CLRRA Greenbelt Management Committee (GMC) to explore options for mitigating wildfire risk in Mummy View Park. Steep slopes make fuel treatments difficult in this greenbelt, making it even more important for adjacent homeowners to mitigate their properties.
- Conduct walking tours to demonstrate home hardening and defensible space practices. Include a discussion about HIZ creation around campers. Much work needs to be done around home hardening and defensible space creation in this filing. Every homeowner in filing 6 should review and consider actions outlined in **Section 3.a. Individual Recommendations**. Even homes in the interior of this filing have the potential for ignition from long-range ember cast during wildfires.
- Encourage all property owners to develop evacuation plans for their family, sign up for emergency notifications from Larimer County, and coordinate with neighbors who might need additional support during evacuations. This filing could experience especially long evacuation times, so property owners should plan to leave early during voluntary evacuation orders to avoid long evacuation times and ensure your family's safe departure during an emergency.
- Replace wooden street signs with metal, reflective signs to make it easier for firefighters to locate homes through heavy smoke and at night.
- Widen roads and create pullouts to facilitate two-way traffic during emergencies.

Filing 7 – Extreme relative risk rating

Vegetation in filing 7 is highly varied with ponderosa pine overstories and grass and shrub understories in lower elevations and dense lodgepole pine forests with occasional aspen at higher elevations. Ladder fuels are abundant in forests throughout this filing. There is a high potential for extreme fire behavior on steep southeast-facing slopes and in dense forests with abundant ladder fuels on hot, dry, and windy days.

Several homes are located mid-slope, which increases their potential exposure to extreme fire behavior. Homes in this filing have highly varied construction material. Some have newer, flame-resistant siding and roofs and others have older, flammable siding and roofs and old wooden decks. Some homes have non-burnable barriers within HIZ 1, but almost all homes have abundant hazards in HIZ 2, including tall grass, shrubs, trees, ladder fuels abutting homes. Some homes have hazards such as wood piles, wooden sheds, and other flammable material within 30 ft of the home.

Over two-thirds of roads in this filing could experience non-survivable conditions during wildfires. Some roads are accessible for Type 3 engines, but other roads and driveways are long, narrow, and have no turnarounds. Most roads can only accommodate one-way traffic. Reflective street signs are present along CR 73C, but wooden street signs along sideroads could burn during a wildfire and would be illegible at night or through heavy smoke.

Predicted wildfire exposure under extreme fire weather in filing 7:

70% non-survivable roadways

73% of homes exposed to radiant heat from burning vegetation

44% of homes exposed to short-range embers from burning vegetation

100% of homes exposed to long-range embers from burning vegetation

Recommendations for collective action in filing 7:

- Remove vegetation along roadways to reduce the risk of non-survivable conditions during wildfires, particularly along CR 73C, Tiny Bob Road, and Shawnee Road (see **Figure 3.c.1**). Treatments along CR 73C and Tiny Bob Road are called out as priority project areas for this CWPP (see **Section 4.b**).
- Work with neighbors to create linked defensible space. Projects that span multiple properties are more effective at reducing wildfire risk and more attractive to grant funders. Contractor costs can sometimes be shared among homeowners, reducing the cost for everyone involved. See **Section 4.c** for implementation recommendations and pictures of effective stand-scale treatments to protect communities and restore ecosystems.
- Speak with the USFS about the potential to coordinate treatments on private land and CLRRA greenbelts when work begins in the priority project area east of the CLFPD boundary on the Arapaho-Roosevelt National Forest (see project area in **Section 4.b**).
- Conduct walking tours to demonstrate home hardening and defensible space practices. Every homeowner in filing 7 should review and consider actions outlined in **Section 3.a. Individual Recommendations**. Even homes in the interior of this filing have the potential for ignition from long-range ember cast during wildfires.
- Encourage all property owners to develop evacuation plans for their family, sign up for emergency notifications from Larimer County, and coordinate with neighbors who might need additional support during evacuations.
- Replace wooden street signs with metal, reflective signs to make it easier for firefighters to locate homes through heavy smoke and at night.
- Widen roads and create pullouts to facilitate two-way traffic during emergencies.

Filing 8 – Extreme relative risk rating

Predicted wildfire exposure under extreme fire weather in filing 8:

77% non-survivable roadways

70% of homes exposed to radiant heat from burning vegetation

80% of homes exposed to short-range embers from burning vegetation

100% of homes exposed to long-range embers from burning vegetation

Most of filing 8 is on a moderate to steep north-facing slope with dense lodgepole pine, Douglas-fir, spruce, and occasional aspen. Ladder fuels are abundant in these dense forests. A small portion of the filing lies along Panhandle Creek and is covered in riparian meadows with willows and aspen. There is a high potential for extreme fire behavior on steep slopes in dense forests with abundant ladder fuels on hot, dry, and windy days.

Numerous homes are located mid-slope, which increases their potential exposure to extreme fire behavior. Homes in this filing have highly varied construction material. Some have newer, flame-resistant siding and roofs and others have older, flammable siding and roofs and old wooden decks. Some homes have non-burnable barriers within HIZ 1, but almost all homes have abundant hazards in HIZ 2, including trees and ladder fuels abutting homes. Some homes have hazards such as wood piles, wooden sheds, and other flammable material within 30 ft of the home.

Over three-fourths of roads in this filing could experience non-survivable conditions during wildfires. Main roads are accessible for Type 3 engines, but some sideroads and driveways are long, narrow, and have no turnarounds. Most roads can accommodate two-way traffic but have no pullovers. Wooden street signs across the filing could burn during a wildfire and would be illegible at night or through heavy smoke.

Recommendations for collective action in filing 8:

- Remove vegetation along roadways to reduce the risk of non-survivable conditions during wildfires, particularly along Ottawa Way, Shoshoni Drive, Cuna Way, and Catamount Way (see **Figure 3.c.1**). Treatments along Ottawa Way are called out as priority project areas for this CWPP (see **Section 4.b**). Retreat areas along roadways thinned in 2012 where trees are regenerating and creating ladder fuels.
- Work with neighbors to create linked defensible space, building on momentum started by several property owners in this filing who have already created defensible space on their properties.

Projects that span multiple properties are more effective at reducing wildfire risk and more attractive to grant funders. Contractor costs can sometimes be shared among homeowners, reducing the cost for everyone involved. See **Section 4.c** for implementation recommendations and pictures of effective stand-scale treatments to protect communities and restore ecosystems.

- Conduct walking tours to demonstrate home hardening and defensible space practices, particularly in HIZ 2. Include a discussion about HIZ creation around campers. Every homeowner in filing 8 should review and consider actions outlined in **Section 3.a. Individual Recommendations**. Even homes in the interior of this filing have the potential for ignition from long-range ember cast during wildfires.
- Encourage all property owners to develop evacuation plans for their family, sign up for emergency notifications from Larimer County, and coordinate with neighbors who might need additional support during evacuations.
- Replace wooden street signs with metal, reflective signs to make it easier for firefighters to locate homes through heavy smoke and at night.
- Create pullouts to facilitate emergency traffic.

Filing 9 – Moderate relative risk rating

Predicted wildfire exposure under extreme fire weather in filing 9:

67% non-survivable roadways	32% of homes exposed to short-range embers from burning vegetation
39% of homes exposed to radiant heat from burning vegetation	100% of homes exposed to long-range embers from burning vegetation

Most of filing 9 has shallow to moderate slopes and a mix of ponderosa pine forests with low to moderate tree density, aspen stands, and dense forests with ponderosa pine, Douglas-fir, and occasional limber pine. The interior of this filing contains a large meadow with grasses, forbs, and shrubs. Dense forests with ladder fuels and downed wood are most prevalent north of CR 73C, and these areas have higher potential for extreme fire behavior than other parts of the filing. There is a potential for fast rates of spread in areas with grass-shrub understories. Aspen stands could slow the spread of fire.

In general, homes are older in this filing and have flammable siding and old wooden decks. Unfortunately, many homes have older asphalt roofs that are less flame resistant than metal, composite, or new asphalt roofs. Most homes have abundant hazards in HIZ 1 and 2. Tree branches overhang roofs, pine needles are accumulated in gutters, and tall grass abut many homes. Many homes have hazards such as old wooden sheds, wood piles, and other flammable material within 30 ft of the home.

Over two-thirds of roads in this filing could experience non-survivable conditions during wildfires. Most roads are accessible for Type 3 engines but can only accommodate one-way traffic and have no pullovers. Reflective street signs are present along CR 73C, but wooden street signs along sideroads could burn during a wildfire and would be illegible at night or through heavy smoke. There were fewer homes in this filing with reflective address signs than in any other CLRRA filing.

Recommendations for collective action in filing 9:

- Remove vegetation along roadways to reduce the risk of non-survivable conditions during wildfires, particularly along Socorro Trail.
- Work with neighbors to create linked defensible space. Projects that span multiple properties are more effective at reducing wildfire risk and more attractive to grant funders. Contractor costs

can sometimes be shared among homeowners, reducing the cost for everyone involved. See **Section 4.c** for implementation recommendations and pictures of effective stand-scale treatments to protect communities and restore ecosystems.

- Conduct walking tours to demonstrate home hardening and defensible space practices. Include a discussion about HIZ creation around campers. Much work needs to be done around home hardening and defensible space creation in this filing. Every homeowner in filing 9 should review and consider actions outlined in **Section 3.a. Individual Recommendations**. Even homes in the interior of this filing have the potential for ignition from long-range ember cast during wildfires.
- Encourage all property owners to develop evacuation plans for their family, sign up for emergency notifications from Larimer County, and coordinate with neighbors who might need additional support during evacuations.
- Replace wooden street signs with metal, reflective signs to make it easier for firefighters to locate homes through heavy smoke and at night.
- Create pullouts to facilitate emergency traffic.

Filing 10 – High relative risk rating

Most of filing 10 is on a moderately steep northeast-facing slope with dense lodgepole pine and aspen and abundant ladder fuels. Some treatments have already occurred along roadways to reduce wildfire risk. There is a high potential for extreme fire behavior in dense forests with abundant ladder fuels on hot, dry, and windy days.

Numerous homes are located mid-slope, which increases their potential exposure to extreme fire behavior. In general, homes in this filing have newer, flame-resistant siding and roofs. Unfortunately, about half of homes have older asphalt roofs that are less flame resistant than metal, composite, or new asphalt roofs. Many homes have non-burnable barriers within HIZ 1, and some have adequate defensible space in HIZ 2, including linked defensible space on neighboring properties. Few homes have hazards such as old wooden sheds, wood piles, and other flammable material within 30 ft of the home.

Over two-thirds of roads in this filing could experience non-survivable conditions during wildfires. Most roads are accessible for Type 3 engines and can accommodate two-way traffic but have no pullovers. Some driveways are steep and narrow and inaccessible for Type 3 engines. Wooden street signs along sideroads could burn during a wildfire and would be illegible at night or through heavy smoke.

Predicted wildfire exposure under extreme fire weather in filing 10:	
70% non-survivable roadways	18% of homes exposed to short-range embers from burning vegetation
31% of homes exposed to radiant heat from burning vegetation	100% of homes exposed to long-range embers from burning vegetation

Recommendations for collective action in filing 10:

- Remove vegetation along roadways to reduce the risk of non-survivable conditions during wildfires, particularly along Shoshoni Drive and Catamount Way (see **Figure 3.c.1**). Retreat areas along roadways thinned in 2012 where trees are regenerating and creating ladder fuels.
- Work with neighbors to create linked defensible space, building on momentum started by several property owners in this filing who have already created defensible space on their properties. Projects that span multiple properties are more effective at reducing wildfire risk and more attractive to grant funders. Contractor costs can sometimes be shared among homeowners, reducing the cost for everyone involved. See **Section 4.c** for implementation recommendations and pictures of effective stand-scale treatments to protect communities and restore ecosystems.
- Target outreach and education campaigns to share the importance of replacing flammable roofs with noncombustible materials. Include a discussion about HIZ creation around campers. Every homeowner in filing 10 should review and consider actions outlined in **Section 3.a. Individual Recommendations**. Even homes in the interior of this filing have the potential for ignition from long-range ember cast during wildfires.
- Encourage all property owners to develop evacuation plans for their family, sign up for emergency notifications from Larimer County, and coordinate with neighbors who might need additional support during evacuations.
- Replace wooden street signs with metal, reflective signs to make it easier for firefighters to locate homes through heavy smoke and at night.
- Create pullouts to facilitate emergency traffic.

Filing 11 – High relative risk rating

Predicted wildfire exposure under extreme fire weather in filing 11:

78% non-survivable roadways

64% of homes exposed to radiant heat from burning vegetation

62% of homes exposed to short-range embers from burning vegetation

100% of homes exposed to long-range embers from burning vegetation

More than half of filing 11 is on a shallow moderately steep northwest-facing slope with variable mixes of ponderosa pine, lodgepole pine, limber pine, and aspen overstories and grass and shrub understories. Ladder fuels are present in some forests but have been removed in some treated areas, particularly around the CLRRA office. The northern part of the filing is covered in aspen, willow, and meadow along Pearl Creek. There is a moderate potential for extreme fire behavior in dense forests on hot, dry, and windy days. Grasses could support fast rates of fire spread up steep, dry slopes and shrubs could support long flame lengths that could cause overhead trees to ignite.

Most homes in this filing have newer, flame-resistant siding and roofs, but some have older, flammable siding and old wooden decks. Many homes have non-burnable barriers within HIZ 1 but abundant hazards in HIZ 2, including trees and ladder fuels abutting homes. Some homes have hazards such as wood piles, wooden sheds, and other flammable material within 30 ft of the home.

Over three-fourths of roads in this filing could experience non-survivable conditions during wildfires. Almost all roads are accessible for Type 3 engines and can accommodate two-way traffic, but there are few pullovers. Reflective street signs are present along CR 73C, but wooden street signs along sideroads could burn during a wildfire and would be illegible at night or through heavy smoke.

Recommendations for collective action in filing 11:

- Remove vegetation along roadways to reduce the risk of non-survivable conditions during wildfires, particularly along CR 73C and Huron Road (see **Figure 3.c.1**). Treatments along CR 73C are called out as priority project areas for this CWPP (see **Section 4.b**).
- Work with neighbors to create linked defensible space. Projects that span multiple properties are more effective at reducing wildfire risk and more attractive to grant funders. Contractor costs can sometimes be shared among homeowners, reducing the cost for everyone involved. See

Section 4.c for implementation recommendations and pictures of effective stand-scale treatments to protect communities and restore ecosystems.

- Conduct walking tours to demonstrate home hardening and defensible space practices, particularly in HIZ 2. Include a discussion about HIZ creation around campers. Every homeowner in filing 11 should review and consider actions outlined in **Section 3.a. Individual Recommendations**. Even homes in the interior of this filing have the potential for ignition from long-range ember cast during wildfires.
- Encourage all property owners to develop evacuation plans for their family, sign up for emergency notifications from Larimer County, and coordinate with neighbors who might need additional support during evacuations.
- Replace wooden street signs with metal, reflective signs to make it easier for firefighters to locate homes through heavy smoke and at night.
- Create pullouts to facilitate two-way traffic during emergencies.

Filing 12 – Extreme relative risk rating

Predicted wildfire exposure under extreme fire weather in filing 12:

73% non-survivable roadways	61% of homes exposed to short-range embers from burning vegetation
57% of homes exposed to radiant heat from burning vegetation	100% of homes exposed to long-range embers from burning vegetation

Filing 12 spans from steep south-facing slope in the north to a riparian corridor with willow, aspen, and blue spruce along Panhandle Creek to steep north-facing slopes in the south. There are numerous valleys throughout the filing creating complex topography that can exacerbate fire behavior. The western part of the filing was burned in the 1980 Bear Trap Fire and is covered in thick, regenerating lodgepole pine. Other parts of the unit have older, taller lodgepole pine forests with scattered ponderosa pine, Engelmann spruce, aspen and numerous beetle-killed pines. The community and property owners have invested in some fuel treatments along roadways, in greenbelts, and around homes, and this work should continue. There is a high potential for extreme fire behavior in dense, untreated forests on hot, dry, and windy days.

Numerous homes are located mid-slope, which increases their potential exposure to extreme fire behavior. Most homes in this filing have newer, flame-resistant siding but older asphalt or cedar shake roofs that are less flame resistant than metal, composite, or new asphalt roofs. There are numerous campers on lots within this filing that do not have adequate mitigation of hazards under and around the camper. Some homes have non-burnable barriers within HIZ 1, but almost all homes have abundant hazards in HIZ 2, including trees and ladder fuels abutting homes. Some homes have hazards such as wood piles, wooden sheds, and other flammable material within 30 ft of the home.

Almost three-fourths of roads in this filing could experience non-survivable conditions during wildfires. Main roads are accessible for Type 3 engines, but many driveways are long, narrow, and have no turnarounds. Main roads can accommodate two-way traffic but have no pullovers. Wooden street signs across the filing could burn during a wildfire and would be illegible at night or through heavy smoke.

Recommendations for collective action in filing 12:

- Remove vegetation along roadways to reduce the risk of non-survivable conditions during wildfires, particularly along Ottawa Way, Mescalero Drive, Catamount Way, and Shoshoni Drive (see **Figure 3.c.1**). Treatments along Ottawa Way and Mescalero Drive are called out as priority project areas for this CWPP (see **Section 4.b**).
- Work with neighbors to create linked defensible space, building off existing treatments along roadways and on private land in this filing and planned treatments in CLRRA greenbelts under the current FEMA grant (see project area in **Section 4.b**). Projects that span multiple properties are more effective at reducing wildfire risk and more attractive to grant funders. Contractor costs can sometimes be shared among homeowners, reducing the cost for everyone involved. See **Section 4.c** for implementation recommendations and pictures of effective stand-scale treatments to protect communities and restore ecosystems.
- Speak with the USFS about the potential to coordinate treatments on private land and CLRRA greenbelts when work begins in the priority project area west of the CLFPD boundary on the Arapaho-Roosevelt National Forest (see project area in **Section 4.b**).
- Target outreach and education campaigns to share the importance of replacing flammable roofs with noncombustible materials and for creating defensible space around campers. Every homeowner in filing 12 should review and consider actions outlined in **Section 3.a. Individual Recommendations**. Even homes in the interior of this filing have the potential for ignition from long-range ember cast during wildfires.
- Encourage all property owners to develop evacuation plans for their family, sign up for emergency notifications from Larimer County, and coordinate with neighbors who might need additional support during evacuations.
- Replace wooden street signs with metal, reflective signs to make it easier for firefighters to locate homes through heavy smoke and at night.
- Create pullouts to facilitate emergency traffic.

Filing 13 – High relative risk rating

Filing 13 is located on a south-facing slope with a steep valley in the center of the unit that could funnel wind and create extreme wildfire behavior. Forests at lower elevations have ponderosa pine and aspen overstories and grass and shrub understories. Most of the unit is dense lodgepole pine forests with few ladder fuels. The community and property owners have invested in some fuel treatments along roadways, in greenbelts, and around homes, and this work should continue. There is a high potential for extreme fire behavior in dense, untreated forests on steep slopes on hot, dry, and windy days.

Despite the high potential for extreme fire danger, the overall relative risk rating is "high" for filing 13 because of adequate home hardening and fuel mitigation in HIZ 1 and HIZ 2 for many homes. Non-burnable areas have been created around the base of many homes, and small trees have been thinned out and limbed. Only a handful of homes have hazards such as wood piles, wooden sheds, and other flammable material within 30 ft of the home.

Almost three-fourths of roads in this filing could experience non-survivable conditions during wildfires. Main roads are accessible for Type 3 engines, but many driveways are long, narrow, and have no turnarounds. Main roads can accommodate two-way traffic but have no pullovers. Wooden street signs across the filing could burn during a wildfire and would be illegible at night or through heavy smoke.

Predicted wildfire exposure under extreme fire weather in filing 13:

70% non-survivable roadways

63% of homes exposed to radiant heat from burning vegetation

54% of homes exposed to short-range embers from burning vegetation

100% of homes exposed to long-range embers from burning vegetation

Recommendations for collective action in filing 13:

- Remove vegetation along roadways to reduce the risk of non-survivable conditions during wildfires, particularly along Osage Trail (see **Figure 3.c.1**).
- Work with neighbors to create linked defensible space, building off existing treatments along roadways and on private land in this filing and planned treatments in CLRRA greenbelts under the current FEMA grant (see project area in **Section 4.b**). Projects that span multiple properties are more effective at reducing wildfire risk and more attractive to grant funders. Contractor costs can sometimes be shared among homeowners, reducing the cost for everyone involved. See **Section 4.c** for implementation recommendations and pictures of effective stand-scale treatments to protect communities and restore ecosystems.
- Conduct walking tours to demonstrate defensible space practices around campers. Every homeowner in filing 13 should review and consider actions outlined in **Section 3.a. Individual Recommendations**. Even homes in the interior of this filing have the potential for ignition from long-range ember cast during wildfires.
- Encourage all property owners to develop evacuation plans for their family, sign up for emergency notifications from Larimer County, and coordinate with neighbors who might need additional support during evacuations.
- Replace wooden street signs with metal, reflective signs to make it easier for firefighters to locate homes through heavy smoke and at night.
- Create pullouts to facilitate emergency traffic.

Filing 14 – High relative risk rating

Predicted wildfire exposure under extreme fire weather in filing 14:	
78% non-survivable roadways	35% of homes exposed to short-range embers from burning vegetation
72% of homes exposed to radiant heat from burning vegetation	100% of homes exposed to long-range embers from burning vegetation

Most of filing 14 has shallow to moderate slopes and a mix of ponderosa pine forests with moderate to high tree density, aspen stands, and dense forests with ponderosa pine, Douglas-fir, and occasional limber pine. The interior of this filing contains a large meadow with grasses, forbs, and shrubs. Dense forests with ladder fuels and downed wood have higher potential for extreme fire behavior than other parts of the filing. There is a potential for fast rates of spread in areas with grass-shrub understories and passive crown fire. Aspen stands could slow the spread of fire.

In general, homes are older in this filing and have flammable siding and old wooden decks. Many homes have metal or new asphalt roofs. Unfortunately, most homes have abundant hazards in HIZ 1 and 2. Tree branches overhang roofs, pine needles are accumulated in gutters, and tall grass, trees, and shrubs abut many homes. Many homes have hazards such as old wooden sheds, wood piles, and other flammable material within 30 ft of the home.

Over two-thirds of roads in this filing could experience non-survivable conditions during wildfires. Almost all roads are accessible for Type 3 engines, but at least half of roads can only accommodate one-way traffic. Reflective street signs are present along CR 73C, but wooden street signs along sideroads could burn during a wildfire and would be illegible at night or through heavy smoke.

Recommendations for collective action in filing 14:

- Remove vegetation along roadways to reduce the risk of non-survivable conditions during wildfires, particularly along CR 73C, Socorro Trail, Voto Way, Yuki Drive, Menominee Circle, and Tesoque Trail (see **Figure 3.c.1**). Treatments along CR 73C are called out as priority project areas for this CWPP (see **Section 4.b**).
- Work with neighbors to create linked defensible space. Projects that span multiple properties are more effective at reducing wildfire risk and more attractive to grant funders. Contractor costs can sometimes be shared among homeowners, reducing the cost for everyone involved. See **Section 4.c** for implementation recommendations and pictures of effective stand-scale treatments to protect communities and restore ecosystems.
- Conduct walking tours to demonstrate home hardening and defensible space practices. Include a discussion about HIZ creation around campers. Much work needs to be done around home hardening and defensible space creation in this filing. Every homeowner in filing 14 should review and consider actions outlined in **Section 3.a. Individual Recommendations**. Even homes in the interior of this filing have the potential for ignition from long-range ember cast during wildfires.
- Encourage all property owners to develop evacuation plans for their family, sign up for emergency notifications from Larimer County, and coordinate with neighbors who might need additional support during evacuations.
- Replace wooden street signs with metal, reflective signs to make it easier for firefighters to locate homes through heavy smoke and at night.
- Widen roads and create pullouts to facilitate two-way traffic during emergencies.

Filing 15 – Extreme relative risk rating

Much of filing 15 is on a steep north-facing slope with numerous valleys creating complex topography that can exacerbate fire behavior. The northwestern part of the filing was burned in the 1980 Bear Trap Fire and is covered in thick, regenerating lodgepole pine. Other parts of the unit have older, taller lodgepole pine forests with scattered ponderosa pine, Engelmann spruce, aspen and numerous beetle-killed pines. The community and property owners have invested in some fuel treatments along roadways, in greenbelts, and around homes, and this work should continue. There is a high potential for extreme fire behavior in dense, untreated forests on hot, dry, and windy days.

Numerous homes are located mid-slope and several on ridgetops, which increases their potential exposure to extreme fire behavior. Most homes in this filing have newer, flame-resistant siding and roofs. There are several campers on lots within this filing that do not have adequate mitigation of hazards under and around the camper. Some homes have non-burnable barriers within HIZ 1, but almost all homes have abundant hazards in HIZ 2, including trees and ladder fuels abutting homes. Some homes have hazards such as wood piles, wooden sheds, and other flammable material within 30 ft of the home.

Over three-fourths of roads in this filing could experience non-survivable conditions during wildfires, and property owners could experience particularly long evacuation times in this filing due to the road network and distance from primary points of egress out of CLFPD. Main roads are accessible for Type 3 engines, but many driveways are long, narrow, and have no turnarounds. Main roads can accommodate two-way traffic but have no pullovers. Wooden street signs across the filing could burn during a wildfire and would be illegible at night or through heavy smoke.

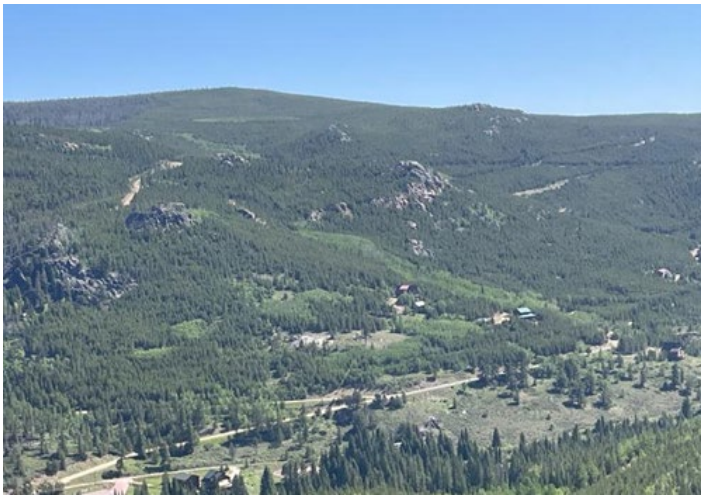
Predicted wildfire exposure under extreme fire weather in filing 15:

83% non-survivable roadways	49% of homes exposed to short-range embers from burning vegetation
60% of homes exposed to radiant heat from burning vegetation	100% of homes exposed to long-range embers from burning vegetation

Recommendations for collective action in filing 15:

- Remove vegetation along roadways to reduce the risk of non-survivable conditions during wildfires, particularly along Ottawa Way, Mosquito Drive, and Shoshoni Drive (see **Figure 3.c.1**). Treatments along Ottawa Way and Mosquito Drive are called out as priority project areas for this CWPP (see **Section 4.b**). Retreat areas along roadways thinned in 2012 where trees are regenerating and creating ladder fuels.
- Ensure grass is mowed and regenerating trees are cleared from around the camper / RV / trailer staging area in this filing.
- Work with neighbors to create linked defensible space, building off existing treatments along roadways and on private land in this filing and planned treatments in CLRRA greenbelts under the current FEMA grant (see project area in **Section 4.b**). Projects that span multiple properties are more effective at reducing wildfire risk and more attractive to grant funders. Contractor costs can sometimes be shared among homeowners, reducing the cost for everyone involved. See **Section 4.c** for implementation recommendations and pictures of effective stand-scale treatments to protect communities and restore ecosystems.
- Speak with the USFS about the potential to coordinate treatments on private land and CLRRA greenbelts when work begins in the priority project area west of the CLFPD boundary on the Arapaho-Roosevelt National Forest (see project area in **Section 4.b**).
- Conduct walking tours to demonstrate defensible space practices, particularly in HIZ 2 and around campers. Every homeowner in filing 15 should review and consider actions outlined in **Section 3.a. Individual Recommendations**. Even homes in the interior of this filing have the potential for ignition from long-range ember cast during wildfires.
- Encourage all property owners to develop evacuation plans for their family, sign up for emergency notifications from Larimer County, and coordinate with neighbors who might need additional support during evacuations. This filing could experience especially long evacuation times, so property owners should plan to leave early during voluntary evacuation orders to avoid long evacuation times and ensure your family's safe departure during an emergency.
- Replace wooden street signs with metal, reflective signs to make it easier for firefighters to locate homes through heavy smoke and at night.
- Create pullouts to facilitate emergency traffic.

Elkridge Ranches – High relative risk rating



Predicted wildfire exposure under extreme fire weather in Elkridge Ranches:

69% non-survivable roadways

33% of homes exposed to radiant heat from burning vegetation

56% of homes exposed to short-range embers from burning vegetation

100% of homes exposed to long-range embers from burning vegetation

Elkridge Ranches is located on a steep south-facing slope. Most of the unit is dense lodgepole pine forests with occasional aspen and Engelmann spruce. Much of the western part of this neighborhood was burned in the 1980 Bear Trap Fire and is covered in thick, regenerating lodgepole pine. Less dense forests at lower elevations have grass, forb, and shrub understories, and those at higher elevations have few ladder fuels. There is a high potential for extreme fire behavior in dense forests on steep slopes on hot, dry, and windy days.

Despite the high potential for extreme fire danger, the overall relative risk rating is "high" for Elkridge Ranches because of adequate home hardening and fuel mitigation in HIZ 1 and HIZ 2 for many homes. Non-burnable areas have been created around the base of most homes and campers, and small trees have been thinned out and limbed. Several homes have hazards such as wood piles, wooden sheds, and other flammable material within 30 ft of the home.

Almost three-fourths of roads in this filing could experience non-survivable conditions during wildfires, and property owners could experience particularly long evacuation times in this filing due to the road network and distance from primary points of egress out of CLFPD. Some roads are accessible for Type 3 engines, but the eastern half of the unit is inaccessible. Most roads can only accommodate one-way traffic and have no pullovers. Many driveways are long, narrow, and have no turnarounds. Wooden street signs across the filing could burn during a wildfire and would be illegible at night or through heavy smoke.

Recommendations for collective action in Elkridge Ranches:

- Remove vegetation along roadways to reduce the risk of non-survivable conditions during wildfires, particularly along Elkridge Road (see **Figure 3.c.1**).
- Speak with the USFS about the potential to coordinate treatments on private land when work begins in the priority project area north of the CLFPD boundary on the Arapaho-Roosevelt National Forest (see project area in **Section 4.b**).
- Work with neighbors to create linked defensible space. Projects that span multiple properties are more effective at reducing wildfire risk and more attractive to grant funders. Contractor costs can sometimes be shared among homeowners, reducing the cost for everyone involved. See **Section 4.c** for implementation recommendations and pictures of effective stand-scale treatments to protect communities and restore ecosystems.
- Every homeowner in Elkridge Ranches should review and consider actions outlined in **Section 3.a. Individual Recommendations**. Even homes in the interior of this neighborhood have the potential for ignition from long-range ember cast during wildfires.
- Encourage all property owners to develop evacuation plans for their family, sign up for emergency notifications from Larimer County, and coordinate with neighbors who might need additional support during evacuations. This neighborhood could experience especially long evacuation times, so property owners should plan to leave early during voluntary evacuation orders to avoid long evacuation times and ensure your family's safe departure during an emergency.
- Replace wooden street signs with metal, reflective signs to make it easier for firefighters to locate homes through heavy smoke and at night.
- Create pullouts to facilitate emergency traffic.

Pearl Creek Estates – Moderate relative risk rating

Predicted wildfire exposure under extreme fire weather in Pearl Creek Estates:

43% non-survivable roadways

24% of homes exposed to radiant heat from burning vegetation

32% of homes exposed to short-range embers from burning vegetation

100% of homes exposed to long-range embers from burning vegetation

Most of Pearl Creek Estates is on moderate to steep south-facing slope with lodgepole pine and aspen overstories. Some stands have moderate tree densities but abundant regeneration that can serve as ladder fuels. Lower elevation forests have variable mixes of ponderosa pine, lodgepole pine, Douglas-fir limber pine, and aspen overstories with grass understories. The southern part of the neighborhood is a riparian area along Pearl Creek with willows and aspen. Fire risk is generally lower in this neighborhood than other parts of the CLFPD.

Most homes in this neighborhood have newer, flame-resistant siding and roofs and non-burnable barriers within HIZ 1. Several homes have abundant hazards in HIZ 2, particularly lodgepole pine regeneration that could act as a ladder fuel. Few homes have hazards such as wood piles, wooden sheds, and other flammable material within 30 ft of the home.

Less than half of roads in this filing could experience non-survivable conditions during wildfires. Almost all roads are accessible for Type 3 engines and can accommodate two-way traffic. Wooden street signs along sideroads could burn during a wildfire and would be illegible at night or through heavy smoke. Very few if any homes have reflective address signs.

Recommendations for collective action in Pearl Creek Estates:

- Remove vegetation along roadways to reduce the risk of non-survivable conditions during wildfires, particularly along Huron Road and Mosquito Drive (see **Figure 3.c.1**). Retreat areas along roadways thinned in 2012 where trees are regenerating and creating ladder fuels.
- Work with neighbors to create linked defensible space, building off existing treatments along roadways in this neighborhood. Projects that span multiple properties are more effective at reducing wildfire risk and more attractive to grant funders. Contractor costs can sometimes be shared among homeowners, reducing the cost for everyone involved. See **Section 4.c** for

implementation recommendations and pictures of effective stand-scale treatments to protect communities and restore ecosystems.

- Conduct walking tours to demonstrate defensible space practices, particularly in HIZ 2. Every homeowner in Pearl Creek Estates should review and consider actions outlined in **Section 3.a. Individual Recommendations**. Even homes in the interior of this neighborhood have the potential for ignition from long-range ember cast during wildfires.
- Encourage all property owners to develop evacuation plans for their family, sign up for emergency notifications from Larimer County, and coordinate with neighbors who might need additional support during evacuations.
- Replace wooden street signs with metal, reflective signs to make it easier for firefighters to locate homes through heavy smoke and at night.

3.c. Community-Wide Recommendations

Slash Management Recommendations

CLFPD and CLRRA should review and revise their slash management strategy. Property owners in CLFPD have experienced difficulties with slash management, like many other communities in Colorado. During the community engagement process for this CWPP, property owners shared that access to inexpensive/easy means of slash disposal would help enable them to do more work to reduce wildfire risk on their property (**Figure 3.c.1**). CLRRA currently operates a community slash depot, but property owners must pay to drop off slash, and the current site is not equipped to handle the volume of slash that will be created by implementing the recommendations outlined in this CWPP.

CLRRA should consider making the slash disposal site free, or available at a reduced cost, to property owners and nearby neighbors. Providing a program that will pick up the slash material and bring it to the slash disposal site will also reduce barriers for property owners to complete mitigation work thoroughly. This program could be either hosted by the CLRRA slash depot or by neighbor-to-neighbor mutual aid. These programs could be funded by grants, such as the Community Wildfire Defense Grant, that will become available to the community upon the completion of this CWPP.

Pile burning is permitted in Larimer County within certain parameters, but property owners within CLRRA cannot burn slash piles on their property due to community regulations. The association should review this current policy and consider tradeoffs to different slash management options. Pile burning is the most feasible and effective method to eliminate slash in some instances (see **Section 4.e. Approaches to Slash Management**). Pile burning is appropriate on larger acreage parcels where piles can be burned at least 50 ft away from the nearest structure. In subdivisions made up of small parcels where homes are densely packed together, alternative slash management methods should be pursued. It is understandable for CLRRA leadership and property owners to have some reservations about allowing property owners to pile burn; however, 90% of property owners who responded to the CWPP survey support or highly support pile burning to mitigate wildfire risk, and 83% support or highly support broadcast prescribed burning (**Figure 3.c.2**). Property owners expressed concerns about prescribed burning being conducted near homes and on windy days, so community-wide conversations are necessary to determine when, how, and if pile burning should be allowed on private land.

Pile burning can be safely conducted under certain weather conditions and with adequate training. The Colorado Division of Fire Prevention and Control (DFPC) offers a certified burner program to ensure that individuals are knowledgeable and capable of safely planning and conducting pile burns. According to DFPC, "By training and certifying private entities to plan and implement prescribed fire in a more systematic and educated manner, similar to that required by policy for natural resource and fire management agencies at all levels of government, the end result would be to promote the relatively safe and efficient use of fire as a management tool regardless of land ownership. The program is also designed to provide some level of civil liability protection for those trained and certified entities." The Ember Alliance also hosts pile burn workshops to provide further hands-on experience and training to Colorado property owners.

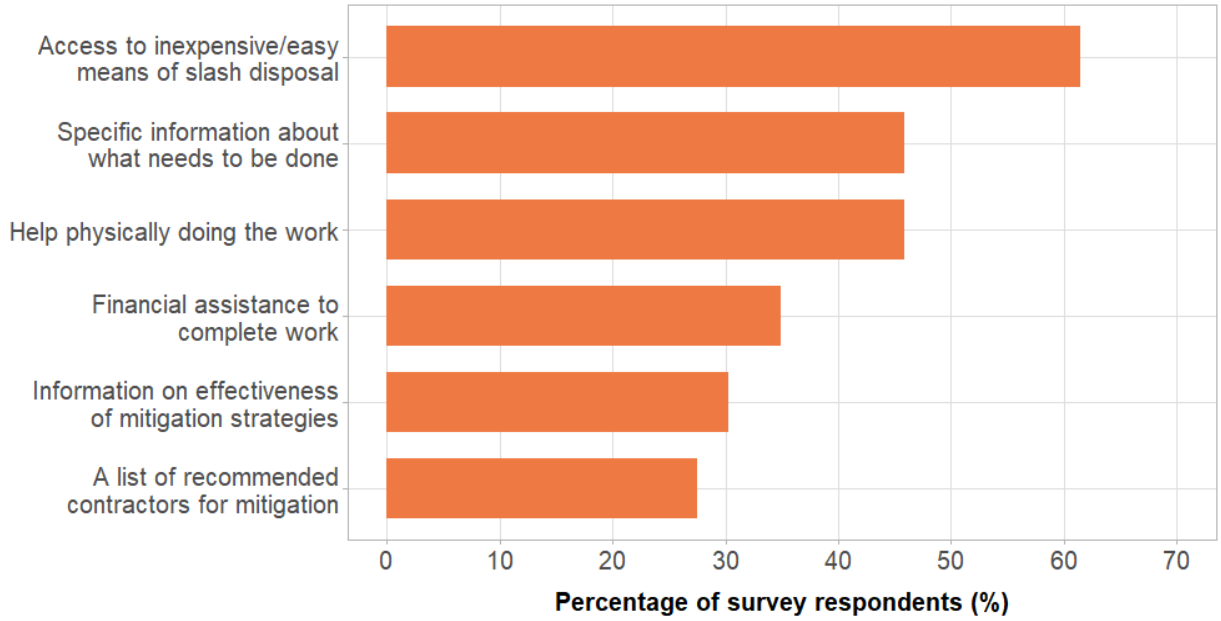


Figure 3.c.1*. Property owner survey responses to the question "Which of the following would encourage and enable you to reduce the wildfire risk on your property?" 61% requested easier slash disposal.*

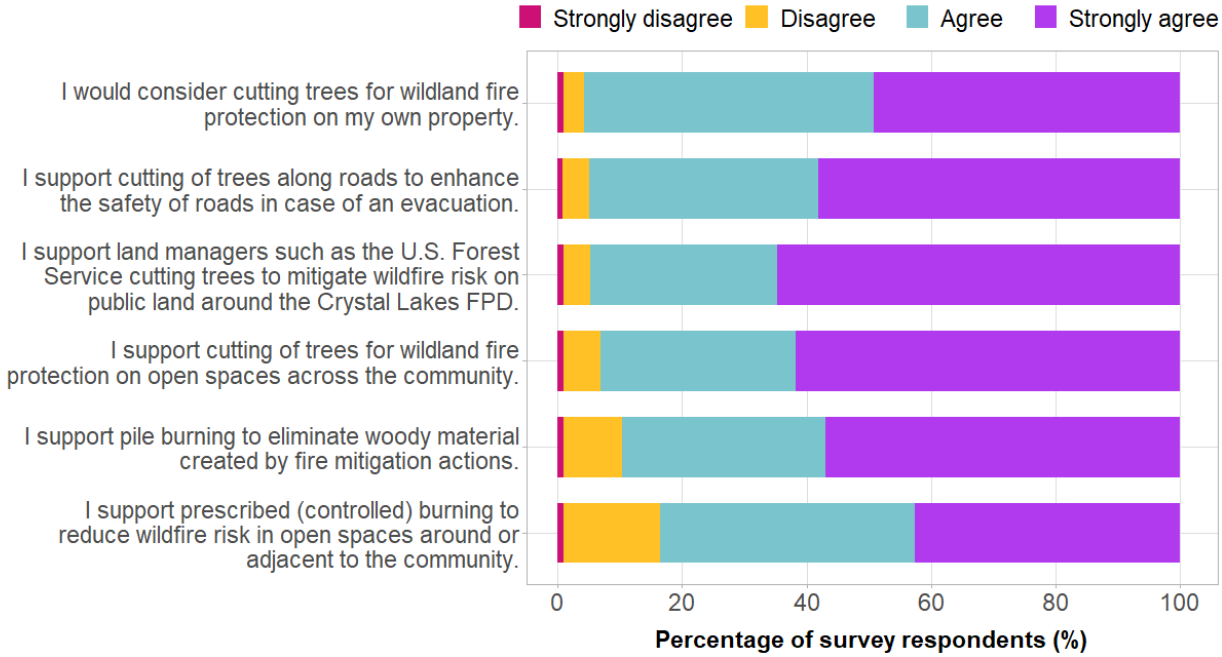


Figure 3.c.2*. Property owner survey responses to the question "Please read each statement and select the degree to which you agree or disagree with it?" 90% of property owners who responded to the CWPP survey support or highly support pile burning to mitigate wildfire risk.*

WUI Building Regulations

We recommend that CLRRA adopt the International Wildland Urban Interface Code to support home hardening. Consider amending of the code recommendations to match current research recommendations (Maranghides et al., 2022):

- Home and structure setbacks should be structure-centric, not parcel-centric. Cross-boundary structure separation should always be a consideration.
- Existing high-density housing areas should prioritize home hardening as opposed to defensible space.
- New high-density developments should have complete defensible space and buildings that are extremely resistant to ignition. They should have CLRRA or other forms of financial and regulatory collaboration set up to maintain community wildfire protection.
- Combustible fences should not be double-wide or placed less than 3 feet apart in parallel.

Evacuation Planning and Capacity

There is a high likelihood of evacuation congestion and long evacuation times during a wildfire in the CLFPD. Evacuation times for individual property owners could exceed 3 to 5 hours in some parts of the CLFPD if the Sheriff's Office were to order a simultaneous, mandatory evacuation order for the district and surrounding communities during a wildfire emergency. Potential for extreme evacuation congestion is due to the high density of homes and limited number of egress routes.

Many roads throughout the community are narrow and lined with dense vegetation that could create non-survivable conditions during wildfires (**Figure 3.c.3**). Under extreme fire weather conditions, over two-thirds of roadways in the CLFPD could experience non-survivable conditions (**Figure 2.f.3**). **Mitigation actions along sections of road with high risk for non-survivable conditions during a wildfire can increase the chances of survival for property owners stranded in their vehicles during a wildfire and decrease the chance that roadways become impassable due to flames.**

Reliable technology to provide warnings and information about evacuations can help property owners feel confident in their ability to evacuate during a wildfire. The Larimer Emergency Telephone Authority (LETA-911) uses NOCO Alert, also known as reverse 911, to communicate evacuation orders to property owners. CLRRA and property owners should actively extend awareness about NOCO Alert to neighbors that are unaware of the program.

CLRRA has placed six warning sirens across the community to warn for wildfire or flooding. There is an alert sound for wildfire and a whoop sound for flooding, both of which can be heard on CLRRA's website.

NOCO Alert is the reverse 911 system used by LETA-911 to contact property owners during emergencies, including during wildfire evacuations. Property ownerial landlines are automatically registered unless their phone uses VoIP (voice-over internet protocol). Property owners can register their cell phones and email addresses on the NOCO Alert website.

We recommend the following steps for property owners, CLRRA, CLFPD, and the Larimer County Sherriff's Office to address evacuation concerns in the CLFPD:

- Conduct tree removal, cut low limbs, and mow grass along roadways to increase the likelihood of survivable conditions during a wildfire. Prioritize the roads with the most traffic and congestion and work out to the less congested roads (**Figure 3.c.2**). See **Section 4.c Logistics of Ecological Restoration and Fuel Treatments** for recommended approaches to reduce wildfire risk along roadways.

- Consider creating pullouts and turnarounds on narrow roads throughout the community to facilitate two-way traffic during evacuations and accommodate fire engines.
- Coordinate with the Larimer County Sherriff's Office to conduct evacuation drills to practice safe and effective evacuation for the entire CLFPD.
- Continue conversations about evacuation planning for the community, including alternative evacuation routes. Specifically, property owners have expressed concerns about the lack of evacuation routes to the north of Crystal Lakes
- Coordinate with LETA-911 to increase participation in NOCO Alert across the CLFPD. Fortunately, 90% of respondents to the CWPP survey indicated that they have signed up for NOCO Alert, but this number should ideally be 100%.
- Regularly test the LETA-911 system to ensure timely and accurate communication could occur during an evacuation.
- Regularly test the CLRRA sirens to ensure they are in functioning order.
- Educate property owners about warning systems, protocols for evacuation orders, and evacuation etiquette prior to the need to evacuate the community. Communicate the importance of following evacuation orders; **failing to leave the community in a timely manner during a wildfire emergency can put first responders at risk.**

CLRRA has six warning sirens across the community to provide emergency alerts for wildfires or floods. Photo credit: The Ember Alliance.

- Encourage property owners to leave with only one vehicle per household to reduce congestion for everyone.
- Encourage all households to develop family evacuation plans and to pack go-bags that are at the ready. Unfortunately, only 53% of respondents to the CWPP survey have evacuation plans for their family and only 38% have go-bags at the ready.
- Encourage property owners to work with their neighbors to develop a plan for helping each other with evacuation if a property owner is not at home, school-aged children or pets might be home alone, or property owners have mobility impairments and need special assistance.
- Encourage property owners who have more animals than can fit in a trailer to develop a plan. Communicate that they might not be able to re-enter the area to take multiple trips if evacuations have been ordered. Coordinate with local animal control or other animal organizations to plan for assistance during an evacuation, including help with trailers and setting up animal care facilities
- Encourage property owners to evacuate whenever they feel unsafe, even before receiving mandatory evacuation orders. All property owners should leave promptly when they receive a mandatory evacuation order. This means having a family emergency plan already in place and having go- bags prepacked.

- Make sure warnings and alerts can be understood by all property owners, including those with English as a second language and with hearing impairments.

Survivable Roadways	Potentially Non-Survivable Roadways
	
	

Figure 3.c.3*. Some roads in the CLFPD have been well mitigated by removing tall trees and saplings, removing limbs on the remaining trees, and keeping grass mowed (left images). Other roads could experience potentially non-survivable conditions because they are lined by thick forests that have an abundance of ladder fuels (right images). Photo credit: The Ember Alliance.*

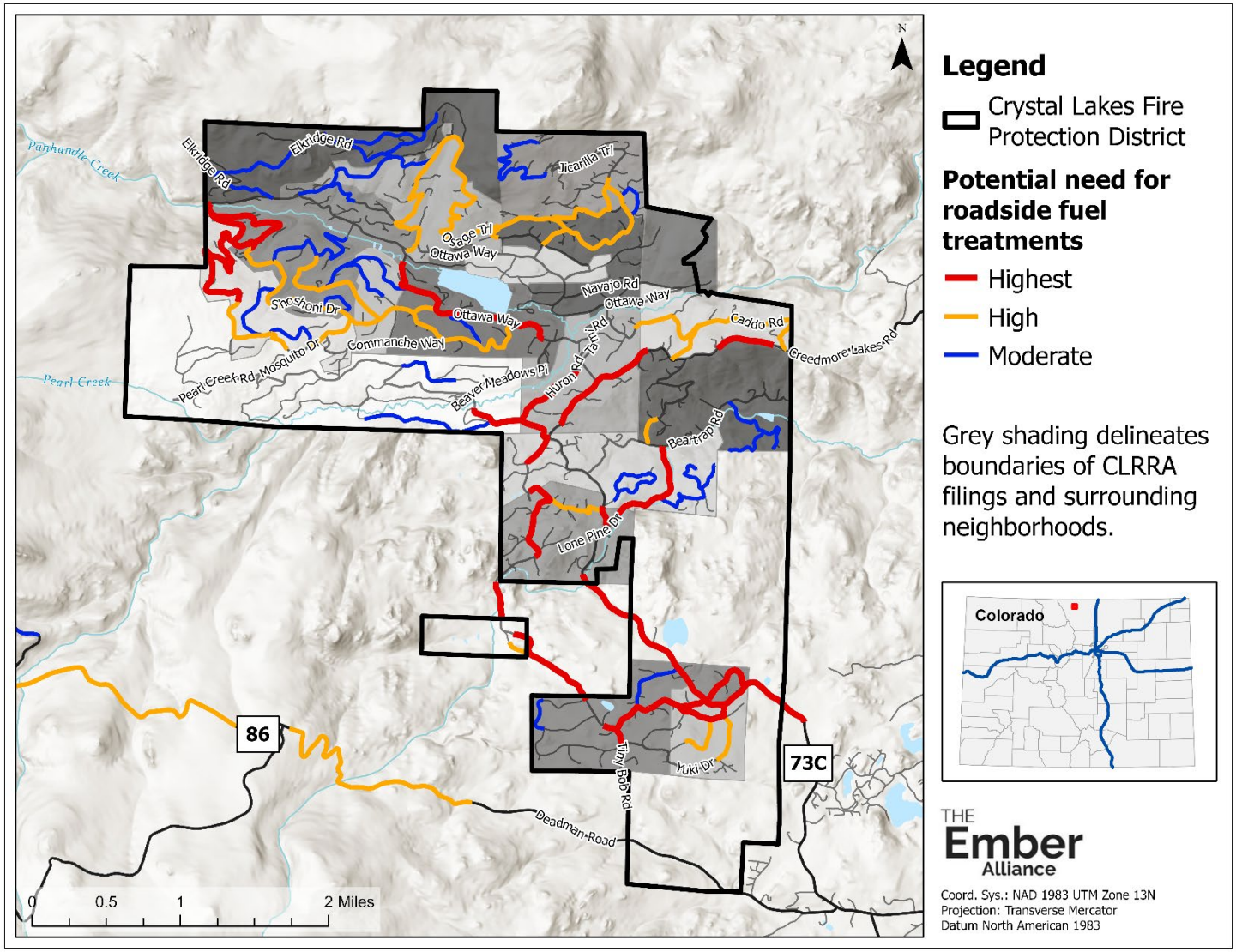


Figure 3.c.4*. Potential need for roadside fuel treatments based on the potential for wildfire to create non-survivable conditions along roadways and the potential for congestion during evacuations (methodology provided in* ***Appendix B****). See* ***Section 4.c Logistics of Ecological Restoration and Fuel Treatments*** *for recommended approaches to reduce wildfire risk along roadways.*

Accessibility and Navigability for Firefighters

Shared Driveways and Community Roads

Property owners, CLRRA, CLFPD, and Larimer County can work together to ensure emergency responders can locate and access everyone's home. Narrow roads without turnarounds, tree limbs hanging over the road, and lots of dead and down trees by the road may make firefighters choose to not defend your home during a wildfire event (Brown, 1994). Of particular concern in the CLRRA community are wooden street signs that could burn during a wildfire and would be illegible at night or through heavy smoke. This would create unsafe conditions for firefighters and impact their ability to navigate around this community. It is highly recommended to replace these wooden signs with metal reflective ones.

Where feasible, CLRRA should improve roadway access by widening road networks in filings with narrow roads and creating turnarounds and pullovers to accommodate fire engines and two-way traffic during evacuation. The community can apply for grants and work with the Larimer County Sheriff's Office to remove trees from along roads to reduce the chance of non-survivable conditions occurring during wildfires. Property owners can remove trees along driveways and prune low-hanging branches to increase horizontal and vertical clearance. According to the National Fire Protection Association, driveways and roads should have a minimum of 20 feet of horizontal clearance and 13.5 feet of vertical clearance to allow engines to safely access the roads (O'Connor, 2021).

Widening roads and removing fuels along roadways can be time-consuming and expensive, but this work is vital for the safety of property owners and first responders. Property owners, leaders in the CLRRA, and county agencies can work together to share costs and apply for grants to facilitate this important work.

Metal, reflective street signs (left) are visible to wildland firefighters under heavy smoke and at night. Wooden road signs (right) can burn and are difficult to see, making it less safe for firefighters navigating your community. Photo credit: The Ember Alliance.

3.d. Outreach and Education

CLFPD should continue to engage with community members using a variety of methods, including community ambassadors, social media, and education materials for visitors of resorts and short-term rentals. The following priority recommendations may fall to different entities or partners within and around the CLFPD.

As your community makes progress on the top-priority actions outlined below, refer to the fire adapted communities' "wheel" (**Figure 3.1**) and seek additional ideas and resources from the Fire Adapted Community Learning Network and Fire Adapted Colorado (FACO). Visit their websites for more information on their programs and upcoming events.

Wildfire Mitigation Specialist

One-on-one home assessments are an important way to help property owners identify specific actions they need to take to reduce wildfire risk. More than half of survey respondents in CLRRA said they would participate in one-on-one home hazard assessments (**Figure 3.d.1**). CLFPD currently provides home-specific assessments (see the CLFPD community page on their website for more information), but they could use additional capacity to offer this service to more property owners.

One option for increasing CLFPD's capacity to work with individual property owners is to create a shared Wildfire Mitigation Specialist position with neighboring fire protection districts, including Red Feather and Glacier View. The goal of this position would be to connect the fire district to property owners and share the professional knowledge on mitigation at no cost to them. Wildfire mitigation specialists can work with property owners to identify their specific risks, prioritize tasks to reduce risk, and share resources. They can also follow up with property owners regularly, work with the CLRRA and agency partners on shared land mitigation and facilitate discussions between neighbors on shared/linked defensible space where needed. Upon the completion of this CWPP, funding may be available to support a shared Wildfire Mitigation Specialist position through the Community Wildfire Defense Grant or another funding source.

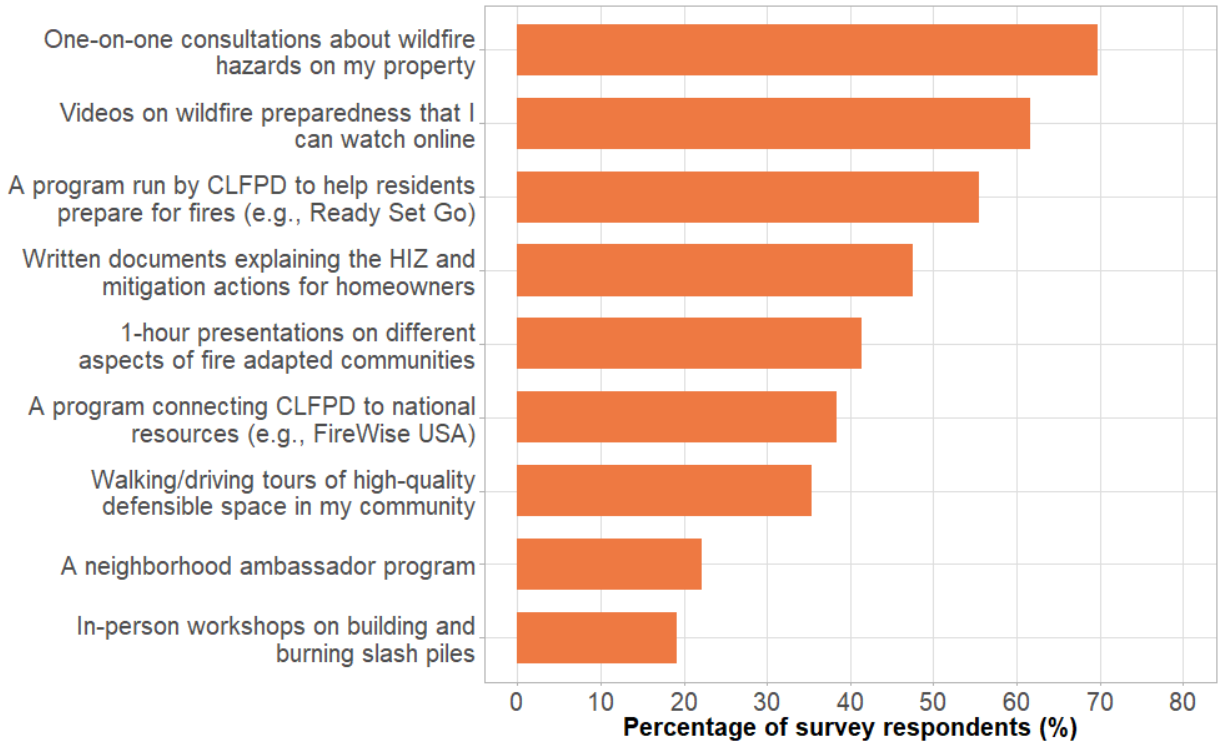


Figure 3.d.1*. Community survey responses to the question "Which of the following educational opportunities would you participate in to learn about wildfire risk mitigation and emergency preparedness?". See* ***Appendix C*** *for a full summary of survey findings.*

Neighborhood Ambassador Program

This CWPP can only result in on-the-ground change if property owners and community groups work with forestry professionals such as the Colorado State Forest Service and Larimer Conservation District to address shared risk. Creating and supporting a **Neighborhood Ambassador Program** could help property owners better understand wildfire risks and spark coordinated action that effects positive change in the CLFPD. The neighborhood ambassador approach requires engaged volunteer ambassadors and a dedicated lead coordinator, potentially one leader for each CLRRA filing. See **Table 3.d.1** from the guide *Fire adapted communities neighborhood ambassador approach: Increasing preparedness through volunteers* for effective activities that neighborhood ambassadors can undertake (Wildfire Adapted Partnership, 2018).

CLRRA has no wildfire committee to keep members up to date on wildfire conditions, preparedness, and changes in best practices. Neighborhood ambassadors can form a committee within the community that can serve this role as well.

***Table 3.d.1**. Potential activities for the neighborhood ambassador program. Table adapted from (Wildfire Adapted Partnership, 2018).*

Example activity	Ambassador responsibility	Coordinator responsibility
Educational programs about defensible space and home hardening	Gauge interest of neighbors and select topics. Find meeting location. Encourage neighbors to attend.	Arrange for specialists to make presentations. Advertise program through CLRRA newsletters, social media, etc.
Emergency planning	Organize an event for people to ask firefighters and law enforcement personnel about emergency planning and evacuation. Encourage property owners to work with their neighbors to develop a plan for evacuation if a property owner is not at home, school-aged children or pets might be home alone, or property owners have mobility impairments and need special assistance.	Provide information to property owners about emergency planning and go-bags. Arrange for specialists to make presentations. Advertise program through CLRRA newsletters, social media, etc.
Community chipping day	Secure CLRRA buy-in and request financial support. Select a date and organize event logistics. Encourage neighbors to attend.	Secure fuels module availability and grants or other financial support. Address liability and safety concerns. Advertise program through CLRRA newsletters, social media, etc.
Defensible-space walking tour	Identify homeowners with exemplary defensible space. Select a date and organize event logistics. Encourage neighbors to attend.	Arrange for fuel treatment specialists to attend and make presentations. Provide handouts and other educational material about defensible space. Advertise program through CLRRA newsletters, social media, etc.
Defensible space projects	Work with neighbors to identify high-priority project locations using insights from this CWPP.	Work with a certified forester for insights about effective treatment location and prescriptions, following guidelines in this CWPP.

	Secure CLRRA buy-in and request financial support. Select contractors and solicit bids. Oversee project completion.	Identify potential contractors. Write scope of work for contract. Inspect project upon completion. Celebrate success through social media posts and newspaper articles.
Roadway fuel treatment projects	Work with neighbors to identify roads and driveways with potentially non-survivable conditions using insights from this CWPP. Secure CLRRA buy-in and request financial support. Select contractors and solicit bids. Oversee project completion.	Work with a certified forester for insights about effective treatment location and prescriptions, following guidelines in this CWPP. Identify potential contractors. Write scope of work for contract. Inspect project upon completion. Celebrate success through social media posts and newspaper articles.
Firewise designation	Apply to become a Firewise community Plan volunteer mitigation events Account for money, time, and resources spent on mitigation in their neighborhood	Guide ambassadors in updating 3-year action plans Support annual community-wide education program

Social Media

Social media is a powerful tool when used properly to connect with audiences. FEMA has a Wildfire and Outdoor Fire Safety Social Media Toolkit that is a great starting place for fire protection districts to begin gaining an audience with their constituents and sharing important fire safety information. Put Fire to Work highlights programs and organizations that are successfully engaging audiences around wildland and prescribed fire work. CalFire's Ready for Wildfire campaign is active and collaboratively created to engage and encourage people to take action on wildfire preparedness.

Considerations for Vulnerable Populations

Social factors influence how impacted an individual or a community may be in the event of wildfire. This is called social vulnerability and is due to a lack of access to resources. The resources that are lacking can include infrastructure, social support, health, and financial means (Cutter et al., 2003). While CLFPD at large may be well prepared for wildfire after engaging in this CWPP planning process, there is potential for some to fall through the cracks or struggle to engage in necessary mitigation and preparation work which makes them more at risk in the event of a fire.

Poverty, racial and ethnic discrimination, age, and physical ability are frequently factors that are associated with social stratification and result in resource inequity (Crowley, 2020; Cutter et al., 2003; Davies et al., 2018; Emrich et al., 2020; Hewitt, 2013; Ojerio et al., 2008). Thus, it is important to consider how to ensure that all community members can participate in the wildfire preparedness actions outlined in this CWPP.

Pre-fire

Before a fire, it is important to ensure that preparation and potential evacuation communication materials are available in other languages spoken in CLFPD. Sole use of English in materials makes it difficult for people with lower proficiency in English to understand. This includes children, people with low literacy, and people who primarily speak other languages. Materials that use images and diagrams rather than words can make sure the broadest audience can understand any materials that CLRRA or CLFPD distribute about wildfire.

Another major barrier is the ability to do the work recommended in this plan. Populations that may be impacted by this include those in lower income brackets who don't have the resources to harden their homes (i.e., by replacing their roofs, siding, and decks with non-combustible construction materials) and those with physical disabilities or impairments that keep them from doing the physical labor often involved in preparation and mitigation actions themselves. A CWPP is a great way to begin addressing economic disparity because it can provide a basis for CLRRA and CLFPD to apply for grant funding to support mitigation work on behalf of the community.

To truly reduce the economic barrier at a community level, community leaders must design programs that are accessible for all income brackets. For example, providing mitigation services such as a community chipping program that is free for property owners who fall within lower income brackets can encourage those property owners to mitigate their properties when they may have otherwise found it inaccessible. Similarly, volunteer days can help those who are not physically able to engage in pre-fire protection of their home by connecting physically able community members with them to help do home hardening work.

Post-fire

Following a fire, households are often solely responsible for their own recovery. While challenging for everyone, this is a particular issue for those without equal access to the social aid that is available like FEMA recovery funds, information on the internet, and claims for insurance (Laska and Morrow, 2006; Méndez et al., 2020). Groups impacted by this can include older adults, undocumented folks, and those who speak English as a second language or not at all.

While planning for post-fire is less of a focus of this CWPP, it is worth mentioning that community ties are as important after a fire as they are in trying to reduce the impact of potential fire. Communities that consider who will need the most assistance after a fire ahead of time are better able to get those folks the help they need quickly.

Short-Term Rental Licensing

Short-term rentals are home or apartment rentals that are leased for 30 days or less at a time. These are frequently called vacation rentals, Airbnb's, or VRBOs. Local governments have struggled to regulate short-term rentals, and a study published in 2018 found that 20% of short-term rentals in the U.S. did not have smoke detectors and 58% didn't have fire extinguishers. Visitors are often unaware of the risks that come with their vacation location. Short term rentals without defensible space, clearly defined escape routes, or basic fire safety measures put visitors and neighbors at high risk in the event of a wildfire.

We suggest that local governments implement more rigorous short-term rental guidelines to protect the life safety of visitors as well as the properties of the homeowners in their district. **Table 3.d.2** and **Figure 4.d.2** contain recommendations that were adapted from Boulder County's Wildfire Partners program.

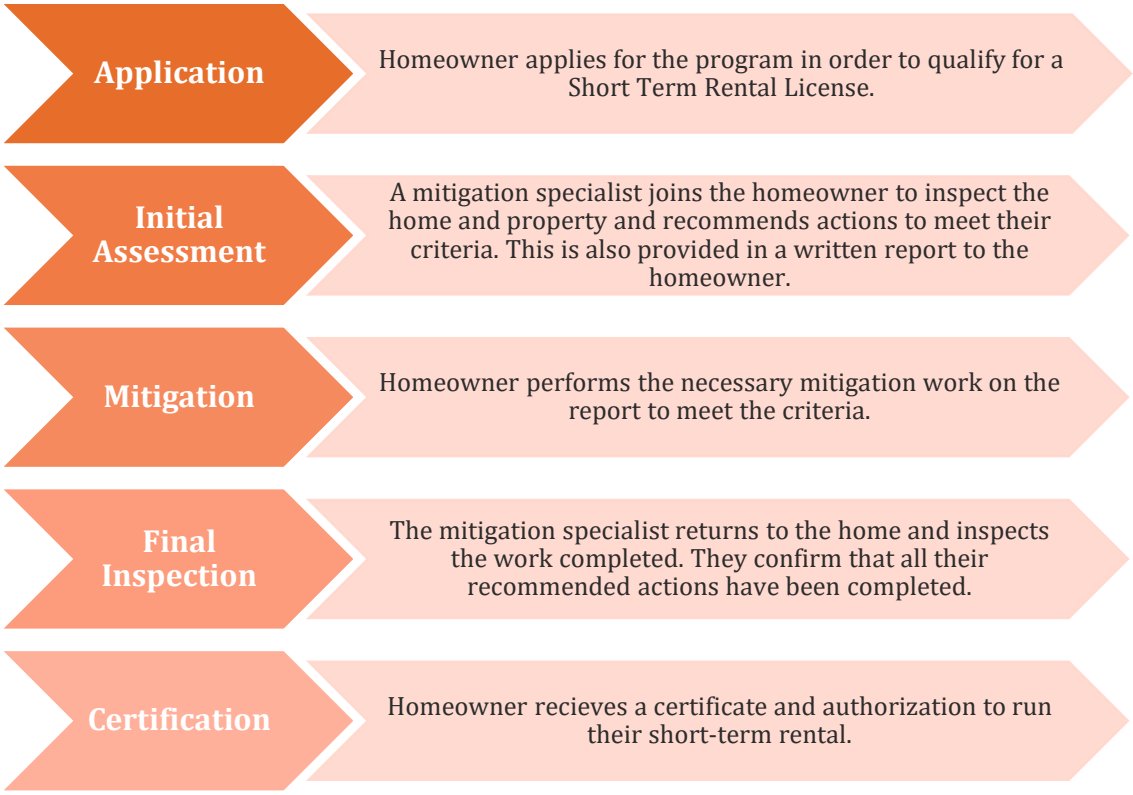


Figure 4.d.2. *Proposed short-term rental licensing process. Homes that are currently operating as short-term rentals could be giving a grace period to complete the mitigation to maintain their business as they complete required mitigation. Process adapted from Wildfire Partners.*

***Table 3.d.2**. Recommended mitigation goals for obtaining Short Term Rental Licenses in the CLFPD. Goals are adapted from [Firewise USA](#).*

Mitigation Measure	Goals
Home Ignition Zones	Create defensible space around homes and outbuildings according to the CSFS Guidelines. See **Figure 3.a.2** and **Table 3.a.1** for specific recommendations.
Landscaping	Maintain HIZ 1 (0-5 feet from the home) to clean, unburnable conditions with litter and duff removed regularly.
Roofing and Vents	Install and maintain a Class-A roof with mesh covers on vents.
Decks and Porches	Keep decks free of flammable materials such as propane tanks or firewood piles. Use non-combustible deck materials when possible.
Siding and Windows	Clean and maintain windows and siding. Use fire-resistant siding and tempered multi-paned windows when building or remodeling.
Emergency Responder Access	Maintain a 20-foot-wide driveway with 13.5 feet of overhead clearance for emergency vehicles. Ensure that street and house numbers are clearly marked from the road, and there is enough turnaround space for fire trucks in front of your house.
Informed Renters	Provide evacuation maps to renters with multiple ways out of the neighborhood. Require renters to sign up for emergency alerts while they are visiting. Share current fire ban information with renters before they visit, and close off outdoor fire pits when they are not allowed to be used.

Collaboration

Collaboration with landowners, community members, local governments, business owners, and other partners the best way to ensure good outcomes from this plan. Partners were engaged in the development of this CWPP and offered input on the recommendations and priorities for CLFPD and CLRRA. It is recommended that the CLFPD and CLRRA continue meetings with land management partners in the district to provide accountability on projects and continue to participate in cross-boundary mitigation programs such as the Northern Colorado Fireshed Collaborative (NCFC) and the Upper Poudre Watershed Resilience Plan.

Partners in and around the CLFPD must work to move mitigation projects from paper to on the ground action, keep lines of communications open and messaging consistent, and to support each other's work in the community. Where some organizations may be able to offer incentives to homeowners, others may be able to provide structure and requirements that must be met to keep life safety for property owners and firefighters a priority. This multi-faceted approach is only possible through compromise, mutual respect, and collaboration on shared goals.

3.e. Funding Opportunities for Wildfire Hazard Mitigation and Emergency Preparedness

There are many funding opportunities from federal, state, and local agencies as well as non-profits to assist in forest health and wildfire mitigation projects. These funds can increase capacity but cannot cover all the costs of fire mitigation needed within the valley. Local property owners and partners must put forth funds and time to complete this work.

Opportunities from Local and State Agencies in Colorado

- The Colorado State Forest Service (CSFS) **Forest Restoration and Wildfire Risk Mitigation (FRWRM)** is a competitive grant program designed to assist with funding community-level actions across the entire state to: reduce the risk to people, property and infrastructure from wildfire in the wildland-urban interface; promote forest health and the utilization of woody material including for traditional forest products and biomass energy; and encourage forest restoration projects. Eligible applicants include local community groups, local government entities such as fire protection districts, public and private utilities, state agencies, and non-profit groups.
- CSFS administers programs for landowner and community assistance, including the **Colorado Forest Ag Program** and **Colorado Tree Farm Program**.
- CSFS regularly updates their **Natural Resources Grants & Assistance Database** to help property owners, agencies, and other partners find funding for natural resource projects.
- The Colorado Department of Revenue provides a **Wildfire Mitigation Measures Subtraction** whereby individuals, estates, and trusts may claim a subtraction on their Colorado income tax return for certain costs incurred in performing wildfire mitigation measures on property in the WUI.
- The **Larimer County Office of Emergency Management** offers community mitigation grants to increase a community's long-term resilience to natural hazards.

Funding from Federal Agencies

- **Building Resilient Infrastructure and Communities (BRIC) grant program** supports states, local communities, Tribes, and territories as they undertake large-sale projects to reduce or eliminate risk and damage from future natural hazards. Homeowners, business operators, and non-profit organizations cannot apply directly to FEMA, but they can be included in sub-applications submitted by an eligible sub-applicant (local governments, Tribal governments, and state agencies).
- **Hazard Mitigation Assistance Grants Program (HMGP)** provides funding to state, local, Tribal, and territorial governments so they can rebuild in a way that reduces, or mitigates, future disaster losses in their communities. This grant funding is available after a presidentially declared disaster.
- **Assistance to Firefighters Grants (AFG)** help firefighters and other first responders obtain critical resources necessary for protecting the public and emergency personnel from fire and related hazards.
- **Fire Prevention & Safety (FP&S) Grants** support projects that enhance the safety of the public and firefighters from fire and related hazards.
- **Staffing for Adequate Fire and Emergency Response (SAFER)** grants directly fund fire departments and volunteer firefighter organizations to help increase their capacity.

- **Community Wildfire Defense Grants** (CWDG) are funded annually through the National Forest Service and help communities take action on implementation projects outlined in recent CWPPs.

Opportunities from Non-Governmental Organizations

- Coalitions and Collaboratives, Inc. manages the **Action, Implementation, and Mitigation Program (AIM)** to increase local capacity and support wildfire risk reduction activities in high-risk communities. AIM provides direct support to place-based wildfire mitigation organization with pass-through grant funding, on-site engagement, technical expertise, mentoring, and training on mitigation practices to help high-risk communities achieve their wildfire adaptation goals.
- **Coalition for the Poudre River Watershed** (CPRW) can aid with small-acreage wildfire mitigation projects on private property. Reach out to the CPRW Forester, Daniel Bowker, for more information.
- Fire Adapted Colorado (FACO) manages the **FACO Opportunity Fund**, which is a matching mini-grant program to support projects, build capacity, and address local needs with funding from the National Fire Adapted Communities Learning Network.
- **The Juniper Initiative** works with rural property owners to support community-based conservation. They can help identify funding opportunities for community stewardship projects, including wildfire mitigation efforts. **Contact** The Juniper Initiative through their website to learn more about specific resources they can provide.

Supporting the Fire Protection District

CLFPD strives to be supportive of forestry projects that improve forest health and wildfire safety. Creating, managing, and implementing fuels mitigation projects takes time and effort that is often unfunded to the district. Education and outreach are incredibly important to the district – connecting with their constituents is a vital part of building relationships and providing the highest quality services. This work requires time and resources that the FPDs do not always have to spare.

- The **Staffing for Adequate Fire and Emergency Response (SAFER)** grants can help fund staff capacity for fire departments.
- The **Assistance to Firefighters Grants (AFG)** can provide critical response resources for firefighters and emergency responders.
- *Community support* is also vital to the success of the fire stations:
    - CLFPD is made of volunteer responders who are ready to respond to fires, medical emergencies, and rescues every day of the year. Learn more about how you can volunteer by contacting the fire department.
    - Financial support in the form of monetary donations or support of local ballot measures that provide tax revenue for the FPD is vital to their success in responding to property owners in their time of need.
    - Attend events hosted by the CLFPD and CLRRA on wildfire preparedness. Seeking out information to protect your home from fire danger can also help protect your local firefighters. Sharing this information within your community can build community resilience and can help lower implementation costs for individual homeowners for many projects.

4. Implementation Recommendations for Fuel Treatments and Ecological Restoration

4.a. Objectives and Benefits of Fuel Treatments and Ecological Restoration

Fuel Treatments

Fuel treatments are a land management tool for reducing wildfire hazard by decreasing the amount and altering the distribution of wildland fuels. Common goals of stand-scale fuel treatments are to reduce the risk of active or passive crown fires and to reduce fire intensity. This is achieved by removing trees, increasing the distance between tree crowns, removing small trees, shrubs, and low branches to increase the space between surface fuels and tree crowns, and removing downed trees and other dead vegetation (Agee and Skinner, 2005). Fuel treatment methods include tree thinning, pruning, pile burning, broadcast prescribed burning, and fuel mastication.

> "Given the right conditions, wildlands will inevitably burn. It is a misconception to think that treating fuels can 'fire-proof' important areas... Fuel treatments in wildlands should focus on creating conditions in which fire can occur without devastating consequences, rather than on creating conditions conducive to fire suppression" (Reinhardt et al. 2008).

Strategically located, high-quality fuel treatments can create tactical options for fire suppression (Jolley, 2018; Plucinski, 2019; Reinhardt et al., 2008). Fuel treatments along trails, ridgelines, and other features can allow firefighters opportunities to use direct or indirect suppression techniques to contain fire spread. Firefighters used fuel treatments in the Red Feather Lakes area as tactical features during the Cameron Peak Fire (Avitt, 2021). In 1980, fuel treatments helped firefighters protect CLFPD during the 1980 Bear Trap Fire (Dennis, 2005).

Strategic fuel treatments, in tandem with work by individual property owners to mitigate hazards in their HIZ (see **Section 3.a. Individual Recommendations**), can help protect life and property. Based on responses to the CWPP survey, almost all property owners understand the risk of fire in the CLFPD. 90-95% of property owners who filled out the survey support or highly support fuel treatments on private and/or public land, and 90% have already cut trees or removed low limbs within their HIZ. Many property owners, CLRRA, and local agencies that manage land within and around the CLFPD are actively reducing wildland fuels. Additional strategic work is required to mitigate wildfire risks across the CLFPD.

Ecological Restoration

Ecological restoration is the process of assisting the recovery of an ecosystem that has been damaged, degraded, or destroyed (SER, 2004). Many forests in the western United States have been damaged, degraded, or destroyed because of changes to their historical fire regimes following Euro-American colonization.

Ecological restoration in ponderosa pine and dry mixed-conifer forests seeks to transform dense forests into ecosystems that are more resilient to wildfire. Tree densities in ponderosa pine forests along the Colorado Front Range average 4.5 times higher today than they were in the mid-1800s (Battaglia et al., 2018). Landscapes of continuous, dense forests are more prone to high-severity fires that are difficult to suppress and can result in catastrophic losses to lives and property (Haas et al.,

2015). Restoration treatments in dry-mixed conifer and ponderosa pine forests seek to reduce tree density and create patterns with single trees, clumps of trees, and meadows—conditions that are more like historical ecosystems along the Front Range of Colorado. Such restoration treatments can reduce crown-fire hazard, increase the abundance and diversity of grasses, shrubs, and wildflowers, and improve habitat for many wildlife species, including deer and elk (Addington et al., 2018).

Lodgepole pine forests are part of fire-adapted ecosystems that are resilient after infrequent, stand-replacing wildfires. Research on historical conditions in lodgepole pine forests suggest they experienced high-severity wildfires every couple of centuries in northern Colorado and southern Wyoming (Higuera et al., 2021). Forest health treatments that focus on fire prevention and restoring historic conditions to lodgepole pines focus on patch cuts to mimic stand-replacing fire events and create mosaic landscapes of forests with different ages, compositions, and fuel loads. Patch cuts remove every overstory tree in a stand to create opportunities for regeneration of aspen and understory plants.

In some cases, fuel treatments can achieve both ecological objectives and wildfire risk reduction. Restoration treatments in dry-mixed conifer and ponderosa pine forests tend to achieve both fuel treatment and ecological restoration objectives. In contrast, a treatment that creates a forest with widely, evenly spaced trees could serve as an effective fuel treatment but would not achieve ecological objectives in most forest types.

Methods Used to Conduct Fuel Treatments and Restore Ecosystems

Mechanical Treatments

Trees can be removed manually or mechanically, providing for considerations of safety, slope, road access, cost, and potential damage to soil. Use of mechanical equipment is often infeasible on slopes greater than 35% (Hunter et al., 2007). Handcrews with chainsaws can operate on steeper slopes, but handcrews usually cover less ground each day than mechanical thinning. Sometimes the only option for tree removal on steep, inaccessible slopes is expensive helicopter logging.

Thinning operations often increase surface fuel loads and can fail to achieve fire mitigation objectives if fuels created by the harvest activities (also known as slash) are not addressed (Agee and Skinner, 2005). See below for options to mitigate surface fuel loads created by fuel management.

Broadcast Prescribed Burning

Broadcast prescribed burning is the most effective method to mitigate wildfire risk and create healthy forest conditions in a variety of grassland, shrubland, and forest ecosystems (Paysen et al., 2000; Stephens et al., 2009). This method has unique impacts on vegetation, soils, and wildlife habitat that cannot be replicated by mechanical treatments alone (McIver et al., 2013). Prescribed burning mimics naturally occurring wildfire, can treat hundreds of acres at a time, removes surface fuel, and is relatively cost-effective (Hartsough et al., 2008; Hunter et al., 2007). Prescribed burns can reduce property damage during wildfires because they are so effective at altering forest fuel loads (Loomis et al., 2019).

Broadcast prescribed burning can be used following mechanical treatments to create conditions that are safer for introducing fire onto the landscape. Thinning and burning treatments tend to achieve fuel reduction objectives and modify fire behavior to a greater extent than thinning alone (Fulé et al., 2012; Prichard et al., 2020).

Broadcast prescribed burning is challenging in the WUI due to diverse fuel types, proximity to homes, risk of visibility impairments on roads from smoke, health impacts of smoke, and political and social concerns. However, with proper planning and implementation, qualified firefighters can safely conduct prescribed burns, even in the WUI (Hunter et al., 2007). Life safety is always a top consideration when developing and conducting prescribed burns.

Prescribed burning can remove surface fuels and ladder fuels and return ecological processes to frequent-fire ecosystems. Firefighters who plan and implement burns must hold rigorous certifications as set by the National Wildfire Coordinating Group. Photo credit: The Ember Alliance.

Broadcast burning is carefully regulated in Colorado by the Division of Fire Prevention and Control (DFPC), the Colorado Department of Public Health and Environment, local sheriff's offices, and fire departments as outlined in the *Colorado Prescribed Burning Act of 2013* and *2019 Colorado Prescribed Fire Planning and Implementation Policy Guide*. Firefighters who plan and conduct prescribed burns are highly qualified under national standards set forth by the National Wildfire Coordinating Group.

It is extremely uncommon for prescribed burns to escape containment lines (Weir et al., 2019) and when they do, the wildland fire community soberly reviews those escapes to produce lessons learned and make improvements (Dether, 2005). Unfortunately, one example is the escape of the Elkhorn Prescribed Burn. This experience has understandably created fear among some members of the public. The prescribed burn community has taken lessons away from the Elk Fire which will reduce the likelihood of future escapes (CO Department of Public Safety, 2020).

Mowing / Grazing

Mowing involves using equipment or grazing animals to trim the height of grasses and forbs. Some equipment can mow down shrubs and small saplings. Mowing is primarily used to reduce flashy fuels in HIZ 1 and 2 and along roadways.

Mowing and grazing can decrease flame length by reducing the height and volume of fine flashy fuels (Harper, 2011). In some cases, it can stimulate the regeneration and growth of some native plants.

Treatment Types Covered in the CWPP

This CWPP covers fuel treatments in the HIZ 3, stand-level fuel treatments, and roadside fuel treatments, each with their own objectives and benefits:

Fuel Treatment Category	Primary Objectives and Benefits
Defensible space in home ignition zone 3 (30-100 feet away from the home)	Reduce surface fuels, reduce tree density, and increase the distance between surface and canopy fuels. Moderate fire behavior near structures and increase their chance of surviving a wildfire. Increase safety and access for wildland firefighters. Increase the visibility of structures from roadways to assist wildland firefighters with locating and accessing your home. Coordinate with partners when HIZ 3 overlaps neighboring properties to address shared wildfire risk. Linked defensible space creates safer conditions and better tactical opportunities for wildland firefighters. Defensible space projects that span ownership boundaries are better candidates for grant funding due to their strategic value.
Stand-level ecological restoration / fuel treatments	Reduce surface fuels, reduce tree density, and increase the distance between surface and canopy fuels. Restore ecological conditions to create more fire-resilient ecosystems. Reduce the likelihood of high-severity wildfires near communities. Create tactical opportunities for fire suppression.
Roadway fuel treatments	Dramatically reduce or eliminate surface and canopy fuels. Reduce the likelihood of non-survivable conditions along roadways during wildfires. Create tactical opportunities for fire suppression. Increase the visibility of structures from roadways to assist wildland firefighters.

4.b. Priorities for Ecological Restoration and Roadside Fuel Treatments in the CLFPD

Altering potential wildfire behavior and restoring ecological conditions requires a landscape-scale approach to treatments across ownership boundaries. We located and prioritized project areas for roadside fuel treatments, ecological restoration, and/or stand-level fuel treatments within and around the CLFPD to be implemented in the next 5 years (**Figure 4.b.1**). These project areas cross ownership boundaries and require community-wide commitment, coordination, and collaboration among private landowners, public land managers, and forestry professionals to create successful outcomes.

Project areas were identified by assessing potential need for treatment based on fire behavior, wildfire exposure, and evacuation analyses (see **Appendix B** for methodology), the location of previous fuel treatments and planned future work, potential funding sources, the location of strategic boundaries for wildfire management and suppression (aka, potential operational delineations [PODs]), and other feasibility considerations. PODs are topographic areas bounded by features suitable for fire control (e.g., ridgetops and roads) that can be used for proactive wildfire decision making and tactical operations during wildfire events. PODs can serve as management units for proactive ecological restoration and wildfire risk mitigation, as well as for cross-boundary and collaborative land and fire management planning (Thompson et al., 2022). The Arapaho-Roosevelt National Forest and other partners with the Northern Colorado Fireshed use PODs to plan landscape-scale projects to protect communities and restore ecosystems.

In summer and fall 2022, TEA, CLRRA leadership, CLFPD, and representatives from land management agencies and other partner groups met to refine project areas and assign project leads. Partners included representatives from the U.S. Forest Service, Larimer County Conservation Corps, Larimer County OEM, Larimer County Emergency Services, Larimer Conservation District, The Nature Conservancy, and Coalition for the Poudre River Watershed.

The section below describes the current conditions in each CWPP project area, treatment objectives and benefits, potential treatment types, project leads, and relative importance. The relative importance and feasibility of treatments is reflected in their timeline—partners aim to conduct treatments for immediate action in the next 1-2 years, short-term treatments are targeted for the next 3-4 years, and mid-term projects for the for the next 5-10 years. Mid-term projects will require more coordination, funding, and other enabling conditions before implementation can begin.

The CWPP implementation plan for stand-level and roadside treatments focuses on high-priority locations, but this does not discourage ecological restoration and fuel mitigation in other areas. If multiple neighbors work together to mitigate fire risk across ownership boundaries, it could attract funding and increase the priority and effectiveness of treating those areas. CLFPD, CLRRA, property owners, and land managers should reevaluate fire risks and reprioritize treatment units as conditions change over time.

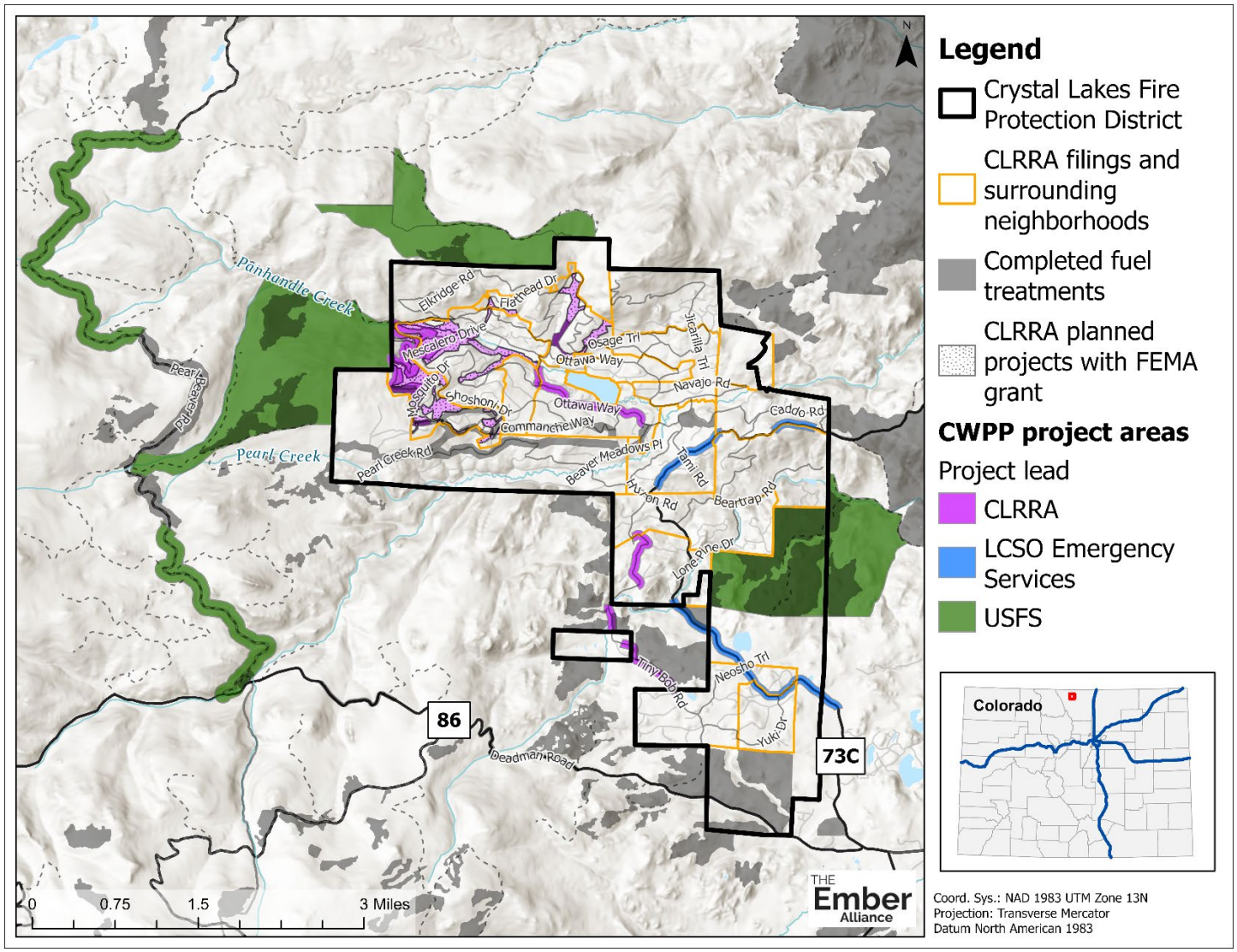


Figure 4.b.1. *Priority project areas for implementation in the next 5 years to reduce the impact of wildfire in the CLFPD, create strategic opportunities for wildland firefighters, create safe conditions for evacuations, and restore ecological conditions. Visit the CLRRA CWPP Map Experience for an interactive version of this map.*

CLRRA FEMA Grant Project Areas and Roadside Fuel Treatments in Western CLRRA Filings

These project areas encompass about 425 acres of CLRRA greenbelts and roadways in Filings 8, 10, 12, 13, and 15 (**Figure 4.b.2**). Many of these projects are planned for implementation in the next few years under a FEMA grant that CLRRA received in 2022 because much of this area poses high wildfire risk to the community. Roadway fuel treatments along Ottawa Way, Mescalero Drive, and Mosquito Drive are high priority because these roads could potentially experience congestion during evacuations and non-survivable conditions under extreme fire conditions (**Figure 3.c.2**).

Slopes are moderately to very steep in these project areas and generally northeast-facing. The dominant vegetation type in these project areas is lodgepole pine, with some interspersed Douglas-fir, Engelmann spruce, ponderosa pine, and aspen. The western portion of this project area was burned by the 1980 Bear Trap Fire and has thick regrowth of lodgepole pine. Dense forests on steep slopes have a high potential for extreme fire behavior under hot, dry, and windy conditions.

CLRRA FEMA Grant Project Areas and Roadside Fuel Treatments in Western CLRRA Filings	
Treatment objectives:	Create healthy forest conditions in greenbelts so the ecosystems are more resistant and resilient to high-severity fire. Create tactical opportunities for wildland fire suppression. Increase the safety of evacuation routes for property owners in the western part of CLFPD.
Treatment type:	Mechanical thinning and slash removal. Patch cutting in lodgepole pine to create large openings up to 5 acres in size. **Section 4.c** provides general recommendations for stand-level treatments and **Section 4.d** for roadside fuel treatments.
Priority:	Immediate action, work starting within 1-2 years.
Lead and support organizations:	CLRRA, with cooperation from private landowners along Ottawa Way, Mescalero Drive, and Mosquito Drive.

Dense fuels along Ottawa Way between filing 8 and 10 (left). Mitigated fuels along powerline and a portion of Mosquito Drive, but dense lodgepole pine representative of forests in much of filings 12 and 15 in the background (right). Photo credit: The Ember Alliance.

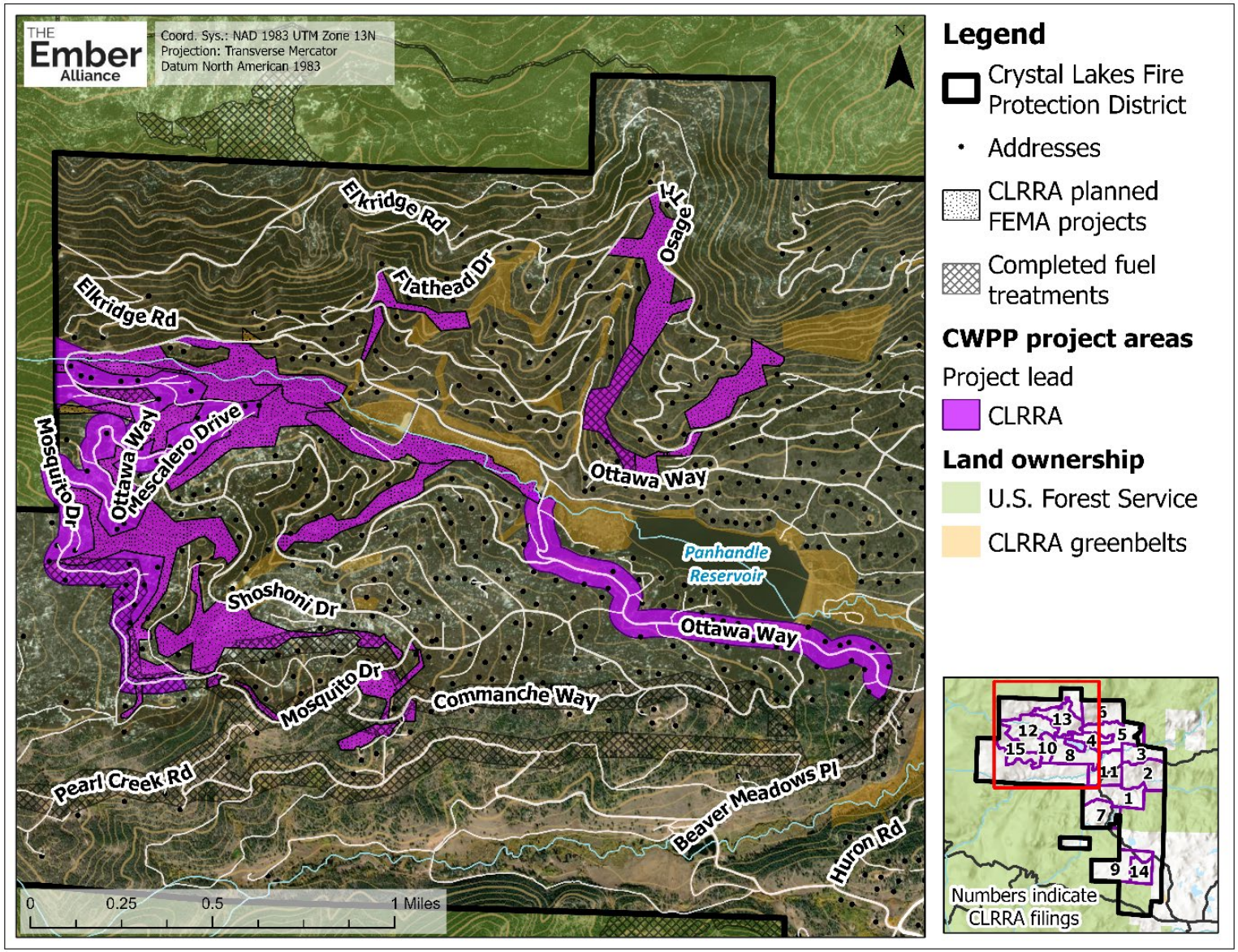


Figure 4.b.2. *CLRRA FEMA grant project areas and roadside fuel treatments in western CLRRA filings.*

CLRRA Roadside Fuel Treatments Along Tiny Bob Road

This project area encompasses about 80 acres along Tiny Bob Road in the southern part of CLFPD (**Figure 4.b.3**). Roadway fuel treatments along Tiny Bob Road are high priority because this road falls along a POD boundary and could create tactical opportunities for wildland fire suppression were a fire to move into the community out of the west. Tiny Bob Road might need to be used during evacuations, but portions of this road could potentially experience non-survivable conditions under extreme fire behavior (**Figure 3.c.2**).

The dominant vegetation types along segments of Tiny Bob Road in this project area are lodgepole pine forests and ponderosa pine forests with a mix of Douglas-fir. Many of these forests have abundant ladder fuels and an accumulation of heavy fuels in the understory.

CLRRA Roadside Fuel Treatments Along Tiny Bob Road	
Treatment objectives:	Create tactical opportunities for wildland fire suppression. Reduce the chance of non-survivable conditions developing along Tiny Bob Road, which might need to be used during evacuations.
Treatment type:	Mechanical thinning and slash removal. Along roadways, vegetation should be removed on either side of the road to increase public safety in the event of an evacuation. See **Section 4.d** for more information on roadside fuel treatments.
Priority:	Immediate action, work starting within 1-2 years.
Lead and support organizations:	CLRRA, in coordination with the USFS where Tiny Bob Road crosses over the Arapaho-Roosevelt National Forest.

Dense forest conditions in lodgepole pine and wet mixed-conifer forests along Tiny Bob Road could result in non-survivable conditions during wildfires, underscoring the need for roadside fuel mitigation. These images illustrate current conditions along Tiny Bob Road, which could support extreme fire behavior. See Section 4.d for examples of ideal conditions along roadways following roadside fuel treatments. Photo credit: The Ember Alliance.

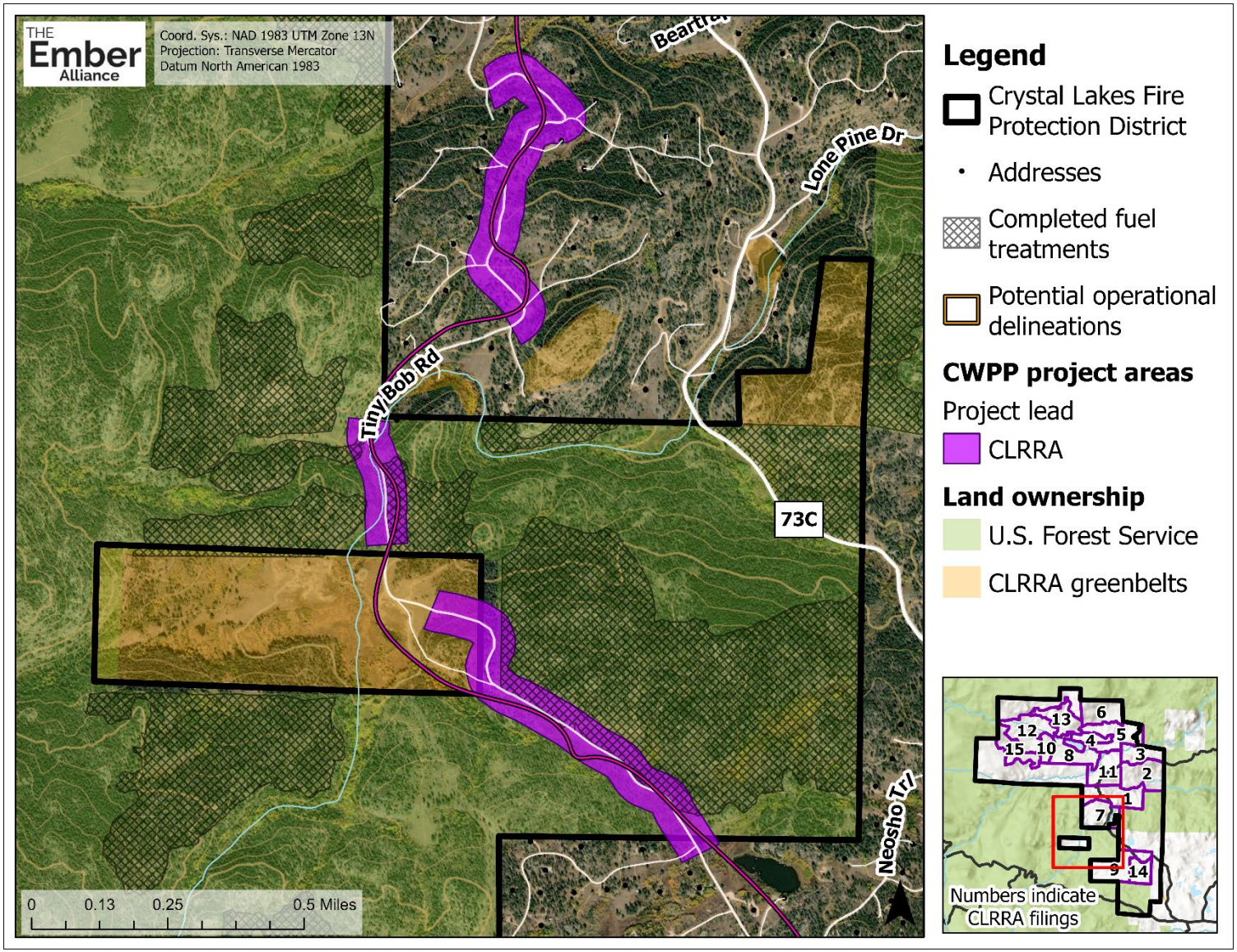


Figure 4.b.3. *Priority locations for roadside fuel treatments along Tiny Bob Road in the southeastern part of CLRRA.*

Roadside Fuel Treatments Along CR 73C

This project area encompasses 160 acres along County Road 73C (**Figure 4.b.4**). Roadway fuel treatments along CR 73C are high priority because portions of this road could potentially experience non-survivable conditions under extreme fire conditions, and this road is an evacuation pinch point for the entire community (**Figure 3.c.2**). Portions of CR 73C fall along a POD boundary and could create tactical opportunities for wildland fire suppression were a fire to move into the community out of the southeast.

Lodgepole pine, wet-mixed conifer, and ponderosa pine forests with a mix of Douglas-fir are the dominant vegetation types along segments of CR 73C included in this project area. Many of these forests have abundant ladder fuels and an accumulation of heavy fuels in the understory.

Roadside Fuel Treatments Along CR 73C	
Treatment objectives:	Improve safety of this important evacuation route.
Treatment type:	Mechanical thinning and slash removal. Along roadways, vegetation should be removed on either side of the road to increase public safety in the event of an evacuation. See **Section 4.d** for more information on roadside fuel treatments.
Priority:	Immediate, work starting within 1-2 years.
Lead and support organizations:	LCSO Emergency Services with support from Larimer County Road & Bridge and Larimer County OEM, in coordination with the USFS where CR 73C crosses over the Arapaho-Roosevelt National Forest.

Some portions of CR 73C have widely spaced trees and limited ladder fuels (right), but others have dense forests with the potential to result in non-survivable conditions during wildfires, underscoring the need for roadside fuel mitigation (left). See Section 4.d for examples of ideal conditions along roadways following roadside fuel treatments. Photo credit: The Ember Alliance.

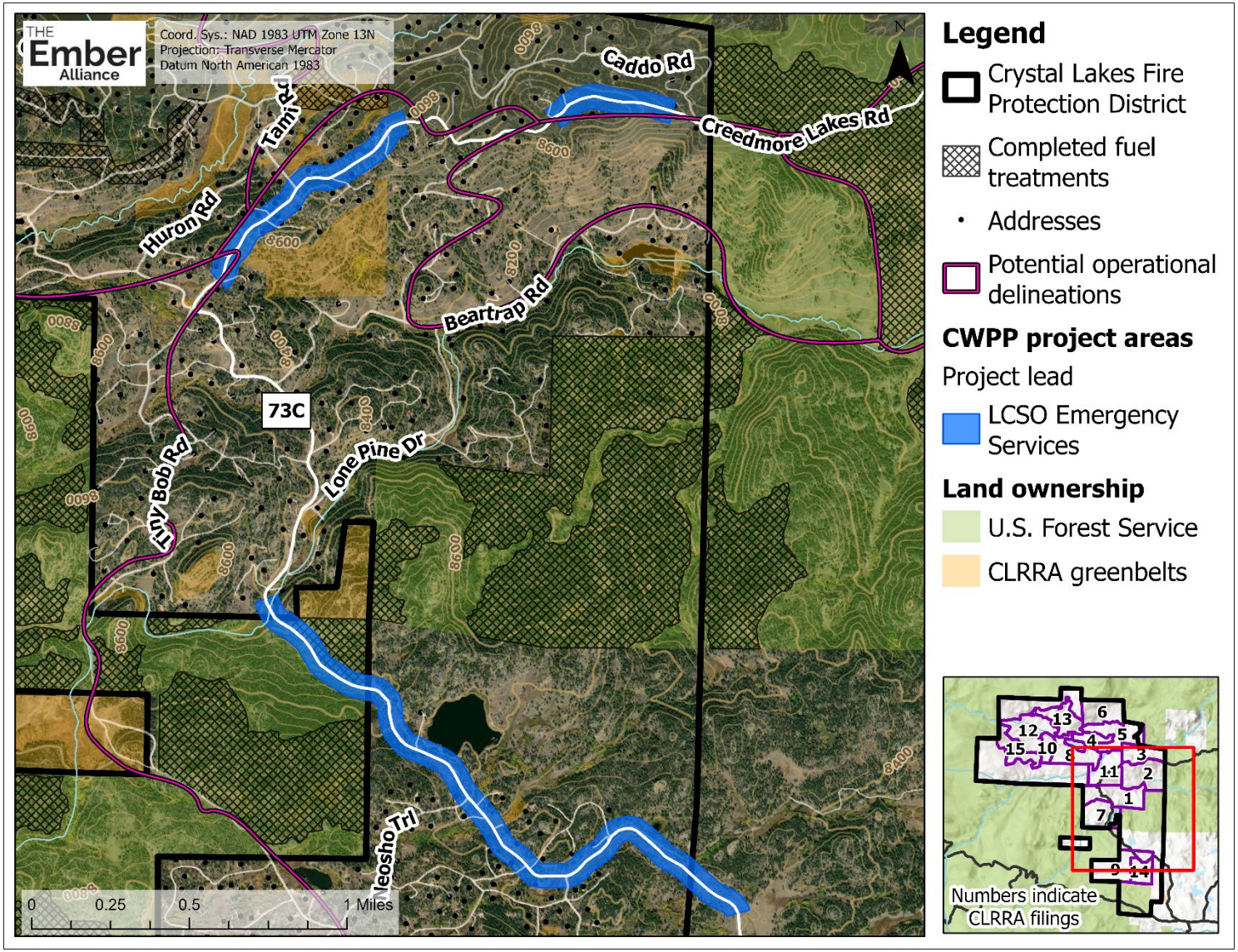


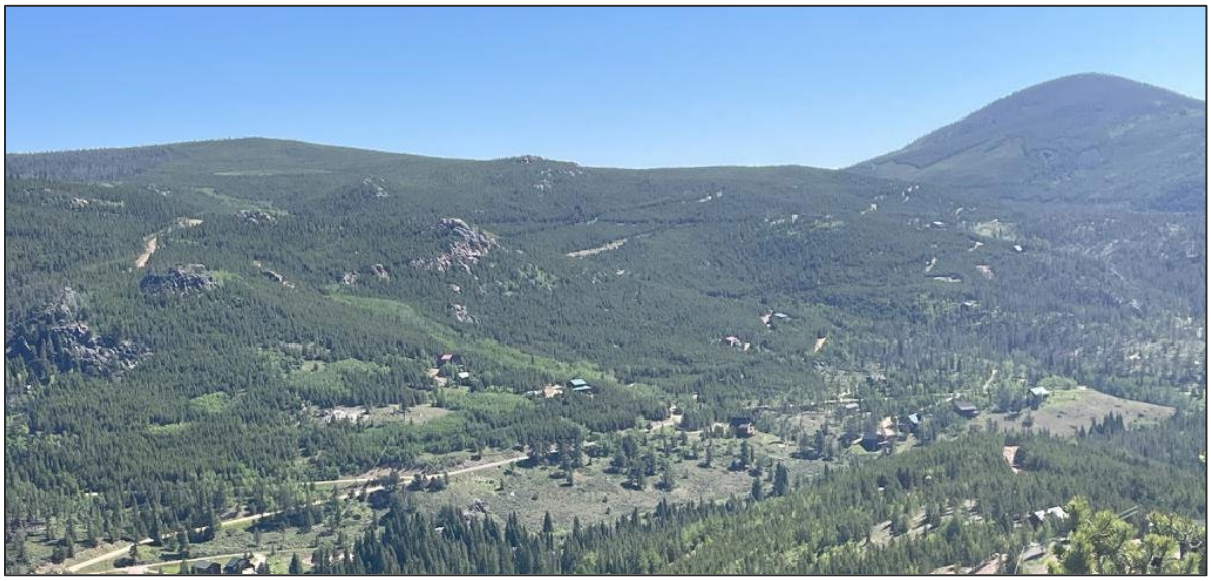
Figure 4.b.4. *Priority locations for roadside fuel treatments along CR 73C in the southwestern part of CLRRA.*

Stand-Scale Treatments on the Arapaho-Roosevelt National Forest North of CLFPD

This project area encompasses 558 acres of Arapaho-Roosevelt National Forest north of CLFPD (**Figure 4.b.5**). The northern boundary of the project area is along a POD boundary that could create tactical opportunities for wildland fire suppression were a fire to move into the community out of the northwest. Additional treatments in this area could connect to and magnify the impact of thinning and pile burn treatments conducted by the USFS in 2009. The southern border of the project area runs along the top of a ravine that poses significant wildfire risk to CLFPD.

Slopes are moderately to very steep in this area and generally south-facing. The area was not burned by the 1980 Bear Trap Fire, so it is covered in older, dense lodgepole pine forest with abundant beetle-killed trees.

Arapaho-Roosevelt National Forest North of CLFPD	
Treatment objectives:	Create healthy forest conditions in greenbelts so the ecosystems are more resistant and resilient to high-severity fire. Create connectivity between previous treatments and strengthen POD boundaries to create tactical opportunities for wildland fire suppression.
Treatment type:	Mechanical thinning and pile burning. Patch cutting in lodgepole pine to create large openings up to 5 acres in size. **Section 4.c** provides general recommendations for stand-level treatments.
Priority:	Short-term, work starting in 3-4 years (pending approval of the Black Diamond Landscape Resiliency & Risk Reduction Project).
Lead and support organizations:	USFS



The proposed project area north of CLFPD skirts the base of Black Mountain (peak to the right in the image) and is covered in dense lodgepole pine forests on moderate to steep slopes. Photo credit: The Ember Alliance.

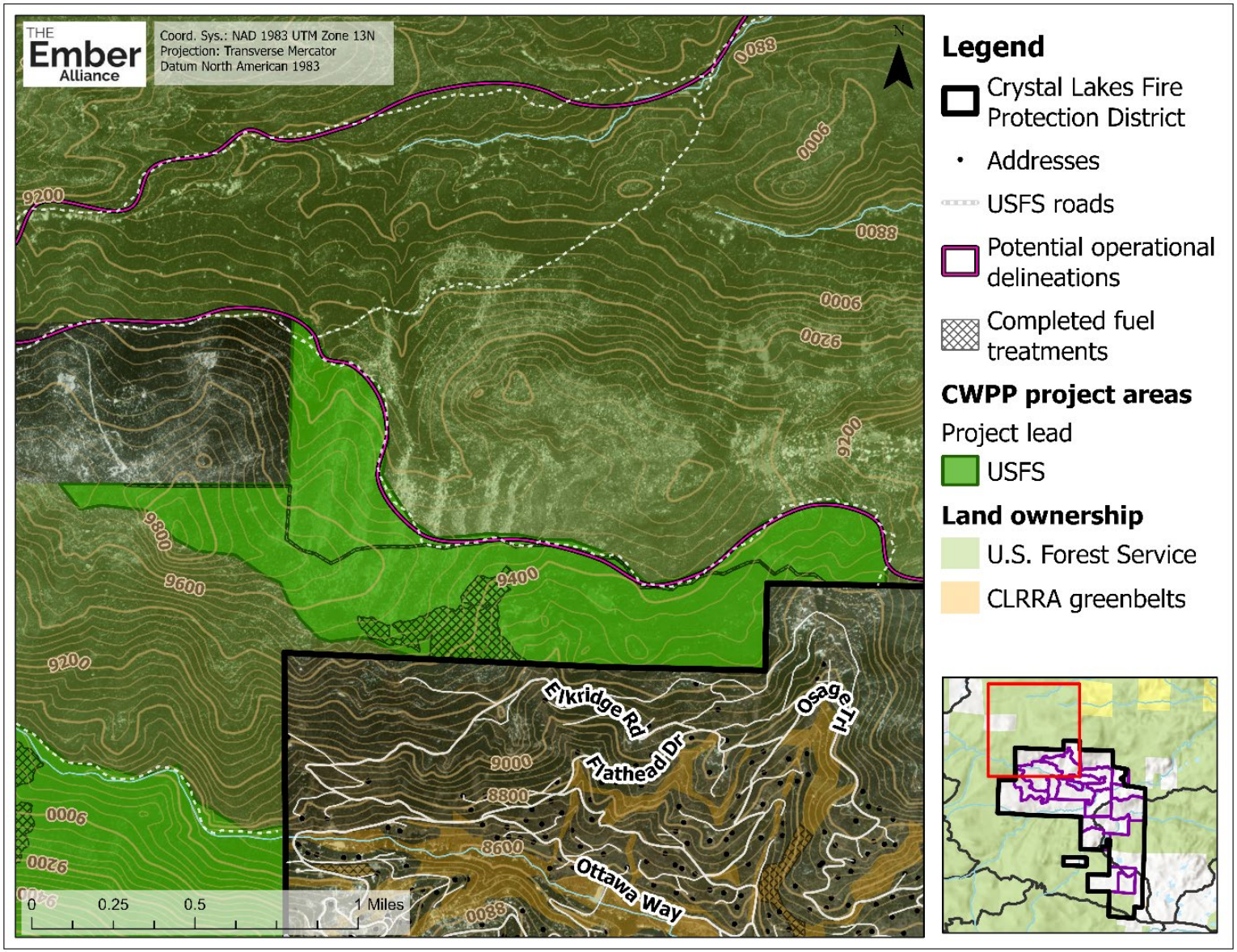


Figure 4.b.5. *Priority area for stand-scale treatments on the Arapaho-Roosevelt National Forest north of CLFPD.*

Stand-Scale Treatments on the Arapaho-Roosevelt National Forest West of CLFPD

This project area encompasses 1,020 acres of Arapaho-Roosevelt National Forest west of CLFPD (**Figure 4.b.6**). Treatments in this area will create connectivity between previous thinning and pile burn treatments implemented by the USFS in 2009, 2011, and 2013. The western boundary of the project area is along a POD boundary that could create tactical opportunities for wildland fire suppression were a fire to move into the community out of the east. The northern project area boundary runs along Panhandle Creek, and the southern boundary runs along a USFS road.

The dominant vegetation type in the project area is lodgepole pine, with some interspersed wet mixed-conifer forests. The area was not burned by the 1980 Bear Trap Fire, so it is covered in older, dense lodgepole pine forest with abundant beetle-killed trees.

Arapaho-Roosevelt National Forest West of CLFPD	
Treatment objectives:	Create healthy forest conditions that are more resistant and resilient to fire. Create connectivity between previous treatments and strengthen POD boundaries to create tactical opportunities for wildland fire suppression.
Treatment type:	Mechanical thinning and pile burning. Patch cutting in lodgepole pine to create large openings up to 5 acres in size. **Section 4.c** provides general recommendations for stand-level treatments
Priority:	Short-term, work starting in 3-4 years (pending approval of the Black Diamond Landscape Resiliency & Risk Reduction Project).
Lead and support organizations:	USFS

The project area west of the CLFPD is covered in dense lodgepole pine forests with abundant dead beetle-killed trees. The burn scar of the 1980 Bear Trap Fire is seen in the left side of this image, but the fire barely entered the Arapaho-Roosevelt National Forest. Photo credit: The Ember Alliance.

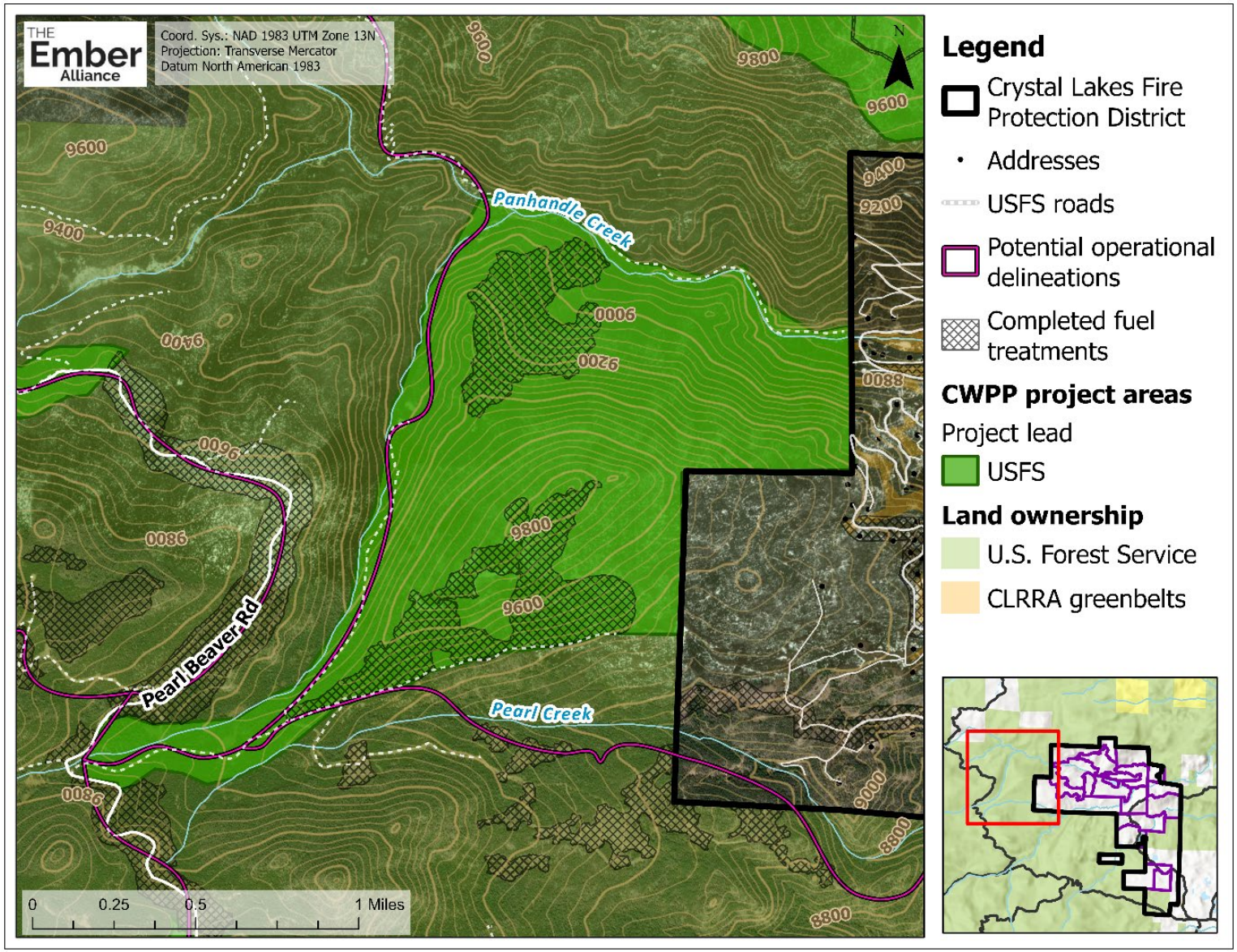


Figure 4.b.6. *Priority area for stand-scale treatments on the Arapaho-Roosevelt National Forest west of CLFPD.*

Stand-Scale Treatments on the Arapaho-Roosevelt National Forest East of CLFPD

This project area encompasses 900 acres of Arapaho-Roosevelt National Forest east of CLFPD (**Figure 4.b.7**). The USFS conducted mechanical thinning treatments in the project area in 2005; however, many trees have regenerated, and these areas should be retreated. To the east of the project area, the USFS implemented broadcast burning in 2018-2019.

Terrain in the project area is complex with several valleys and a mixture of shallow to steep slopes. Vegetation types are a mix of dense lodgepole pine forests and ponderosa pine and dry mixed-conifer forests with moderate to high tree densities. Previously treated areas with regeneration have substantial ladder fuels that could cause wildfires to transition into treetops.

Arapaho-Roosevelt National Forest East of CLFPD	
Treatment objectives:	Create healthy forest conditions in greenbelts so the ecosystems are more resistant and resilient to high-severity fire. Create connectivity between previous treatments and improve the effectiveness of past treatments that now have significant regeneration.
Treatment type:	Mechanical thinning and pile burning.
Priority:	Short-term, work starting in 3-4 years (pending approval of the Black Diamond Landscape Resiliency & Risk Reduction Project).
Lead organization:	USFS

Vegetation east of the CLFPD varies from previously treated dry mixed-conifer and ponderosa pine to dense, unmitigated forests on steep slopes as seen above. Some treated areas have abundant regeneration and require retreatment. Photo credit: The Ember Alliance.

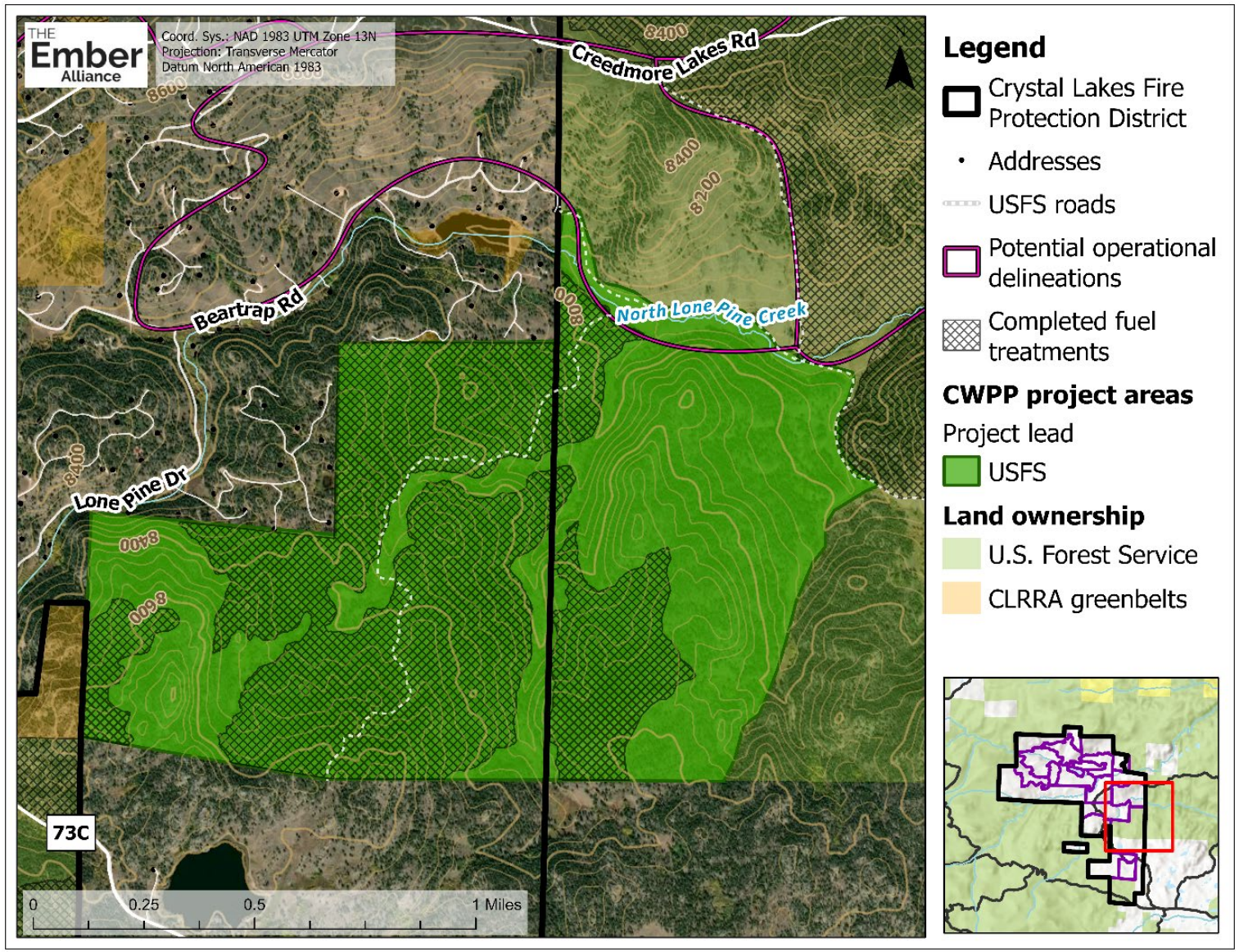


Figure 4.b.7. *Priority area for stand-scale treatments on the Arapaho-Roosevelt National Forest east of CLFPD.*

Roadside Fuel Treatments Along Pearl Beaver Road (FS Rd 169)

This project area encompasses 633 acres of roadside fuel treatment along Pearl Beaver Road (aka, Forest Service Road 169), which is an evacuation route and a POD boundary (**Figure 4.b.8**). Roadway fuel treatments along Pearl Beaver Road are high priority because portions of this road could potentially experience non-survivable conditions under extreme fire conditions, and this road is an alternate evacuation route for the entire community (**Figure 3.c.2**). Additional roadside treatments could connect to and magnify the impact of thinning and pile burn treatments conducted by the USFS in 2008.

The dominant vegetation type in this project area is lodgepole pine with some interspersed wet mixed-conifer and spruce-fir forests. Many of these forests have abundant ladder fuels and an accumulation of heavy fuels in the understory.

Roadside Fuel Treatments Along Pearl Beaver Road (FS Rd 169)	
Treatment objectives:	Extend previous roadside fuel treatment along Pearl Beaver Road to strengthen POD boundaries to create tactical opportunities for wildland fire suppression. Increase the safety of evacuation routes for property owners in the western part of CLFPD.
Treatment type:	Mechanical thinning and pile burning. Along roadways, vegetation should be removed on either side of the road to increase public safety in the event of an evacuation. See **Section 4.d** for more information on roadside fuel treatments.
Priority:	Short-term, work starting in 3-4 years.
Lead organization:	USFS

Many segments of Pearl Beaver Road have dense forests with abundant ladder fuel and a high potential to result in non-survivable conditions during wildfires, underscoring the need for roadside fuel mitigation. These images illustrate current conditions along Pearl Beaver Road, which could support extreme fire behavior. See Section 4.d for examples of ideal conditions along roadways following roadside fuel treatments. Photo credit: IRES, ColoProperty.com.

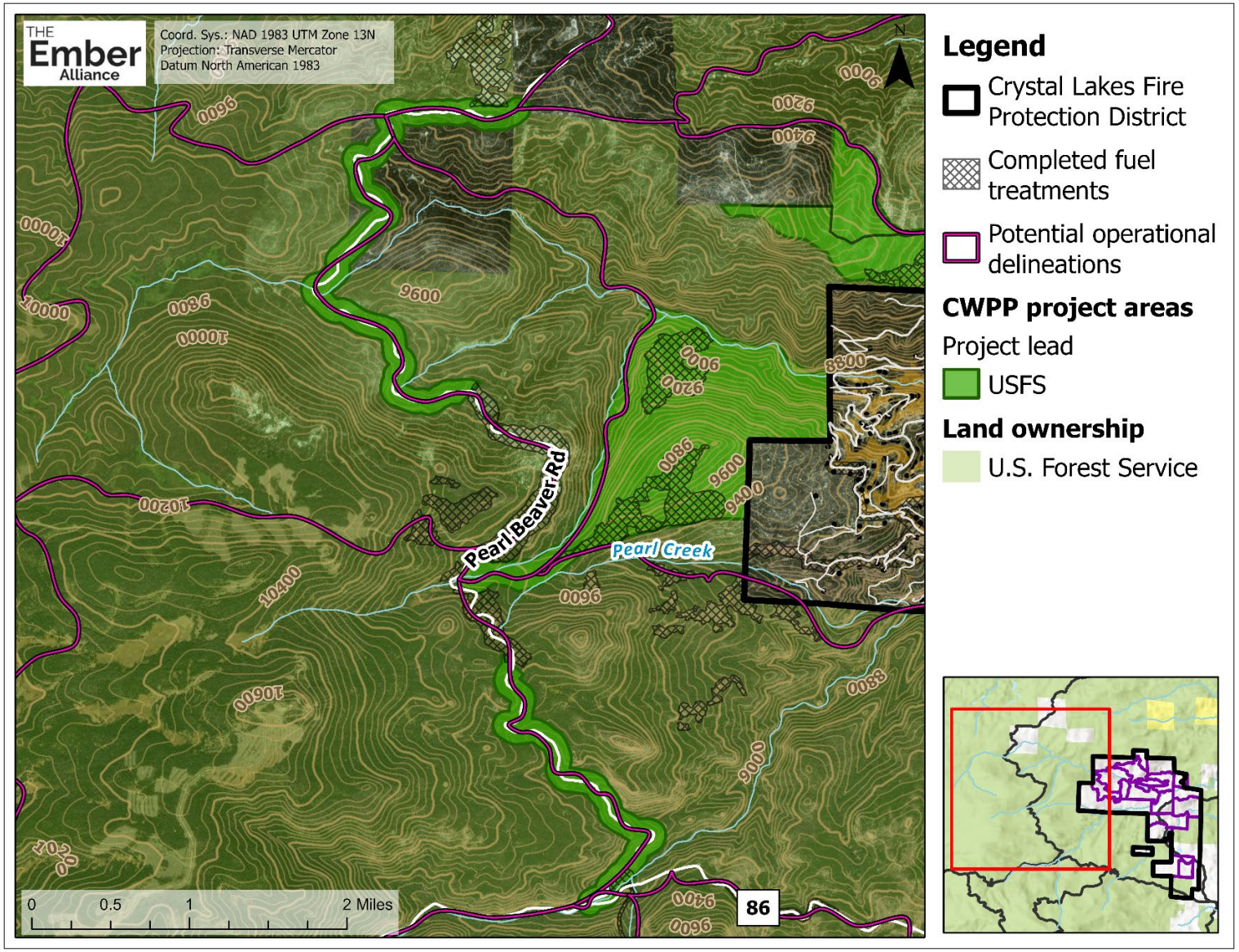


Figure 4.b.8. *Priority area for roadside fuel treatments along Pearl Beaver Road (FS Rd 169).*

4.c. General Recommendations for HIZ 3 and Stand-scale Treatments

Local knowledge and professional expertise are needed to design effective, site-specific fuel treatments based on the best available science. Specific fuel treatment recommendations are dependent on forest type, tree density, fuel loads, terrain, land use, and management objectives. The location and purpose of treatments also matter. Treatments in large, forested areas can include the retention of individual trees and groups of trees. Evenly and widely spacing trees might be reasonable in HIZ 3, but this tree arrangement would not be appropriate for restoration-style fuel treatments.

Treatments in HIZ 3 (30-100 feet away from the home) can restore historical forest structure, but it is most important to focus on reducing wildfire risk to the home, creating safe conditions for fire fighters, and increasing the visibility of your home from the road for firefighters. Homeowners often enjoy the more open forest around their home because it lets in more light which encourages understory grasses and shrubs to grow and, in turn, can increase wildlife sightings near their home. HIZ 3 often overlaps neighboring properties and requires property owners to work together to address shared wildfire risk.

For all fuel treatments, it is important to address surface fuels. Forest management operations often increase surface fuel loads and can fail to achieve fire mitigation objectives if fuels created by the harvest activities (also known as slash) are not addressed (Agee and Skinner, 2005). Slash can include small trees, limbs, bark, and treetops. See **Section 4.e Approaches to Slash Management** for pros and cons of different slash management options.

Mitigating the impacts of tree removal on soil compaction and erosion is also important when treatments occur near streams and riparian ecosystems. The Colorado State Forest Service recommends streamside management zones of at least 50 feet (CSFS, 2010). Treatments should be monitored for colonization of invasive, weedy plants that might require control through integrated weed management. It's always a good idea to take pictures of treatments before and after to help evaluate effectiveness and monitor changes over time (for an example of a repeat photograph see **Figure 3.a.4**).

Here we provide general recommendations for treatments in HIZ 3 and stand-scale fuel treatments and ecological restoration by vegetation types. Guidance for defensible space is summarized from the CSFS publication The Home Ignition Zone. It is important to work with a forester that has experience creating defensible space so they can help you design an effective treatment specific to vegetation type, slope, and other conditions around your home.

Ponderosa Pine and Dry Mixed-Conifer Forests

Ponderosa pine and dry-mixed conifer forests occur at lower elevations in the eastern part of the CLFPD. Some ponderosa pine forests in the CLFPD have low to moderate tree densities and understories with grasses, forbs, and shrubs. Dry mixed conifer forests often occur on warm, dry south-facing slopes and contain ponderosa pine, Douglas-fir, and Rocky Mountain juniper, with occasional blue spruce.

Ponderosa pine and mixed-conifer forests were fire-adapted ecosystems and very resilient to wildfires. Low- to mixed-severity fires occurred every 7 to 50 years and occasional severe, stand-replacing fires. Frequent fires would kill many tree seedlings and saplings, thereby preventing the accumulation of ladder fuels and reducing the potential for surface fires to transition into crown fires.

Recommendations for HIZ 3:

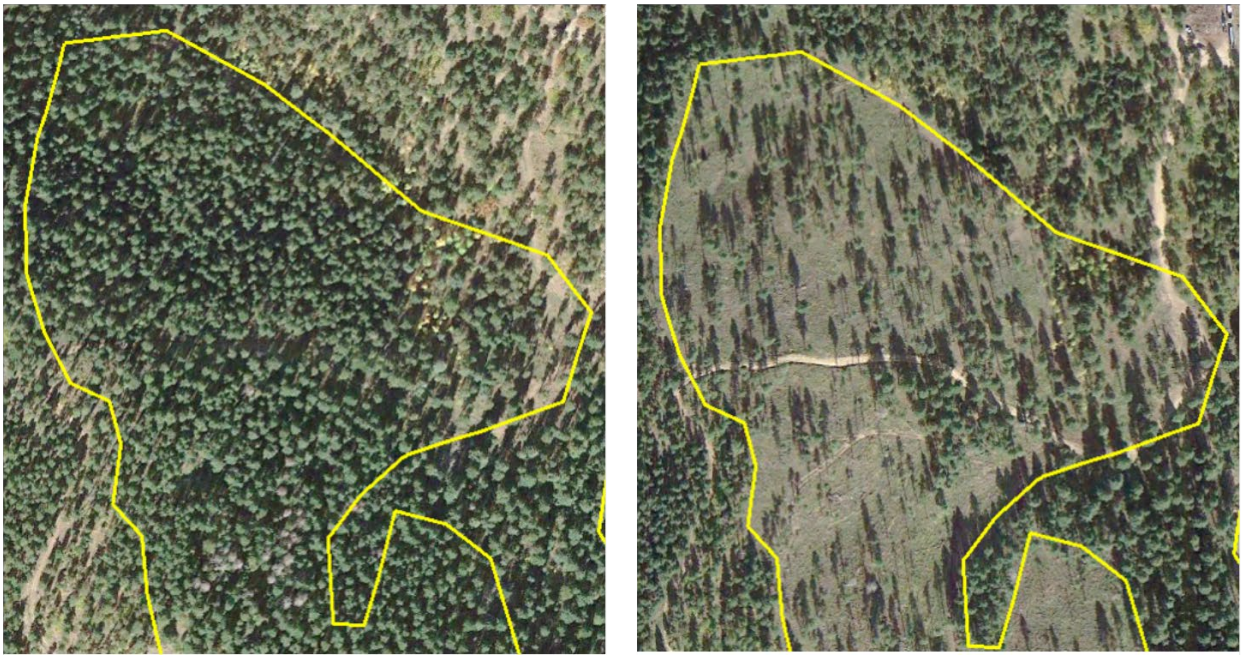
- Remove shrubs and small trees that can serve as ladder fuels.
- Remove large trees so that the crown spacing of remaining trees is 6 to 10 feet. Favor leaving large, older trees that have naturally lost their lower branches and have thick bark that confers resistance to wildfires. See **Figure 3.a.3** for how to measure crown spacing.
- Remove limbs of all remaining trees so branches do not hang below 6 feet above the ground**,** ideally not below 10 feet above the ground, to reduce the risk of wildfire transitioning from the surface into treetops. See **Figure 3.a.3** for how to measure limb height.
- If desired, retain scattered, small clumps of trees (about 6-10 trees) with interlocking crowns. Ensure these clumps are at least 10 feet away from single trees and other tree clumps.
- Remove slash from the site. Avoid lop-and-scatter and mulching treatments that only rearrange fuels without removing them.

Recommendations for stand-scale fuel treatments and ecological restoration:

Follow the principles of ecological restoration as outlined in Addington et al., 2018 to help achieve fuel reduction and ecosystem restoration objectives. In frequent-fire forests, such as ponderosa pine and dry mixed-conifer forests along the Colorado Front Range, restoration treatments involve converting dense forests into a mosaic of single trees, clumps of trees, and meadows. These conditions are similar to historical forests that were maintained by wildfires and very resilient to them.

Thinning combined with broadcast burning is the most effective treatment for ponderosa and dry mixed conifer forests (Addington et al., 2018; Fulé et al., 2012; Prichard et al., 2020). Older trees can withstand the fire while small trees, shrubs, downed logs, and fine fuels are consumed.

Larimer County Conservation District conducted this high-quality restoration treatment to reduce tree densities, remove ladder fuels, and create open areas, in what was a dense ponderosa pine forest. Grasses and forbs are quickly responding to increased light availability, increasing biodiversity and creating wildlife habitat in this ecosystem. Photo credit: The Ember Alliance.



Before and after aerial photos illustrating how effective restoration treatments convert dense ponderosa pine forests into a mosaic of single trees, clumps of trees, and meadows. Photo credit: Jefferson Conservation District.

Aspen and Other Riparian Hardwood Species

Aspen is found scattered throughout forests and riparian areas in CLFPD but there are few large stands of aspen. Willow is abundant in riparian areas along Panhandle Creek and Pearl Creek.

Aspen groves are important food and habitat for mountain fauna. They tend to have higher moisture contents and can slow the spread of wildfire. Fires often kill mature aspen but initiate rapid resprouting, and the death of conifer trees from wildfire can increase light availability for aspen. Cottonwood and willow trees are excellent at stabilizing riverbanks and wetland habitat. They grow quickly and provide habitat and forage for many species.

Recommendations for HIZ 3:

- There is no need to remove aspen, cottonwood, or willows in HIZ 3 unless they are within 5 feet of sheds or other outbuildings.
- Remove shrubs and small conifer trees that can serve as ladder fuels.
- Remove large conifer trees so that the crown spacing of remaining trees is 6 to 10 feet. Remove limbs of all remaining trees so branches do not hang below 6 feet above the ground**,** ideally not below 10 feet above the ground, to reduce the risk of wildfire transitioning from the surface into treetops. See **Figure 3.a.3** for how to measure crown spacing and limb height.
- Mitigate the impacts of tree removal on soil compaction and erosion by maintaining streamside management zones of at least 50 feet (CSFS, 2010).
- More information can be found in the Cottonwood Management publication from the Colorado State Forest Service.
- Remove slash from the site. Avoid lop-and-scatter and mulching treatments that only rearrange fuels without removing them.

Lodgepole Pine and Wet Mixed-Conifer Forests

Lodgepole pine and wet mixed conifer are common at higher elevations in the western part of the CLFPD. Wet mixed-conifer forests typically occur on north-facing slopes with cooler temperatures and higher soil moisture. They consist of any of the following species: lodgepole pine, subalpine fir, Engelmann spruce, Douglas-fir, limber pine, and bristlecone pine. These forests typically grow in dense, even-age stands. In lodgepole pine forests it is common for the understory to be nearly devoid of grasses and forbs due to limited light availability.

Lodgepole pine rely on stand-replacing fire every 75-300 years to regenerate the next generation of trees. Mature lodgepole pine trees are not resistant to fire and often die, which creates open conditions for new trees to regenerate. Many lodgepole pine trees have serotinous cones that are sealed shut with resin and only open under high heat caused by wildfire. Most species in wet-mixed conifer forests are not resistant to fire and will burn easily. The death of overstory trees increases the availability of sunlight to regenerating trees, including sun-loving aspen.

Recommendations for HIZ 3:

There are two main options in lodgepole pine and wet mixed-conifer forests in HIZ 3:

- Thin trees to create 6- to 10-foot crown spacing. In general, you should not remove more than 30% of overstory trees because lodgepole pine are susceptible to windthrow. Retreatment to further reducing tree density and remove regenerating trees is imperative. See **Figure 3.a.3** for how to measure crown spacing.
- Create a mosaic of open areas and groups of trees through patch cutting. Groups can include 30-50 trees and must be separated from other groups by at least 30-50 feet. Patch cutting is recommended because it reduces the chance of windthrow, and it increases the likelihood that wildfire will be unable to spread from tree clump to tree clump.

For all treatments in lodgepole pine and wet mixed-conifer forests:

- Remove small trees and shrubs that serve as ladder fuels.
- Remove limbs of all remaining trees so branches do not hang below 6 feet above the ground**,** ideally not below 10 feet above the ground, to reduce the risk of wildfire transitioning from the surface into treetops. See **Figure 3.a.3** for how to measure limb height.
- Favor leaving aspen on site to create beautiful post-treatment conditions with greater resistance to wildfire.
- Remove slash from the site. Avoid lop-and-scatter and mulching treatments that only rearrange fuels without removing them.
- See additional guidance in the CSFS publication *Lodgepole Pine Management Guidelines for Land Managers in the Wildland-Urban Interface.*

Recommendations for stand-scale fuel treatments and ecological restoration:

In infrequent-fire forests, removing all trees can imitate high-severity wildfires that these systems are adapted to. Creating heterogeneous landscapes with patch cuts, decreasing the density of trees, and increasing diversity in age, size, and species in lodgepole and wet mixed-conifer forests can also be effective at altering the intensity of fire (Dennis et al., 2009). Broadcast burning is rarely feasible in lodgepole stands because they are susceptible to active crown fire that is not easily managed in prescribed burning scenarios.

Thinning (top) and patch cutting (bottom) are two options for treatments in HIZ 3 in lodgepole pine and wet mixed-conifer forests. If homeowners opt for thinning, it is important to remove trees in stages to reduce the risk of windthrow while eventually creating 10-foot canopy spacing. Retreating to remove regenerating trees is important over time to remove ladder fuels that could carry surface fire into treetops. Photo credit: The Ember Alliance.

This high-quality treatment in CLRRA reduced tree densities, created open areas, and favored the regeneration of aspen in what was a dense lodgepole pine forest. Photo credit: The Ember Alliance.

Patch cutting in lodgepole pine in HIZ 3, such as this exemplary treatment by the Larimer Conservation District, retains groups of trees and separation between groups to reduce the chance of wildfire spreading from tree-top to tree-top in an active crown fire that is difficult if not impossible to suppress. Aspen should also be retained in this treatment type due to their natural resistance to fire. Photo credit: The Ember Alliance.

Rocky Mountain Lower Montane-Foothill Shrublands

Rocky Mountain lower montane-foothill shrublands include a mixture of grass and shrub species such as mountain mahogany and big sagebrush. Shrublands provide important forage to ungulates like mule deer and elk. Shrublands are found scattered throughout the eastern part of the CLFPD.

Wildfires in shrublands have high rates of spread, particularly when there are continuous grasses, and burning shrubs can emit significant radiant heat. Fire is a naturally occurring process in Rocky Mountain lower montane-foothill shrubland, and this ecosystem historically experienced wildfires every 14-112 years at a variety of fire severities depending on local site factors (Decker et al., 2020; Missoula Fire Sciences Laboratory, 2012).

Recommendations for HIZ 3:

- Unlike HIZ 1 and 2, shrubs do not need to be removed in HIZ 3 unless they occur in continuous dense stands, occur under trees and can serve as ladder fuels, or abut sheds or other outbuildings.
- Remove slash from the site. Avoid lop-and-scatter and mulching treatments that only rearrange fuels without removing them.

Recommendations for stand-scale fuel treatments and ecological restoration:

Management in Rocky Mountain lower montane-foothill shrublands usually involves careful management of livestock grazing and integrated weed management where appropriate. Conditions in these ecosystems can be improved by infrequent prescribed burning and allowing wildfires to burn where they can be controlled to prevent damage to homes.

4.d. General Recommendations for Roadside Fuel Treatments

Treatments along roadways require a dramatic reduction of fuels to create safe and survivable conditions. This includes removing most trees adjacent to the roadway, limbing remaining trees, and regularly mowing grass and shrubs (**Figure 4.c.1**). Treatments along roadways are often described as shaded fuelbreaks (Dennis, 2005).

The width of an effective roadway fuel treatments (distance to the left and right of a road) is dependent on slope. CSFS recommends that treatments extend 150 to 240 feet off the downhill side of the road and 100 to 150 feet off the uphill side. Wider treatments are necessary on the downhill side on steeper slopes due to the exacerbating effect of slope on fire intensity when fires travel uphill (**Table 4.c.**) (Dennis, 2005).

Along important evacuation routes that could experience extreme congestion, roadside treatments should be more aggressive and consist of near removal of all trees within at least 30 feet of roadways. Clearcutting along roads when surrounding forest remain dense can cause problems with snow drifting, so shaded fuelbreaks might be more appropriate in areas where drifting is more likely, or snow fences might need to be installed.

Some property owners find roadside fuel treatments aesthetically displeasing because of the removal of so many trees, but these treatments are vital for increasing the safety of property owners and firefighters in this community. Roadside treatments must dramatically reduce fuel loads to effectively reduce the risk of non-survivable conditions developing during wildfires.

It is vital to address slash following roadside fuel treatment. See **Section 4.e Approaches to Slash Management** for pros and cons of different slash management options.

Figure 4.c.1. *Effective roadway fuel treatments remove enough trees to result in widely space crowns, remove ladder fuels (seedlings, saplings, shrubs, and low limbs), and reduce surface fuels. The bottom images show a roadside fuel treatment conducted by the Colorado State Forest Service in 2012 along Mosquito Drive in CLRRA filing 15. Photo credits: Boulder Mountain Fire Protection District (top) and USDA/FPAC/GEO/Google Earth (bottom).*

Table 4.c.1. *Minimum fuel treatment width uphill and downhill from roads depends on the slope along the roadway[1]. Recommendations from the Colorado State Forest Service (Dennis, 2005).*

Percent slope (%)	Downhill distance (feet)	Uphill distance (feet)	Total fuel treatment width (feet)
0	150	150	300
10	165	140	305
20	180	130	310
30	195	120	315
40	210	110	320
50	225	100	325
60	240	100	340

[1]Measurements are from the toe of the fill for downhill distances and above the road cut for uphill distances. Distances are measured parallel to flat ground, not along the slope.

***Table 4.c.2**. Examples of conditions occurring along roadways in the CLFPD and suggestions for improvement.*

Roadway example	Suggestions for improvement
	• Remove dead trees that could fall on the roadway and block access • Remove shrubs and small conifers that could serve as ladder fuels • Create pullouts and turnaround locations to facilitate two-way traffic during evacuations
	• Regularly mow grasses along the side of the road • Retreat the area as trees regenerate to maintain at least 10-foot crown spacing • Remove all trees that could fall on overhead powerlines • Create pullouts and turnaround locations to facilitate two-way traffic during evacuations

Roadway example	Suggestions for improvement
	• Remove dead trees that could fall on the roadway and block access • Slope above and below road is about 20%, so thin large trees at least 180 feet on the downhill side of the road and at least 130 feet on the uphill side to create at least 10-foot crown spacing • Consider removing all trees within at least 20 feet of the road • Remove all limbs below 10 feet from the ground • Remove all small trees and shrubs that could serve as ladder fuels • Create pullouts and turnaround locations to facilitate two-way traffic during evacuations
	• Remove trees on each side of driveway to create at least 20-foot width for engine access • Remove limbs so there is at least 13.5 feet of vertical clearance for engine access • Remove enough trees to make home visible to firefighters so they can assess whether conditions are safe for entry during a wildfire • Ensure adequate space for an engine to turnaround at the end of the driveway • Install reflective address numbers on a noncombustible post

4.e. Slash Management Approaches

Forest management operations often increase surface fuel loads and can fail to achieve fire mitigation objectives if fuels created by the harvest activities (also known as slash) are not addressed (Agee and Skinner, 2005). Slash can include small trees, limbs, bark, and treetops. Slash management is a critical step in the forest management process. It is unwise, ineffective, and even dangerous to conduct poor-quality fuels treatments that fail to reduce canopy fuels, result in increased surface fuel loads, and do not receive maintenance treatments. Such treatments can lead to a false sense of security among property owners and fire suppression personnel (Dennis, 2005), and they divert limited funds away from more effective, strategic projects.

Leaving untreated slash within roadway fuel treatments is particularly counterproductive. The risk of active crown fire might be lower after a thinning operation, but untreated slash in fuel treatments can burn at high intensities and endanger the lives of property owners stuck on roadways during a wildfire. Slash is easier and cheaper to manage along roadways due to access, and roads can serve as highly effective holding features for controlled burning of grass in the spring and fall and pile burning in the winter.

Slash removal in this part of Colorado is quite difficult due to limited biomass and timber industries. Fortunately, the CLRRA has a slash depot for property owners; but the site cannot handle the tremendous load of material produced from large-scale thinning operations. Material is collected at the site and later burned under directions from Larimer County, Crystal Lakes Volunteer Fire Department, and the Red Feather Lakes Volunteer Fire Department in the winter when conditions are safe for burning.

Methods for managing slash come with different benefits and challenges (**Table 4.c.3**). For example, lop-and-scatter and mastication do not remove surface fuels from the site, they only rearrange them. It can take a decade or more for slash to decompose to a point where it no longer poses a significant fire hazard. Broadcast prescribed burning and pile burning are more effective at removing surface fuels, but they require extensive planning and expertise to conduct properly.

CLFPD and CLRRA should work together to review and update their slash management strategy for the area. This can and should include a combination of the following slash management techniques.

Broadcast Prescribed Burning

Broadcast prescribed burning is generally the most effective method to reducing surface, ladder, and canopy fuel loads. Prescribed burning mimics naturally occurring wildfire, can treat hundreds of acres at a time, consumes surface fuel, and is relatively cost-effective (Addington et al., 2018; Fulé et al., 2012; McIver et al., 2013; Prichard et al., 2020). Strategically-located prescribed burns can reduce property damage during wildfires by effectively reducing fuel loads (Loomis et al., 2019).

Broadcast burning can be safely and successfully conducted with proper planning and implementation by qualified firefighters. Broadcast burning requires careful planning and tactical decisions to prevent smoke from impacting sensitive populations and roadways. Broadcast burning is regulated in Colorado by the Division of Fire Prevention and Control, Department of Public Health and Environment, local sheriff's offices, and fire departments as outlined in the *2019 Colorado Prescribed Fire Planning and Implementation Policy Guide.*

Challenges with broadcast burning can include public concerns about risk from flames, embers, and smoke. There are often limited opportunities to conduct burns under appropriate fire weather conditions, and firefighters are often on wildfire assignments and unavailable to conduct burns.

Pile Burning

Pile burning is another effective way to remove surface fuels following forest management. However, CLRRA regulations currently prevent pile burning. In order to support completion of the mitigation actions recommended for homeowners and agencies in this document, CLRRA should consider judiciously relaxing slash burning prohibitions. Pile burning can be the best and sometimes only option for slash removal in steep, inaccessible areas, and incomplete slash management can leave an area just as at risk as an unmitigated area. Pile burning is appropriate on larger acreage parcels where piles can be burned at least 50 ft away from the nearest structure. In subdivisions made up of small parcels where homes are densely packed together, alternative slash management methods should be pursued.

Pile burning is different from broadcast burning; the overall complexity of pile burn operations is lower because fire activity is limited to discrete piles, and piles can be burned when snow covers the ground. Burning piles can produce embers, but the risk of these embers igniting spot fires or structures is low. Piles are typically burned on days with snowpack, high fuel moistures, and low to moderate wind speeds. Embers from burn piles travel shorter distances than embers from passive and active crown fires because the burning material is closer to the ground (Evans and Wright, 2017). In the rare occurrence that a wildfire encounters unburned piles, unintended ignition of the pile can exacerbate fire behavior, as was observed during the 2010 Fourmile Canyon Fire in Colorado (Evans and Wright, 2017).

Pile burning can be a safe and effective method to consume slash created by thinning operations. Photo credit: The Ember Alliance.

Challenges with pile burning can include public concerns about risk from flames, embers, and smoke. There are often limited opportunities to conduct pile burns because of requirements for snowpack and atmospheric ventilation. Intense heat from pile burning can sterilize soils and result in slow recovery of plants. Mitigation measures, such as raking the burnt soil and seeding with native plants, are sometimes warranted after pile burning if the soil was completely sterilized by extreme heat or if invasive species are prevalent in the area (Miller, 2015).

It is critical to properly construct piles either by hand or with machines and to burn them as soon as conditions allow (see the 2015 *Colorado pile construction guide* from the DFPC and CSFS for guidance). Unburnt slash piles can become a hazard during wildfires, especially if loose logs catch fire and roll down slopes. Burning older piles is less effective and does not consume as much material because piles become compact and lose fine fuels over time (Wright et al., 2019).

Individuals must apply for smoke permits from the Colorado Department of Public Health and Environment to burn piles and apply for open burn permits from the Larimer County Department of Health and Environment. In Larimer County, pile burning above 6,000 feet in elevation can only occur between October 1st and May 1st, when winds are less than 10 mph, and there are at least 3 inches of snow on the ground.

DFPC administers a certified burner program that provides civil liability protection to individuals planning and leading burns if smoke or flames cause damage. The burn must have been properly planned, approved, and executed to receive liability protection. The rigorous certification program requires individuals to complete 32-hours of training, pass an exam, lead at least three pile burns, complete a task book, and comply with all legal requirements for pile burning in Colorado. Visit The Ember Alliance web page for more resources about pile burning.

Air Curtain Burners

Air curtain burner operations in Divide, CO. Photo credit: The Ember Alliance.

Air curtain burners are machines that burn woody material cleanly in contained space. They typically consist of a box or trench into which slash is loaded and ignited. A strong fan blows a curtain of air down and over the burning material in a way that keeps oxygen flowing through the fire and keeps most smoke from escaping out the top. Carbon from the smoke is filtered out of the air and kept inside the box.

Air curtain burners can be used under a much wider range of conditions and locations than pile burning or broadcast burning. Air curtain burners can burn more kinds of slash than pile burning, including green wood, lumber, and general yard waste. Burning material is contained and can be extinguished with relative ease.

Air curtain burners can be an acceptable form of slash removal where there is not social license for pile or broadcast burning. They produce significantly less smoke than open burns and can be placed in accessible locations in the WUI.

Challenges with air curtain burners include their substantial upfront cost and the need for professional operators. They also come with effort to haul slash from treatment areas to the site of the air curtain burner. Nutrients are permanently removed from the treatment site, but they can be returned to the ground in the location of the burner if ash is removed and spread out.

Community Slash Piles

The CLRRA manages a community slash depot where property owners can take slash from their property. Material is collected at the site and later burned under directions from Larimer County, Crystal Lakes Volunteer Fire Department, and the Red Feather Lakes Volunteer Fire Department in the winter when conditions are safe for burning.

Community slash piles allow property owners to immediately reduce fuel loads on their property, and it eliminates the need for property owners to burn or chip their own material. However, it can be challenging for property owners to haul material from their properties to the slash pile.

The success of community slash piles is dependent on consistent management of the pile. If large slash piles are left in the community, they can pose a fire risk. Community slash piles also come with a cost for management and maintenance, but the cost is spread across all property owners and therefore lower than if individual property owners were to create and burn their own slash piles.

Woody material at the CLRRA slash depot waiting to be burned in the winter. Photo credit: The Ember Alliance.

Lop-and-Scatter

Lopping involves cutting limbs, branches, treetops, smaller-diameter trees, or other woody plant residue into shorter lengths. Scattering involves spreading lopped slash so it lies evenly and close to the ground. The lop-and-scatter approach reduces the height of slash relative to untreated slash, therefore increasing the distance between surface and canopy fuels (but not as effectively as broadcast prescribed burning or pile burning).

Lop-and-scatter can contribute to more intense fire behavior by not addressing increased surface fuel loads created by thinning (Agee and Skinner, 2005; Hunter et al., 2007). **Lop-and-scatter should not be utilized in HIZ 1, 2, or 3 or along roadways** because this method does not remove surface fuels from the site, it just rearranges them. Lop-and-scatter is better suited to areas with low slash accumulations and for stand-scale fuel treatment areas far away from homes.

Mastication or Chipping

Mastication involves using specialized machines like a tow-behind chipper or a hydro-ax to grind up standing saplings and shrubs and cut slash into medium-sized chips. Chipping involves processing slash through a mechanical chipper to break material into small chips or shreds. Mastication and chipping can reduce fire intensity and rates of spread by increasing the distance between surface and canopy fuels and suppressing the regrowth of grasses (Kreye et al., 2014).

However, unless material is hauled away after treatment, fuels are just rearranged, not reduced. Smoldering fires in masticated and chipped fuels can be difficult to suppress, produce abundant smoke, kill tree roots, and lead to spot fires if high winds reignite masticated fuels and blow them across containment lines (Kreye et al., 2014). Additionally, fuels left behind in mastication and chipping treatments are deeper and more compact than natural fuels (Kreye et al., 2014). Thus, they can impede plant regeneration, particularly when the depth of masticated and chipped fuels exceeds 4 inches (Jain et al., 2018).

Neighborhood chipping programs are cost-effective ways for communities to gain access to chippers without individuals paying for the unit and service each time they need it. Many communities create chipping programs where a chipper can be brought to anyone's property and chip the material there

for them to spread across their land again. CLRRA could host a chipping program for property owners as another cost-effective slash management option.

Hauling Material Offsite

Cut trees can be loaded on trucks and removed completely from the site, thereby immediately reducing fuel loads on the site. The destinations of removed trees are mills to be turned into boards, yard waste disposal sites to be composted and turned into garden soil or mulch, or the landfill.

Hauling material offsite can be expensive and labor intensive. There is a limited biomass and timber industry in Colorado, so material often costs more to transport than it is worth. Needles, bark, and small branches are often left behind, which means surface fuel loads can be greater after treatment than before. Hauling material outside the community can also spread insects like mountain pine beetles and emerald ash borer.

Utilizing Material for Firewood

Wood leftover from thinning operations can be used as firewood. Firewood needs to be "seasoned" before use, which involves splitting the wood into usable logs and drying it for 6-18 months. Homeowners can often manage preparing firewood themselves, so it can be an inexpensive way to manage slash. Utilizing material for firewood can relocate surface fuels from one site to another, but it increases fuel loads near a home until burned. **Firewood must be stored at least 30 feet and uphill of structures; otherwise, it can create hazardous conditions during a wildfire.**

If firewood is used locally, it reduces the chances of introducing non-native insects and diseases to the ecosystem that cause outbreaks and damage forest health. Transporting firewood outside the community is not recommended if there are insects like mountain pine beetles and emerald ash borer in the area.

Table 4.c.1. Many methods are available to remove slash created by forest thinning, each with their own benefits and challenges.

Method	Removes surface fuel from site	Restores ecosystem functions	Retains nutrients on the site	Expertise required to conduct	Effort to conduct	Relative cost / acre	Total time to plan and conduct
Broadcast prescribed burning	✓	✓	✓	Very high	Very high	$$$	Months to years
Pile burning on site	✓		✓	Moderate	Moderate to high	$$	Weeks to months
Air curtain burner	✓			High	Moderate	$$$$ (upfront)	Weeks to months
Community slash pile	✓			Low to moderate	Moderate	$$	Ongoing
Lop-and-scatter			✓	Low to moderate	Moderate	$ - $$	Weeks to months
Mastication or chipping	(✓)		✓	High	Moderate to high	$$$	Weeks to months
Hauling material away	✓			Low to moderate	High	$$ - $$$	Weeks to months
Utilizing material for firewood	(✓)			Low	Low to moderate	$	Days to weeks

Note: Mastication and chipping only remove surface fuel from the site if material is hauled away after treatment. Utilizing material for firewood can relocate surface fuels from one site to another but increase fuel loads near a home until burned.

4.f. Logistics of Treatment Implementation

Roles and Responsibilities

Homeowners are responsible for fuel mitigation on their own lands, including along their private driveways. Property owners must initiate and follow through on this work, but that does not mean they must do it alone. For assistance in planning and implementing fuel treatments, contact the Larimer Conservation District, Colorado State Forest Service, Coalition for the Poudre River Watershed, or other wildfire mitigation specialists. Tree cutting with a chainsaw and other forestry equipment should be done by experienced and certified individuals. The Colorado State Forest Service provides guidance for how to select a contractor for forest management.

For fuel treatments to effectively mitigate wildfire risk, property owners and land managers must cooperate to implement cross-boundary treatments. If you live adjacent to Forest Service land, mitigating your property can create an anchor point for the USFS to build off. The wildfire risk is shared among property owners in CLFPD and land managers, so the responsibility to mitigate that risk must also be shared.

Stand-level fuel treatments in community green belts can be planned by the CLRRA. This includes using this CWPP to determine priority locations, writing grants to subsidize the cost, communicating with all property owners about the work, and identifying contractors to complete the work. The CLRRA is already working with partners like the Larimer County Sheriff's Office Initial Attack Module to conduct fuel treatments on green belts, and they submitted a grant to FEMA to fund additional treatments across the community. The U.S. Forest Service is currently planning for fuel treatments on the Arapaho-Roosevelt National Forest adjacent to the CLFPD, and they were consulted during the development of treatment priorities for this CWPP.

The responsibility for conducting roadside fuel treatments depends on the location of the road. Homeowners are responsible for treatments along their private driveways. CLRRA can initiate treatments along roads within the CLRRA boundary. Treatments along country roads like Creedmore Lakes Road need to be coordinated with the Larimer County Road and Bridge Department. **Cooperation from private property owners is necessary for effective roadside fuel treatments; roadside easements for CLRRA are rarely wide enough to satisfy the minimum of 150 feet treatment depth on each side of roads.**

Treatment Costs

The cost of fuel treatment depends on management objectives, treatment specifications, slope, accessibility, and treatment method (e.g., mechanical thinning, hand thinning, or prescribed burning). Costs of $2,500 to $10,000 per acre are not uncommon along the Colorado Front Range where there is little biomass or timber industry to provide financial return (Gannon et al., 2019). Follow-up treatments are generally less expensive than the initial entry and help maintain the efficacy of the original treatment investment.

Since fuel treatments are expensive, it is important to conduct strategic, well-designed, landscape-scale treatments to increase the likelihood that fuel treatments modify fire behavior, save lives, and restore ecosystems. Fuel treatments can reduce property damages by making wildfires less damaging and easier to control; this is especially true for prescribed burning which is often cheaper and more effective at altering forest fuel loads than mechanical thinning alone (Fulé et al., 2012; Loomis et al., 2019; Prichard et al., 2020). Proactive management of forests can also reduce the cost of rehabilitating water sources when wildfires are followed by large storms and result in massive erosion (Jones et al., 2017). Fuel treatments can also reduce suppression costs due to the increased efficiency of firefighting (Loomis et al., 2019).

Longevity of Fuel Treatment Benefits

Benefits of fuel treatments are not permanent and decrease overtime, with treatment "lifespan" depending on forest type, topography, rates of seedling regeneration (which is often influenced by precipitation), and the number of trees removed during treatments. Many forests require more than one treatment to reduce fuels and restore ecosystem structure. Some areas might require mechanical tree removal followed by prescribed burning, and then a maintenance treatment with tree removal and/or prescribed burning 10 to 20 years later. With a single pulse of tree regeneration, the risk of torching returns to near pre-treatment levels within 10 to 35 years in ponderosa pine forests in Colorado (Tinkham et al., 2016).

5. The Future of the CWPP and Implementation Plan

Below are strategic actions for CLFPD, CLRRA, property owners, public land managers, county, state, and federal agencies, and non-profit conservation groups to accomplish in the short-, mid-, and long-term (see definitions below). Some activities have low financial cost but require a fundamental shift in attitudes and behavior to prioritize wildfire risk mitigation. Other actions are more substantial and require commitment and collaboration across the community to pool resources, apply for grants, and make incremental steps towards meaningful change. Many of these recommendations are aspirational and will require expanded capacity and funding, as well as patience and hard work from community members and leaders to make lasting changes.

5.a. Implementation Phases

Immediate Action	Short-Term Action	Mid-Term Action
• Has the highest potential for immediate return-on-investment • Can be funded within the current capacity of CLFPD and CLRRA with some supplemental funding from grants available in the next 18 – 24 months (such as CWDG) • Can occur with modest expansion of the current CLFPD and CLRRA volunteer organizations • Can capitalize on current relationships with emergency response partners, land management agencies, non-profit organizations	• Requires moderate expansion of financial and implementation capacity of CLFPD and CLRRA • Requires new cooperative relationships with emergency response partners, land management agencies, and non-profit organizations • Requires greater level of coordination among partners • Requires greater level of community discussion and decision making	• Requires multi-year planning and funding • Requires extensive grant funding • Requires substantial expansion of financial and implementation capacity of CLFPD and CLRRA • Requires substantial coordination among partners • Requires substantial community discussion and decision making

5.b. Implementation Activities and Responsibilities

Recommendation	Responsibility	Priority
Category: Fire Adapted Communities		
Host an annual wildfire education day that is open to all property owners within CLFPD.	CLRRA, CLFPD	Immediate
Adopt the Fire Adapted Communities as the overarching vision and strategy for CWPP implementation.	CLRRA, CLFPD, property owners	Immediate
Strive to become a Firewise community.	CLRRA, CLFPD	Short-term
Category: District Capacity		
Become a volunteer with the CLFPD to inspire fellow property owners to engage in wildfire mitigation and emergency preparedness.	Property owners	Immediate
Continue coordination between CLFPD and CLRRA around wildfire mitigation and emergency preparedness to pool resources and avoid duplicated efforts.	CLRRA, CLFPD	Immediate
Cooperate with adjacent fire protection districts to establish a cooperative paid position to increase capacity.	CLFPD	Short-term
Category: Outreach		
Improve the CLRRA and CLFPD websites, social media, and other outreach materials to increase property owner awareness of wildfire risk and resources available for mitigation.	CLRRA, CLFPD	Immediate
Form a volunteer group called the CWPP Implementation Committee, or other mutually agreeable name to continue momentum developed by the CWPP. Expand CLRRA Greenbelt Management Committee to include wildfire mitigation implementation efforts.	Greenbelt Management Committee (GBC)	Immediate
Inform property owners about ecological benefits of restoration-style fuel treatments.	CLRRA, GBC, USFS, other partners	Immediate
Conduct targeted outreach efforts to property owners in all filings with special emphasis in HIZ hazards (Especially filings 3, 4, 6, 9, and 14). See **Section 3.b** for specific recommendations for these filings.	CLRRA, CLFPD	Immediate

Recommendation	Responsibility	Priority
Discuss shared risk and encourage neighborhood-wide implementation of defensible space, for example through walking tours of well-mitigated properties.	CLRRA, property owners	Immediate
Provide welcome packets to new property owners with information on wildfire preparedness.	CLRRA	Immediate
Encourage wider participation in the CLFPD email list so property owners can receive information on local events, fire conditions, and safety information.	CLRRA, CLFPD	Immediate
Create informational video summarizing wildfire mitigation and make it available on the CLRRA and CLFPD websites.	CLRRA, CLFPD	Short-term
Category: Home Ignition Zone		
Engage in annual maintenance of your HIZ.	Property owners	Immediate
Establish defensible space around homes, detached garages, storage buildings, barns, and other structures so that the home can stand alone without relying on limited firefighting resources. Follow recommendations in the CSFS The Home Ignition Zone and this CWPP.	Property owners	Immediate
Advocate for CLRRA regulations that align with the CSFS The Home Ignition Zone and more strict WUI codes. If you live in Pearl Creek Estates, Poudre Meadows, or Elkridge Ranches, speak to your HOA representatives about this.	Property owners	Immediate
Annually mow grass and remove regenerating trees from around the camper/RV/trailer staging area in filing 15.	CLRRA	Immediate
Increase capacity to conduct home assessments to provide specific recommendations to individual homeowners.	CLFPD and CLRRA volunteers, shared mitigation specialist	Short-term
Host HIZ training for contractors so they can be familiar with best practices for defensible space creation.	CLRRA and other partners	Short-term
Replace flammable material on the CLRRA Base Camp and strengthen defensible space so the Base Camp can serve as a model for HIZ mitigation. As maintenance is required on the building, replace older materials with non-combustible materials.	CLRRA	Mid-term

Recommendation	Responsibility	Priority
Category: Linked Defensible Space and Fuel Treatments		
Re-activate the "Adopt a Greenbelt" program to continue mitigating fuels on CLRRA property. Consider expanding program to include volunteer days to help property owners with their own defensible space creation.	CLRRA	Immediate
Work together to pool financial and other resources and pursue grants to mitigate wildfire risk across the community.	CLRRA, CLFPD, GBC, property owners	Immediate
Continued maintenance of homes and treatments that have been implemented.	GBC, property owners, USFS, other partners	Immediate
Focus initial efforts on mitigating fire risk in CWPP priority project areas, with a focus on treatment methods to restore ecological conditions.	CLRRA, CLFPD, USFS, other partners	Short-term
Build off the CWPP to identify projects that improve linked defensible space and create mosaic landscapes.	CLRRA, property owners	Short-term
Continue collaborating with large landowners and public lands to conduct priority fuel treatments.	CLRRA, USFS	Short-term
Category: Slash Management		
Re-examine the current slash management strategy in the CLFPD. Consider judiciously relaxing pile burning prohibitions in CLRRA. Pile burning can be the best and sometimes only option for slash removal in steep, inaccessible areas. For more information about pile burning refer to **Section 3.e**. Pile burning is appropriate on larger acreage parcels where piles can be burned at least 50 ft away from the nearest structure. In subdivisions made up of small parcels where homes are densely packed together, alternative slash management methods should be pursued.	CLRRA, CLFPD	Immediate
Apply for grant funding that could subsidize the costs of the current slash disposal site so it can be available to property owners at a reduced cost or even free.	CLRRA, CLFPD	Short-term
Apply for grant funding to implement a slash pick up program for property owners (to pick up and transport slash to the disposal site).	CLRRA, CLFPD	Short-term

Recommendation	Responsibility	Priority
Apply for grant funding to implement a community chipping program so property owners can chip material on their property.	CLRRA, CLFPD, in coordination with surrounding FPDs	Mid-term
Category: Evacuation Preparedness		
Develop a family evacuation plan and go-bags. Plans should include considerations of pets and livestock if applicable.	Property owners	Immediate
Cooperate with neighbors to develop plans for evacuating children who may be home alone or property owners with mobility impairments or other special needs.	Property owners	Immediate
Educate property owners with campers that they need to leave during voluntary evacuation orders if they plan to haul out their camper.	CLFPD, CLRRA	Immediate
Increase property owner awareness of evacuation planning, processes, and NOCO Alert.	CLFPD, CLRRA	Immediate
Sign up for emergency notification through NOCO Alert.	Property owners	Immediate
Provide access to water supplies when evacuating for firefighters to use if. Property owners must NOT turn on sprinklers during evacuation.	Property owners	Immediate
Cooperate with emergency response partners to conduct district-wide evacuation drills.	CLFPD, emergency response partners	Immediate
Continue conversations about evacuation planning for the community, including alternative evacuation routes.	CLFPD, CLRRA, LCSO Emergency Services	Immediate
Category: Firefighter Access and Evacuation Safety		
Replace burnable, non-reflective address numbers with reflective signs available from the CLFPD.	Property owners	Immediate
Mount address numbers on non-burnable posts or on rocks, not on stumps, and not on chains across driveways that might be taken down by firefighters during structure protection actions.	Property owners	Immediate
Develop standards for cistern and pipe compatibility to ensure that private water resources are compatible with the Crystal Lakes Fire Department's equipment.	CLFPD, CLWSA, CLRRA	Immediate

Recommendation	Responsibility	Priority
Replace wooden street signs throughout CLRRA with metal, reflective signs so they are non-flammable and visible to firefighters at night and with thick smoke from wildfires.	CLRRA	Short-term
Improve driveway access for firefighters (e.g., widen driveways, fill potholes, remove and limb trees along driveways, create turnarounds at end of driveways).	Property owners	Short-term
Create pullouts and turnarounds on narrow roads throughout CLRRA for emergency vehicles.	CLRRA	Short-term
Coordinate efforts to mitigate hazardous conditions along roadways.	CLFPD, LCSO, County Road & Bridge, USFS	Short-term

5.c. CWPP as a Living Document

The CSFS requires CWPPs to be updated on a regular basis. It is recommended to update them every 5 years, at minimum. CWPPs greater than 10 years old are outdated and can exclude communities from successfully applying for competitive funding opportunities.

The update to this plan can either be a preface to this document or a new document that integrates with this one. The update to this plan must include:

- A description of progress made since the CWPP was created.
- A description of demographic changes in the community and other important infrastructure changes.
- Identification of new risks in the community.
- Updated risk analysis if major changes have happened between revisions.
- Updated and prioritized projects for the community with maps and descriptions.

The suggested review process by CSFS involves:

- Reviewing the existing CWPP
- Engaging partners that have a vested interest in the plan
- Hosting collaborative meetings
- Documenting completed projects and demographic and landscape changes
- Developing updated wildfire risk reduction priorities
- Updating maps
- Distributing updated drafts to key partners for review and input prior to final approval
- Finalizing with core team signatures and submit to CSFS State Office

The Crystal Lakes CWPP is a **call to action!** Becoming a fire adapted community and decreasing wildfire risk takes effort, time, and coordination. Use the risk analyses and implementation recommendations from the CWPP to spark action on your property and across your neighborhood and entire community. The need to protect lives, safety, and property from wildfire is too great to wait.

6. Glossary

20-foot wind speed: The rate of sustained wind over a 10-minute period at 20 feet above the dominant vegetation. The wind adjustment factor to convert surface winds to 20-foot wind speeds depends on the type and density of surface fuels slowing down windspeeds closer to the ground (NWCG, 2021).

Active crown fire: Fire in which a solid flame develops in the crowns of trees and advances from tree crown to tree crown independently of surface fire spread (NWCG, 2018b).

ArcCASPER: An intelligent capacity-aware evacuation routing algorithm used in the geospatial information system mapping program ArcMap to model evacuation times and congestion based on roadway capacity, road speed, number of cars evacuating per address, and the relationship between roadways congestion and reduction in travel speed (Shahabi and Wilson, 2014).

Basal area: Cross sectional area of a tree measured at breast height (4.5 feet above the ground). Used as a method of measuring the density of a forest stand in units such as ft^2/acre (USFS, 2021b).

Broadcast prescribed burning (aka, prescribed burn, controlled burn, prescribed fire): A wildland fire originating from a planned ignition in accordance with applicable laws, policies, and regulations to meet specific objectives (NWCG, 2018b).

Canopy base height (CBH): The average height from the ground to a forest stand's canopy bottom. CBH is the lowest height in a stand at which there is sufficient forest canopy fuel to propagate fire vertically into the canopy. Ladder fuels such as lichen, dead branches, and small trees are incorporated into measurements of CBH. Forests with lower canopy base heights have a higher risk of torching (NWCG, 2019).

Canopy fuels: The stratum of fuels containing the crowns of the tallest vegetation (living or dead), usually above 20 feet (NWCG, 2018b).

Canopy: The more or less continuous cover of branches and foliage formed collectively by adjacent tree crowns (USFS, 2021b).

Canyon: A long, deep, very steep-sided topographic feature primarily cut into bedrock and often with a perennial stream at the bottom (NRCS, 2017).

Chain: Chains are commonly used in forestry and fire management as a measure of distance. 1 chain is equivalent to 66 feet. Chains were used for measurements in the initial public land survey of the U.S. in the mid-1800s.

Chute: A steep V-shaped drainage that is not as deep as a canyon but is steeper than a draw. Normal upslope air flow is funneled through a chute and increases in speed, causing upslope preheating from convective heat, thereby exacerbating fire behavior (NWCG, 2008).

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 governments, local fire departments, other partners, and federal land management agencies in the vicinity of the planning area. CWPPs identify and prioritize areas for hazardous fuel reduction treatments, recommend 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 recommend measures to reduce structural ignitability throughout the at-risk community. A CWPP may address issues such as wildfire response, hazard mitigation, community preparedness, and structure protection (NWCG, 2018b).

Convection: A type of heat transfer that occurs when a fluid, such as air or a liquid, is heated and travels away from the source, carrying heat along with it. Air around and above a wildfire expands as it is heated, causing it to become less dense and rise into a hot convection column. Cooler air flows in to replace the rising gases, and in some cases, this inflow of air creates local winds that further fan the flames. Hot convective gases move up slope and dry out fuels ahead of the flaming front, lowering their ignition temperature and increasing their susceptibility to ignition and fire spread. Homes located at the top of a slope can become preheated by convective heat transfer. Convection columns from wildfires carry sparks and embers aloft.

Crown (aka, tree crown): Upper part of a tree, including the branches and foliage (USFS, 2021b).

Defensible space: The area around a building where vegetation, debris, and other types of combustible fuels have been treated, cleared, or reduced to slow the spread of fire and reduce exposure to radiant heat and direct flame. It is encouraged that property owners develop defensible space so that during a wildfire their home can stand alone without relying upon limited firefighter resources due to the great reduction in hazards they have undertaken. The Colorado State Forest Service defines three zones of defensible space: zone 1 (HIZ 1) as 0 to 5 feet from the home, zone 2 (HIZ 2) as 5 to 30 feet from the home, and zone 3 (HIZ 3) as 30 to about 100 feet from the home (CSFS, 2021).

Direct attack: Any treatment applied directly to burning fuel such as wetting, smothering, or chemically quenching the fire or by physically separating the burning from unburned fuel (NWCG 2018b).

Draws: Topographic features created by a small, natural watercourse cutting into unconsolidated materials. Draws generally have a broader floor and more gently sloping sides than a ravine or gulch (NRCS, 2017).

Ecological restoration: The process of assisting the recovery of an ecosystem that has been damaged, degraded, or destroyed (SER, 2004). In ponderosa pine and dry mixed-conifer forests of the Colorado Front Range, ecological restoration involves transforming dense forests into a mosaic of single trees, clumps of trees, and meadows similar to historic forests that were maintained by wildfires and very resilient to them (Addington et al., 2018).

Ember: Small, hot, and carbonaceous particles. The term "firebrand" is also used to connote a small, hot, and carbonaceous particle that is airborne and carried for some distance in an airstream (Babrauskas, 2018).

Ember cast: The process of embers/firebrands/flaming sparks being transported downwind beyond the main fire and starting new spot fires and/or igniting structures. Short-range ember cast is when embers are carried by surface winds and long-range ember cast is when embers are carried high into the convection column and fall out downwind beyond the main fire. The number of embers reaching an area decreases exponentially with distance traveled, and the likelihood of structure ignition increases with the number of embers landing on receptive fuels (Caton et al., 2016). The distance used to differentiate short-range and long-range ember cast varies among sources. NWCG (2018b) classifies short-range ember cast as embers that travel less than 0.25 miles and long-range ember cast as embers that travel more than 0.25 miles, whereas Beverly et al., (2010) use a threshold of 0.06 miles. We use the Beverly et al., (2010) definition in this CWPP.

Fire adapted community (FAC): A human community consisting of informed and prepared citizens collaboratively planning and taking action to safely coexist with wildland fire (NWCG, 2018b). There is not a checklist or one silver bullet to become a FAC; there are many strategic actions and tools that should be used together to reduce shared risk. Risk mitigation is the responsibility of everyone who lives and works in the community—property owners, community groups, fire protection districts,

agency partners, non-governmental organizations, etc. Fire adaptation is an ongoing process of collaborative action to identify risk, mitigate it, and maintain the work overtime.

Fire behavior: The manner in which a fire reacts to the influences of fuel, weather, and topography. Characteristics of fire behavior include rate of spread, fire intensity, fire severity, and fire behavior category (NWCG, 2018b).

Fire history: A general term referring to the historic fire occurrence in a specific geographic area (NWCG, 2018b).

Fire intensity (aka, fireline intensity): (1) The product of the available heat of combustion per unit of ground and the rate of spread of the fire, interpreted as the heat released per unit of time for each unit length of fire edge, or (2) the rate of heat release per unit time per unit length of fire front (NWCG, 2018b).

Fire regime: Description of the patterns of fire occurrences, frequency, size, and severity in a specific geographic area or ecosystem. A fire regime is a generalization based on fire histories at individual sites. Fire regimes can often be described as cycles because some parts of the histories usually get repeated, and the repetitions can be counted and measured, such as fire return interval (NWCG, 2018b).

Fire severity. Degree to which a site has been altered or disrupted by fire; loosely, a product of fire intensity and residence time (NWCG, 2018b). Fire severity is determined by visually inspecting or measuring the effects that wildfire has on soil, plants, fuel, and watersheds. Fire severity is often classified as low-severity (less than 20% of overstory trees killed) and high severity (more than 70% of overstory trees kills). Moderate-severity or intermediate fire severity falls between these two extremes (Agee, 1996). Specific cutoffs for fire severity classifications differ among researchers. For example, Sherriff et al. (2014) define high-severity fires as those killing more than 80% of overstory trees.

Fire weather conditions: Weather conditions that influence fire ignition, behavior, and suppression, for example, wind speed, wind direction, temperature, relative humidity, and fuel moisture (NWCG, 2018b).

Firebreak: A natural or constructed barrier where all vegetation and organic matter have been removed down to bare mineral soil. Firebreaks are used to stop or slow wildfires or to provide a control line from which to work (Bennett et al., 2010; NWCG, 2018b).

FireFamilyPlus: A software application that provides summaries of fire weather, fire danger, and climatology for one or more weather stations extracted from the National Interagency Fire Management Integrated Database (NWCG, 2018b).

Fireline: (1) The part of a containment or control line that is scraped or dug to mineral soil, or (2) the area within or adjacent to the perimeter of an uncontrolled wildfire of any size in which action is being taken to control fire (NWCG, 2018b).

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 measured on an angle when the flames are tilted due to effects of wind and slope. Flame length is an indicator of fire intensity (NWCG, 2018b).

FlamMap: A fire analysis desktop application that can simulate potential fire behavior and spread under constant environmental conditions (weather and fuel moisture) (Finney, 2006). FlamMap is one of the most common models used by land managers to assist with fuel treatment prioritization, and it is often used by fire behavior analysts during wildfire incidents.

Fuel model: A stylized set of fuel bed characteristics used as input for a variety of wildfire modeling applications to predict fire behavior (Scott and Burgan, 2005).

Fuel reduction: Manipulation, combustion, or removal of fuels to reduce the likelihood of ignition and/or to lessen potential damage from wildfires and resistance to control (NWCG, 2018b).

Fuelbreak: A natural or manmade change in fuel characteristics which affects fire behavior so that fires burning into them can be more readily controlled. Fuelbreaks differ from firebreaks due to the continued presence of vegetation and organic soil. Trees in shaded fuelbreaks are thinned and pruned to reduce the fire potential but enough trees are retained to make a less favorable microclimate for surface fires (NWCG, 2018b).

Fuels mitigation / management: The 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 (NWCG, 2018b).

Fuels: Any combustible material, most notably vegetation in the context of wildfires, but also including petroleum-based products, homes, and other man-made materials that might combust during a wildfire in the wildland-urban interface. Wildland fuels are described as 1-, 10-, 100-, and 1000-hour fuels. One-hour fuels are dead vegetation less than 0.25 inch in diameter (e.g., dead grass), ten-hour fuels are dead vegetation 0.25 inch to 1 inch in diameter (e.g., leaf litter and pine needles), one hundred-hour fuels are dead vegetation 1 inch to 3 inches in diameter (e.g., fine branches), and one thousand-hour fuels are dead vegetation 3 inches to 8 inches in diameter (e.g., large branches). Fuels with larger diameters have a smaller surface area to volume ratio and take more time to dry out or become wetter as relative humidity in the air changes (NWCG, 2018b).

Handcrews: A number of individuals that have been organized and trained and are supervised principally for operational assignments on an incident (NWCG 2018b).

Handline: Fireline constructed with hand tools (NWCG 2018b).

Hazards: Any real or potential condition that can cause injury, illness, or death of personnel, or damage to, or loss of equipment or property (NWCG, 2018b).

Home hardening: Steps taken to improve the chance of a home and other structures withstanding ignition by radiant and convective heat and direct contact with flames or embers. Home hardening involves reducing structure ignitability by changing building materials, installation techniques, and structural characteristics of a home (California Fire Safe Council, 2020). A home can never be made fireproof, but home hardening practices in conjunction with creating defensible space increases the chance that a home will survive a wildfire.

Home ignition zone (HIZ): The characteristics of a home and its immediate surroundings within 100 feet of structures. Conditions in the HIZ principally determine home ignition potential from radiant heat, convective heat, and embercast (NWCG, 2018b).

Ignition-resistant building materials: Materials that resist ignition or sustained flaming combustion. Materials designated ignition-resistant have passed a standard test that evaluates flame spread on the material (Quarles, 2019; Quarles and Pohl, 2018).

Incident Response Pocket Guide (IRPG): Document that establishes standards for wildland fire incident response. The guide provides critical information on operational engagement, risk management, all hazard response, and aviation management. It provides a collection of best practices that have evolved over time within the wildland fire service (NWCG, 2018a).

Indirect attack A method of suppression in which the control line is located some considerable distance away from the fire's active edge. Generally done in the case of a fast-spreading or high-

intensity fire and to utilize natural or constructed firebreaks or fuelbreaks and favorable breaks in the topography. The intervening fuel is usually backfired; but occasionally the main fire is allowed to burn to the line, depending on conditions (NWCG 2018b).

Insurance Services Office (ISO) rating: ISO ratings are provided to fire departments and insurance companies to reflect how prepared a community is for fires in terms of local fire department capacity, water supply, and other factors (see more information online at https://www.isomitigation.com/ppc/fsrs/).

Ladder fuels: Fuels that provide vertical continuity between strata, thereby allowing fire to carry from surface fuels into the crowns of trees with relative ease. Ladder fuels help initiate torching and crowning and assure the continuation of crowning. Ladder fuels can include small trees, brush, and lower limbs of large trees (NWCG, 2018b).

LANDFIRE: A national program spearheaded by the U.S. Department of the Interior and the U.S. Department of Agriculture to provide spatial products characterizing vegetation, fuels, fire regimes, and disturbances across the entire United States. LANDFIRE products serve as standardized inputs for fire behavior modeling. More information about the program is available online at https://www.landfire.gov/.

Lop-and-scatter: Cutting (lopping) branches, tops, and unwanted boles into shorter lengths and spreading that debris evenly over the ground such that resultant logging debris will lie close to the ground (NWCG, 2018b).

Mastication: A slash management technique that involves using a machine to grind, chop, or shred vegetation into small pieces that then become surface fuel (Jain et al., 2018).

Mitigation actions: Actions that are implemented to reduce or eliminate (mitigate) risks to persons, property, or natural resources. These actions can be undertaken before and during a wildfire. Actions before a fire include fuel treatments, vegetation modification in the home ignition zone, and structural changes to increase the chance a structure will survive a wildfire (aka, home hardening). Mitigation actions during a wildfire include mechanical and physical tasks, specific fire applications, and limited suppression actions, such as constructing firelines and creating "black lines" through the use of controlled burnouts to limit fire spread and behavior (NWCG, 2018b).

Mosaic landscape: A heterogeneous area composed of different communities or a cluster of different ecosystems that are similar in function and origin in the landscape. It consists of 'patches' arranged in a 'matrix', where the patches are the different ecosystems and the matrix is how they are arranged over the land (Hansson et al., 1995).

National Wildfire Coordinating Group (NWCG): An operational group established in 1976 through a Memorandum of Understanding between the U.S. Department of Agriculture and Department of the Interior to coordinate programs of the participating agencies to avoid wasteful duplication and to provide a means of constructively working together. NWCG provides a formalized system and agreed upon standards of training, equipment, aircraft, suppression priorities, and other operational areas. More information about NWCG is available online at https://www.nwcg.gov/.

Noncombustible building materials: Material of which no part will ignite or burn when subjected to fire or heat, even after exposure to moisture or the effects of age. Materials designated noncombustible have passed a standard test (Quarles, 2019; Quarles and Pohl, 2018).

Non-survivable road: Portions of roads adjacent to areas with predicted flame lengths greater than 8 feet under severe fire weather conditions. Potentially non-survivable flame lengths start at 8 feet according to the Haul Chart, which is a standard tool used by firefighters to relate flame lengths to tactical decisions (NWCG, 2019). Drivers stopped or trapped on these roadways would have a low

chance of surviving radiant heat from fires of this intensity. Non-survivable conditions are more common along roads that are lined with thick forests, particularly with trees that have limbs all the way to the ground and/or abundant saplings and seedlings.

Overstory: Layer of foliage in a forest canopy, particularly tall mature trees that rise above the shorter immature understory trees (USFS, 2021b).

Passive crown fire: Fire that arises when surface fire ignites the crowns of trees or groups of trees (aka, torching). Torching trees reinforce the rate of spread, but passive crown fires travel along with surface fires (NWCG, 2018b).

Pile burning: Piling slash resulting from logging or fuel management activities into manageable piles that are subsequently burned during safe and approved burning conditions (NWCG, 2018b).

Potential operational delineations (PODs): PODs are topographic areas bounded by features suitable for fire control (e.g., ridgetops and roads) that can be used for proactive wildfire decision making and tactical operations during wildfire events. PODs can serve as management units for proactive ecological restoration and wildfire risk mitigation, as well as for cross-boundary and collaborative land and fire management planning (Thompson et al., 2022).

Radiation: A method of heat transfer by short-wavelength energy through air (aka, infrared radiation). Surfaces that absorb radiant heat warm up and radiate additional short-wavelength energy themselves. Radiant heat is what you feel when sitting in front of a fireplace. Radiant heat preheats and dries fuels adjacent to the fire, which initiates combustion by lowering the fuel's ignition temperature. The amount of radiant heat received by fuels increases as the fire front approaches. Radiant heat is a major concern for the safety of wildland firefighters and can ignite homes without direct flame contact.

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. Rate of spread is usually expressed in chains or acres per hour for a specific period in the fire's history (NWCG, 2018b).

Ravine: Topographic features created by streams cutting into unconsolidated materials and that are narrow, steep-sided, and commonly V-shaped. Ravines are steeper than draws (NRCS, 2017).

Remote Automatic Weather Stations (RAWS): A weather station that transmits weather observations via satellite to the Wildland Fire Management Information system (NWCG, 2018b).

Risk: (1) The chance of fires starting as determined by the presence and activity of causative agents (e.g., lightning), (2) a chance of suffering harm or loss, or (3) a causative agent (NWCG, 2018b).

Roadway fuel treatment: A natural or manmade change in fuel characteristics along a roadway which affects fire behavior so that fires burning into them can be more readily controlled, survivable conditions with shorter flame lengths are more likely during a wildfire, and firefighter access is enhanced (NWCG, 2018b).

Saddle: A low point on a ridge or interfluve, generally a divide or pass between the heads of streams flowing in opposite directions. The presence of a saddle funnels airflow and increases windspeed, thereby exacerbating fire behavior (NRCS, 2017).

Safety zones: An area cleared of flammable materials used by firefighters for escape in the event the line is outflanked or spot fires outside the control line render the line unsafe. In firing operations, crews progress so as to maintain a safety zone close at hand, allowing the fuels inside the control line to be consumed before going ahead. Safety zones may also be constructed as integral parts of

fuelbreaks; they are greatly enlarged areas which can be used with relative safety by firefighters without the use of a fire shelter (NWCG, 2018b).

Shaded fuelbreak: Fuel treatments in timbered areas where the trees on the break are thinned and pruned to reduce fire potential yet enough trees are retained to make a less favorable microclimate for surface fires (NWCG, 2018b).

Slash: Debris resulting from natural events such as wind, fire, or snow breakage or from human activities such as road construction, logging, pruning, thinning, or brush cutting. Slash includes logs, bark, branches, stumps, treetops, and broken understory trees or brush (NWCG, 2018b).

Smoldering combustion: The combined processes of dehydration, pyrolysis, solid oxidation, and scattered flaming combustion and glowing combustion, which occur after the flaming combustion phase of a fire; often characterized by large amounts of smoke consisting mainly of tars (NWCG, 2018b).

Spot fire: Fire ignited outside the perimeter of the main fire by an ember (NWCG, 2018b). Spot fires are particularly concerning because they can form a new flaming front, move in unanticipated directions, trap firefighters between two fires, and require additional firefighting resources to control.

Spotting: Behavior of a fire producing sparks or embers that are carried by the wind and start new fires beyond the zone of direct ignition by the main fire (NWCG, 2018b).

Stand: An area of forest that possesses sufficient uniformity in species composition, age, size, structural configuration, and spatial arrangement to be distinguishable from adjacent areas (USFS, 2021b).

Structure protection: The protection of homes or other structures from an active wildland fire (NWCG, 2018b).

Structure triage: The process of inspecting and classifying structures according to their defensibility or non-defensibility, based on fire behavior, location, construction, and adjacent fuels. Structure triage involves a rapid assessment of a dwelling and its immediate surroundings to determine its potential to escape damage by an approaching wildland fire. Triage factors include the fuels and vegetation in the yard and adjacent to the structure, roof environment, decking and siding materials, prevailing winds, topography, etc. (NWCG, 2018b). There are four categories used during structure triage: (1) defensible – prep and hold, (2) defensible – stand alone, (3) non-defensible – prep and leave, and (4) non-defensible – rescue drive-by. The most important feature differentiating defensible and non-defensible structures is the presence of an adequate safety zone for firefighters (NWCG 2018a). Firefighters conduct structure triage and identify defensible homes during wildfire incidents. Categorization of homes are not pre-determined; triage decisions depend on fire behavior and wind speed due to their influence on the size of safety zones needed to keep firefighters safe.

Suppression: The work and activity used to extinguish or limit wildland fire spread (NWCG, 2018b).

Surface fire: Fire that burns fuels on the ground, which include dead branches, leaves, and low vegetation (NWCG, 2018b).

Surface fuels: Fuels lying on or near the ground, consisting of leaf and needle litter, dead branch material, downed logs, bark, tree cones, and low stature living plants (NWCG, 2018b).

Task book: A document listing the performance requirements (competencies and behaviors) for a position in a format that allows for the evaluation of individual (trainee) performance to determine if an individual is qualified in the position. Successful performance of tasks, as observed and recorded

by a qualified evaluator, will result in a recommendation to the trainee's home unit that the individual be certified in the position (NWCG, 2018b).

Torching: The burning of the foliage of a single tree or a small group of trees from the bottom up. Torching is the type of fire behavior that occurs during passive crown fires and can initiate active crown fires if tree canopies are close to each other (NWCG, 2018b).

Values at risk: Aspects of a community or natural area considered valuable by an individual or community that could be negatively impacted by a wildfire or wildfire operations. These values can vary by community and include diverse characteristics such as homes, specific structures, water supply, power grids, natural and cultural resources, community infrastructure, and other economic, environmental, and social values (NWCG, 2018b).

Watershed (aka, drainage basin or catchment): An area of land where all precipitation falling in that area drains to the same location in a creek, stream, or river. Smaller watersheds come together to create basins that drain into bays and oceans (NOAA, 2021).

Wildfire-resistant building materials: A general term used to describe a material and design feature that can reduce the vulnerability of a building to ignition from wind-blown embers or other wildfire exposures (Quarles, 2019; Quarles and Pohl, 2018).

Wildland-urban interface (WUI): Any area where the built environment meets wildfire-prone areas—places where wildland fire can move between natural vegetation and the built environment and result in negative impacts on the community (Forge, 2018). For the purpose of this CWPP, the WUI boundary includes all of the CLFPD and the surrounding landscape that could transmit wildland fire into the CLFPD and the area along important evacuation routes (**Figure 2.c.2**). Strategic wildfire mitigation across the WUI can increase the safety or property owners and wildland firefighters and reduce the chances of home loss.

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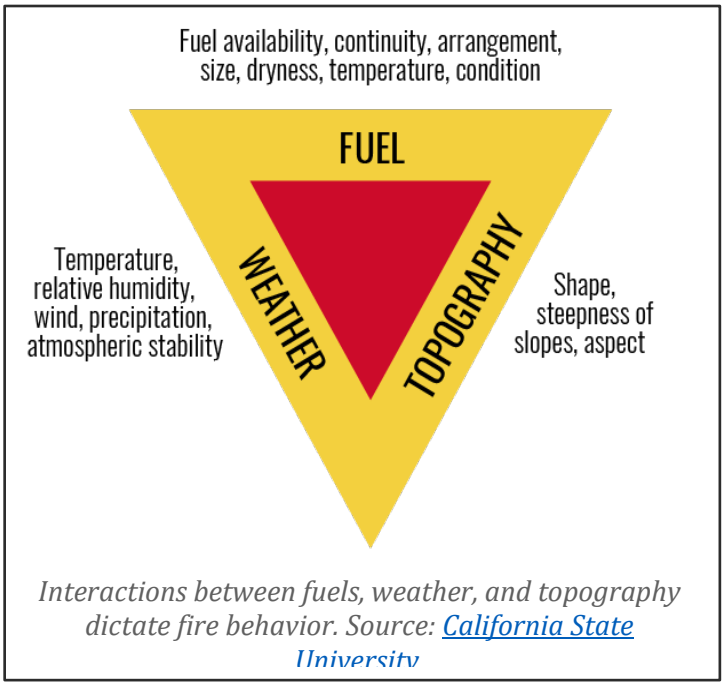
Appendix A. Introduction to Wildfire Behavior and Terminology

Fire Behavior Triangle

Complex interactions among wildland fuels, weather, and topography determine how wildfires behave and spread. These three factors make up the sides of the fire behavior triangle, and they are the variables that wildland firefighters pay attention to when assessing potential wildfire behavior during an incident (NWCG, 2019).



Interactions between fuels, weather, and topography dictate fire behavior. Source: California State University

Fuels

Fuels include live vegetation such as trees, shrubs, and grasses, dead vegetation like pine needles and cured grass, and materials like houses, sheds, fences, trash piles, and combustible chemicals.

Grasses and pine needles are known as "flashy" fuels because they easily combust and burn the fastest of all fuel types. Flashy fuels dry out faster than other fuel types when relative humidity drops or when exposed to radiant and convective heat[3]. If you think of a campfire, flashy fuels are the kindling that you use to start the fire. Fires in grassy fuel types can spread quickly across large areas, and fire behavior can change rapidly with changes in weather conditions.

Dead branches on the surface dry out slower than flashy fuels, release more radiant heat when they burn, and take longer to completely combust. The rate of spread is fast to moderate through shrublands depending on their moisture content, and long flame lengths can preclude direct attack by firefighters. Shrubs and small trees can also act as ladder fuels that carry fire from the ground up into the tree canopy.

Dead trees (aka, snags) and large downed logs are called "heavy fuels", and they take the longest to dry out when relative humidity drops and when exposed to radiant and convective heat. Heavy fuels release tremendous radiant heat when they burn, and they take longer to completely combust, just like a log on a campfire. Fire spread through a forest is slower than in a grassland or shrubland, but

[3] Radiant heat transfer occurs by short-wavelength energy traveling through air. Radiant heat is what you feel when sitting in front of a fire. Radiant heat preheats and dries fuels adjacent to a wildfire, which initiates combustion by lowering the fuel's ignition temperature. Convective heat transfer occurs when air is heated, travels away from the source, and carries heat along with it. Convective heat is what you would feel if you put your hand in the air above an open flame. Air around and above a wildfire expands as it is heated, causing it to become less dense and rise into a hot convection column. Cooler air flows in to replace the rising gases, and in some cases, this inflow of air creates local winds that further fan the flames. Hot convective gases move up slope and dry out fuels ahead of the flaming front, lowering their ignition temperature and increasing their susceptibility to ignition and fire spread.

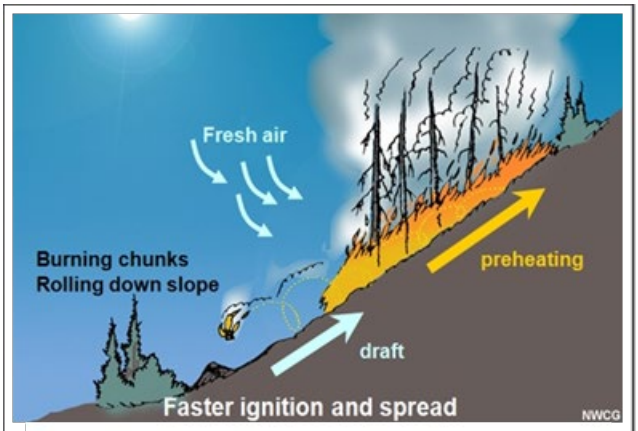
forest fires release more heat and can be extremely difficult and unsafe for firefighters to suppress. An abundance of dead trees killed by drought, insects, or disease can exacerbate fire behavior, particularly when dead trees still have dry, red needles (Moriarty et al., 2019; Parsons et al., 2014).

Topography

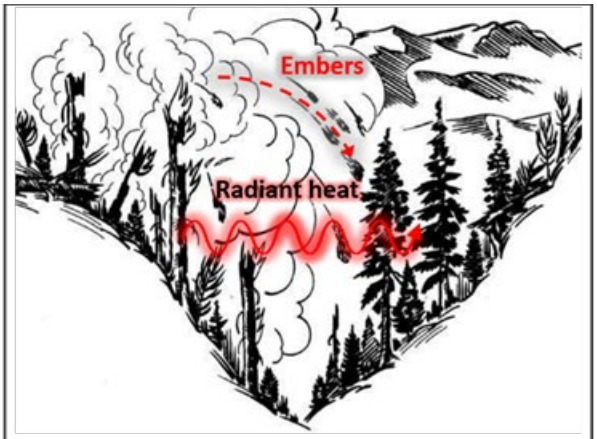
Topography (slope and aspect) influences fire intensity, speed, and spread. In the northern hemisphere, north-facing slopes experience less sun exposure during the day, resulting in higher fuel moistures. Tree density is often higher on north-facing slopes due to higher soil moisture. South-facing slopes experience more sun exposure and higher temperatures and are often covered in grasses and shrubs. The hotter and drier conditions on south-facing slopes mean fuels are drier and more susceptible to combustion, and the prevalence of flashy fuels results in fast rates of fire spread.

Fires burn more quickly up steep slopes due to radiant and convective heating. Fuels are brought into closer proximity with the progressing fire, causing them to dry out, preheat, and become more receptive to ignition, thereby increasing rates of spread. Steep slopes also increase the risk of burning material rolling and igniting unburnt fuels below.

Narrow canyons can experience increased combustion because radiant heat from fire burning on one side of the canyon can heat fuel on the other side of the canyon. Embers can easily travel from one side of a canyon to the other. Topography also influences wind behavior and can make fire spread unpredictable. Wildfires burning through steep and rugged topography are harder to control due to reduced access for firefighters and more unpredictable and extreme fire behavior.



Slope increases fire spread through radiant and convective heating (source: NWCG).



Fires can easily cross narrow canyons (source: U.S. Forest Service).

Steep slopes and topographic features such as narrow canyons exacerbate fire behavior.

Weather

Weather conditions that impact fire behavior include temperature, relative humidity, precipitation, and wind speed and direction. The National Weather Service uses a system called a red flag warning to indicate local weather conditions that can combine to produce increased risk of fire danger and behavior. Red flag warning days indicate increased risk of extreme fire behavior due to a combination of hot temperatures, very low humidity, dry fuels, strong winds, and the presence of thunderstorms (**Table A.1**).

Direct sunlight and hot temperatures impact how ready fuels are to ignite. Warm air preheats fuels and brings them closer to their ignition point. When relative humidity is low, the dry air can absorb moisture from fuels, especially flashy fuels, making them more susceptible to ignition. Long periods of dry weather can dehydrate heavier fuels, including downed logs, increasing the risk of wildfires in areas with heavy fuel loads.

Wind influences fire behavior by drying out fuels (think how quickly your lips dry out in windy weather), increasing the amount of oxygen feeding the fuel, preheating vegetation through convective heat, and carrying embers more than a mile ahead of an active fire. Complex topography, such as chutes, saddles, and draws, can funnel winds in unpredictable directions, increasing wind speeds and resulting in erratic fire behavior.

Table A.1*. Red flag days are warnings issued by the National Weather Service using criteria specific to a region.*

National Weather Service – Denver/Boulder Forecast Office Red Flag Warning Criteria	
Option 1	**Option 2**
Relative humidity less than or equal to 15%	Widely scattered dry thunderstorms
Wind gusts greater than or equal to 25 mph	Dry fuels
Dry fuels	

Categories of Fire Behavior

Weather, topography, and fuels influence fire behavior, and fire behavior in turn influences the tactical options available for wildland firefighters and the risks posed to lives and property. There are three general categories of fire behavior described throughout this CWPP: surface fire, passive crown fire, and active crown fire.

- **Surface fire –** Fire that burns fuels on the ground, which include dead branches, leaves, and low vegetation. Surface fires can be addressed with direct attack using handcrews when flame lengths are less than four feet and with equipment when flame lengths are less than eight feet. Surface fires can emit significant radiant heat, which can ignite nearby vegetation and homes.
- **Passive crown fire –** Fire that arises when surface fire ignites the crowns of trees or groups of trees (aka, torching). Torching trees reinforce the rate of spread, but passive crown fires travel along with surface fires. Firefighters can sometimes address passive crown fires with indirect attack, such as dropping water or retardant out of aircraft or digging fireline at a safe distance from the flaming front. The likelihood of passive crown fire increases when trees have low limbs and when smaller trees and shrubs grow below tall trees and act as ladder fuels. Radiant heat and ember production from passive crown fires can threaten homes during wildfires.
- **Active crown fire –** Fire in which a solid flame develops in the crowns of trees and advances from tree crown to tree crown independently of surface fire spread. Crown fires are very difficult to contain, even with the use of aircraft dropping fire retardant, due to long flame lengths and tremendous release of radiant energy. The likelihood of active crown fires increases when trees have interlocking canopies. Radiant heat and ember production from active crown fires can threaten homes during wildfires.

Passive and active crown fires can result in short- and long-range ember production that can create spot fires and ignite homes. Spot fires are particularly concerning because they can form a new flaming front, move in unanticipated directions, trap firefighters between two fires, and require additional firefighting resources to control. Crown fires are generally undesirable in the wildland-urban interface (WUI) because of the risk to lives and property; however, passive and active crown fires are part of the natural fire regime for some forest types and result in habitat for plant and animal species that require recently disturbed conditions (Keane et al., 2008; Pausas and Parr, 2018). Passive and active crown fires historically occurred in some lodgepole pine forests and higher-elevation ponderosa pine and mixed-conifer forests on north-facing slopes (Addington et al., 2018; Romme, 1982).

Wildfire Threats to Homes

Wildfires can ignite homes through several pathways: radiant heat, convective heat, and direct contact with flames or embers. The ability for radiant heat to ignite a home is based on the properties of the structure (i.e., wood, metal, or brick siding), the temperature of the flame, the ambient air temperature, and distance from the flame (Caton et al., 2016). Ignition from convective heat is more likely for homes built along steep slopes and in ravines and draws. For flames to ignite a structure, they must directly contact the building long enough to cause ignition. Flames from a stack of firewood near a home could cause ignition to the home, but flames that quickly burn through grassy fuels are less likely to ignite the home (although the potential still exists). Fires can also travel between structures along fuel pathways such as a fence or row of shrubs connecting a shed and a home (Maranghides et al., 2022). Some housing materials can burn hotter than the surrounding vegetation, thereby exacerbating wildfire intensity and initiating home-to-home ignition (Mell et al., 2010).

Homes built mid-slope and at the top of steep slopes and within ravines and draws are at greater risk of convective heat from wildfires. A wildfire could rapidly spread up this steep slope and threaten the home above. Photo credit: The Ember Alliance.

Homes can be destroyed during wildfires even if surrounding vegetation has not burned. During many wildland fires, 50 to 90% of homes ignite due to embers rather than radiant heat or direct flame (Babrauskas, 2018; Gropp, 2019). Embers can ignite structures when they land on roofs, enter homes through exposed eaves, or get under wooden decks. Embers can also ignite nearby vegetation and other combustible fuels, which can subsequently ignite a home via radiant heating or direct flame contact. Burning homes can release embers that land on and ignite nearby structures, causing destructive home-to-home ignitions, as evidenced by the destructive 2021 Marshall Fire in Boulder County. Structural characteristics of a home can increase its exposure to embers and risk of combustion, such as wood shingle roofs and unenclosed eaves and vents (Hakes et al., 2017; Syphard and Keeley, 2019). Embers can also penetrate homes if windows are destroyed by radiant or convective heat. See your community's CWPP for specific recommendations to harden your home against wildfires.

Resources for More Information on Fire Behavior

- Introduction to Fire Behavior from the National Wildfire Coordinating Group (9:57 minute video)
- The Fire Triangle from the National Wildfire Coordinating Group (7:26 minute video)
- Understanding Fire Behavior in the Wildland/Urban Interface from the National Fire Protection Association (20:51 minute video)
- Understanding Fire from California State University (website)
- S-190 Introduction to Wildland Fire Behavior Course Materials from the NWCG (PowerPoints, handouts, and videos)

Appendix B. Community Risk Assessment and Modeling Methodology

WUI Delineation

Delineating the wildland-urban interface is a critical component of CWPPs in compliance with the Healthy Forest Restoration Act (HFRA) of 2003. Communities can extend the WUI boundary into adjacent areas that pose a wildfire threat to their community, can serve as a strategic location for wildland firefighting, and are adjacent to evacuation routes for the community (HFRA 4 U.S.C. §101.16). Strategic wildfire mitigation across the WUI can increase the safety or property owners and wildland firefighters and reduce the chances of home loss.

We delineated the WUI for the CLFPD to include any area that could transmit wildland fire into the community during a 4-hour period in the absence of firefighter suppression and control measures under extreme fire weather conditions with 25 mph winds out of the east southeast or west northwest based on our wildfire modeling with FlamMap (see below). We extended the western and southwestern boundary of the WUI to include Pearl Beaver Road and Deadman Road; these roads could serve as important evacuation routes for the community, so fuel mitigation along these roadways is imperative for the protection of lives during wildfire emergencies.

Fire Behavior Analysis

Interpretations and Limitations

Fire behavior models have been rigorously developed and tested based on over 40 years of experimental and observational research (Sullivan, 2009). Fire behavior models allow us to identify areas that could experience high-severity wildfires and pose a risk to lives, property, and other values at risk.

We used the fire behavior model FlamMap, which is a fire analysis desktop application that simulates potential fire behavior and spread under constant weather and fuel moisture (Finney, 2006). FlamMap is one of the most common models used by land managers to assist with fuel treatment prioritization, and it is often used by fire behavior analysts during wildfire incidents.

Fire behavior analyses are useful for assessing relative risk across the entire CLFPD and are not intended to assess specific fire behavior in the vicinity of individual homes. It is not feasible to predict every combination of fire weather conditions, ignition locations, and suppression activities that might occur during a wildfire. Uncertainty will always remain about where and how a wildfire might behave until a fire is actually occurring, and even then, fire behavior can be erratic and unpredictable.

Fire behavior models can provide reasonable estimates of relative wildfire behavior across a landscape. However, wildfire behavior is complex, and models are a simplification of reality. It is recommended to use fire behavior analyses to assess relative risk across the entire CLFPD. Models cannot produce specific and precise predictions of what will occur in the vicinity of an individual home during a wildfire incident.

Fire behavior models like FlamMap do not include structures as a fuel type. Structures like homes, sheds, fences, and other buildings are absolutely a source of fuel during wildland fires and can produce massive amounts of embers that contribute to home-to-home ignitions (Maranghides et al.,

2022). However, FlamMap cannot account for fine-scale variation in surface fuel loads, defensible space created by individual homeowners, and the ignitability of building materials, nor are these data available at the scale of individual homes across an entire fire protection district. In the absence of this information and a deeper quantitative understanding of interactions between structures and wildland vegetation during a wildfire, fire behavior cannot be modeled for areas dominated by homes in the same fashion as areas dominated by grassland, shrubland, or forest vegetation. For this reason, we conducted a separate analysis to predict potential exposure of homes to radiant heat and ember cast (see section below).

Model Specifications and Inputs

We used FlamMap to model flame length, crown fire activity, potential fire sizes, and conditional burn probability. FlamMap requires information on topography and fuel loads across the area of interest (**Figure B.1**). See **Table B.1** and **Table B.2** for details on model inputs and specifications.

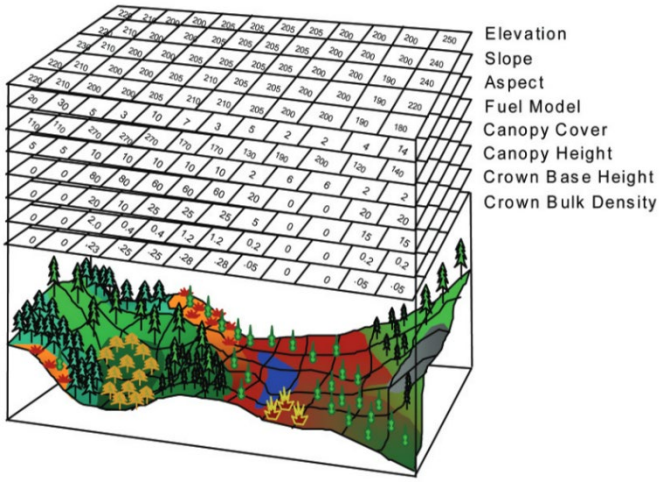


***Figure B.1**. FlamMap requires a variety of information about topography and fuels. Image from Finney (2006).*

We used LANDFIRE data modified by the Colorado Forest Restoration Institute in 2021 as the basis for our modeling. LANDFIRE is a national program spearheaded by the U.S. Department of the Interior and the U.S. Department of Agriculture to provide spatial products characterizing vegetation, fuels, fire regimes, and disturbances across the entire United States. LANDFIRE products serve as standardized inputs for fire behavior modeling. CFRI modified LANDFIRE data by assigning TL5 fire behavior fuel model to lodgepole pine forests and reducing canopy base height by 30% to more closely replicate observed crown fire activity in this forest type. They also modified surface and canopy fuels in areas that experienced fuel treatments and/or wildfires since 2016. We thoroughly quality controlled fuel data and worked with CLFPD to assess the reasonableness of model predictions.

Figure B.2 depicts the fire behavior fuel models present across the CLFPD. Fuel models are a stylized set of fuel bed characteristics used as input for a variety of wildfire modeling applications to predict fire behavior (Scott and Burgan, 2005). Half of the area in and around the CLFPD has high load conifer litter (TL5). About a fifth of the area has very high load, dry climate timber-shrub (TU5) and a tenth has moderate load, dry climate grass-shrub (GS2). Portions of the Crystal Lakes Fuel Reduction Project have surface fuels created by forest thinning (i.e., slash). Our maps of fire behavior predictions include areas indicated as "unburnable / not modeled"—parking lots, roadways, bodies of water, and barren areas are considered unburnable; areas dominated by homes and buildings were classified as "not modeled" because fire behavior models do not include structures as a fuel type (Scott and Burgan, 2005).

Fire behavior models require estimates of fire weather conditions, and a common practice is to model fire behavior under hot, dry, and windy conditions for an area—not the average conditions, but

extreme conditions. Wildfires that grow to large sizes, exhibit high-severity behavior, and overwhelm suppression capabilities tend to occur under extreme fire weather conditions (Williams, 2013).

We modeled potential wildfire behavior under moderate (60th percentile) and extreme (90th percentile) fire weather conditions (**Table B.2**). Weather parameters for our analysis came from data collected at the Red Feather RAWS and fuel moisture conditions from FireFamilyPlus. 60th percentile conditions are like a normal summer day, whereas 90th percentile conditions are extremely hot, dry days—days that would qualify for red flag warnings and result in large-fire growth, such as conditions in early September 2020 during the Cameron Peak fire. These two benchmarks allow us to analyze where an average fire in the district may burn so the CLFPD can prioritize outreach and treatment under regular circumstances, as well as what can be expected under more extreme circumstances, as was seen in 2020.

Winds across the Front Range of Colorado are unpredictable and can be extremely gusty in mountainous areas. We modeled 20-foot windspeeds of 15 mph for moderate fire weather conditions and 25 mph for extreme fire weather conditions. Wind speeds of 25 mph qualify as red flag warnings when occurring with low relative humidity and dry fuels. We modeled potential fire spread under winds blowing out of the east southeast (113°) and out of the west northwest (293°) based on observations from the Red Feather RAWS and observations of local firefighters. We modeled flame length and crown fire activity based on winds out of the west northwest, and we modeled burn probability based on both these prevailing winds.

FlamMap offers two methods for calculating crown fire initiation and spread: the Scott and Reinhardt method and the Finney method. We used the Scott and Reinhardt method as this method resulted in predictions of crown fire occurrence more consistent with expectations and has been found more reliable than the Finney method (Scott, 2006).

Fire spread was modeled with FlamMap's "minimum travel time" algorithm to predict fire growth between cells and account for fire spread through spotting. We modeled fire growth under 10,000 random ignitions across the landscape, and we allowed fires to grow for 4 hours in the absence of firefighter suppression and control measures. We modeled fire behavior in an area 66 times larger than the CLFPD and centered on the CLFPD to capture the landscape-scale movement of fire. Then we then identified the ignition locations with fires that spread into the CWPP boundary for the CLFPD under 90th percentile fire weather for a total of 1,870 ignition locations. We used these ignition locations to calculate burn probability. Conditional burn probability is calculated as the percentage of simulated fires that burn each 30-meter by 30-meter (0.2 acre) area under specified fire weather conditions, wind directions, and wind speeds.

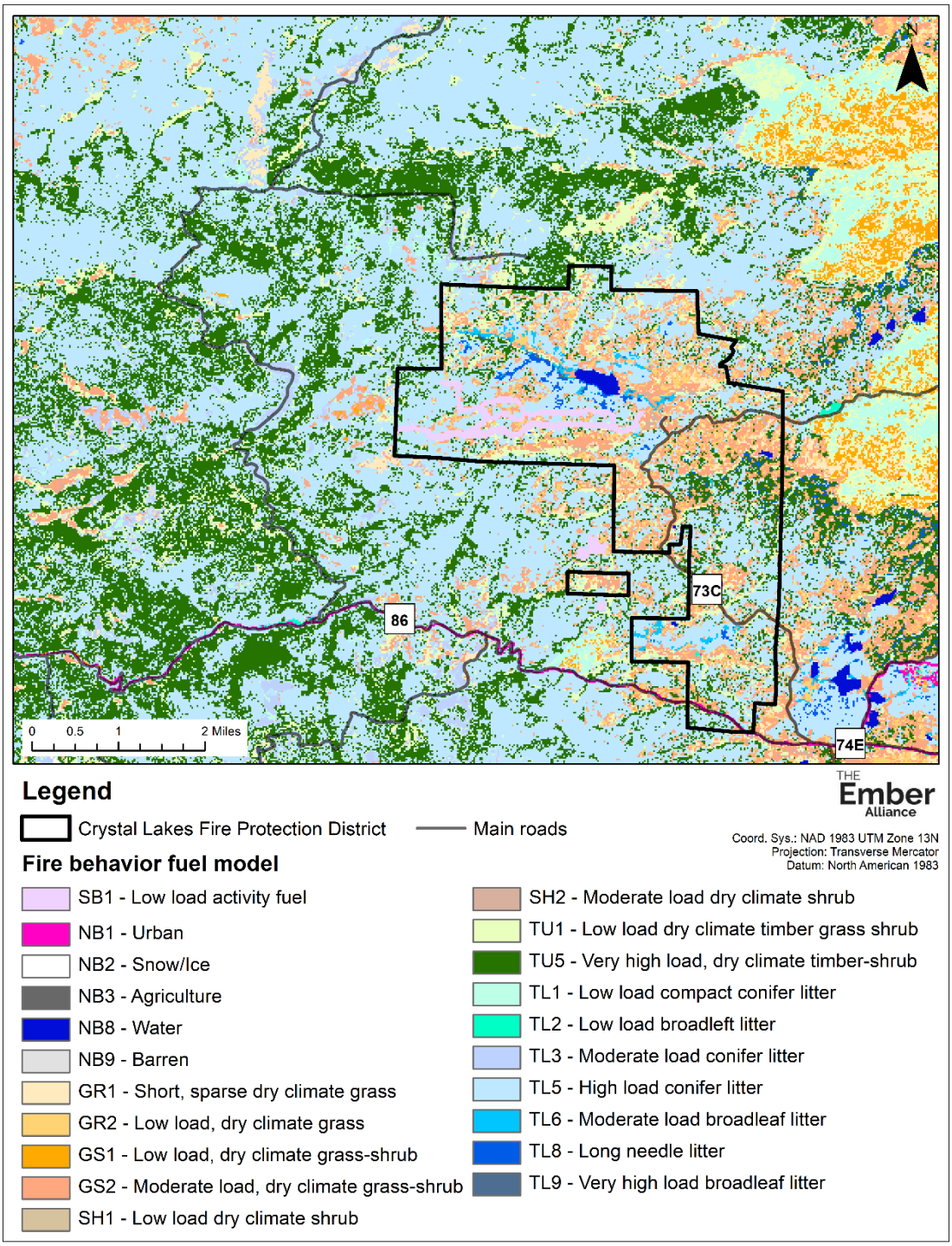


Figure B.2*. Half of the area in and around the CLFPD has high load conifer litter (TL5). About a fifth of the area has very high load, dry climate timber-shrub (TU5) and a tenth has moderate load, dry climate grass-shrub (GS2). Portions of the Crystal Lakes Fuel Reduction Project have surface fuels created by forest thinning (i.e., slash). Fire behavior fuel models are an important input for making fire behavior predictions. See Scott and Burgan (2005). for a description of each fuel model. Source: LANDFIRE with modifications by the Colorado Forest Restoration Institute*

Table B.1. *Model specifications used for fire behavior analyses with FlamMap for the 2022 CLFPD CWPP.*

Model specification	Value
Crown fire calculation method	Scott/Reinhardt (2001)
Wind options	Gridded winds
Wind grid resolution	60 meters
Number of random ignitions	10,000*
Resolution of calculations	30 meters
Maximum simulation time	240 minutes
Minimum travel paths	500 meters
Spot probability	0.7
Spotting delay	15 minutes
Lateral search depth	6 meters
Vertical search depth	4 meters

*We used the same random ignition locations for fire spread analysis under 60th and 90th fire weather conditions. We then identified the ignition locations with fires that spread into the CWPP analysis area for the CLFPD under 90th percentile fire weather for a total of 1,870 ignition locations.

Table B.2. *Fire weather conditions utilized for fire behavior modeling are based on weather observations from the Red Feather Remote Automatic Weather Station between June 15 and October 15, 2014-2021 and fuel moisture predictions from FireFamilyPlus. Weather conditions on September 6, 2020, during the Cameron Peak Fire are presented for comparison.*

Variable	Moderate fire weather (60th percentile)	Extreme fire weather (90th percentile)	Cameron Peak Fire (for comparison)
Temperature	73° Fahrenheit	80° Fahrenheit	83° Fahrenheit
Relative humidity	23%	13%	9%
Wind direction	East southeast (113°) and west northwest (293°)	East southeast (113°) and west northwest (293°)	194° South-Southwest
20-foot wind speed[1]	15 mph	25 mph	13 mph, gusting up to 35 mph
Fuel moisture[2]			
1-hour	6%	5%	3%
10-hour	11%	8%	6%
100-hour	13%	11%	10%
1000-hour[3]	20%	13%	12%
Live woody	90%	75%	---
Live herbaceous	50%	30%	---
Crown foliage	100%	80%	---

[1]20-foot wind speeds are approximately 5 times faster than winds at ground level in fully sheltered fuels; vegetation and friction slow down windspeeds closer to ground level (NWCG, 2021).

[2]One-hour fuels are dead vegetation less than 0.25 inch in diameter (e.g., dead grass), ten-hour fuels are dead vegetation 0.25 inch to 1 inch in diameter (e.g., leaf litter and pine needles), one hundred-hour fuels are dead vegetation 1 inch to 3 inches in diameter (e.g., fine branches), and one thousand-hour fuels are dead vegetation 3 inches to 8 inches in diameter (e.g., large branches). Fuels with larger diameters have a smaller surface area to volume ratio and take more time to dry out or to become wetter as relative humidity in the air changes.

[3]1000-hour fuel is moisture not used by FlamMap for predicting fire behavior but is included here to provide additional context.

Predicted Fire Behavior

Wildland firefighters keep abreast of current and expected fire behavior when making tactical decisions. Fire behavior classes are based on flame length, rate of spread, and crown fire activity and are utilized by firefighters to guide tactical decisions following the Haul Chart (**Table B.3**).

Flame length is the distance measured from the average flame tip to the middle of the flaming zone at the base of the fire. Flame length is measured on an angle when the flames are tilted due to effects of wind and slope (see image at right). Flame length is an indicator of fireline intensity—the amount of energy released by a fire. **Figure B.3** depicts predicted flame lengths across the CLFPD.

The occurrence of torching (aka, passive crown fire), spotting, and active crown fire are notable fire behaviors that must inform tactical decisions on the fireline. Both passive and active crown fires pose a significant risk to the safety of firefighters and property owners and can destroy homes through radiant and convective heating and ember production. See **Appendix A. Introduction to Wildfire Behavior and Terminology** for a description of different types of fire behavior. **Figure B.4** depicts crown fire occurrence across the CLFPD.

Fire behavior class was determined for the CLFPD by combining predictions of flame length and crown fire activity following the Haul Chart. Under moderate fire weather conditions—conditions typical of a summer day in CLFPD—27% percent of the CLFPD could experience high to extreme fire behavior, and this percentage increases to 50% under less common but more extreme, hot, dry, and windy conditions (**Figure B.5**). Under extreme fire weather conditions, at least some portion of each CLRRA filing contains fuel and topographic conditions that could support high to extreme fire behavior.

High to extreme fire behavior includes ember production that ignites additional fires away from the main fire and the movement of high-intensity fire from treetop to treetop. Such fires are extremely challenging if not impossible to control until winds die down and fuel moistures increase. Exceptional hot, dry, and windy conditions are increasingly common due to climate change and could result in even more extreme fire behavior across the CLFPD than predicted by this analysis.

Under moderate fire weather conditions, much of the CLFPD could experience low fire behavior (surface fires with shorter flame lengths). Surface fires could move through pine litter in lodgepole pine forests across the western portion of the CLFPD, but very high to extreme fire behavior is likely under dry fuel moistures and high winds if ladder fuels are present and surface fires can transition into tree crowns. Northwest-facing slopes are likely to have dense forest conditions and a greater quantity of fuel available to burn if conditions are dry enough.

The central-eastern portion of the CLFPD, which includes private and U.S. Forest Service land, could experience high to very high fire behavior even under moderate fire weather conditions. This area includes steep, south-facing slopes that support dry mixed-conifer forests and shrublands. South-facing slopes are usually drier than north-facing slopes, and grasses present in moderately dense forests and shrublands can dry out very quickly on hot days. Shrubs and small regenerating trees serve as ladder fuels that carry surface fires into treetops, creating additional challenges for firefighters.

Wet meadows with willows and aspen in the bottom of valleys across the CLFPD are less likely to experience extreme fire behavior. However, even areas along streams can burn with moderate to high severity following summer drought and on days with hot, dry, and windy conditions. On days with extreme fire weather conditions, all homes within the CLFPD could be exposed to embers from burning vegetation, regardless of vegetation in the immediate vicinity of the home.

Table B.3. *Description of fire behavior and tactical interpretations for firefighters from the Haul Chart (NWCG, 2019).*

Fire behavior class	Flame length (feet)	Rate of spread (chains/hr)*	Tactical interpretation
Very low, smoldering	<1	0-2	Fire is not spreading and has limited flaming. Fire can be attacked at the head or flanks by persons using handtools. Handline will hold the fire.
Low, creeping, spreading	1-4	2-5	Fire can be attacked at the head or flanks by persons using handtools. Handline should hold the fire.
Moderate, running	4-8	5-20	Fires are too intense for direct attack on the head of the fire by persons using handtools. Handline cannot be relied on to hold fire. Equipment such as dozers, engines, and retardant aircraft may be effective.
High, torching and spotting	8-11	20-50	Fires present serious control problems with torching, crowning, and spotting. Control efforts at the head of the fire are probably ineffective.
Very high, active crown fire	11-25	50-150	Crowning, spotting, and major fire runs are expected. Control efforts at the head of the fire are ineffective.
Extreme and erratic	>25	>150	Extreme intensity, turbulent fire, and chaotic spread. Escape to safety should be considered.

*__Note:__ 1 chain = 66 feet. Chains are commonly used in forestry and fire management as a measure of distance1 chain / hour = 1.1 feet / minute.

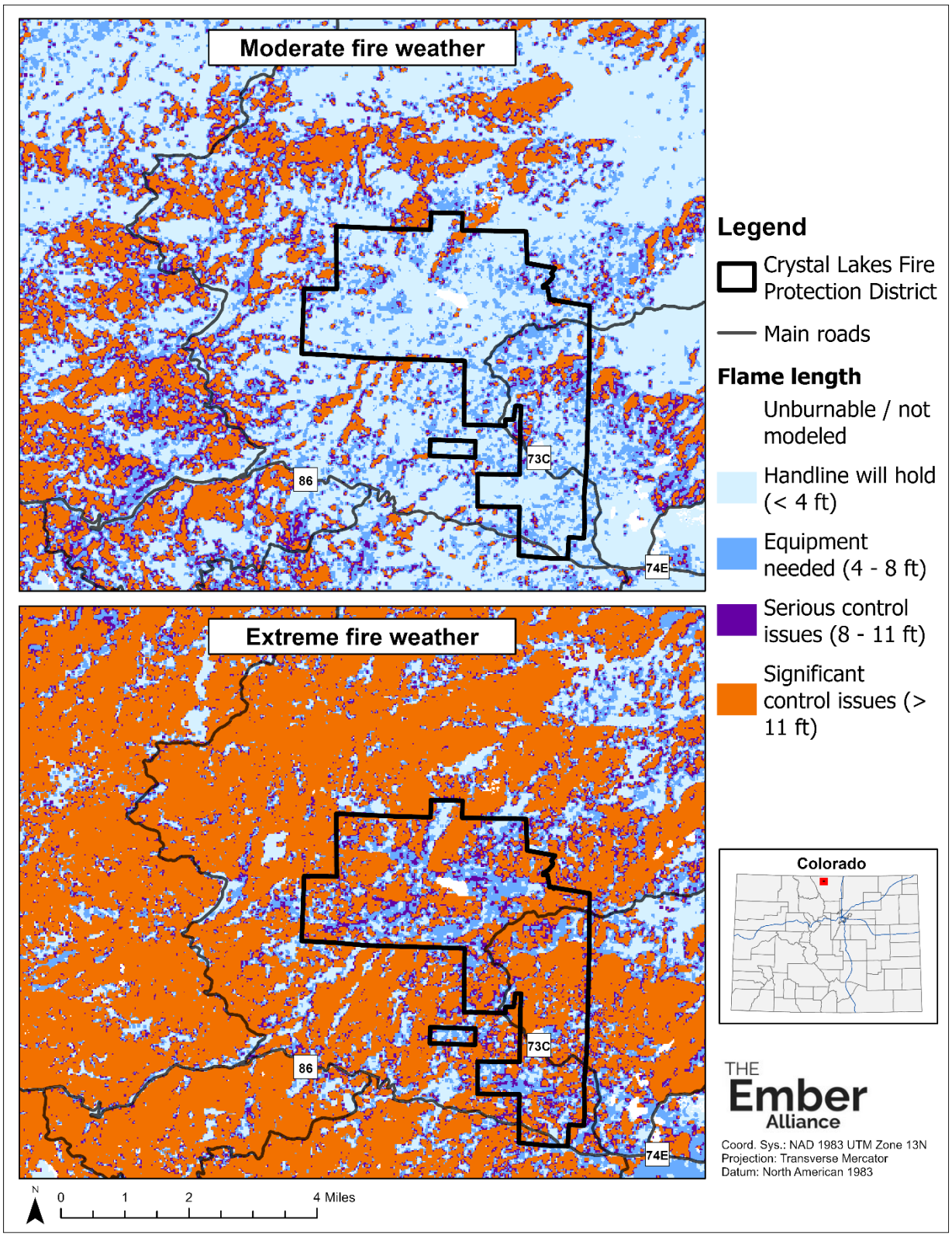


Figure B.3. *Flame lengths in the CLFPD under moderate and extreme fire weather conditions, categorized by the Haul Chart (**Table B.3**).*

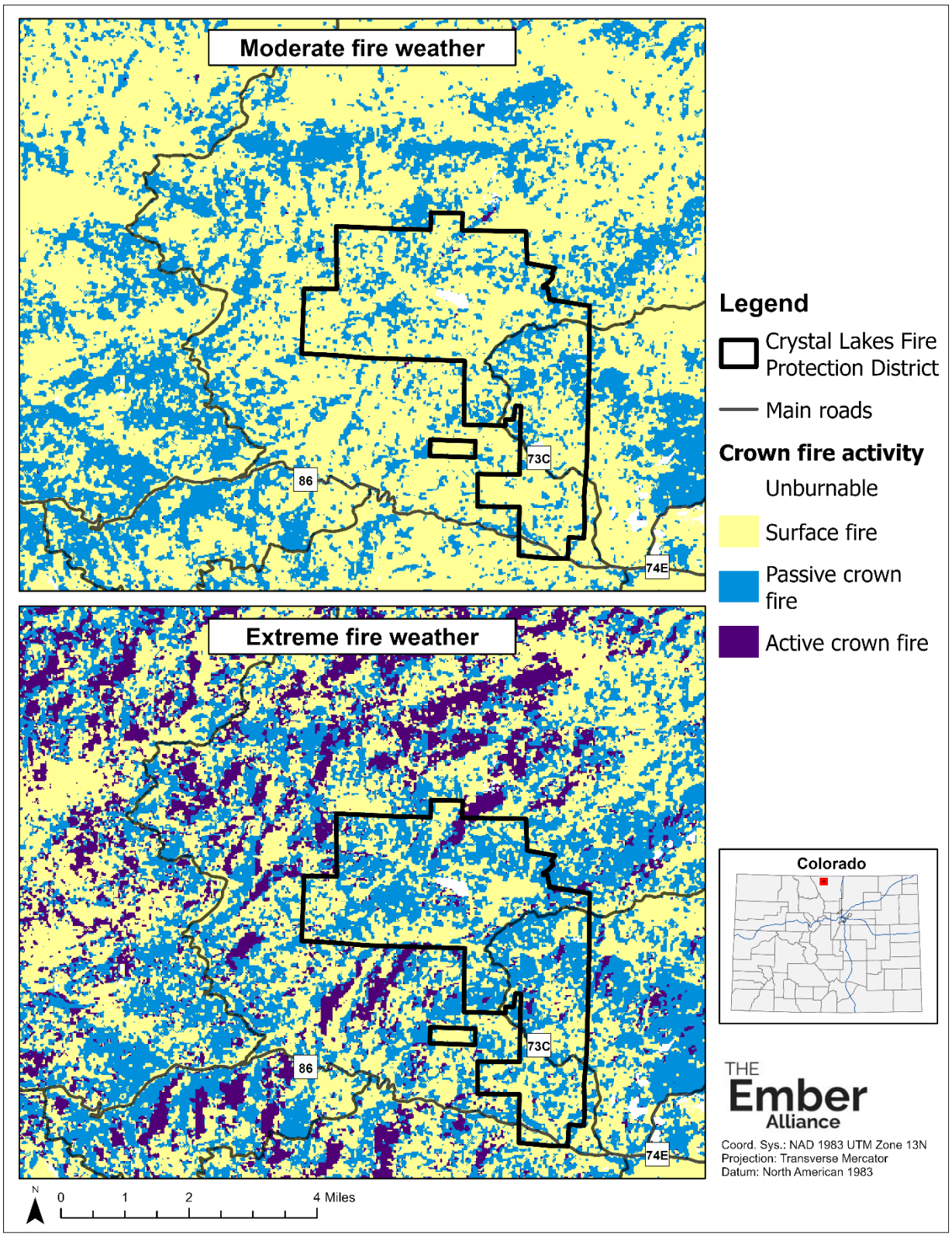


Figure B.4. *Crown fire activity in the CLFPD under moderate and extreme fire weather conditions.*

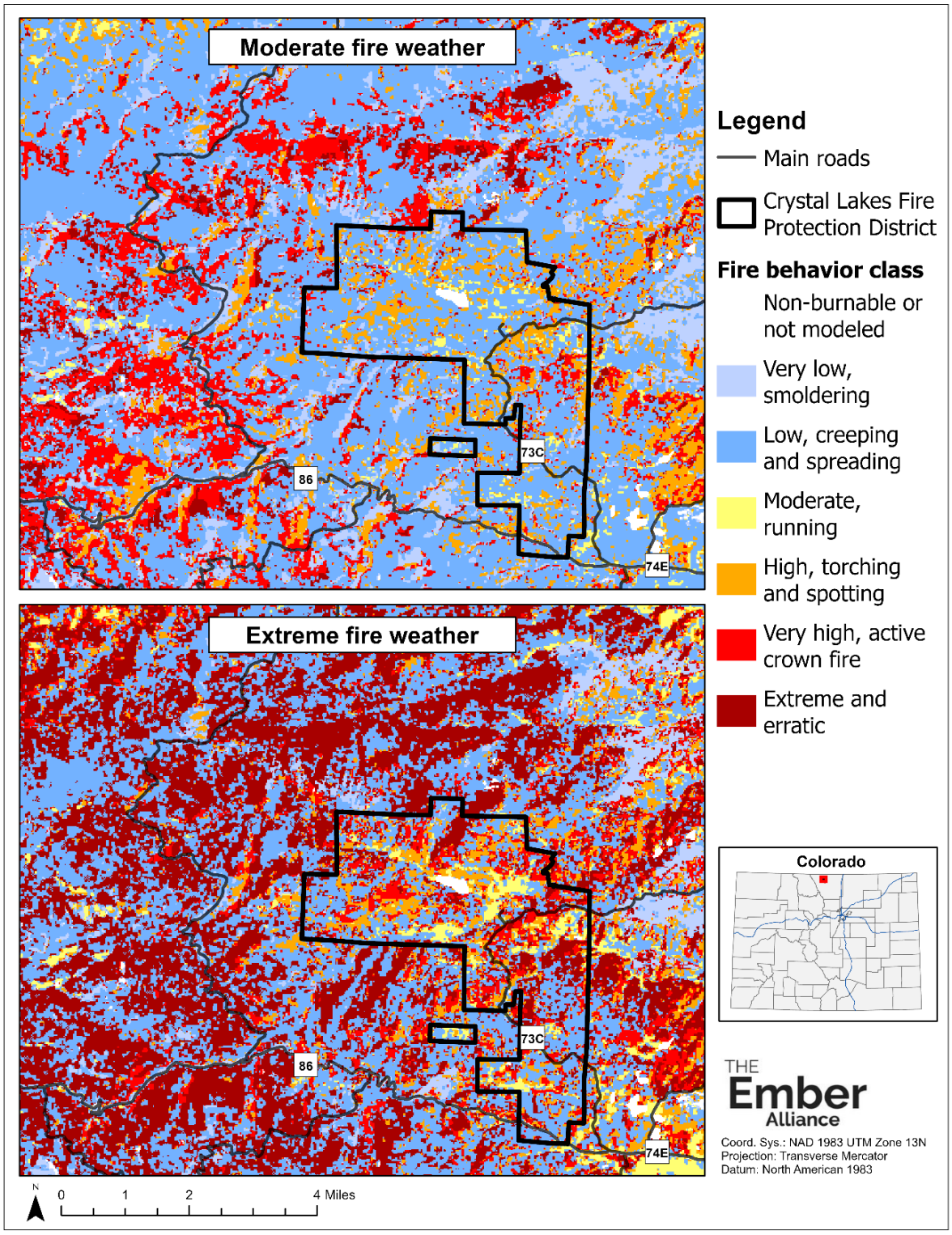


Figure B.5. *Under moderate fire weather conditions, 27% percent of the CLFPD could experience high to extreme fire behavior, and this percentage increases to 50% under less common but more extreme, hot, dry, and windy conditions. High to extreme fire behavior includes ember production that ignites additional fires away from the main fire and the movement of high-intensity fire from treetop to treetop. Such fires are extremely challenging if not impossible to control until winds die down and fuel moistures increase. Visit the CLRRA CWPP Map Experience for an interactive version of this map.*

Predicted Conditional Burn Probability

Conditional burn probability indicates how likely an area is to burn during a wildfire. Wind direction strongly affects burn probability, carrying fires quickly up slopes facing toward the incoming winds. Topography, non-burnable barriers such as wide rivers, interstates, and highways, and fuel loads also influence conditional burn probability by dictating how fire spreads across the landscape. Short-range transport of embers can cause spot fires to ignite even across major roads in the CLFPD, such as CR 73C (Creedmore Lakes Road). Rapid fire growth and spotting across roadways is more likely under higher windspeeds and with drier fuel conditions.

Burn probability is highest across the north/northeast part of the district. Under moderate fire weather, Filings 5, 9, and 11 have the highest burn probability, and under extreme weather conditions, Filings 2, 3, and 4 have the highest burn probability (**Figure B.6**). These relative probabilities are only relative to other areas within and directly around the FPD.

Unpredictable wind conditions along the Colorado Front Range make it difficult to predict potential fire spread, making it imperative for property owners across the CLFPD to take measures to mitigate their HIZ.

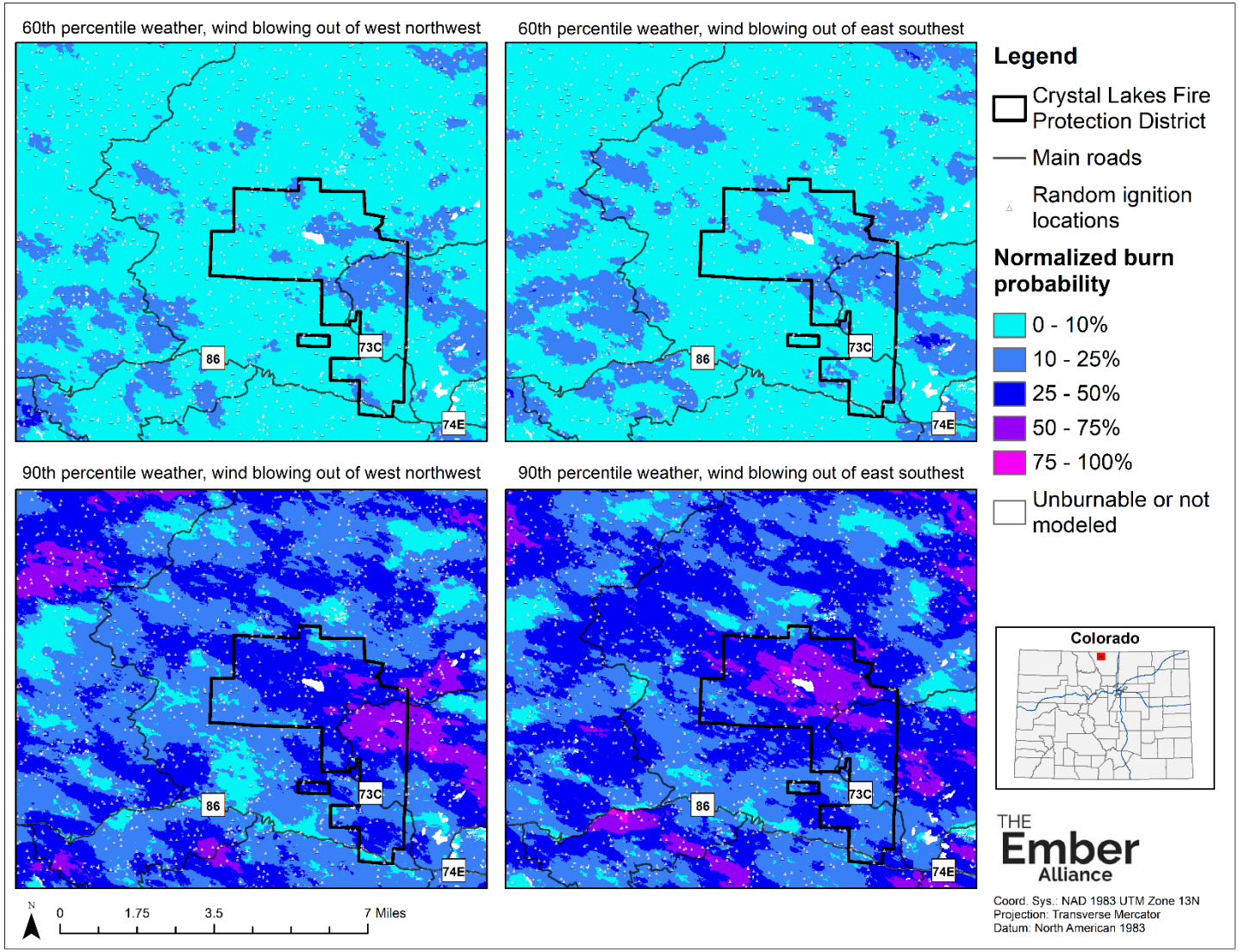


Figure B.6. *Conditional burn probability under moderate and extreme fire weather conditions with winds blowing out of the west northwest and out of the east southeast. Wildfire spread was simulated for 4-hours without suppression activities from 1,870 random ignition locations across an area 12 times larger than and centered on the CLFPD.*

Predicted Radiant Heat and Ember Cast Exposure

We assessed the risk that radiant heat and short-range and long-range ember cast pose to structures. See **Appendix A. Introduction to Wildfire Behavior and Terminology** for a description of how wildfires can ignite homes. Ember production and transport and their ability to ignite recipient fuels are guided by complex processes, so we utilized the simplified approach of Beverly et al., (2010) to assess home exposure to radiant heating and short- and long-range ember cast. Exposure is based on distance from long flame lengths and potential active crown fire assuming:

- Radiant heat can ignite homes when extreme fire behavior (flame lengths > 16 feet) occurs within 33 yards (30 meters) of structures.
- Short-range embers can reach homes within about 110 yards (100 meters) of active crown fires.
- Long-range embers can reach homes within about 550 yards (500 meters) of active crown fires.

Embers can ignite homes even when the flaming front of a wildfire is far away. See **Mitigate the Home Ignition Zone** for tangible and relatively simple steps you can take to harden your home against embers. Mitigation practices, such as removing pine needles from gutters and installing covers over vents, can make ignition less likely and make it easier for firefighters to defend your property.

Distance thresholds used by Beverly et al., (2010) are based on observations from actual wildfires, but their estimates are lower than those from some researchers. Studies on wildfires burning eucalyptus forests in Australia and wildfires burning chaparral in California demonstrated that embers can travel 12 to 15 miles from the flaming front and ignite spot fires (Caton et al., 2016), but these fuel types are very different from conifer forests in Colorado. Embers from ponderosa pine trees tend to ignite fuels at a much lower rate than embers from other tree species (Hudson et al., 2020). In addition, the number of embers reaching an area decreases exponentially with distance traveled, and the likelihood of structure ignition increases with the number of embers landing on the structure (Caton et al., 2016). Therefore, using conservative estimates of distance allows us to identify areas with the greatest risk of ignition from short- and long-range embers.

We determined whether exposure to radiant heat and short- and long-range ember cast from active crown fires was possible within the HIZ (100-feet radius) of each structure in the CLFPD[4].

Potential exposure to radiant heating and long- and short-range embers is widespread across the CLFPD, and this awareness should encourage property owners and business owners to complete home hardening practices to reduce the risk of ignition. Potential exposure to radiant heat, short-range ember cast, and long-range ember cast is widespread across the district (Figure 8.a.8). Under moderate fire weather, 10% of homes in the CLFPD are at risk of exposure to radiant heat and 27% to long-range ember cast, and these percentages increase to 55% of homes potentially exposed to radiant heat and 100% potentially exposed to long-range ember cast under extreme fire weather. Under moderate fire weather, at least a quarter of structures in Filings 1, 3, and 7 are at risk of radiant heat, and more than half the homes in Filings 3, 7, 8, and 13 are at risk of long-range ember cast.

[4] It is recommended to use this analysis to assess relative risk across the entire Fire Protection District and not to evaluate absolute risk to individual homes. FlamMap and the approach of Beverly et al. (2010) cannot account for defensible space, the fire resistance of materials used in home construction, and other fine-scale variation in fuel loads that contribute to the ignition potential of individual homes.

Under extreme fire weather, the majority of homes in Filings 1, 2, 3, 7, 8, 11, 12, 13, 14, and 15 are at extreme risk of radiant heat and all homes are at a risk of long-range embers. It is important to remember that embers can ignite homes even when the flaming front of a wildfire is far away. (**Figure B.7**; **Figure B.8**).

A vast majority of homes in the CLFPD (80%) could be exposed to short-range ember cast from at least one neighboring home, with some homes potentially exposed to short-range ember cast from up to 10 other homes (**Figure B.9**). Homes within 100-meters of other homes are at greater risk of home-to-home ignitions from short-range ember cast (Syphard et al., 2012). Fuel treatments within HIZs and surrounding undeveloped areas could help reduce the exposure of homes to radiant heat and short-range ember cast.

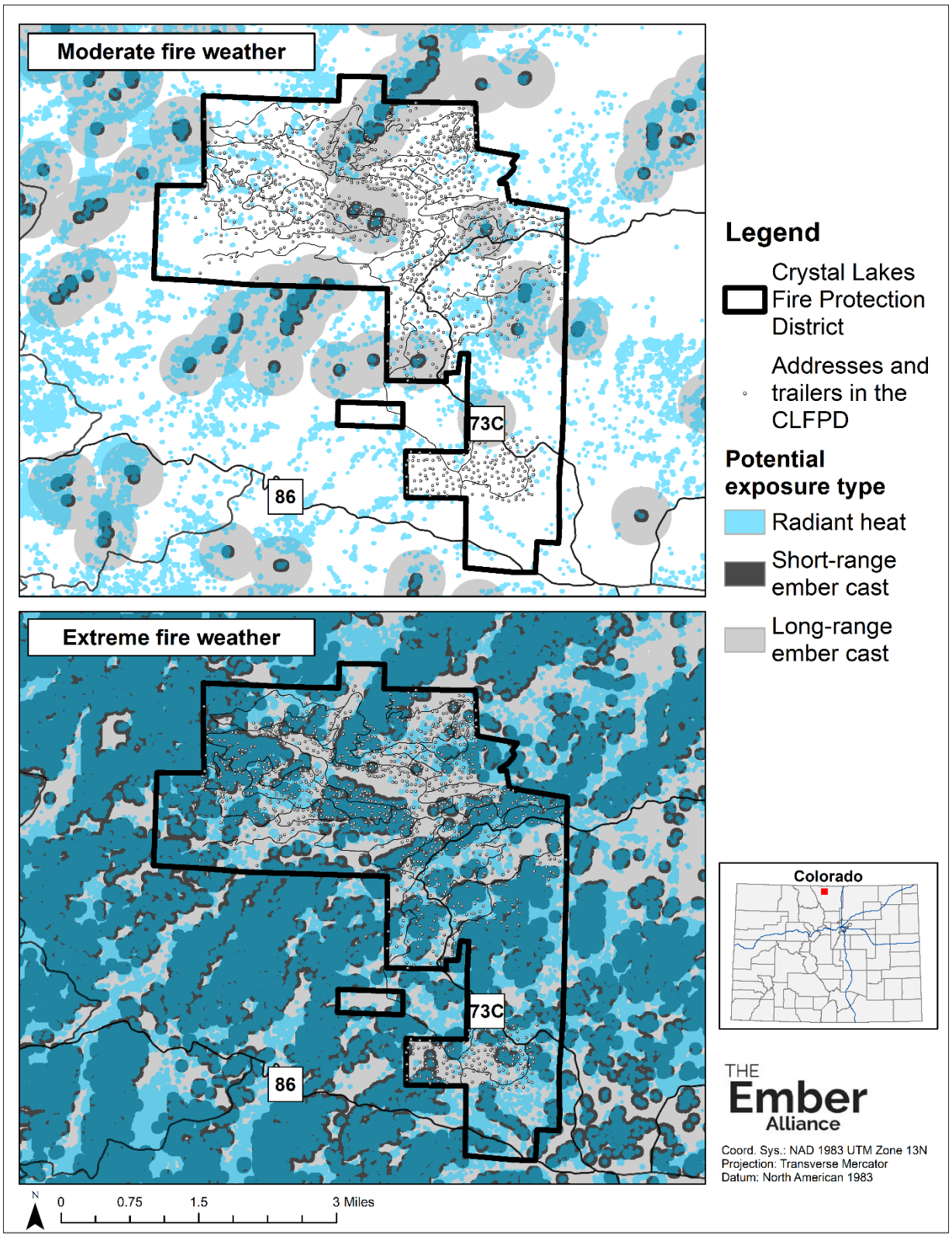


Figure B.7. *Predicted exposure to short-and long-range ember cast and radiant heat in the CLFPD under moderate and extreme fire weather conditions.*

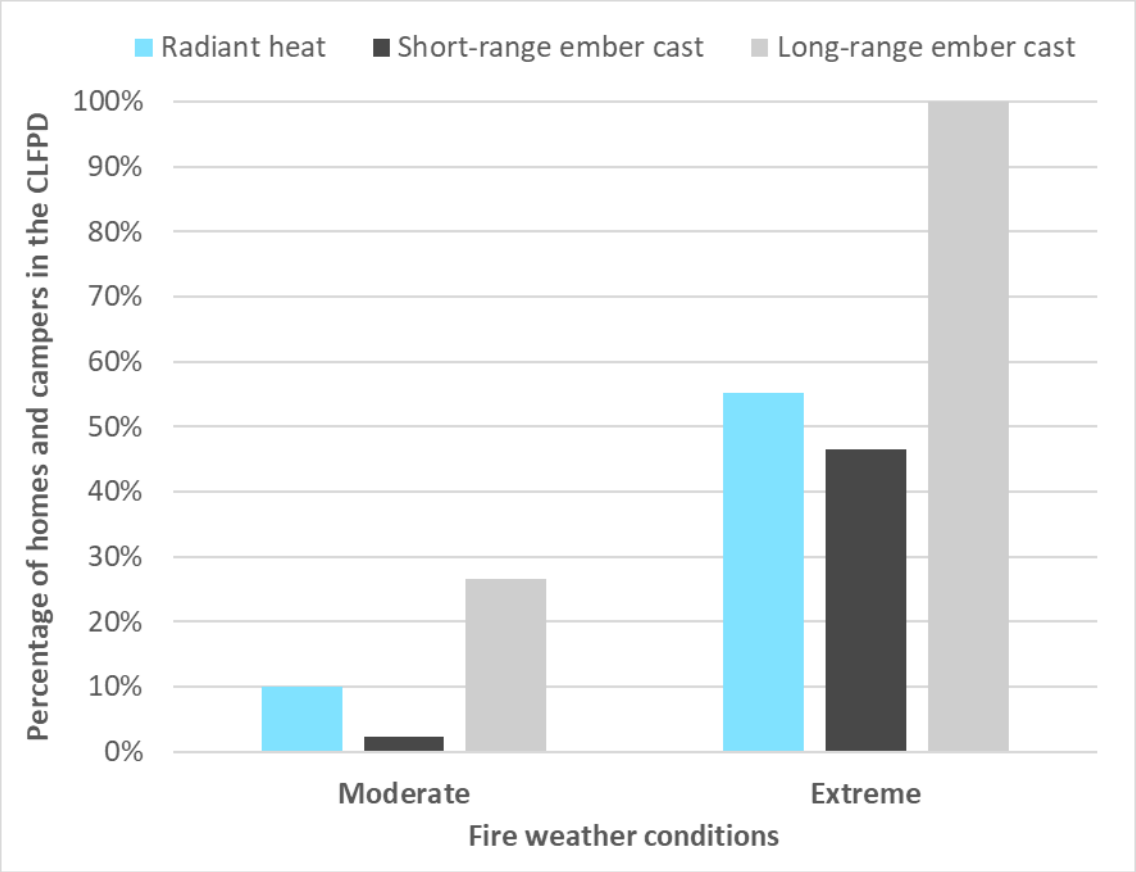


Figure B.8. *Percentage of homes and campers in the CLFPD with different types of exposure to wildfire under moderate and extreme fire weather conditions. Radiant heat from burning vegetation can ignite nearby homes, and embers emitted from burning vegetation or other homes can travel long distances and ignite vegetation and homes away from the main fire.*

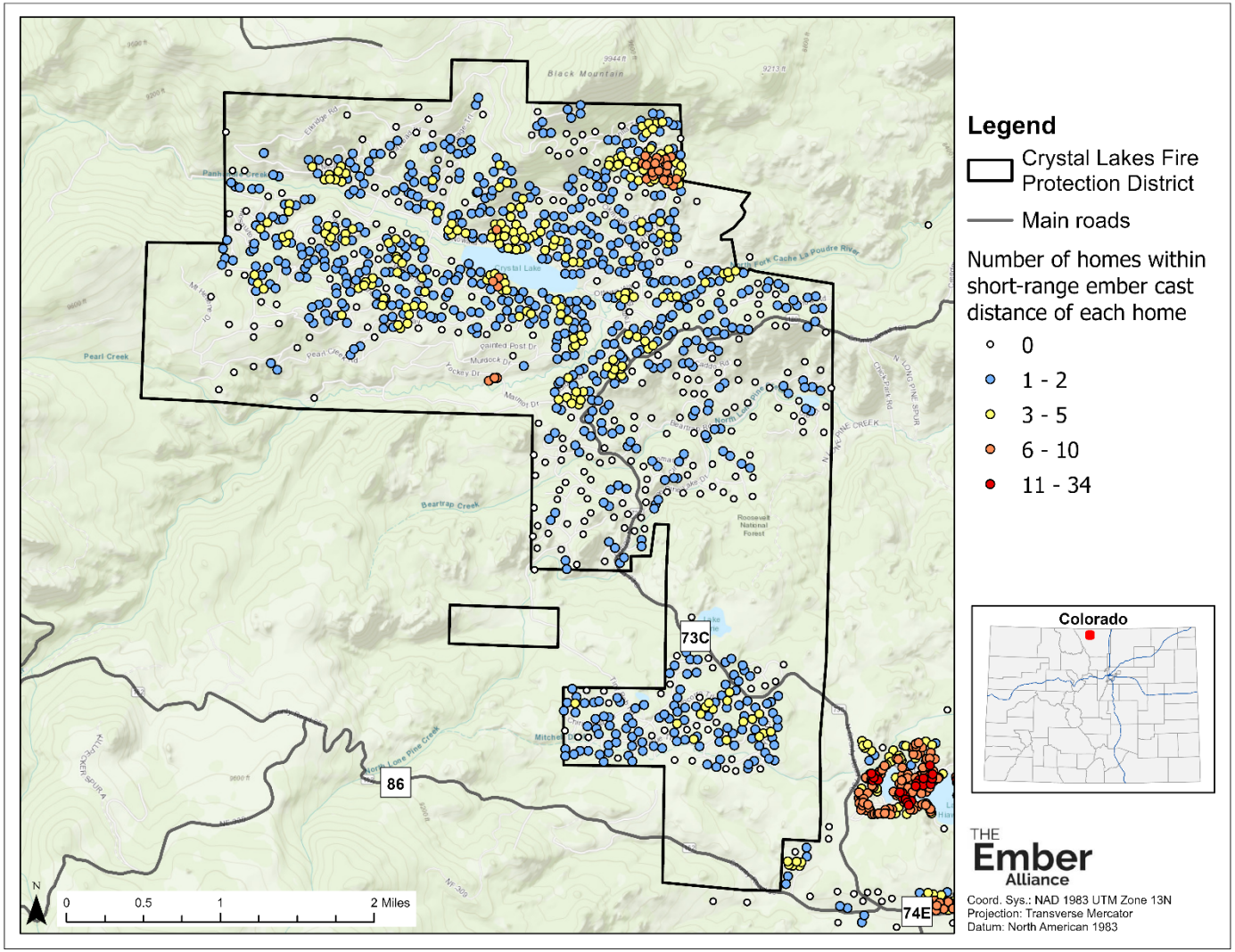


Figure B.9. *80% of homes could be exposed to short-range ember cast from at least one neighboring home in the CLFPD, with some homes potentially exposed to short-range ember cast from up to 10 other homes. Homes within 100-meters of other homes are at greater risk of home-to-home ignitions from short-range ember cast (Syphard et al., 2012). Analysis included permanent structures and campers.*

Evacuation Analysis

Evacuation concerns can weigh heavily on the minds of many property owners in the CLFPD. The death of 86 people in Paradise, California during the 2018 Camp Fire, many of whom were stranded on roadways during evacuation, underscores the importance of evacuation preparedness and fuel mitigation along evacuation routes.

Evacuation Modeling and Scenarios

We modeled evacuation time and roadway congestion using ArcCASPER (Shahabi and Wilson, 2014). The ArcCASPER model considers roadway capacity, road speed, number of cars evacuating per address, and the relationship between roadway congestion and reduction in travel speed. The model assumes simultaneous departure of vehicles, but it starts by determining evacuation routes for vehicles with the longest distance to travel. The purpose of the model is to minimize evacuation time for the entire district, not to minimize the evacuation time for each individual property owner.

Keep in mind: Simulation models cannot account for all variables present during an evacuation, so these results are useful as a guide for strategic planning rather than a depiction of what will occur in any specific evacuation event.

The model's algorithm starts with the evacuee farthest from predefined evacuation destinations and finds that evacuee's shortest path to a predefined safe evacuation location. It iteratively continues this process until there are no more evacuees left. During the analysis, ArcCASPER dynamically updates how long it takes to traverse each road segment based on the number of evacuees using that route and the relationship between traffic and travel speeds. The model adjusts evacuation routes until it minimizes the global evacuation time (i.e., the time it takes for all evacuees to reach a safe evacuation location).

For our analysis, we used an exponential traffic model with a critical density of 10 and saturation density of 150. The critical density is the maximum number of cars that can be on a road with two lanes (one lane in each direction) without a reduction in travel speed, and saturation density is the number of cars on the road at which the traversal speed reduces to half the original speed.

ArcCASPER does not account for unpredictable events, such as roadway blockage from accidents or reduced visibility from smoke. It also does not consider emergency vehicles traveling the opposite direction of evacuation traffic.

Based on research by Beloglazov et al., (2016), we assumed that it takes 30 minutes for individuals to mobilize and depart their homes after receiving a mandatory evacuation order. We modeled two different scenarios—one where property owners were directed east from the CLFPD along CR 74E (Red Feather Lakes Road) and to CR 80C (Cherokee Park Road) and another scenario where property owners were directed west along CR 86 (Deadman Road) and south along SH 69 (Manhattan Road). We used roadway data from OpenStreetMap and the Colorado Department of Transportation, with modifications to the road network based on local expertise.

For both scenarios we evacuated all 1,136 addresses in the CLFPD and 1,062 addresses in Red Feather Lakes and south near SH 69 because it is likely all these addresses would be evacuated simultaneously during a wildfire. For the scenario with evacuation to the east, we also included 131 addresses along CR 74E and CR 67J (Prairie Divide Road), and for the scenario with evacuations to the south and west, we also included 60 addresses farther south near SH 69 (see evacuee locations in **Figure B.10**). These addresses would likely evacuate at the same time as CLFPD and Red Feather Lakes during a wildfire.

We modeled two vehicles leaving each residential address with a permanent structure and one to two vehicles leaving each address that might have a camper but no permanent structure. Addresses assigned one vs. two vehicles were randomly assigned, assuming only 50% percent of evacuees would leave with their personal vehicle and camper. We modeled 10 vehicles departing from each non-residential address, 12 from Red Feather Lakes Elementary School, 40 from the Drala Mountain Center, and 45 from Fox Acres based on feedback from the CLFPD.

Estimates of evacuation times assume that all addresses are occupied, and a mandatory evacuation time is issued for everyone simultaneously. This scenario could occur were a wildfire to ignite in close proximity to the CLFPD during the summer when there are many property owners and visitors in the area. The intent of running the evacuation model for all of the CLFPD at once was to assess an extreme scenario when the most cars would be on the road at the same time. This allowed us to identify areas of major congestion during a large-scale evacuation and therefore plan for worst-case scenarios.

Estimates from ArcCASPER are useful for determining relative evacuation capacity and congestion across the CLFPD and are not intended to predict household-specific evacuation times. Law enforcement personnel will direct traffic during a wildfire event, so our evacuation modeling is not meant to suggest alternate routes for individual property owners. **Property owners need to follow guidance from law enforcement personnel during evacuation events, practice safe driving, and practice good evacuation etiquette (e.g., allowing cars to merge and not texting or stopping to take photographs.)**

Evacuation Congestion

It is important for law enforcement personnel to plan for areas of high congestion when making decisions about how to conduct actual evacuations in the CLFPD. Roads were categorized by how much congestion may occur, and how much longer it may take to evacuate compared to everyday scenarios without evacuation traffic. Roadways that could experience high to extreme congestion include CR 74E, CR 73C (Creedmore Lakes Road), CR 86, and SH 69. Congestion along CR 73C is concerning because most property owners in CLFPD will funnel through this area during an evacuation because it is the only primary evacuation route (**Figure B.10**).

It is important to reiterate that congestion modeling does not account for unexpected barriers such as cars breaking down, car accidents, road closures, etc. It also does not take into consideration additional traffic aside from individual evacuation groups; if an evacuation were ordered over a weekend, these congestion indices would increase dramatically. However, this analysis does show areas that are prone to traffic build up even under the best-case scenario.

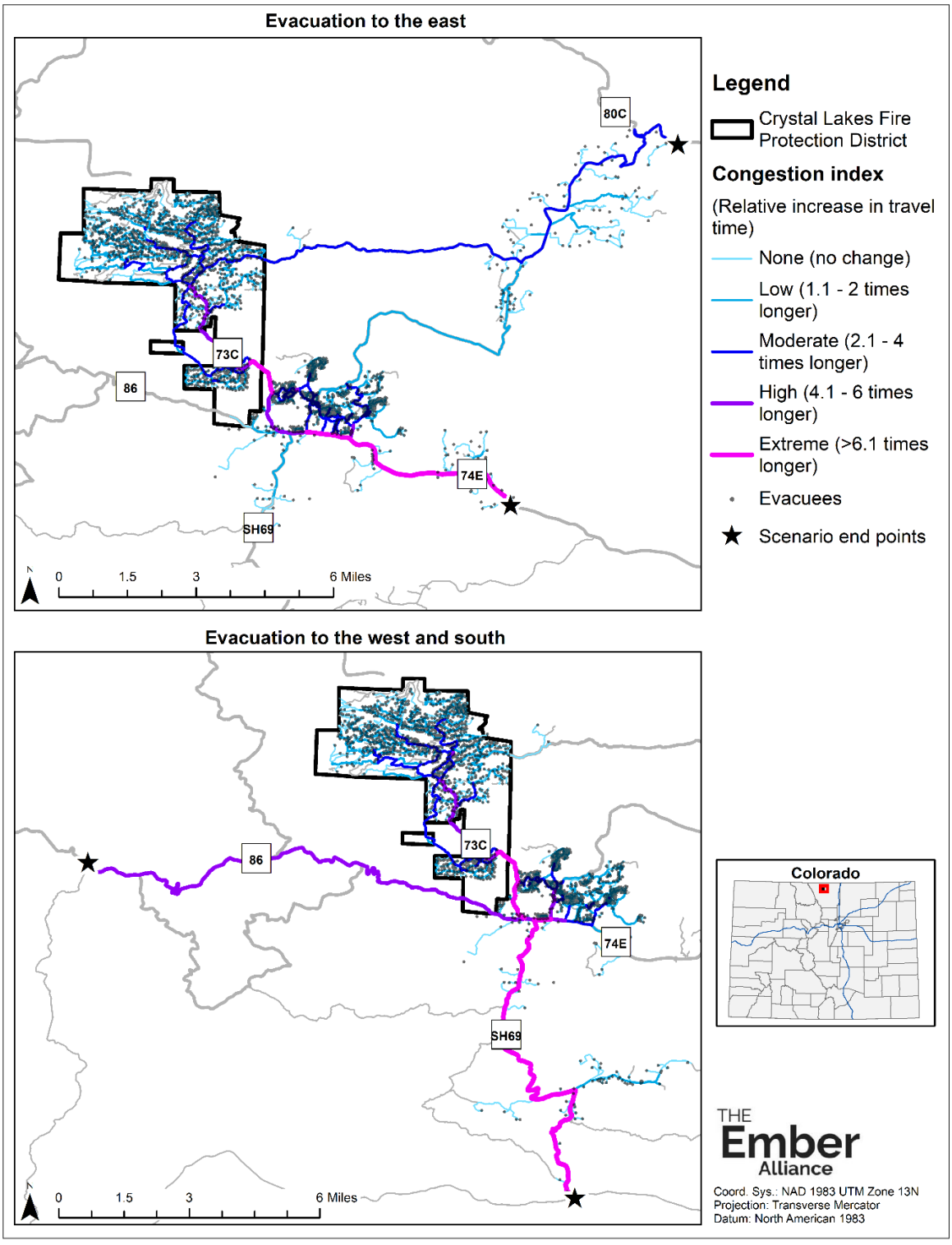


Figure B.10. *Predicted congestion across the CLFPD under a simultaneous district-wide evacuation order for a scenario with evacuation routing to the east of the CLFPD and another scenario with evacuation routing to the south and west of the CLFPD. Congestion categories (none, low, moderate, high, extreme) are based on the ratio between the time required to traverse a segment of road with congestion vs. without congestion.*

Evacuation Time

Evacuation time indicates how long it might take for a vehicle to receive an evacuation order, depart from an address, and reach the scenario endpoints (see locations in **Figure B.10**). Estimates of evacuation time can serve as a benchmark for emergency pre-planning and strategic decision making. Remember, these scenarios assume an emergency, mandatory evacuation with simultaneous departures and assuming property owners are safely and efficiently evacuating (i.e., there are no accidents blocking the roads, there is no smoke hindering visibility, etc.).

The actual time it would take to evacuate during a specific incident is influenced by a variety of factors not considered in this modeling effort, such as the staggering of evacuation orders, the nature of evacuation orders (i.e., voluntary versus mandatory), traffic accidents, delays from people stopping to take photographs, reduced visibility from smoke, etc.

Evacuees within the CLFPD have higher evacuation times than those in Red Feather Lakes and other addresses outside the CLFPD (**Figure B.11**). This is due to substantial congestion that could occur along CR 73C and the greater distance of addresses within CLFPD from major roads like CR 74E, CR 80C, CR 86, and SH 69. Evacuation times in the CLFPD could exceed 5 hours for evacuations to the west and south and exceed 2 hours for evacuations to the east. All property owners in the CLFPD need to be prepared for evacuation warnings so they can leave promptly and practice evacuation etiquette so everyone can evacuate safely and efficiently.

How realistic are estimated evacuation times from ArcCASPER?

The estimates we present make assumptions about the number of vehicles leaving each residency and the time it takes for property owners to mobilize and depart after receiving an evacuation order. We could not account for unpredictable events in this modeling effort, such as roadway blockage from accidents or reduced visibility from smoke. It is impossible to know what actual evacuation times might be during a specific wildfire incident. Evacuation times and congestion in this area were much lower during the 2020 Cameron Peak Fire, but that was due to the greater distance between the wildfire and CLFPD, allowing for voluntary and mandatory evacuations and the staggered nature of property owners' departures. Were a wildfire to ignite directly adjacent to the CLFPD prompting an emergency, mandatory evacuation, evacuation times and congestion would be much higher, underscoring the importance of property owner preparedness so they can leave promptly during an evacuation.

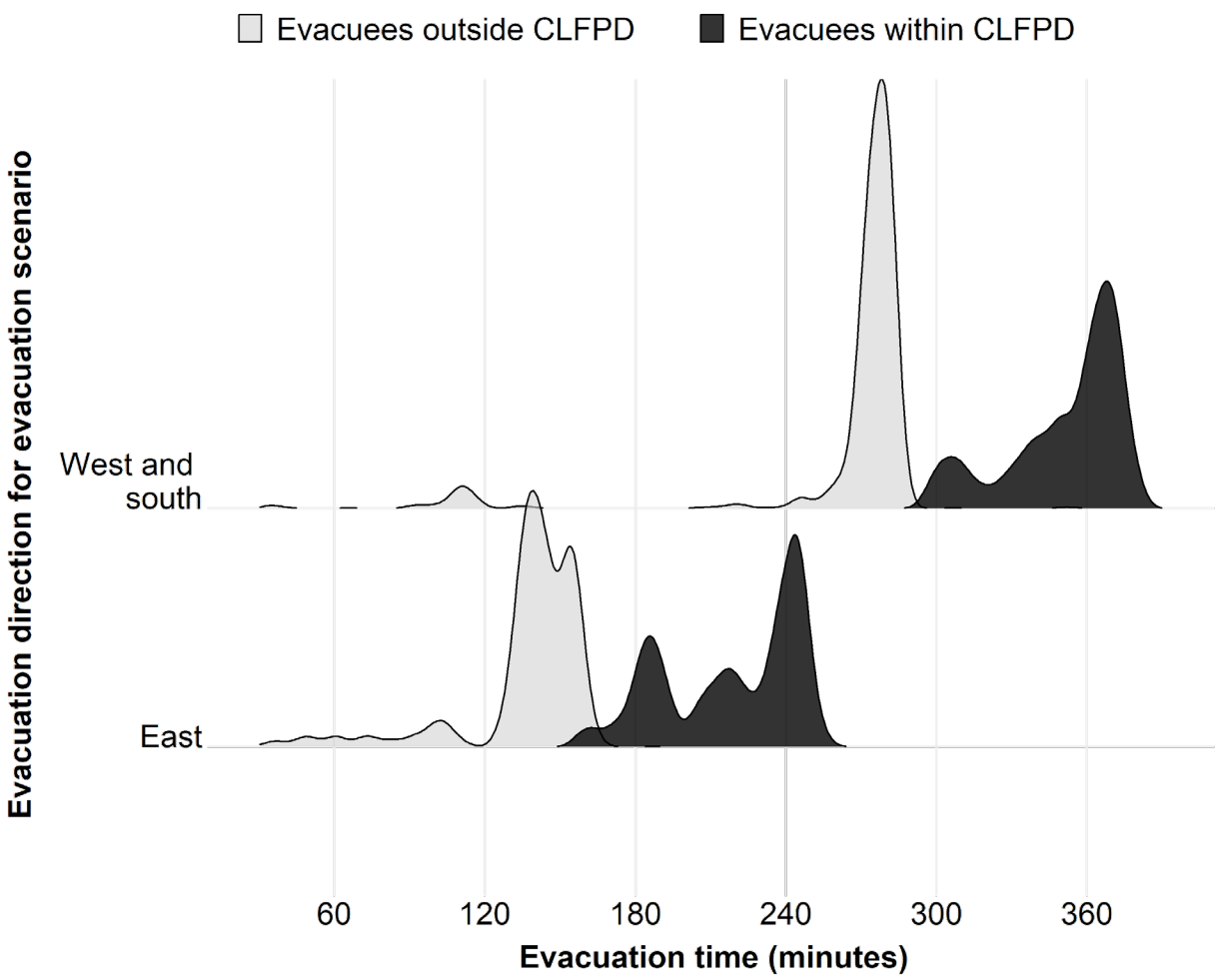


Figure B.11. *Distribution of predicted evacuation times under a simultaneous district-wide evacuation order for a scenario with evacuation routing to the east of the CLFPD and another scenario with evacuation routing to the south and west of the CLFPD. We assumed that it takes 30 minutes for individuals to mobilize and depart after receiving an evacuation order. Locations of evacuees are shown in* ***Figure B.10****. Peaks in the distribution indicate a larger number of evacuees with that predicted evacuation time. Evacuation times include a 30-minute estimate for people to gather their belongings and depart after receiving an evacuation order.*

Roadway Survivability

Tragedies have occurred when flames from fast-moving wildfires burn over roads while property owners are evacuating. Property owners can perish in their vehicles trapped on the road, and egress routes can become blocked from flames. **Mitigation actions along sections of road with high risk for non-survivable conditions during a wildfire can increase the chances of survival for property owners stranded in their vehicles during a wildfire and decrease the chance that roadways become impassable due to flames.**

We utilized fire behavior predictions to identify road segments that could experience non-survivable conditions during a wildfire. We used roadway data from OpenStreetMap and the Colorado Department of Transportation, with modifications to the road network based on local expertise. We identified "non-survivable roadways" as portions of roads adjacent to areas with predicted flame lengths greater than 8 feet. Drivers stopped or trapped on these roadways could have a low chance of survival due to radiant heat emitted from fires of this intensity. This assumption is based on the Haul Chart, which is a standard tool used by firefighters to relate flame lengths to tactical decisions (**Table B.3**) (NWCG, 2019). Direct attack of a flaming front is no longer feasible once flame lengths exceed about 8 feet due to the intensity of heat output. Flames greater than 8 feet could also make roads impassable and cut property owners off from egress routes. Non-survivable conditions are more common along roads lined by thick forests with abundant ladder fuels, such as trees with low limbs and saplings and tall shrubs beneath overstory trees.

Under moderate fire weather conditions, 3% of the roads in the CLFPD could experience non-survivable conditions, and this percentage rises to 67% under extreme fire weather conditions (**Figure B.12**). Filing 1 and Elk Ridge Ranches have 9-12% of potentially non-survivable roads under moderate weather conditions, and every planning unit except Filing 4 and Poudre Meadows has more than half potentially non-survivable roads under extreme fire weather conditions. Some non-survivable road segments are part of key evacuation routes and a high priority for mitigation to reduce fuels and potential flame lengths, including portions of Creedmore Lakes Rd. We identified these areas as evacuation pinch points and incorporated them into recommendations for roadway fuel treatments across the CLFPD.

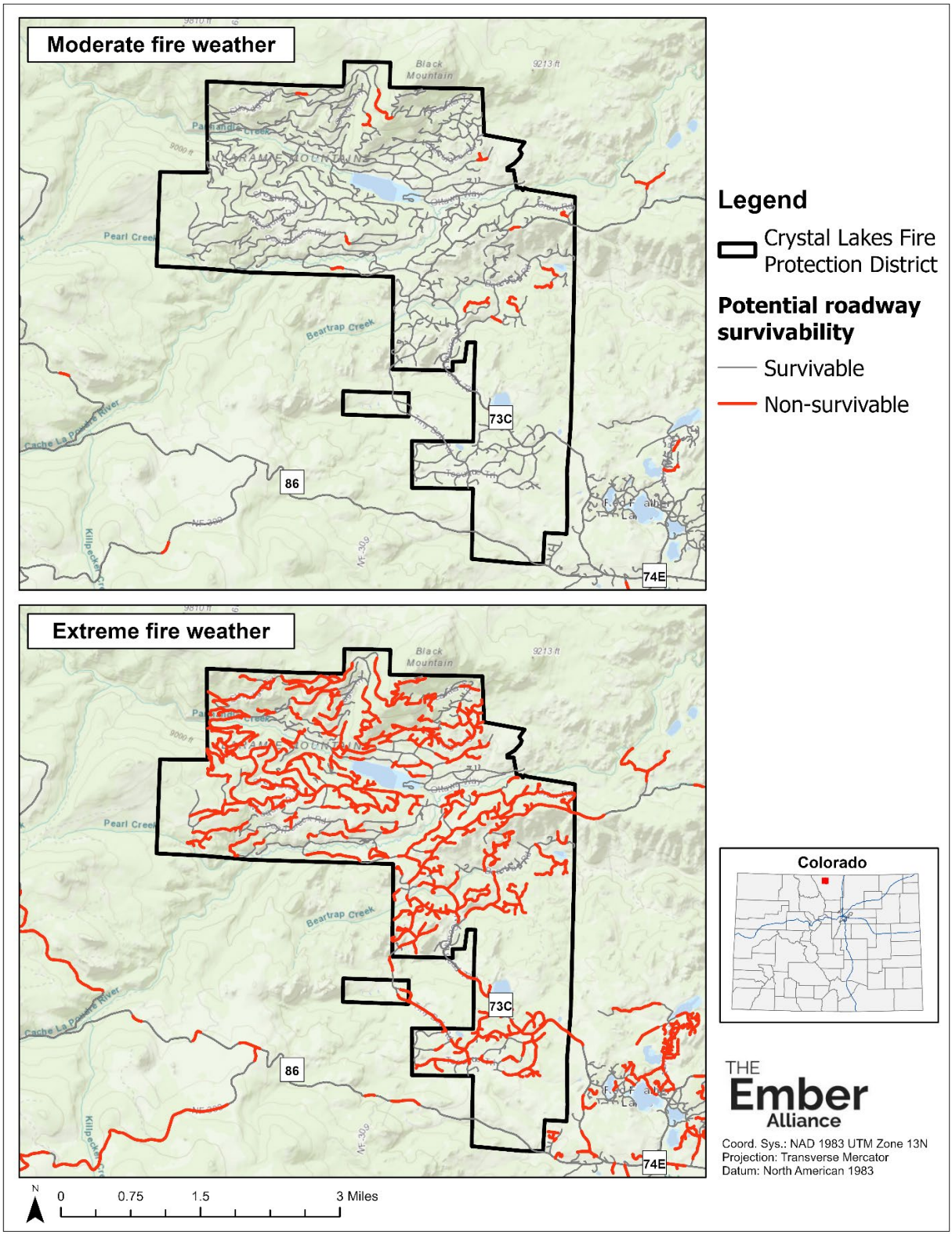


Figure B.12. *Under moderate fire weather conditions, 3% of roads and driveways in the CLFPD could potentially experience non-survivable conditions during wildfires (i.e., flame lengths over 8 feet). This percentage rises to 67% under extreme fire weather conditions.*

Climate Change Assessment

Climate change has a measurable impact on fire intensity and frequency, and this is likely to continue given current trajectories. Fire behavior modeling for this CWPP utilizes weather data from 2014-2021 and does not include future weather predictions. Therefore, we used the Climate Toolbox's Future Climate Scatter to explore the potential for exacerbated fire weather conditions in the future for this area. This tool models climate scenarios for the next fifty years using the Representative Concentration Pathways 4.5 and 8.5. These two models forecast future climate scenarios based on different levels of global greenhouse gas emissions. We analyzed four variables: expected maximum temperature each year and the number of days expected to be "high fire danger" days, and annual 100-hour fuel moisture levels and days with a heat index over 90° Fahrenheit.

The models predict that under moderate or intense greenhouse gas concentrations, the CLFPD will experience hotter summer temperatures and an increased number of days considered to be high fire danger. In the next 50 years, it would be reasonable to expect maximum summer temperatures to **increase by 5-7° Fahrenheit**, and the number of high fire danger days is likely to **increase by 12-15 more days per year**. The number of days that reach over 86° F may go **from nearly zero to 4-8 days per year** (**Figure B.14**; **Figure B.15**).

Fire behavior has the potential to be extreme based on the weather from the past twenty years, and it may be even more extreme and frequent under the future conditions presented here. This behavior could include longer flame lengths, faster rates of spread, higher fire severity, and more crown fire activity. More extreme fire behavior increases danger to the life safety of property owners, as well as to their homes, businesses, and community resiliency.

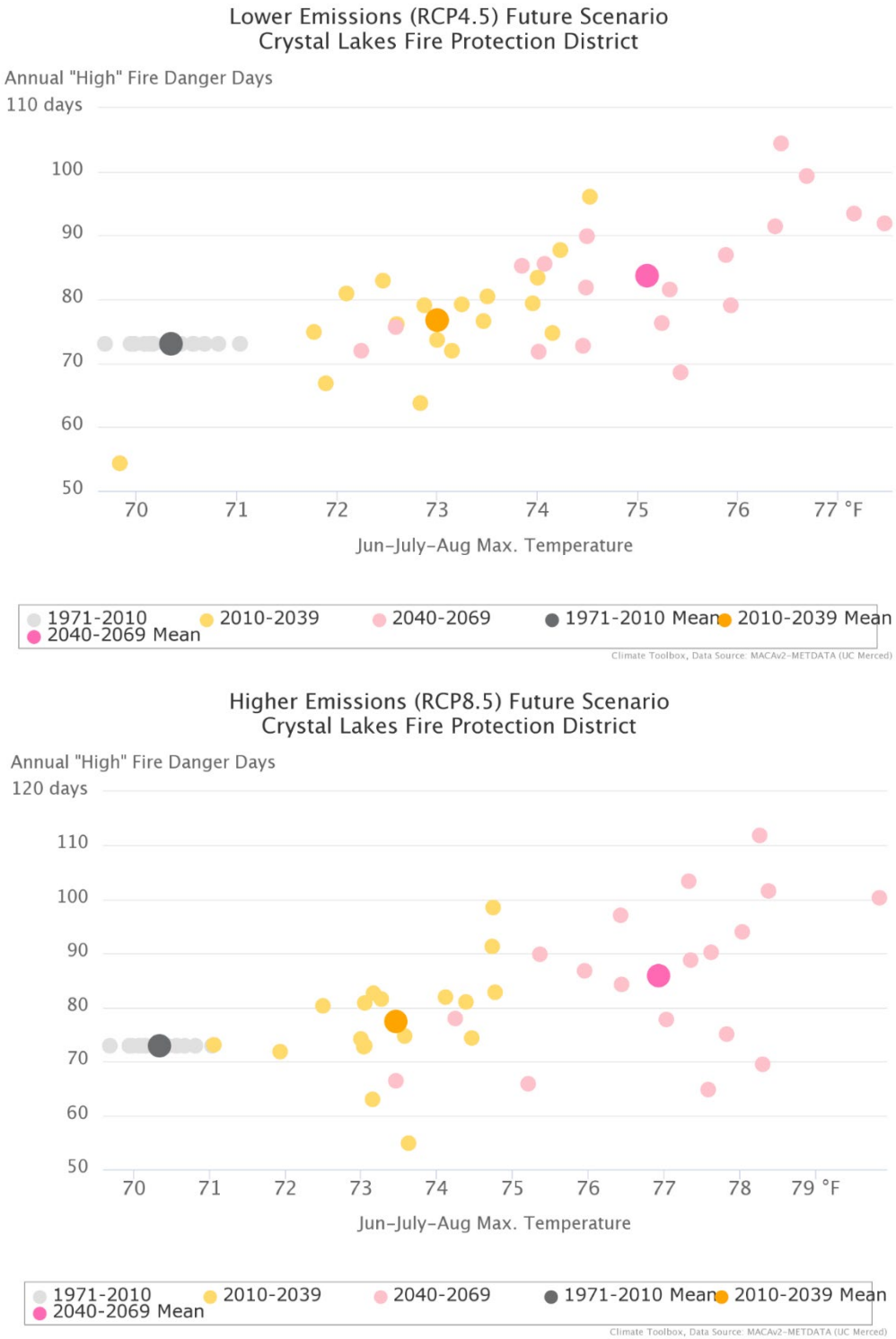


Figure B.13*. Annual "high" fire danger days and maximum temperature in June, July, and August are both conditions that impact fire behavior and suppression activities in the CLFPD. Future changes to these conditions were modelled with the Climate Toolbox Future Climate Scatter (Hegewisch et al., 2021). The top graph is modelled under the RCP 4.5 scenario, where greenhouse gas emissions stabilize before the year 2100, peaking around 2040. The bottom graph is modelled under the RCP 8.5 scenario, where greenhouse gas emissions are not curtailed by 2100.*

Figure B.14*. 100-hour fuel moisture and days per year with a maximum temperature above 86° F are both conditions that impact fire behavior and suppression activities in the CLFPD. Future changes to these conditions were modelled with the Climate Toolbox Future Climate Scatter (Hegewisch et al., 2021). The top graph is modelled under the RCP 4.5 scenario, where greenhouse gas emissions stabilize before the year 2100, peaking around 2040. The bottom graph is modelled under the RCP 8.5 scenario, where greenhouse gas emissions are not curtailed by 2100.*

Relative Risk Assessment

We compared the ***relative*** risk that wildfires pose to life and property in the 15 CLRRA filings and Pearl Creek Estates, Elkridge Ranches, and Poudre Meadows. Due to the limited number of homes in Poudre Meadows, this neighborhood was combined with CLRRA Filing 5 for the purpose of assessing relative risk (**Figure B.16**). Homes across the CLFPD have high risk from wildfire damage, but to help prioritize hazard mitigation, we developed a rating of relative risk. A filing receiving a relative rating of "moderate risk" has risk factors that are lower than risk factors in other filings, but it is still an area with wildfire hazards. We assessed hazards in four categories: fire risk, fire suppression challenges (e.g., limited hydrant availability and engine access), evacuation hazards, and HIZ hazards. We developed the ratings of relative risk specifically for the CLFPD, so the assessment is not suitable for comparing CLFPD to other communities.

Our assessment was based on predictions of fire behavior, potential exposure to radiant heat and ember cast, roadway survivability, and evacuation time, as well as an on-the-ground assessment of each filing. In summer 2022, TEA employees drove around the CLFPD and used a modified version of the NFPA Wildfire Hazard Severity Form Checklist (NFPA 299 / 1144) to rate HIZ hazards within each filing.

A rating scale was developed specifically for the CLFPD based on the range of values observed across the community (**Table B.4**). The purpose of the assessment is to compare relative hazards within the community and is not suitable for comparing the CLFPD to other communities.

Table B.4. *Relative risk rating values for the CLFPD.*

	Points		Relative hazard rating		
Hazard category	Max. possible	Range of values observed in CLFPD filings	Moderate	High	Extreme
A. Fire risk	59	12 – 50	≤29	30-39	≥40
B. Fire suppression challenges	44	15 – 32	≤20	21-25	≥26
C. Evacuation hazards	40	5 – 35	≤19	20-24	≥25
D. Home ignition zone hazards	58	19 – 50	≤29	30-44	≥45
Overall risk	201	73 – 140	≤110	111-120	≥121

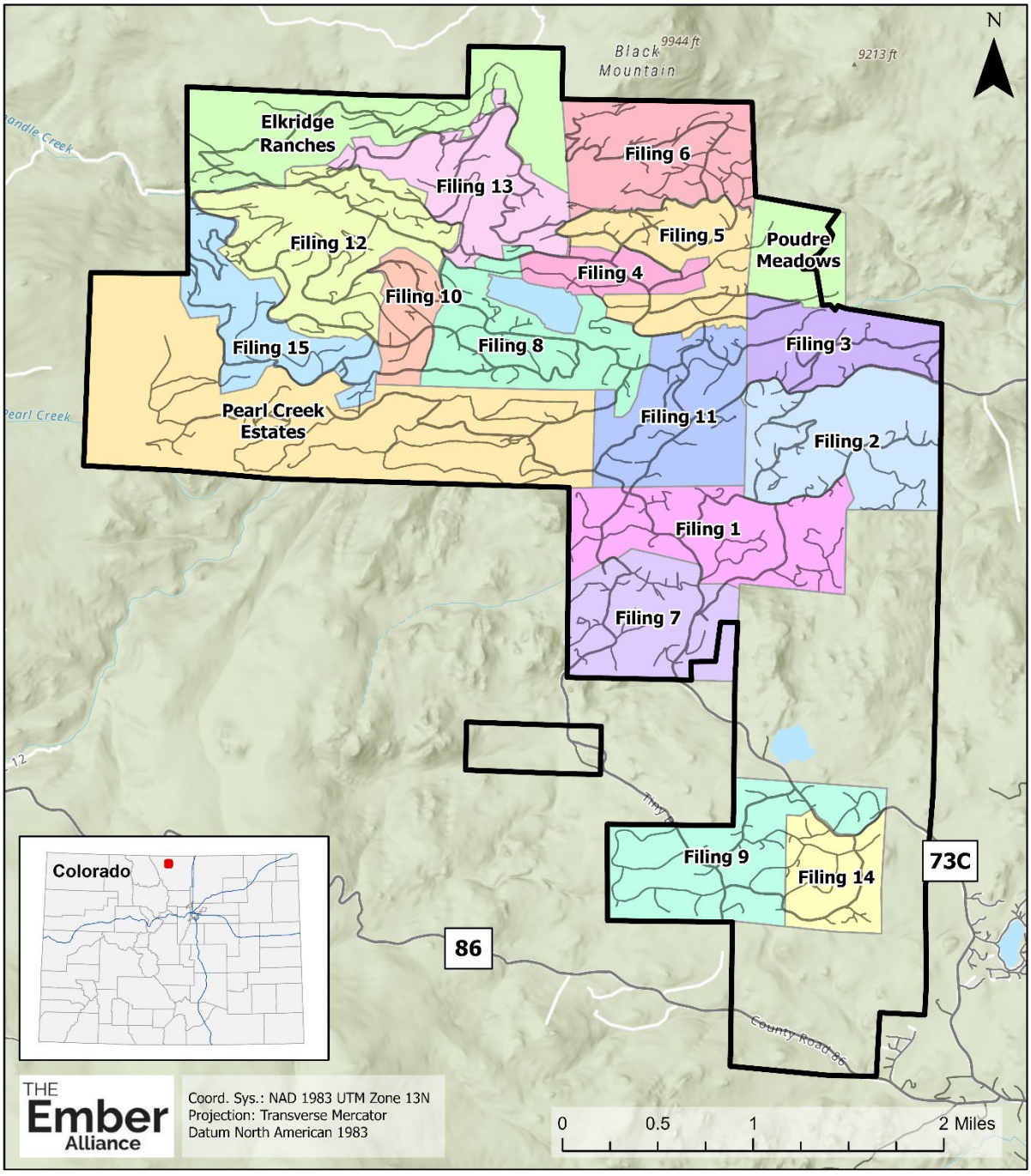


Figure B.15*. CLRRA filings and neighborhoods in the CLFPD.*

Relative Risk Rating Form

A. Fire Risk	Points
1. Average flame length[1]	
<4 feet	0
4-<5 feet	6
≥5 feet	12
2. Percent area predicted for active crown fire[2]	
<7%	0
7-<10%	6
≥10%	12
3. Percent of homes exposed to extreme radiant heat[2]	
<40%	0
40-<60%	6
≥60%	12
4. Average conditional burn probability[2]	
<0.8%	0
0.8-<1.0%	3
≥1.0%	6
4. Additional risk factors	
Mid-slope homes	2
Homes on ridge tops	2
Saddles / ravines / chimneys	4
Utilities (gas / electric) placement	
All underground	0
Infrequent overhead powerlines	3
Frequent overhead powerlines	5
A. Total points possible	**59**

[1]Predictions from FlamMap under 60th percentile fire weather conditions for filings and adjacent watersheds.
[2]Predictions from FlamMap under 90th percentile fire weather conditions for filings and adjacent watersheds.
*Different percentile fire weather conditions were used for flame length than other metrics of fire behavior to capture a greater variation in potential fire behavior among filings.

B. Fire Suppression Challenges	Points
1. Average response time[3]	
<5 minutes	0
5-<8 minutes	2
≥8 minutes	4
2. Percentage of homes near hydrants	
>75%	0
25-75%	5
<25%	10
3. Presence of dip / draft sites	
At least one dip / draft site OR not necessary due to hydrants	0
No dip / draft site	5
4. Road/driveway accessibility for Type 3 engines (percent of roads/driveways)	
>90%	0
75-90%	5
50-75%	10
<50%	15
5. Presence of legible and reflective signs (percent of roads and homes)	
>90%	0
75-90%	3
<75%	5
6. Presence / absence of HazMat	
Absent	0
Present	5
B. Total points possible	**44**

[3]Response time estimated using Service Area analysis in ArcMap.

C. Evacuation Hazards	Points
1. Number of lanes in each direction	
At least 1 lane on >75% of roads	0
At least 1 lane on >50-75% of roads	5
Less than 1 lane on >50% of roads	10
2. Mean household evacuation time[4]	
<210 minutes	0
210-<240 minutes	5
≥240 minutes	10
3. Percentage of road with non-survivable conditions under 90th percentile fire weather	
<50%	0
50-<70%	10
≥70%	20
C. Total points possible	**40**

[4]Estimates from ArcCASPER (see evacuation modeling methodology above).

D. Home Ignition Zone Hazards	Points
1. Roof construction material	
Class B or C on <10% of homes	0
Class B or C on 10-15% of homes	5
Class B or C on >25% of homes	10
Class C on >50% of homes	15
2. Percent of homes with combustible or non-ignition resistant siding	
<10%	0
10-50%	3
>50%	5
3. Percent of homes with combustible or non-ignition resistant decking	
<10%	0
10-25%	3
>25%	5
4. Percent of homes with wooden fences	
<10%	0
10-25%	1
>25%	2
5. Percent of homes with adequate mitigation in HIZ 1	
>90%	0
75-90%	3
50-75%	6
<50%	10
6. Percent of homes with adequate mitigation in HIZ 2	
>90%	0
75-90%	3
50-75%	6
<50%	10
7. Percent of homes with additional hazards in HIZ 1 and 2 (e.g., wood piles, propane tanks, wooden sheds)	
<10%	0
10-25%	1
25-50%	3
>50%	5
8. Average number of homes potentially exposed to short-range ember cast from other homes	
0 homes	0
1-2 homes	3
≥3 homes	6
D. Total points possible	**58**

Fuel Treatment Prioritization

Roadside Fuel Treatments

We assessed the potential need for roadside fuel treatments based on non-survivable conditions (predicted flame lengths >8 feet) under 90th percentile fire weather conditions and the potential for the roadway to become an evacuation pinch point under a district-wide evacuation order. **Table B.5** describes the criteria used for rating the potential need for roadside fuel treatments. Keep in mind that our fire behavior analyses occurred at the scale of 0.2 acres (30 x 30 meters), so locations of potential treatment areas are approximate.

Roads in need of fuel treatments are abundant and scattered across the CLFPD (**Figure B.17**; **Table B.6**). Due to limited points of egress, evacuation congestion could be experienced across much of the community, and dense forests lining many roadways could result in non-survivable conditions during wildfires. We used this assessment of treatment need to start conversations with partners about specific project areas for this CWPP in summer and fall 2022. After considering feasibility and potential benefits, portions of Mescalero Drive, Mosquito Drive, Ottawa Way, Tiny Bob Road, CR 73C, and Pearl Beaver Rd were selected as high priority project areas for roadside fuel treatments (see CWPP **Section 4.b**).

Table B.5. *Methodology for ranking potential need for roadside treatments to mitigate fire hazards along roadways in the CLFPD.*

Need for roadside fuel treatment	Conditions
Highest	• Non-survivable conditions (flame lengths >8 feet) under 90th percentile fire weather conditions • High to extreme evacuation pinch points (congestion ratio ≥2.0)
High	• Non-survivable conditions (flame lengths >8 feet) under 90th percentile fire weather conditions • Moderate evacuation pinch points (congestion ratio ≥1.5 to <2.0)
Moderate	• Non-survivable conditions (flame lengths >8 feet) under 90th percentile fire weather conditions • Minor evacuation pinch points (congestion ratio <1.5)

Table B.6. *Total length and names of road segments potentially in need of roadside fuel treatments in the CLFPD.*

Potential Need for Treatment	Highest	High	Moderate
Total length of road segments (miles)	13.0	19.3	22.0
Road names	Catawaba Way CR 73C (Creedmore Lakes Road) Huron Road Lone Pine Drive Menominee Circle Mescalero Drive Mosquito Drive Ottawa Way Socorro Trail Tiny Bob Road Voto Way	Caddo Road Catamount Way CR 86 (Deadman Road) Cuna Way Manhattan Road Mosquito Drive Muskogee Trail Okmulkee Circle Osage Trail Ottawa Way Pottawatomie Trail Pueblo Road Shawnee Road Shoshi Drive Tesoque Trail Yuki Drive	Chicksaw Court Chiricahua Circle Commanche Circle Delaware Court Elkridge Road Flathead Drive FS Road 185 Hatchetumi Way Hopi Court Natchez Circle Neosho Trail Panamint Way Pearl Beaver Road Shasta Way South CR 169 Sutiki Court Tuscarora Way Ute Court Ute Way Yockey Drive

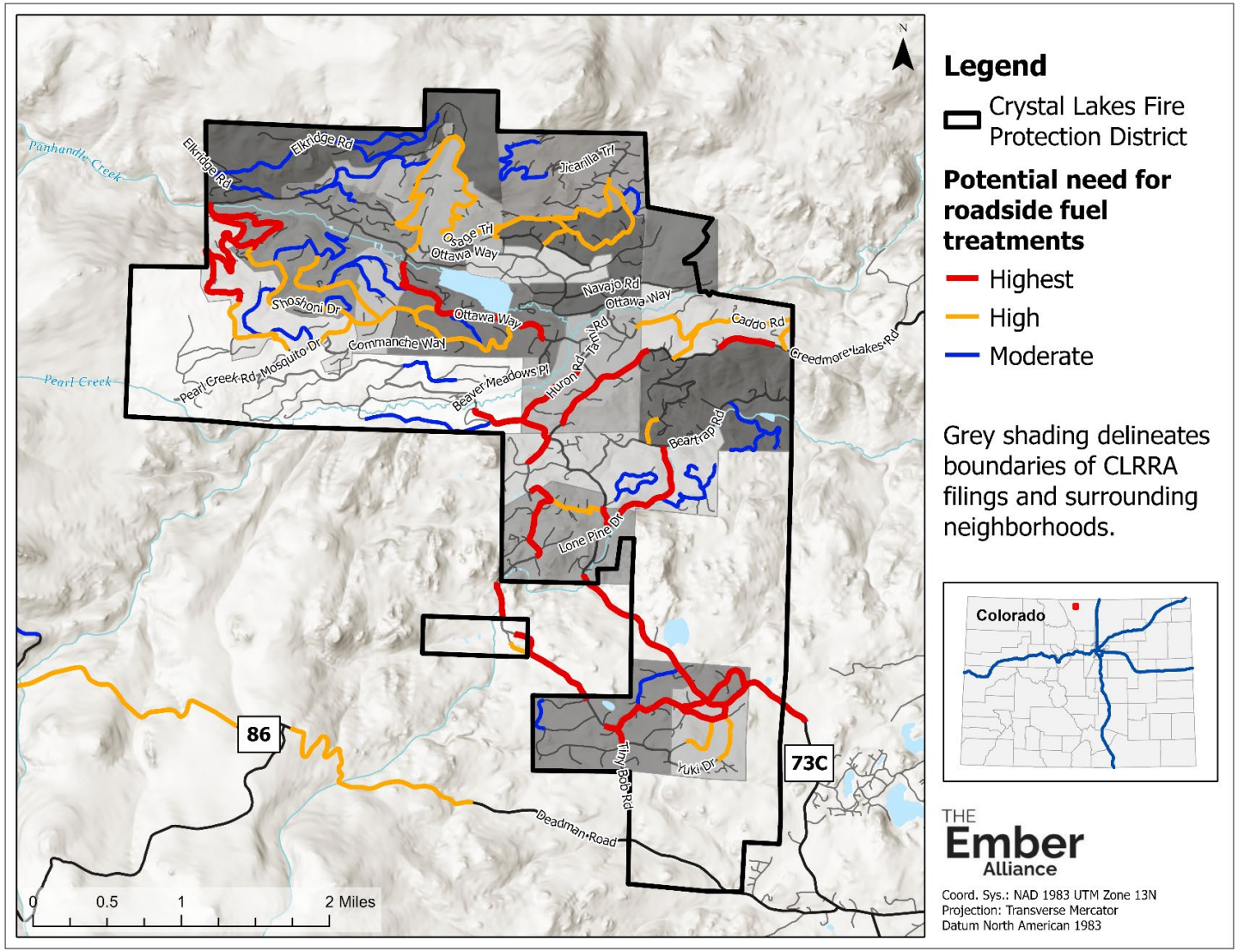


Figure B.16. *Potential need for roadside fuel treatments based on potential fire behavior and evacuation congestion. Our fire behavior analyses occurred at the scale of 0.2 acres (30 x 30 meters), so locations of potential treatment areas are approximate. Visit the CLRRA CWPP Map Experience for an interactive version of this map.*

Stand-Scale Fuel Treatments

We created topographic units for assessing the potential need for stand-scale fuel treatments by delineating small watersheds (i.e., an area of land where all precipitation falling in that area drains to the same location) and subdividing these into three hillslopes—one on each side of a stream or river and one above the headwaters of the watershed (**Figure B.18**). We delineated hillslopes in ArcGIS using a modified version of the WEPP Hillslope Toolbox, which is based on TOPAZ (Topographic Parameterization Software) from the USDA Agricultural Research Service.

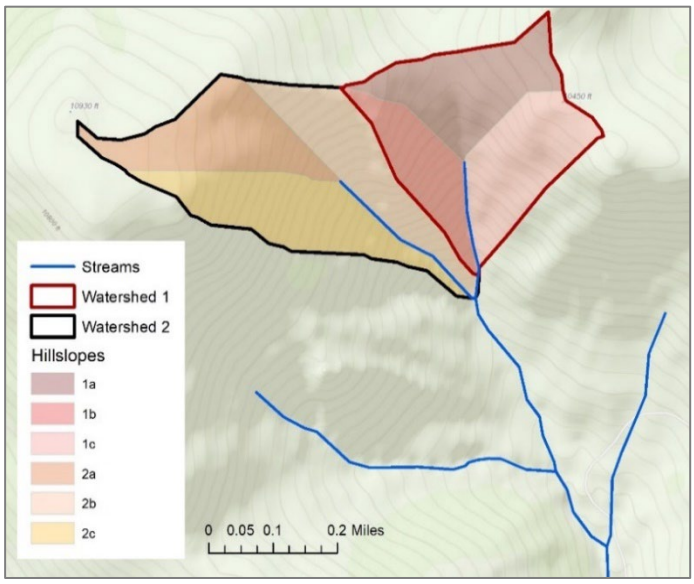


Figure B.17. *Depiction of small watersheds and their subdivided hillslopes.*

We used 30 m resolution digital elevation models from the U.S. Geological Service, and delineated hillslopes with a critical source area of 75 acres (30 hectares) and a minimum source channel length of 330 feet (100 meters). Critical source area is the minimum allowable area above the head of a first-order channel, and minimum source channel length is the minimum length of a channel used to delineate watersheds. Hillslopes were also split by Creedmore Lakes Road (CR 73C), Deadman Road (CR 86), Red Feather Road (CR 74E), and Pearl Beaver Road (FS Rd 169) because stand-scale fuel treatments often occur on one side of a major road at a time. Areas that were less than 20 acres in size were combined with adjacent hillslopes to result in potential treatment areas in size from 20 to 400 acres—reasonable sizes for forest management projects in the WUI.

The factors included in the assessment and their relative weights were decided iteratively based on conversations among TEA, the CWPP core team, and land managers. We assessed the potential need for fuel treatments in each hillslope based on presence of priority roadway treatments, presence of potential operational delineation (POD) boundaries, and predicted fire behavior (**Table B.7**). PODs are topographic areas bounded by features suitable for fire control (e.g., ridgetops and roads) that can be used for proactive wildfire decision making and tactical operations during wildfire events. PODs can serve as management units for proactive ecological restoration and wildfire risk mitigation, as well as for cross-boundary and collaborative land and fire management planning (Thompson et al., 2022). Land managers, wildland fire / fuel planners, and researchers have worked together to define POD boundaries across all of Larimer County.

A total of about 4,500 acres had the highest potential need for stand-scale fuel treatments (**Figure B.18**). About 7,100 acres had a high potential need and about 11,300 acres a moderate potential need for stand-scale fuel treatments. Due to the importance of fuel treatments that can assist with suppression and proactive wildfire management, several areas with the highest treatment need are located outside the CLFPD to the north and west. Areas with highest treatment need within the CLFPD occur where topography and fuels create the potential for extreme fire behavior and/or fall along major roads that can serve as control points during wildfire suppression.

We used this assessment of treatment need to start conversations with partners about specific project areas for this CWPP in summer and fall 2022. After considering feasibility, ongoing work, and

potential benefits, portions of filings 12, 13, and 15 were selected for treatments led by CLRRA. Portions of the Arapaho-Roosevelt National Forest west, north, and east of CLFPD were selected for treatments led by the USFS (see CWPP **Section 4.b**).

Table B.7. *Methodology for ranking potential need for stand-scale fuel treatments to mitigate fire hazards within and adjacent to the CLFPD.*

Potential need for fuel treatments	Maximum weight		Highest	High	Moderate
Contains priority roadways (non-survivable evacuation pinch point)	30%	Cutoff	At least one 1st priority roadway	At least one 2nd or 3rd priority roadway	No priority roadways
		Weight	30	15	0
Contains a POD boundary for potential control lines during fire suppression	15%		Yes	---	No
		Weight	15	---	0
Percent active crown fire (**90th percentile fire weather**)	20%	Cutoff	≥30%	10 - <30%	<10%
		Weight	20	10	0
Percent area with flame lengths > 16 feet (**60th percentile fire weather**)	20%	Cutoff	≥30%	10 - <30%	<10%
		Weight	20	10	0
Average conditional burn probability (**90th percentile fire weather**, average BP of 25 mph ESE winds and 25 mph WNW winds)	15%	Cutoff	≥1.0%	0.7 - <1.0%	<0.7%
		Weight	15	8	0
Overall priority (sum of values)		Cutoff	>50	36-50	21-35

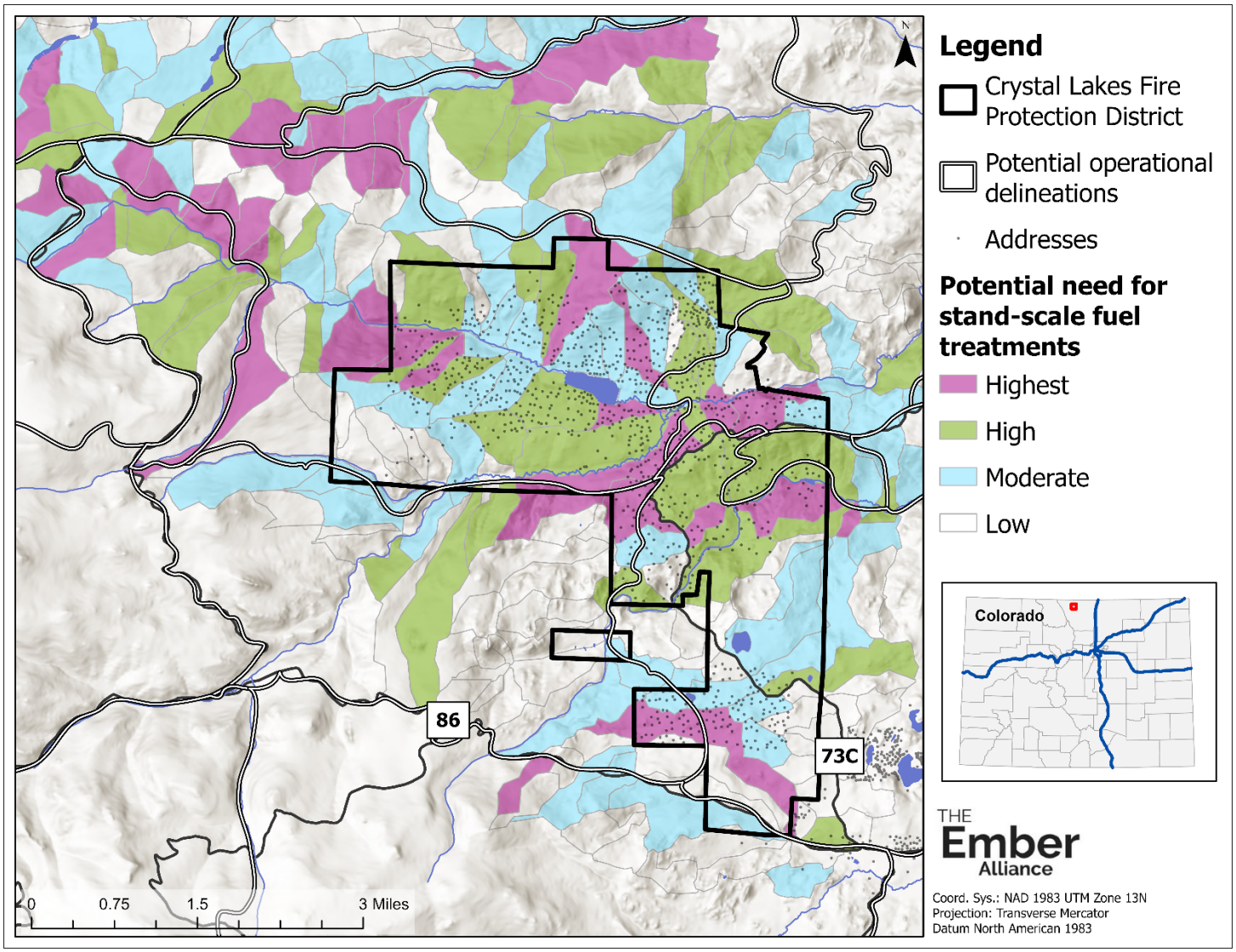


Figure B.18. *Potential need for stand-scale fuel treatments based on presence of non-survivable roadway conditions, presence of potential operational delineation (POD) boundaries, and predicted fire behavior.*

Appendix C. Community Survey Methods and Results

Community Survey Distribution

The community survey was shared with all property owners of the CLFPD. Property owners were able to take the survey online via links sent out in emails and shared within the community. Paper surveys were also distributed at events and at the fire station. The survey was open from June 16, 2022 to July 15, 2022.

Results and Interpretation

Results from the survey were compiled and analyzed for themes, correlations, and other important information. 119 people responded to the survey, but some individuals did not provide a response to all questions and their responses are recorded as "no answer." The percentages reported below are out of 100% of survey respondents.

Understanding and support for mitigation:

- 97% of property owners understand the risk of fire in CL
- 90-95% support mitigation action on private and public land
- At least 81% of property owners support prescribed burning, either broadcast or pile burning

Level of concern around wildfire impacts:

- 94% of property owners are moderately or very concerned about damage to their business/home/property
- 89% are concerned about wildlife habitat
- 87% are concerned about the beauty of their property, insurance, and post-fire erosion and flooding
- People are least concerned about impacts to their livelihood—only 47%
- The greatest number of property owners indicated "very concerned" compared to "moderately concerned" for loss of life and loss of insurance coverage at 68% and 70% respectively

Mitigation and education activity:

- 90% of people have cut trees or limbs near structures on their property
    - 88% have signed up for NOCO Alert
    - 62% have an evacuation plan for the family
    - 48% of people say a lack of time prevents them from completing more mitigation
    - 32% say a physical inability to do the work prevents more mitigation
- 56% say access to a free/inexpensive slash disposal site will help them complete more mitigation
    - 42% say the need specific information or help doing the work
- 75% of folks get their information on wildfires from CLFPD
    - 43% receive it from CLRRA
- 58% of folks would like to learn about mitigation through one-on-one site visits at their hours
    - 51% would like videos on fire preparedness
    - 46% would like a program from CLFPD on preparedness, such as Ready Set Go
- 87% prefer communications via email, and the majority of remaining individuals prefer Nextdoor

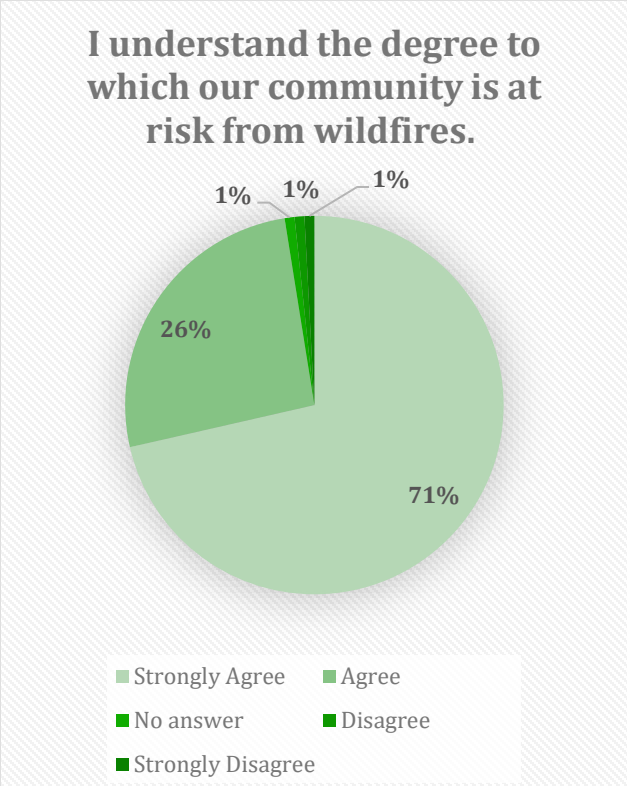
Cross-section connections:

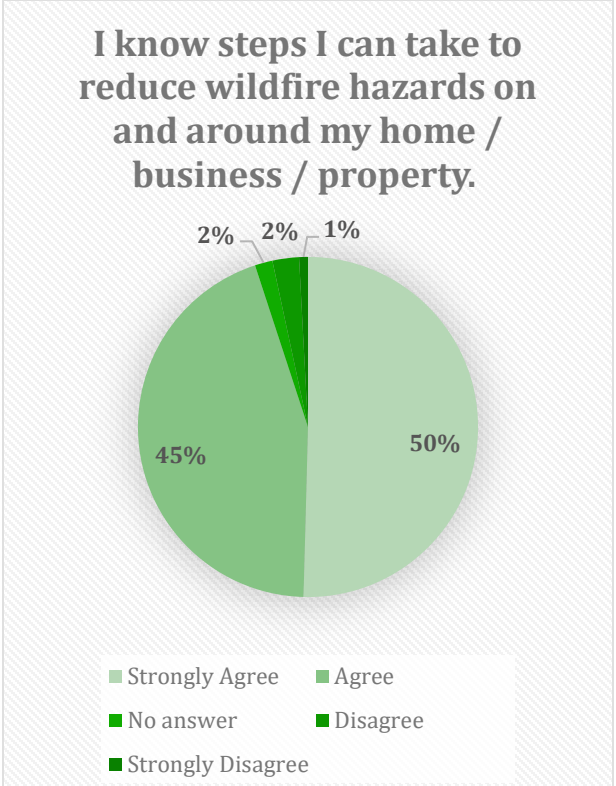
- There is no strong correlation between level of concern around wildfire and support for mitigation activities. Many people had a high level of concern and strong support for mitigation activities, but those who had low levels of concern did not lack support for mitigation, and those who didn't support mitigation still held high levels of concern.
- There is no correlation between a respondent's level of concern around wildfire and how much mitigation activity they have already taken.
- There is no correlation between respondents who would not consider cutting trees on their property and respondents who have taken fewer mitigation actions on their property.
- There is no correlation between a respondent's understanding of fire risk and their concern about fire impacts.

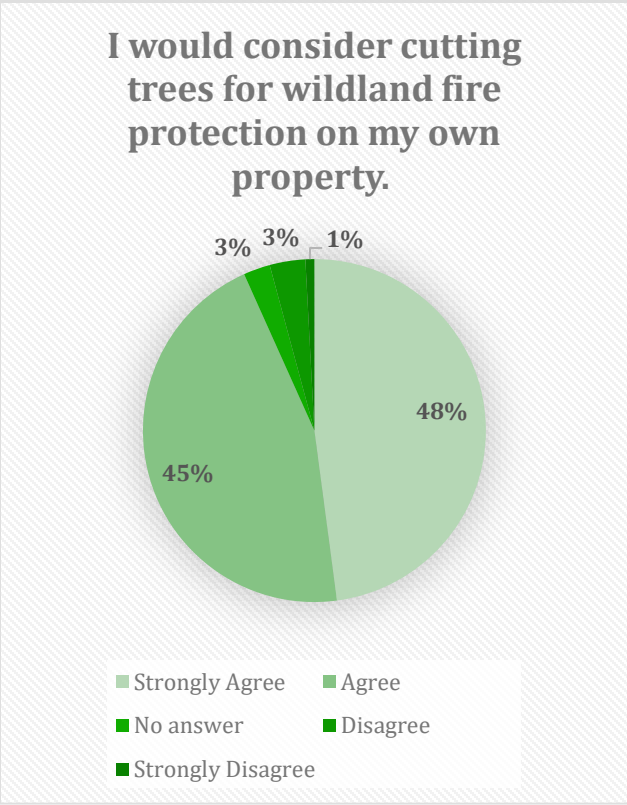
These results indicate that there is a disconnect between people's understanding of fire risk and the action they take in response to that. Most property owners are aware of the danger where they live and do not need to be educated on that, but that connecting the reduction in danger to their action and to community action may be important. Discussing loss of life and loss of insurance may be the most useful motivators when conducting outreach in the community. Email and Nextdoor will be the most useful tools in connecting with the community on a regular basis.

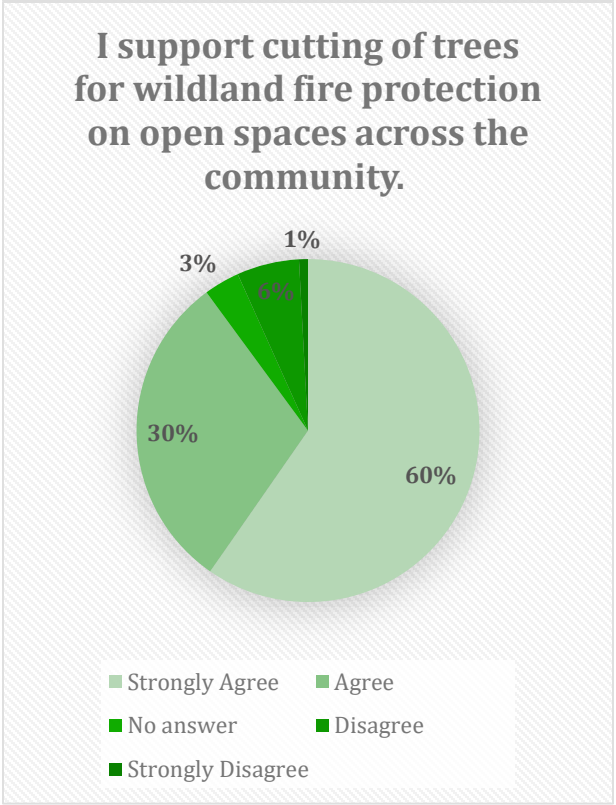
Questions and Responses

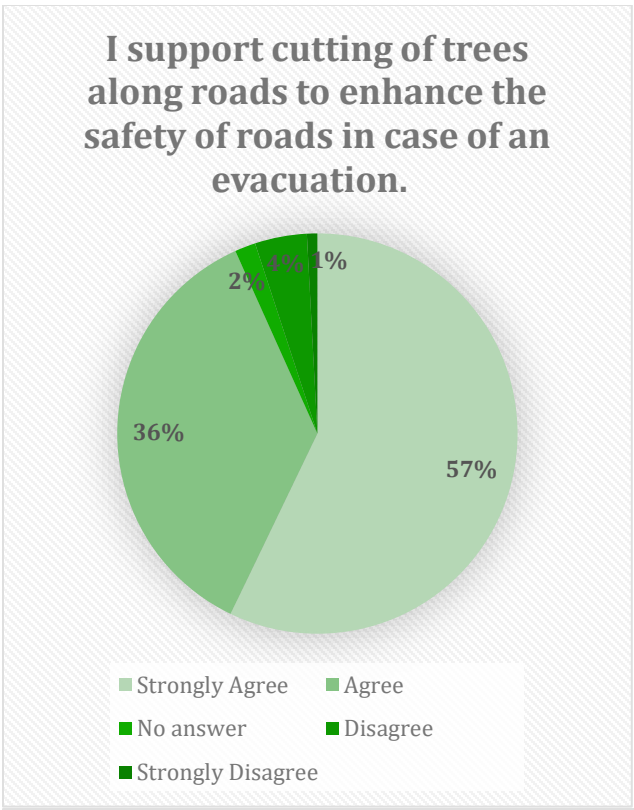
The following charts show all the questions asked in the survey in the order they were presented and the responses received by the 119 respondents.

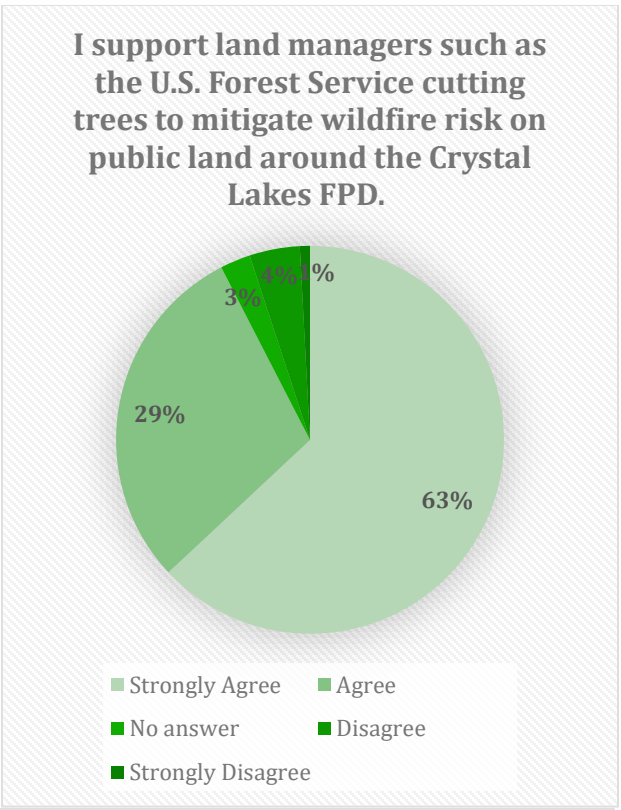

I understand the degree to which our community is at risk from wildfires.
1%
1%
1%
26%
71%
Strongly Agree
Agree
No answer
Disagree
Strongly Disagree

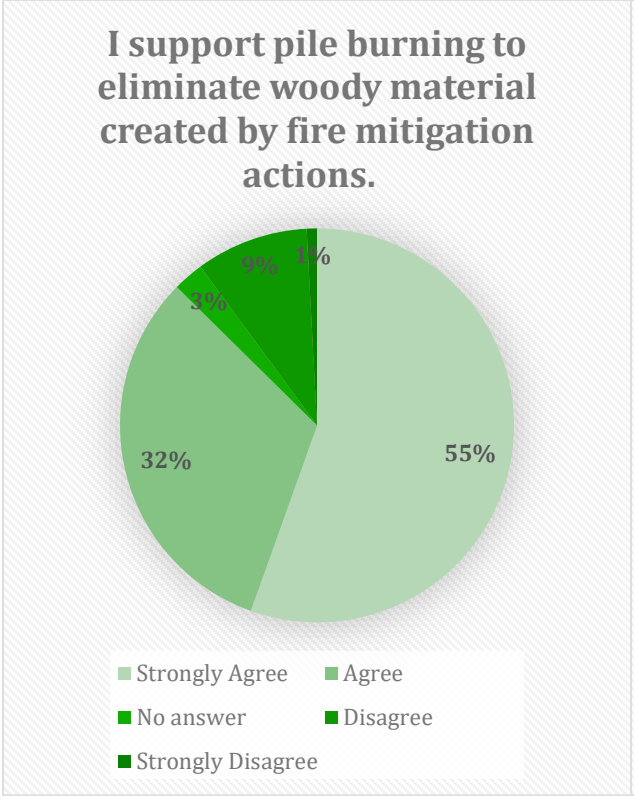

I know steps I can take to reduce wildfire hazards on and around my home / business / property.
2%
2%
1%
45%
50%
Strongly Agree
Agree
No answer
Disagree
Strongly Disagree

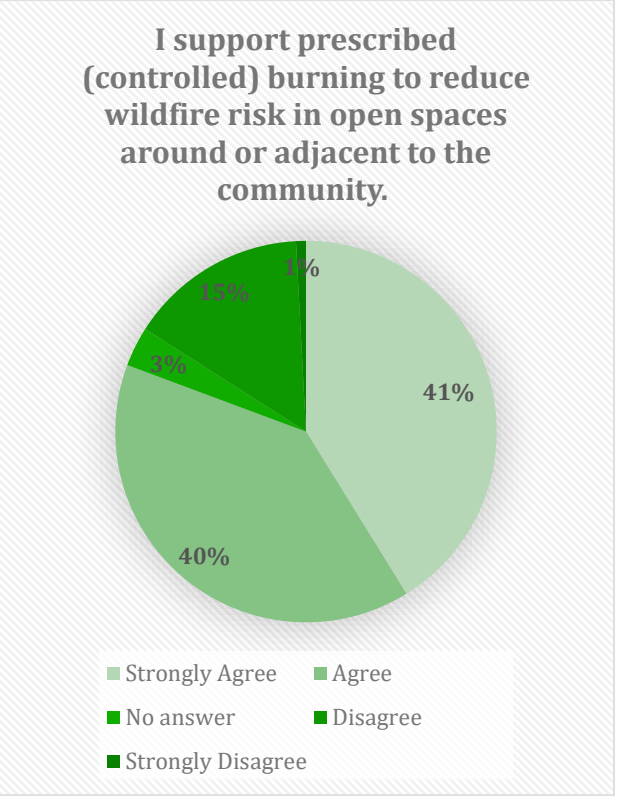

I would consider cutting trees for wildland fire protection on my own property.
3%
3%
1%
48%
45%
Strongly Agree
Agree
No answer
Disagree
Strongly Disagree

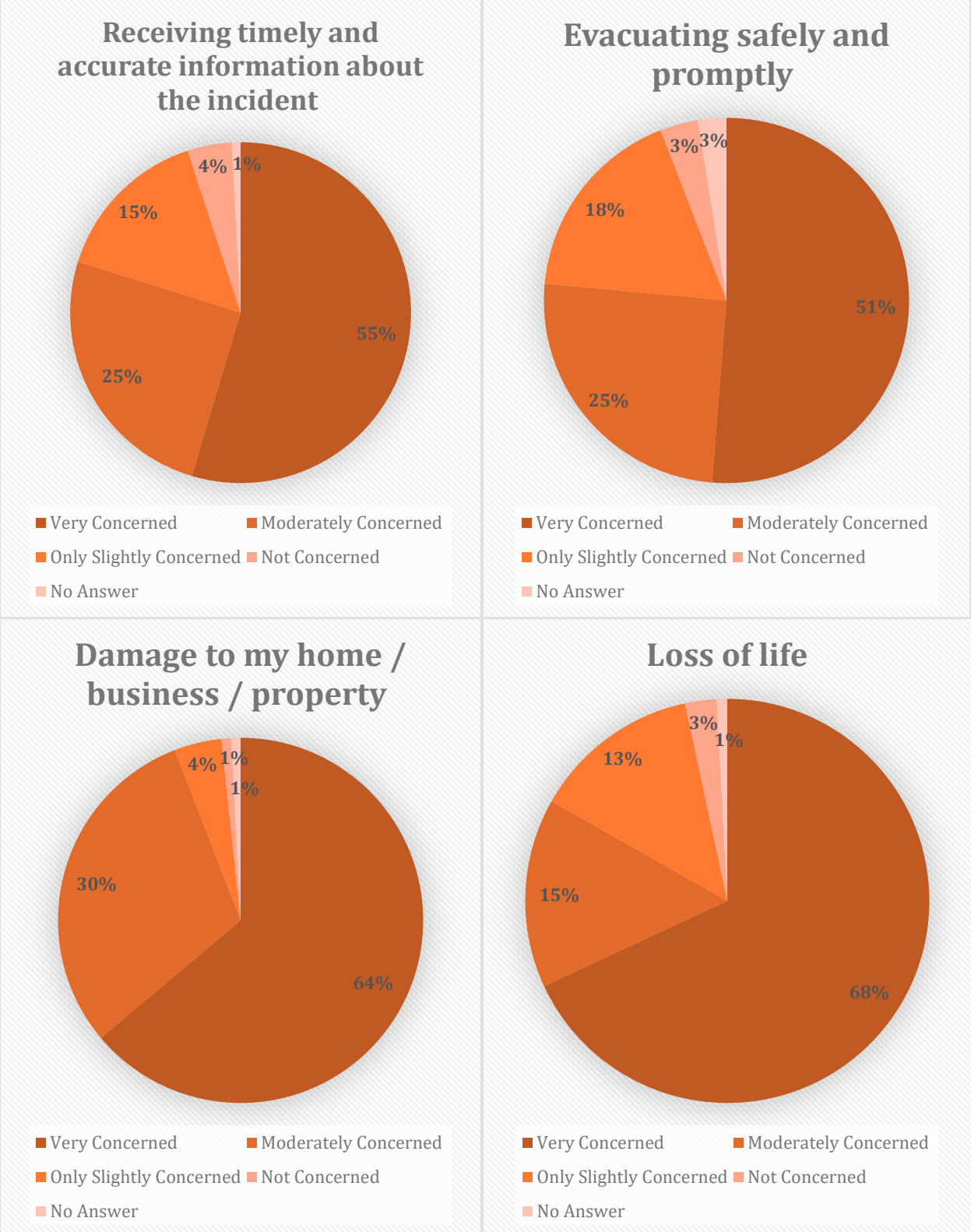

I support cutting of trees for wildland fire protection on open spaces across the community.
3%
1%
6%
30%
60%
Strongly Agree
Agree
No answer
Disagree
Strongly Disagree

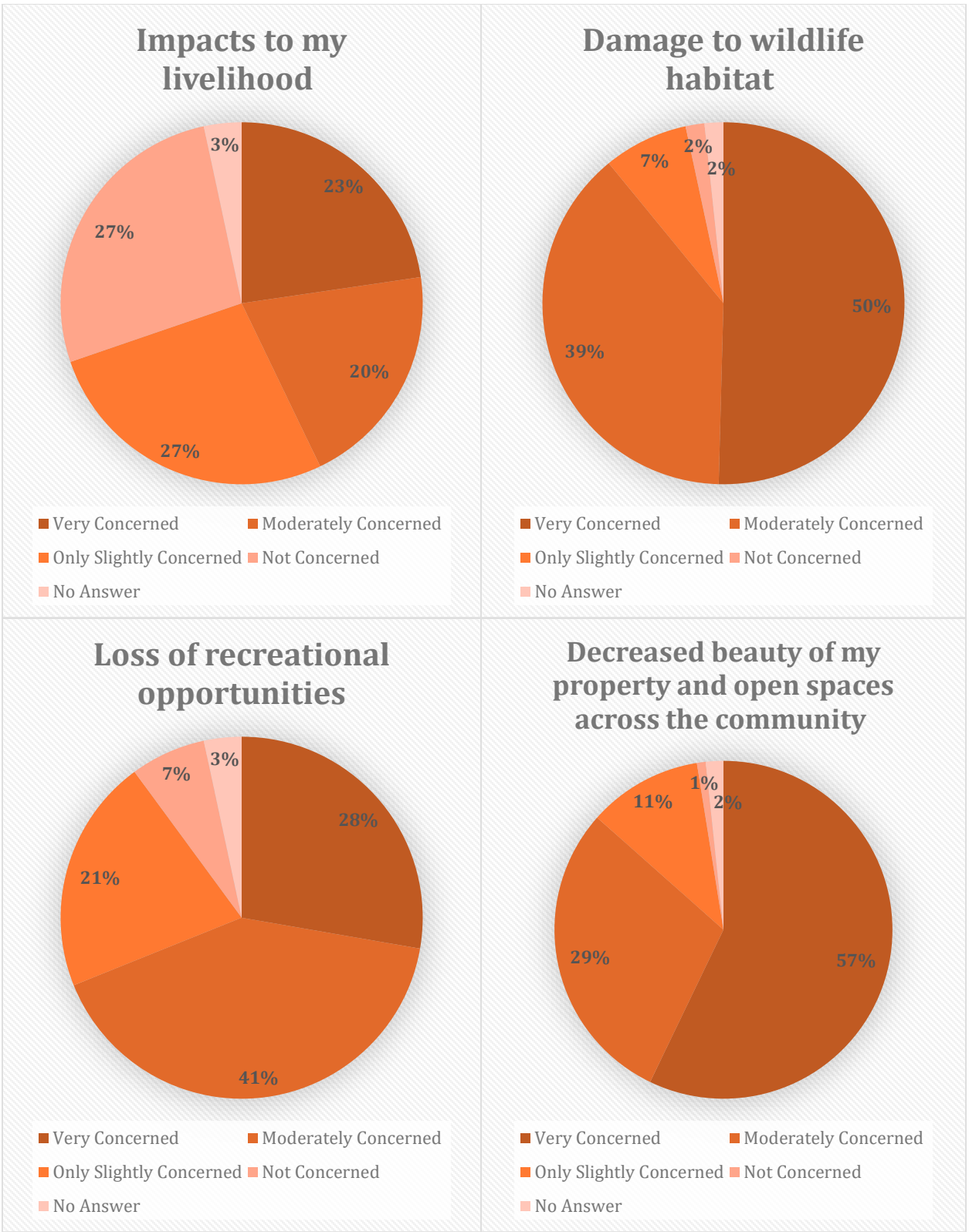

I support cutting of trees along roads to enhance the safety of roads in case of an evacuation.
1%
4%
2%
36%
57%
Strongly Agree
Agree
No answer
Disagree
Strongly Disagree

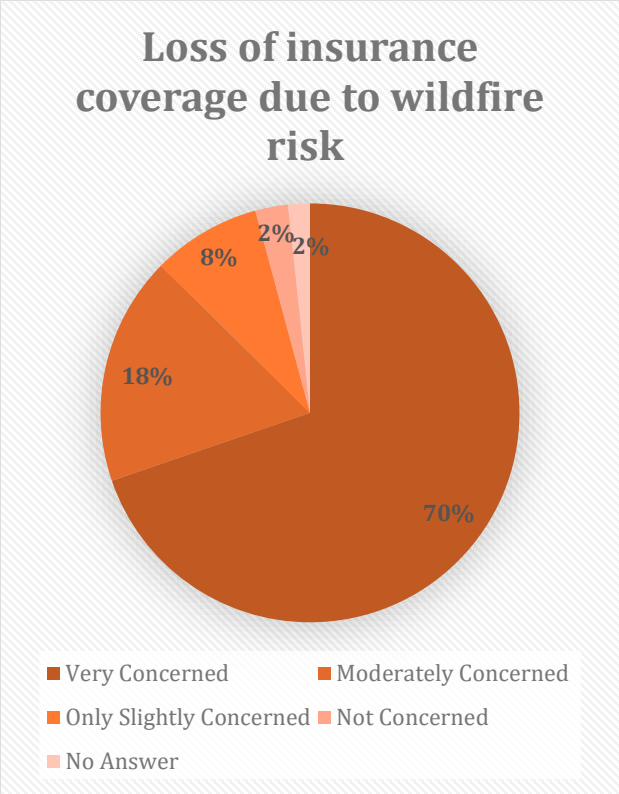

I support land managers such as the U.S. Forest Service cutting trees to mitigate wildfire risk on public land around the Crystal Lakes FPD.
1%
4%
3%
29%
63%
Strongly Agree
Agree
No answer
Disagree
Strongly Disagree

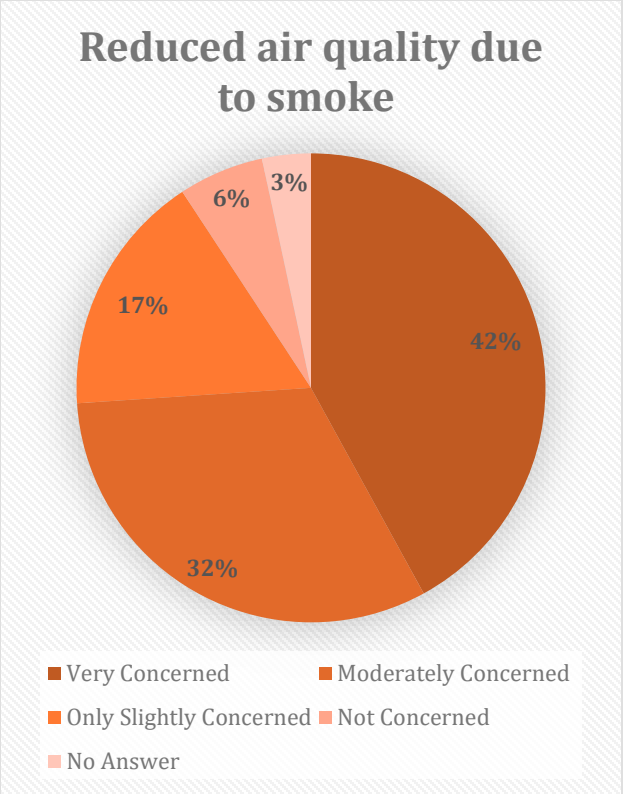

I support pile burning to eliminate woody material created by fire mitigation actions.
1%
9%
3%
32%
55%
Strongly Agree
Agree
No answer
Disagree
Strongly Disagree

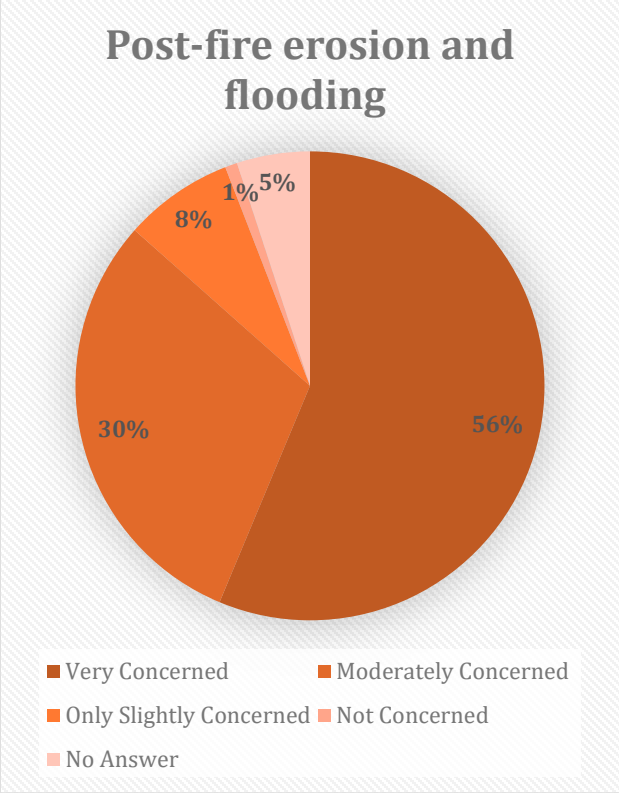

I support prescribed (controlled) burning to reduce wildfire risk in open spaces around or adjacent to the community.
1%
15%
3%
41%
40%
Strongly Agree
Agree
No answer
Disagree
Strongly Disagree

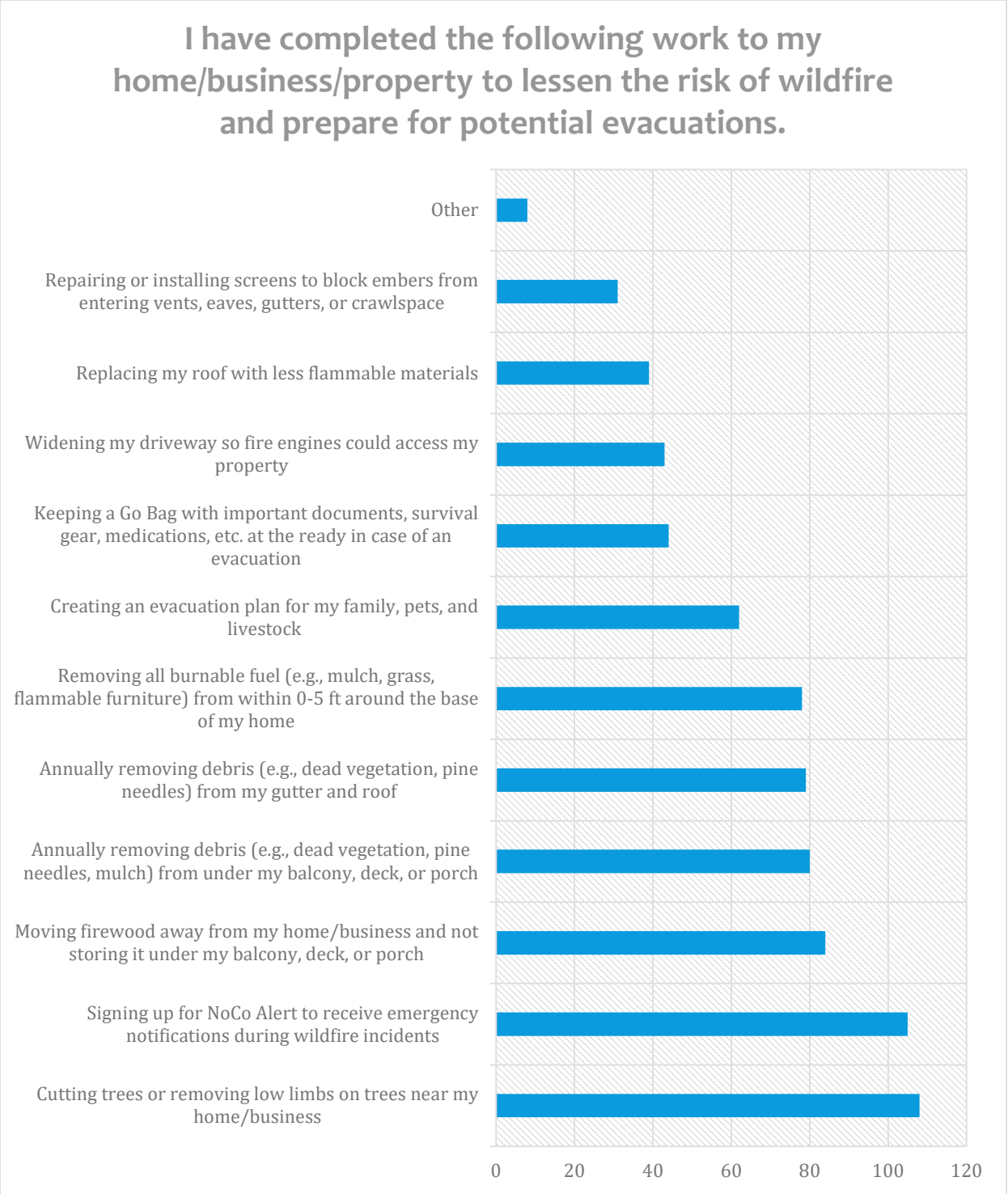

Receiving timely and accurate information about the incident
55%
25%
15%
4%
1%
Very Concerned
Moderately Concerned
Only Slightly Concerned
Not Concerned
No Answer
Evacuating safely and promptly
51%
25%
18%
3%
3%
Very Concerned
Moderately Concerned
Only Slightly Concerned
Not Concerned
No Answer
Damage to my home / business / property
64%
30%
4%
1%
1%
Very Concerned
Moderately Concerned
Only Slightly Concerned
Not Concerned
No Answer
Loss of life
68%
15%
13%
3%
1%
Very Concerned
Moderately Concerned
Only Slightly Concerned
Not Concerned
No Answer


Impacts to my livelihood
23%
20%
27%
27%
3%
Very Concerned
Moderately Concerned
Only Slightly Concerned
Not Concerned
No Answer
Damage to wildlife habitat
50%
39%
7%
2%
2%
Very Concerned
Moderately Concerned
Only Slightly Concerned
Not Concerned
No Answer
Loss of recreational opportunities
28%
41%
21%
7%
3%
Very Concerned
Moderately Concerned
Only Slightly Concerned
Not Concerned
No Answer
Decreased beauty of my property and open spaces across the community
57%
29%
11%
1%
2%
Very Concerned
Moderately Concerned
Only Slightly Concerned
Not Concerned
No Answer


Loss of insurance coverage due to wildfire risk
70%
18%
8%
2%
2%
Very Concerned
Moderately Concerned
Only Slightly Concerned
Not Concerned
No Answer


Reduced air quality due to smoke
42%
32%
17%
6%
3%
Very Concerned
Moderately Concerned
Only Slightly Concerned
Not Concerned
No Answer


Post-fire erosion and flooding
56%
30%
8%
1%
5%
Very Concerned
Moderately Concerned
Only Slightly Concerned
Not Concerned
No Answer

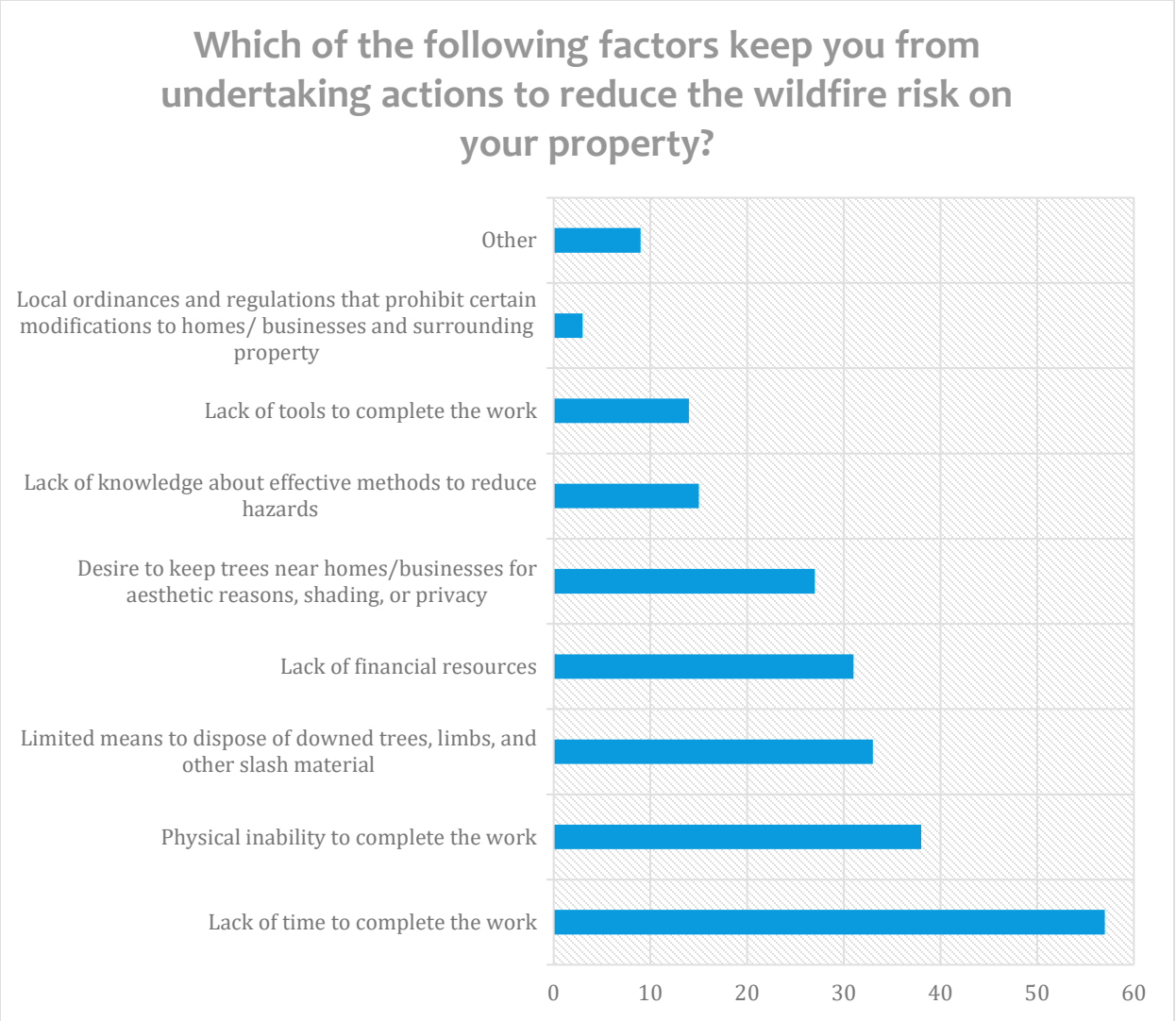


Other answers provided:

- Replacing siding with stone and James Hardie Fiber Cement Siding
- Still in the process of cutting ladder limbs
- In response to question 2, it seems more important to remove all the deadfall before going after healthy trees. The Nat Forest Service has quite a backlog of dead trees along PanHandle Creek to the west of Crystal Lake land. before we'd consider removing anymore of our healthy

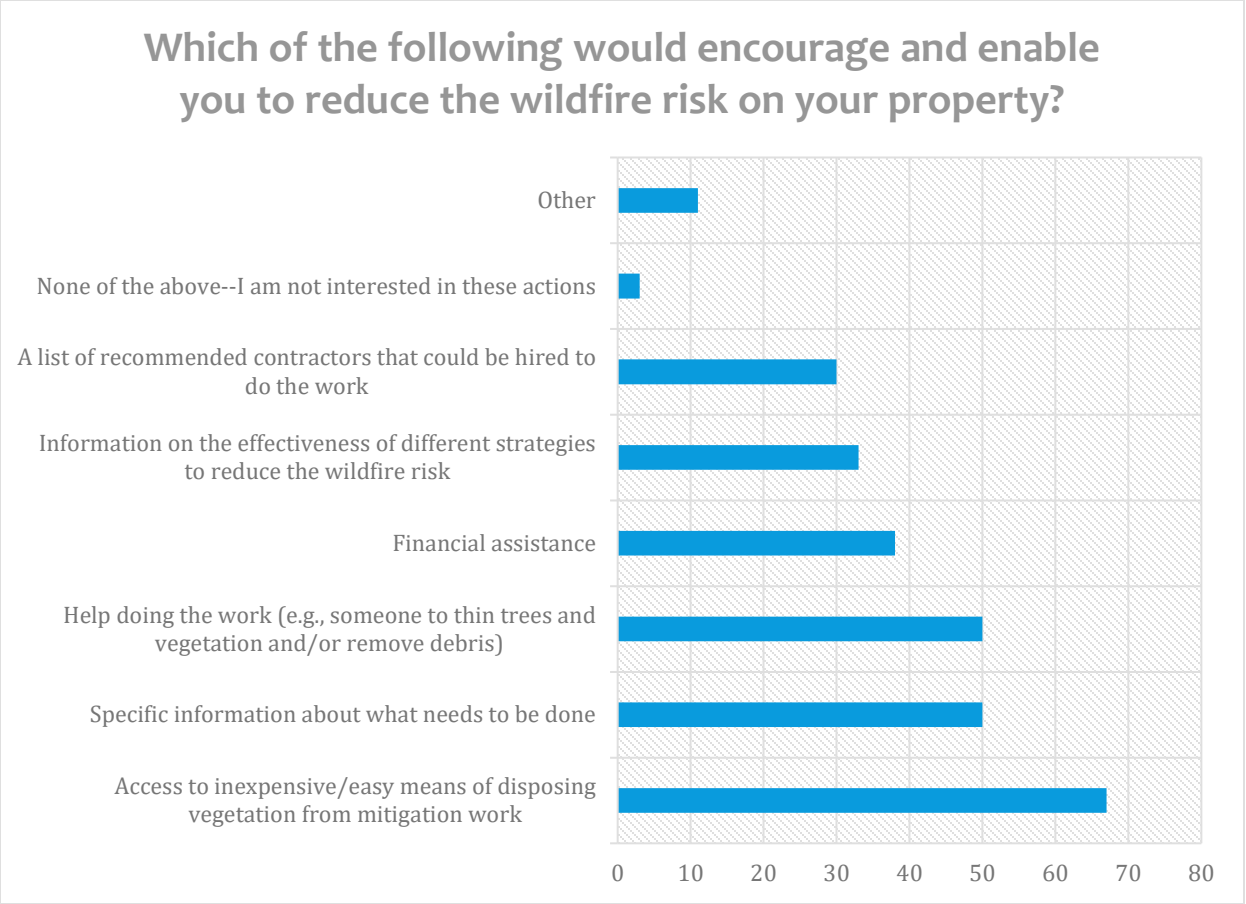
trees, the enormous amount of deadfall and standing dead trees on our adjoining lot should be dealt with.

- Very concerned about the interface of Beaver Meadows property to our community
- Making sure we have gas in our vehicle
- We just own land at this point and are working every year to cut down and mitigate standing dead
- Just began removing years of slash build up
- Fire pit inspected per CLRRA regulations on 3-year basis; don't use firepit on windy days



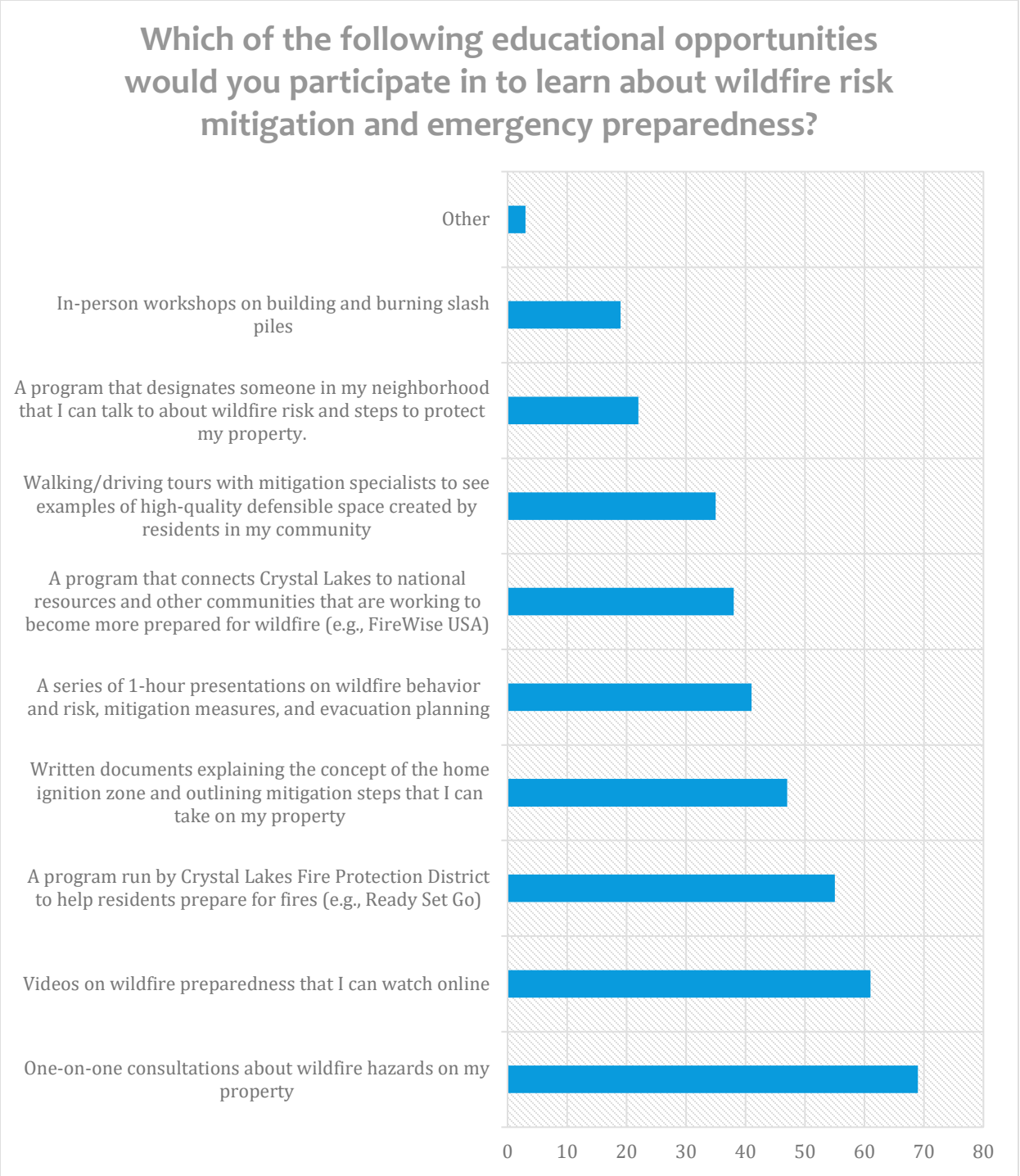
Other answers provided:

- Disposing at the CLRRA slash depot costs money and it's an effort to load and drop off slash
- Terrain prohibits the removal of dead trees
- Lack of access to a place to take slash for free like we used to have
- CL common area directly behind my home is the most fire prone area (lots of dead and down trees) Filing 11 Lot 9
- Already mitigated
- Wildfire risk is high on community trail property bordering our property
- I don't have a home yet, but want to protect my property and shed
- I did not get any assistance with my property
- Cost of mitigation



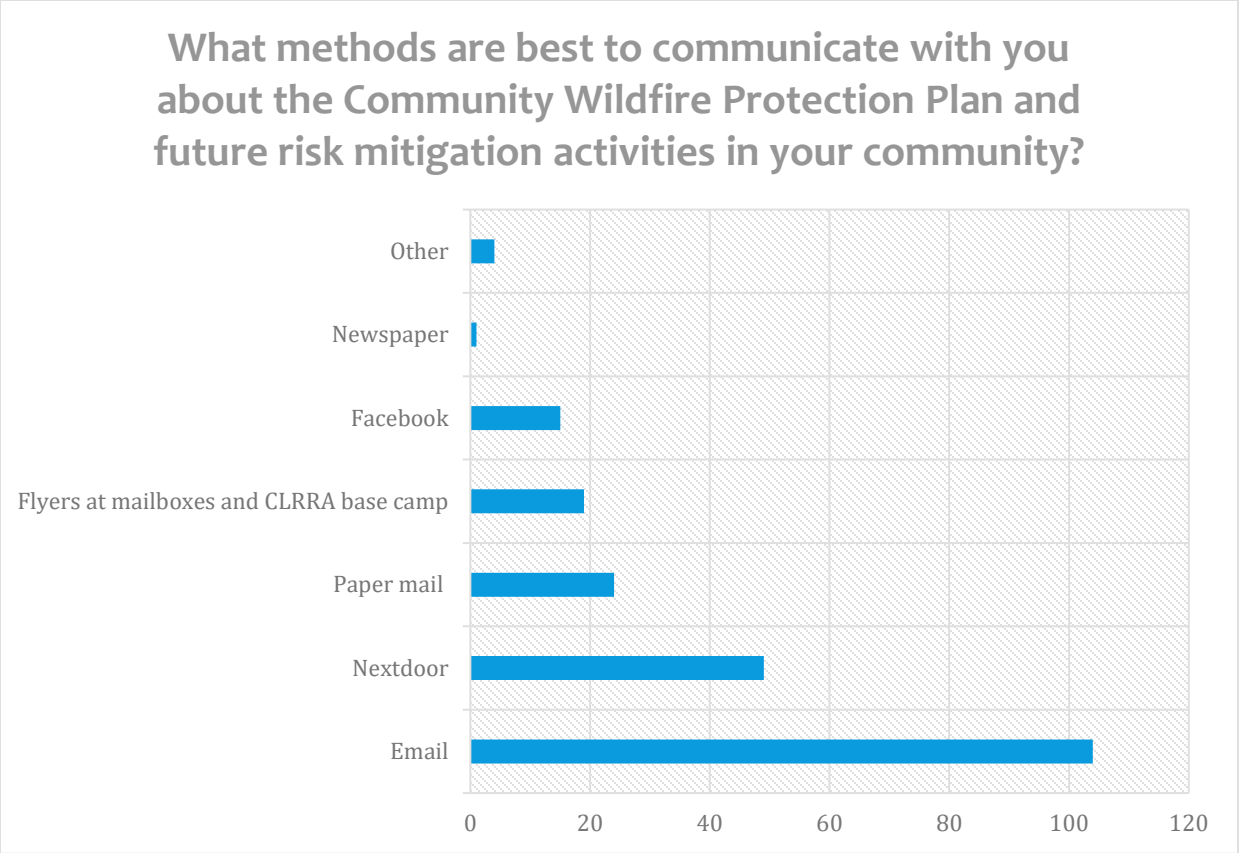
Other answers provided:

- I have completed a risk reduction on my property
- We work on it as often as possible
- Affordable location to dispose of materials
- Help cleaning up downed and dead trees on river trail that abuts our property
- We purchased our lot already mitigated, and just spent $500 to remove a big living bristlecone that the wind blew down
- Don't need help
- Association help with common areas
- Finding help with cutting down some trees that a large and to close to the back of my house
- A place to dispose of tree waste that is close by
- None of the above—I am not interested in these actions
- Help putting screens on vents



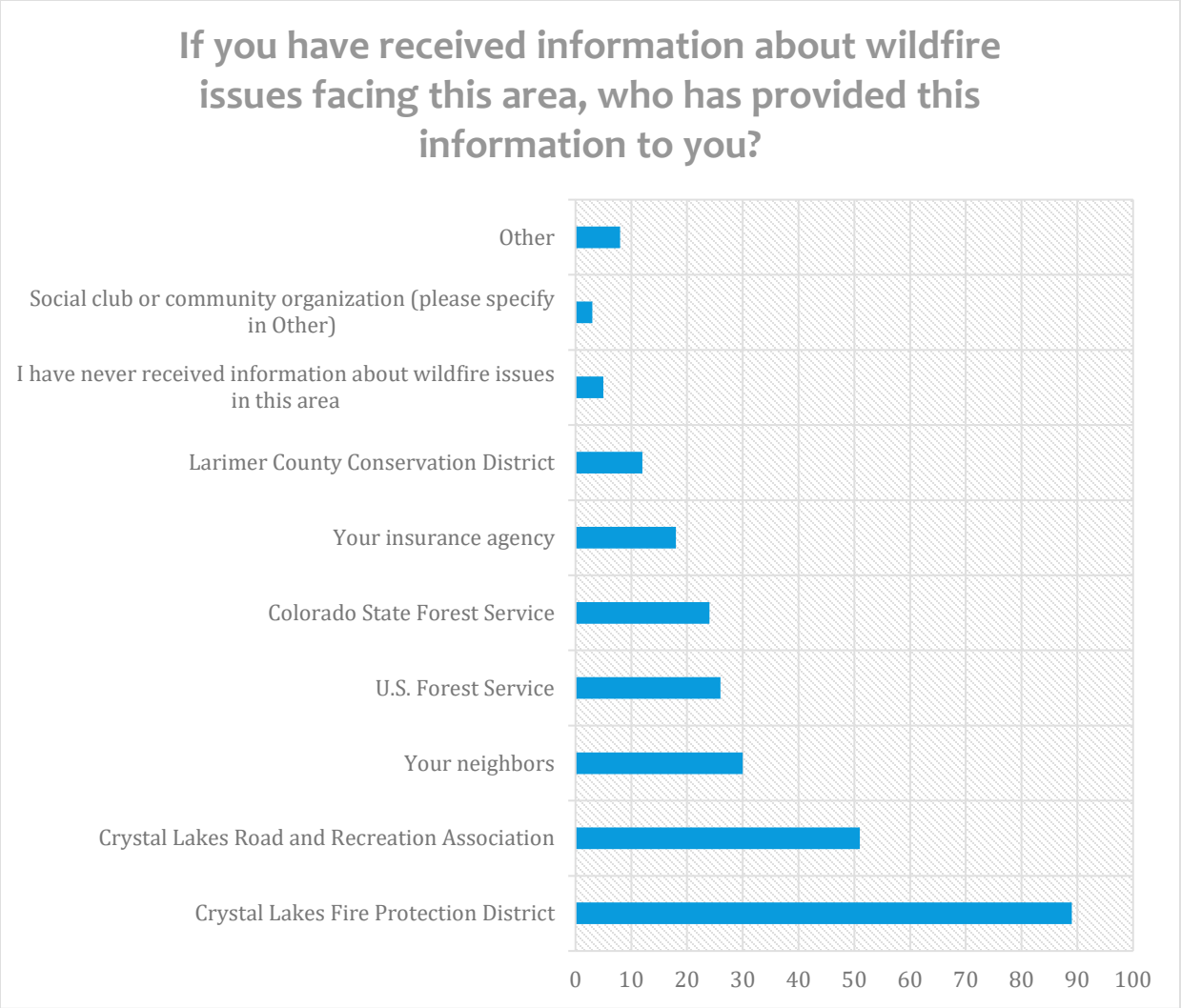
Other answers provided:

- Again. I know what to do for risk reduction around my property
- Virtual options of any if the above because I am not in the area most of the year
- Access to grants for mitigation of community trail



Other answers provided:

- Text
- Crystal Lakes Website
- I have never been allowed to access Nextdoor
- CLRRA board newsletters



Other answers provided:

- I am a wildland firefighter so I know what needs to be done around my property
- News media
- Googling various sites
- CSU
- I'm not sure what information we may have received because we bought the property a year ago and do not live there most of the time
- CLRRA Greenbelt Committee
- The Ember Alliance
- S-130, 180, 190, 280