Nederland and Timberline Fire Protection Districts

BOULDER COUNTY, COLORADO

Community Wildfire Protection Plan

Nederland and Timberline Fire Protection District Community Wildfire Protection Plan 2024 Update

Prepared for the Nederland and Timberline Fire Protection Districts

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APPROVAL AND SIGNATURES

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 actions. Where possible, we intend to apply the recommended practices to improve our community and increase public safety.

The following individuals and organizations were engaged in creating the Nederland and Timberline CWPP and approve the 2024 update.

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How to use this CWPP Document

This document is designed for everyone that lives, works, and manages land within and around the NFPD and TFPD. 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 to learn about CWPPs •Section 2 to learn about wildfire threats in your local fire district •Section 3 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 to learn about the actions you can take, including detailed recommendations and guidance for protecting your home and family
I want to learn about community-led wildfire mitigation actions.	**Look for:** •Section 3 to learn about the actions communities can take together to better protect everyone, including funding opportunities •Section 3.c 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 to learn about fire history and treatment history in the area •Section 4 to learn about priority fuel treatment projects for this community •Appendix C for general recommendations for stand-level and roadside fuel treatments and 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 A to learn about methodology for assessing fire behavior and evacuation, on-the-ground hazard assessments, and treatment prioritization

Acronyms

BAER	Burned Area Emergency Response
BCLUP	Boulder County Land Use Planning
BCPOS	Boulder County Parks and Open Space
BCRB	Boulder County Road and Bridge
BCSO	Boulder County Sheriff's Office
BVLCD	Boulder Valley-Longmont Conservation Districts
BWC	Boulder Watershed Collective
CDPH	Colorado Department of Public Health
CFRI	Colorado Forest Restoration Initiative
CO	Colorado
CO-WRA	Colorado Wildfire Risk Assessment
CPAW	Community Planning Assistance for Wildfire
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
GNA	Good Neighbor Authority
HFRA	Healthy Forest Restoration Act
HIZ	Home Ignition Zone
HOA	Homeowner's Association
IIBHS	Insurance Institute for Business & Home Safety
IRPG	Incident Response Pocket Guide
ISO	Insurance Services Office
NFPA	National Fire Protection Association
NFPD	Nederland Fire Protection District
NWCG	National Wildfire Coordinating Group
ODM	Office of Disaster Management (Boulder County)
OSCAR	Office of Sustainability, Climate Action, and Resilience (Boulder County)
PBC	Pile Burn Cooperatives
PPGIS	Public Participatory Geographic Information System
PODs	Potential Operational Delineations
RAWS	Remote Automatic Weather Stations
TEA	The Ember Alliance
TFPD	Timberline Fire Protection District
USFS	U.S. Forest Service
WP	Wildfire Partners
WUI	Wildland-Urban Interface

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

1. Introduction

1.a. Why Update the Nederland/Timberline Community Wildfire Protection Plan?

Wildfire is a natural and integral part of Colorado ecosystems. Communities in Peak to Peak areas, including Nederland, are located in the Wildland Urban Interface (WUI) of these fire-adapted ecosystems, and therefore must plan and act collectively to better live with fire.

Figure 1: Elements of a holistic and actionable CWPP.

Community Wildfire Protection Plans (CWPPs) help communities assess local hazards and identify strategic investments to mitigate the risk of wildfire and promote individual and community preparedness. In 2011, the Nederland and Timberline Fire Protection Districts (NFPD/TFPD) came together to create their first CWPP to meet the goals outlined in the Healthy Forest Restoration Act (HFRA) passed in 2003. These are:

1. Address structural ignitability
2. Assess community fire-suppression capabilities
3. Collaborate with stakeholders
4. Identify and prioritize fuel reduction opportunities

In the period since the initial CWPP was completed, Colorado has experienced a rapid increase in the size and severity of wildfires on the landscape. Both the largest (Cameron Peak Fire, 2020) and the most destructive (Marshall Fire, 2021) fires in Colorado history have occurred within the past 5 years. With climate change bringing increasingly hot, dry weather, the frequency and severity of wildfires are increasing, further impacting WUI communities that have experienced continued growth in recreational use and housing density. The rising threat of fire paired with continuing human development increases the urgency and necessity of improving how we prevent, manage, and prepare for fires.

This CWPP update renews the analysis of wildfire related hazards outlined in the previous CWPP using the most recent Colorado Wildfire Risk Assessment (CO-WRA) data describing landscape make-up, and improved fire behavior modeling that more accurately reflects the increased risk posed by climate change. By comparing these analyses against current community values within the NFPD and the TFPD within Boulder County (the portion of TFPD in Gilpin County is captured in the Gilpin County CWPP), the CWPP update provides a comprehensive assessment of the wildfire hazards in the Nederland and Timberline community area.

Finally, a CWPP is a process as well as a document. Throughout the planning process, agency partners and stakeholders engaged in discussions and assessments that will assist fire protection districts with mitigation and fire operations planning. Robust community engagement is also an integral part of this process. Through workshops, interviews, and events, residents were engaged to

prioritize mitigation actions for their homes and neighborhoods, and identify areas to strategically reduce fuel loads on the landscape. The CWPP process is intended to be dynamic, and to help the community better organize and create action to prepare for fire.

The 5-year recommended update interval for CWPPs also allows changes to the on-the-ground reality of the community to be reflected within the planning document. Regularly updating a CWPP allows a community to:

- Influence how wildfire is managed on federal, state, and county lands;
- Identify and map wildfire hazards in the local community;
- Periodically update and reprioritize projects as others are completed or the landscape/community changes;
- Identify mitigation strategies that are supported by and are beneficial to the community;
- Apply for competitive federal, state, and local funding opportunities that require projects and action items to be identified and prioritized in the CWPP.

Figure 2: The Forsythe Prescribed Burn project helps reduce wildfire intensity and protect important water resources for the Denver Metro Area. Photo credit: Rihanna Truex

1.b. Goals and Objectives of the Updated CWPP

This CWPP prepared for the NFPD and TFPD is the result of a dynamic process of collaboration between local, state, and federal agencies, analysts, and community members throughout the 2022-2024 work period. This document is intended to help reduce wildfire hazards through education and community engagement, increased community preparedness, hazardous fuels reduction, and improved levels of fire suppression response.

Detailed recommendations for specific actions that will aid stakeholders in preventing and/or reducing the negative impacts of wildfire are included in this document. It is important to note that this CWPP is not a static document, but an evolving process, and therefore requires regular updates to project prioritization, and re-evaluation every 5 years from the date of adoption, or after a significant "event" such as wildfire, flood, insect infestation, or even significant new home or structure development.

This document provides a comprehensive analysis of wildfire related hazards and risks in the WUI areas of the NFPD and TFPD located within Boulder County.
Goals for this project include the following:

- Enhance life safety for residents and responders
- Mitigate undesirable fire outcomes to property and infrastructure
- Educate and support community members on mitigation actions on resident and commercial properties
- Inspire collective community action
- Reduce fuel hazards and fire intensity on the landscape and promote ecosystem health
- Improve stakeholders' position as they compete for grants

To accomplish these goals, the following objectives have been identified:

- Update the Wildfire Risk Analysis and Fire Behavior Potential modelling within the project area using the most recent available data to determine the approximate level of risk within identified neighborhoods
- Identify and quantify factors that limit undesirable fire effects on the Values at Risk (hazard levels)
- Engage the community to map and identify qualitative descriptions of community values and desired project priorities
- Recommend specific actions that will reduce hazards to the Values at Risk

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. The information and recommendations included in this CWPP are based on the latest 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.

In reducing wildfire hazards, fuels management is often at the forefront of practical solutions. This is because while land managers and practitioners cannot alter weather patterns or topography, fuels *can* be managed. Scientific research on forest structure and composition continues to develop and improve. Fuels reduction strategies and techniques are also improving to take better account of forest health impacts. Recommendations for fuels treatments in this CWPP attempt to combine both wildfire mitigation and forest health objectives by designing treatments to mimic historical disturbance patterns, and promote ecosystem regeneration. Other practical solutions to reduce wildfire hazards include up to date recommendations for home hardening, defensible space, and the home ignition zone, and ecological solutions (such as riparian and wetland expansion and floodplain connection) which can complement pre- and post-wildfire planning.

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 Nederland and Timberline Fire Protection Districts 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 how to protect the lives of firefighters engaged in protecting your community.

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 this a beautiful and safe community. Land management partners and the Nederland and Timberline Fire Protection Districts 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.

1.c. National Cohesive Wildland Fire Management Strategy

This CWPP aligns with the National Cohesive Wildland Fire Management Strategy – an effort to align management actions of different agencies, organizations, tribal governments, and public stakeholders across the nation to prepare for wildfire. The strategy outlines 3 core goals:

- **Resilient Landscapes** - landscapes, regardless of jurisdictional boundaries are resilient to fire, insect, disease, invasive species and climate change disturbances, in accordance with management objectives.
- **Fire Adapted Communities** - Human populations and infrastructure are as prepared as possible to receive, respond to, and recover from wildland fire.
- **Safe, Effective, Risk-based Wildfire Response** - All jurisdictions participate in making and implementing safe, effective, efficient risk-based wildfire management decisions.

The information, analysis, and action recommendations outlined in this CWPP are intended to aid the NFPD/TFPD in achieving these goals.

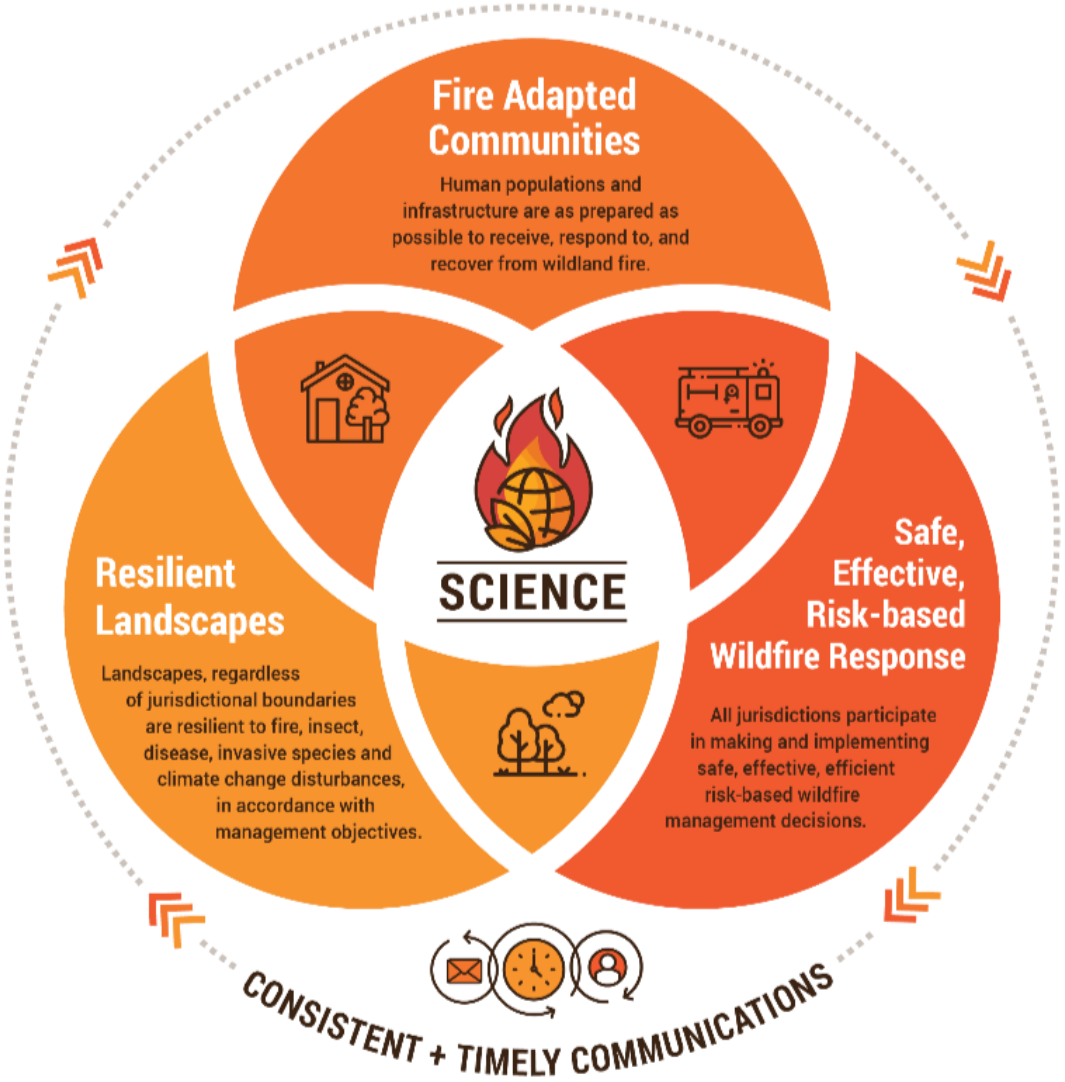


Figure 3: The three pillars of wildfire resilience. Source: The National Cohesive Wildland Fire Mangement Strategy.

1.d. 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 Core Team would like to thank the following partners for their time and effort in funding, developing, providing data, providing feedback, and planning implementation projects for this CWPP:

- Boulder County
- Boulder Watershed Collective
- City of Boulder
- Coalitions and Collaboratives
- Colorado State Forest Service
- Community Members
- Nederland Fire Protection District
- Timberline Fire Protection District
- The Ember Alliance
- Town of Nederland
- United Power
- United States Forest Service

The Core Team of agency partners met monthly over a period of one year to discuss the risk analysis, fire behavior modeling, values at risk, and to prioritize projects and plan engagement opportunities for the community.

Extensive community engagement was implemented in 2022 by a team of graduate students from CU Boulder's Masters of the Environment program. This initial community input included 38 interviews and three workshops. The results of this effort can be found here. This provided an initial list of **non-place-based** actions recommended by the community around 1) safe and effective fire response, 2) home hardening and defensible space, 3) collective community action, 4) land management, and 5) ecosystem health. In July 2023, a "CWPP Kickoff Event" was held to provide information to community members regarding the timing, content, and purpose of the CWPP update and information on upcoming ways to get involved at multiple levels of engagement.

Throughout 2023, the community was invited to attend four in-person Public Participatory Geographic Information System (PPGIS) workshops and one digital survey alternative. Participants mapped community values and provided recommended place-based actions for wildfire resilience, as well as personal and ecological values and actions (e.g. wetland restoration, recreational pathways, historic landmarks). Participants ranked their own and others' ideas, and provided input on forming a community-led wildfire group. The wildfire group will provide support to the community in realizing their visions for wildfire resilience, and implementing actions identified within and beyond this CWPP.

Figure 4: Community members contributing to Public Participatory Geographic Information Systems (PPGIS) process. Photo credit: Maya MacHamer

1.e. Accomplishments Since the Previous CWPP

The 2011 CWPP for the Nederland and Timberline Fire Protection Districts outlined 4 key priorities for improving wildfire risk levels within the project area. These were:

1. Improved capacity and training for Nederland and Timberline Fire Departments
2. Improved home hardening and defensible space within high risk neighborhoods
3. Targeted forest treatment projects to reduce wildfire risk to Values at Risk
4. Increased funding for mitigation implementation

1. Improved Capacity and Training

The Nederland and Timberline Fire protection districts were able to complete all recommendations for improved firefighter training and department capabilities. These were:

- Provide structural and medical training opportunities to meet district needs
- Provide Red Card documentation for all qualified personnel
- Recommended wildland firefighter classes including NWCG S-215 Fire Operations in the Urban Interface; S-290 Intermediate Fire Behavior; and I-200 and I-300 Basic and Intermediate ICS
- Participation of Type 3 Incident Management Team
- Personnel seek higher qualifications and participate in out-of-district fire assignments
- Provide/attend cross-district training opportunities
- Provide PPE in compliance with NFPA 1977 standards
- Provide new generation fire shelters for all firefighters with appropriate consideration for regular or large size needs
- Inspect and service municipal hydrants annually
- Apparatus to be equipped with portable water storage and engine checks including drafting tests should be performed monthly
- Create a Cooperator Resource Rate Form (CRRF) with Colorado State Forest Service
- Ensure all firefighters are comfortable with basic engine operations such as pumping and drafting
- Require NWCG S-130/190 for all firefighters
- Annual wildland refresher for NWCG RT-130 and pack test for seasonal Red Card status for all firefighters

TFPD hired a mitigation coordinator, a position which will interface with residents and community members to provide guidance and connect them to available resources. This will greatly improve the connection between TFPD and residents within their district, and ensure continued action on the part of homeowners to improve home hardening and defensible space.

2. Improved Home Hardening and Defensible Space within community neighborhoods

Numerous private landowners and the NFPD and TFPD collaborate with Wildfire Partners. Wildfire Partners is a Boulder County program which supports collective and individual action to create wildfire resilient communities by helping homeowners identify fire hazards and prioritize home hardening and defensible space projects on their properties.

For a period of time, Saws & Slaws was an active organization in the Nederland area, consisting of neighbors helping neighbors complete defensible space. In 2016 the Town of Nederland obtained a designation as a Firewise USA® site, though the designation is no longer active.

3. Planning and Community Engagement
In 2020 the Town of Nederland completed the Community Planning Process for Wildfire (CPAW). The outcome of this process included numerous recommendations to reduce wildfire risk for the Town of Nederland. In response to these recommendations, the Town of Nederland adopted the 2018 ICC code suite (fire, building, residential, etc.) with amendments. The municipal code requires ignition resistant materials on all new construction projects. This will improve fire resilience for all new home and other builds within the town. In the Unincorporated areas of NFPD and TFPD the 2018 International Fire Code has been adopted. Building codes are adopted by Boulder County for these areas.

Planning community engagement, surveying, and concept designs for a Big Springs egress route are coming to an end, with work on the egress route to begin 2024-2025 dependent on funding. Town of Nederland is working with engineers, and the JVA to complete additional planning activities for a viable egress route from the Big Springs neighborhood.

The Sediment Source and Storage Study for Disaster Planning was completed in 2020 to guide disaster planning to mitigate post wildfire hazards associated with flooding and erosion to protect ecosystems and critical infrastructure. A Dangerous Path: Understanding and Preparing for Debris Flows in Colorado was developed in 2022 to assist communities in understanding post-wildfire hazards associated with large scale sediment movement from unstable, burned hillslopes.

4. Targeted Fuel Treatment Projects
Fuel treatments aim to reduce the amount of fuel in strategic locations, with the goal of reducing fire risk to nearby communities. The effectiveness of fuel treatments is influenced by a variety of factors, including the intensity, quality, and extent of treatment, location of treatments, maintenance of treatments, weather conditions and fire behavior, and actions of firefighters (Agee et al., 2000; Jain et al., 2021). Fuel treatment methods include tree thinning, pruning, pile burning, broadcast prescribed burning, and fuel mastication.

Public land managers and private residents have conducted fuel treatments to reduce wildfire risk and restore ecosystem health in and around the planning area. USFS has completed treatments as part of their Forsythe II Project. Boulder County Parks and Open Space (BCPOS) completed fuels treatments at Reynolds Ranch, and Sherwood Gulch.

The U.S. Forest Service and partners, including NFPD and TFPD, safely conducted a broadcast prescribed burn on about 307 acres to the west of Gross Reservoir in April 2023. 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). Less than 1% of prescribed burns escape containment lines, and most of these are rapidly suppressed (Weir et al., 2019). The wildland fire community soberly reviews prescribed burn escapes to produce lessons learned and make improvements (Dether, 2005).

Of the 7 landscape-scale fuels treatments recommended in the 2011 CWPP, only one project was completed; the Big Springs Fuel Break. A number of thinning and pile burning projects targeted in

the Big Springs area covers roughly the recommended treatment area described in the previous CWPP.

Out of the 18 recommended small-scale projects, 10 projects were partially or wholly completed. These included thinning projects in the neighborhoods identified as Shady Hollow, North Beaver Road, Reynolds Ranch, Ridge Road, Saint Anton's, Cougar Run, Summer Road, and Tungsten Road, as well as at Nederland High School. Both power line project recommendations were completed, at St Anton's and Whispering Pines. See **Figure 24: Fuel treatment history in and around Nederland and Timberline FPDs** for a map of fuel treatment history in the planning area.

5. Increased Funding

It has been challenging for the NFPD/TFPD to secure funding for the implementation of mitigation projects, largely due to a lack of resources and capacity. Project implementation has historically been completed by the Colorado State Forest Service (CSFS), the US Forest Service (USFS), private landowners, and Boulder County, and has not been part of the FPDs' responsibilities.

However, as of 2023-2024, Town of Nederland has an emergency manager who is tasked with mitigation outreach efforts, and a budget of $10,000 as part of the Board of Trustee's (BOT's) 2023-2024 Strategic Plan. The TFPD has added a mitigation coordinator to support residents undertaking mitigation projects. In addition, there are many more funding opportunities to complete wildfire mitigation work available, from federal, state, and local grants, and partnership opportunities with organizations like Boulder County, BWC, CSFS, USFS, and landowners.

2. Nederland/Timberline Area Background

2.a. General Description

Town of Nederland

Nederland is a statutory town located 17 miles west of Boulder. The town center is situated at an elevation of 8,200 feet, and has a population of around 1,500 people. However, many of the residents and community members associated with the town live in neighborhoods and homes that wind through the surrounding mountains in a rural sprawl that spreads throughout the project area.

Like many small towns scattered throughout the Colorado mountains, Nederland began first as a trading post and later as a promising cluster of mining camps. It endured through several mining booms and busts, and today Nederland is a self-contained community and popular tourist destination.

Additional development throughout the fire protection districts has occurred since, as new homes and businesses have been built to accommodate growth. Nederland attracts visitors and recreators through its access to the Indian Peaks Wilderness, Arapaho-Roosevelt National Forest, Eldora Mountain Ski Resort, and multiple Boulder County Parks and Open Space properties, as well as Rocky Mountain National Park. Many of the campgrounds nearby are full all season long, and the busy town center brings in huge crowds during farmer's market days and during its unique array of other events and festivities.

Adobe Stock Images

Nederland/Timberline Fire Protection Districts

This CWPP covers lands within Nederland Fire Protection District and the part of Timberline Fire Protection District located within Boulder County. The planning area is approximately 40,000 acres. The planning area lies within the South Platte Basin, and includes the headwaters to North and Middle Boulder Creek.

NFPD is bordered by Indian Peaks and Sugarloaf Fire Protection District to the North. TFPD's district includes a small portion of Boulder County and unincorporated Gilpin County. TFPD in Boulder County is bordered by Mountain View and Coal Creek Fire Protection Districts to the East. NFPD and TFPD often coordinate with neighboring districts to provide mutual aid and respond to calls near the borders of the district.

Land ownership is a mix of private, county, City of Boulder and USFS land. County, City, and parcels of private land intermix between the populated town center and the sparse wilderness of the western mountain slopes.

The primary landscape vegetation varies east to west as the terrain gains in elevation. Elevation ranges from 13,000ft mountain peaks in the west to 6800ft valleys in the east. The primary vegetation type to the east, where canyons and valleys sit at lower elevations (below 8000ft), is ponderosa pine, though with variation that includes hardwoods, shrubs, riparian corridors and grassland meadows. At around 8,000ft elevation the dominant vegetation type transitions to lodgepole pine. This mid-elevation terrain also includes mixed conifer and areas of ponderosa pine, with some variation including hardwoods, riparian corridors, and shrubs. Deeper into the mountains in the west, as elevation increases above 10,000 ft, vegetation shifts to predominantly spruce and fir, with barren and sparsely populated slopes occurring at the highest elevations (above 11,000ft) (**Figure 6: Map of vegetation**).

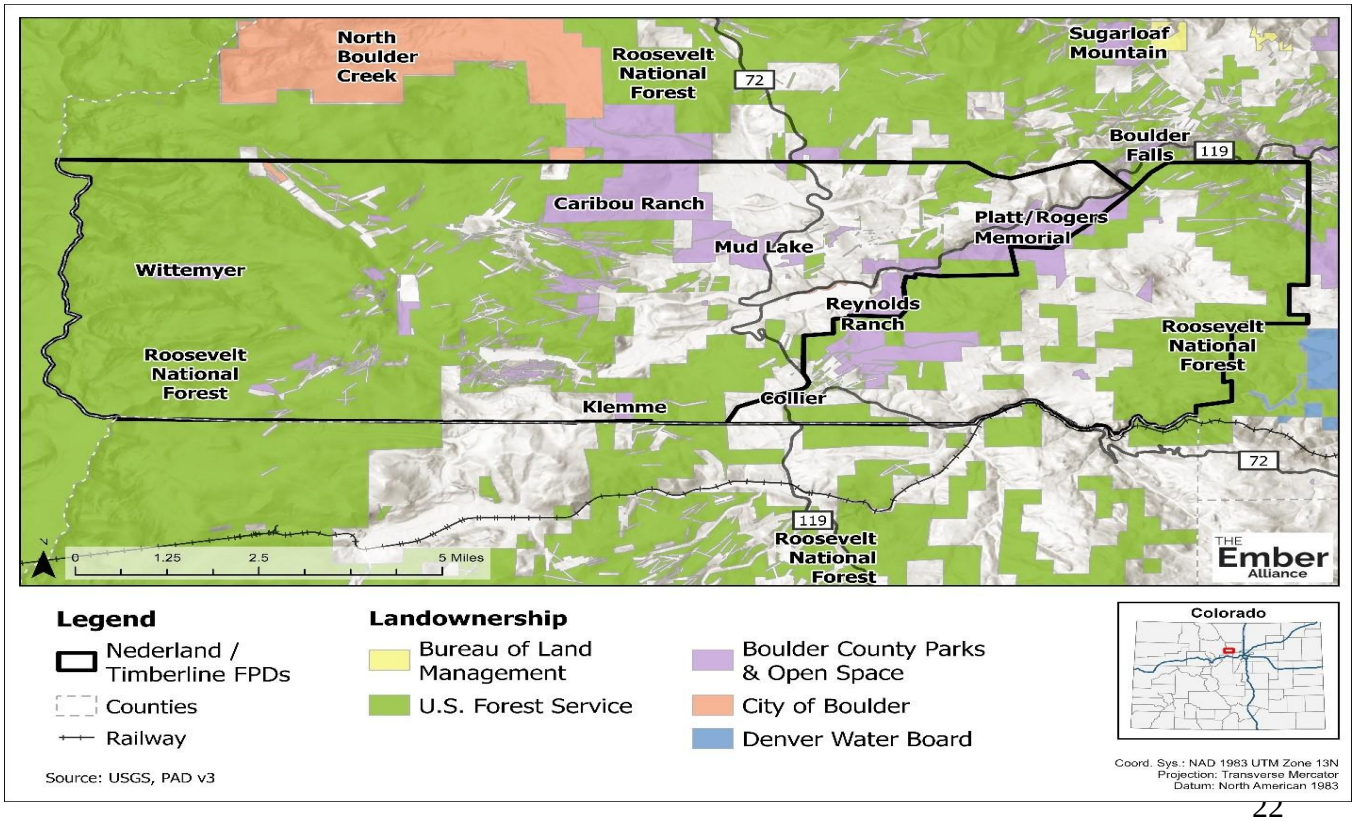


Figure 5: Publicly owned land across Nederland and Timberline FPDs. Source: U.S. Geological Survey, Protected Areas Database of the United States.

Vegetation Type

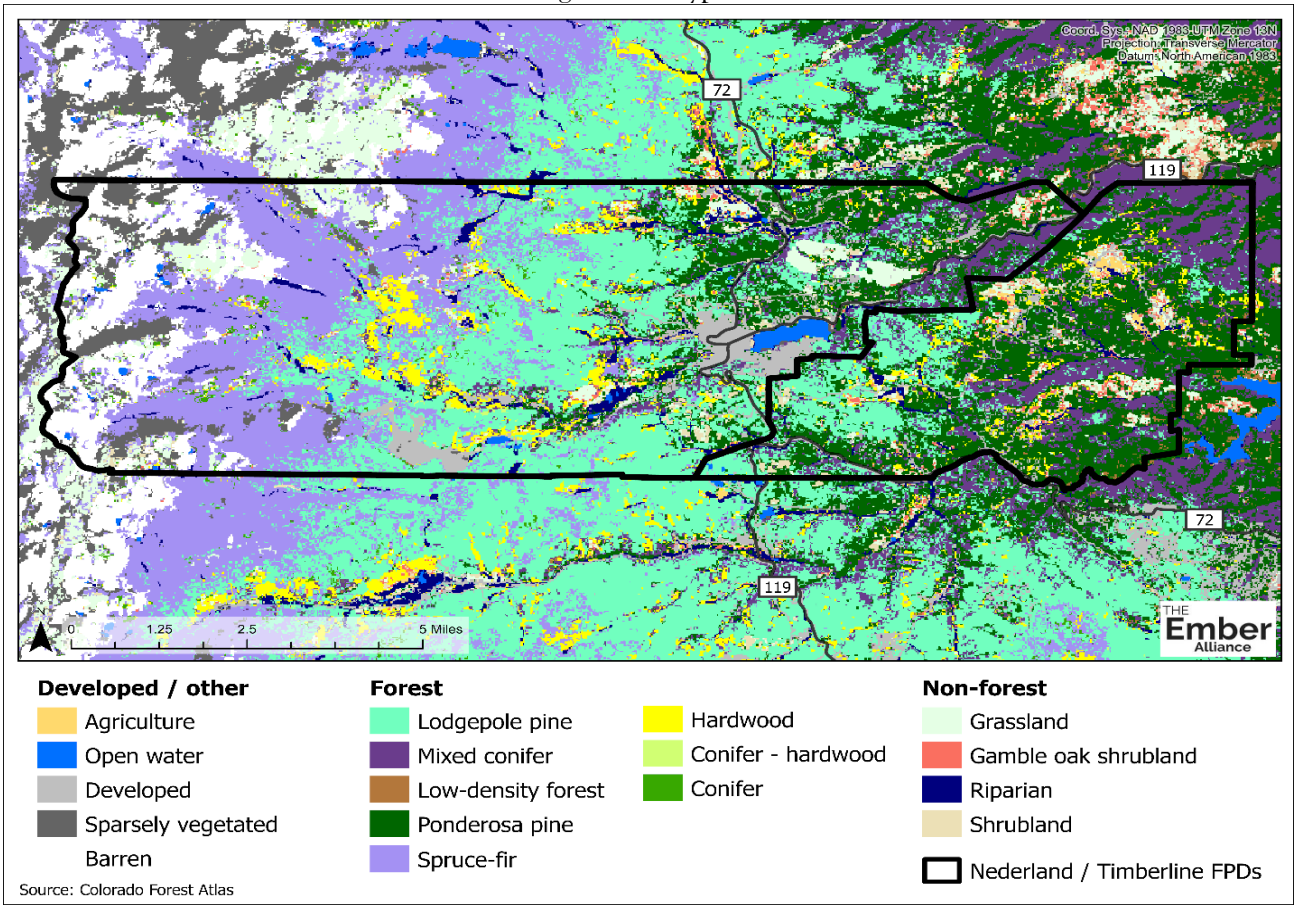


Figure 6: Map of vegetation across Nederland/Timberline FPDs. Source: Colorado State Forest Service, Colorado Forest Atlas.

Table 1: Vegetation type and acreage within NFPD/TFPD. Source: The Ember Alliance

Vegetation Type	Area in NFPD/TFPD (acres)	Percent
Lodgepole pine	10757	22%
Ponderosa pine	9395	20%
Spruce-fir	8224	17%
Mixed conifer	4778	10%
Barren	3105	6%
Developed	2595	5%
Grassland	2227	5%
Hardwood	2063	4%
Sparsely vegetated	1708	4%
Riparian	1143	2%
Shrubland	766	2%
Gamble oak shrubland	458	1%
Open water	309	1%

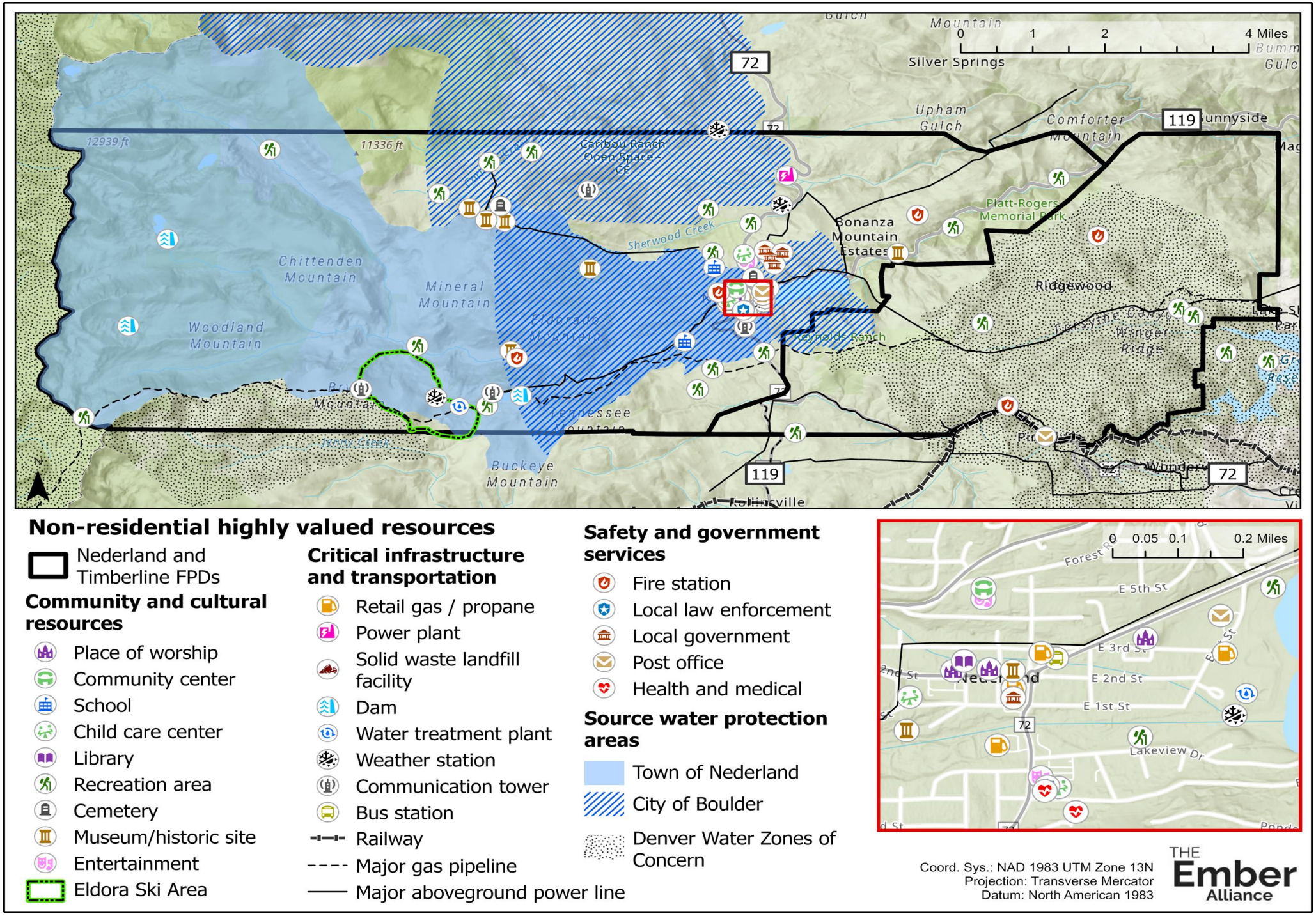


Figure 7: Non-residential values within and around Nederland/Timberline FPDs. Sources: Boulder County Parks and Open Space, CO Department of Public Health & Environment, CO Division of Oil and Public Safety, CO Parks & Wildlife, Federal Emergency Management Agency, Google Maps, Homeland Infrastructure Foundation-Level Data, National Park Service, Nederland and Timberline FPDs, Town of Nederland, U.S. Department of Transportation, U.S. Environmental Protection Agency, U.S. Forest Service, U.S. Geological Survey, University of Redmon, and Western Regional Climate Center

Values at Risk

Life Safety and Homes

Within the Town of Nederland, there are approximately 720 housing units as of the 2020 census, 645 of which are currently occupied. Some of these homes may be second homes or seasonally occupied, but the number of these is unknown. There are also numerous non-residential highly valued resources within NFPD and TFPD, including fire stations, communication towers, Nederland Elementary, Middle, and Senior High schools, Barker Reservoir, places of worship, the Nederland Community Center, and numerous businesses. There are also dozens of recreation areas, including campgrounds, trailheads, and picnic areas.

Nederland is similar to many mountain communities on the Front Range. A historic mountain town, many locals have lived in the area for decades or more, while a broader societal shift towards remote work has brought many wealthy, younger people into the mountains. As a result, the disparity between available local work and the rising cost of living in mountain towns can strain long-time residents and renters, making fire mitigation and preparedness actions challenging. The development of additional residential buildings contributes to a rising population of new residents who may not be as familiar with the risk wildland fire poses. Education, community support, and access to both financial and informational resources are all important parts of an effective wildfire preparedness strategy.

Commerce and Infrastructure

Economic Values

Tourism is an important part of Nederland's economy, with more than 67% of jobs in the area involved in the service and retail industries. Owing to its location, the town receives a large portion of the annual area tourist traffic, which includes more than 6 million visitors to the nearby Arapaho-Roosevelt National Forest, more than 200,000 visitors to the Eldora ski resort and almost 2 million vehicles traveling the Peak-to-Peak Scenic Byway. In addition to tourism, the town services a population of more than 5,000 people who visit weekly for goods and services. The large number of trails and campsites in and around town contributes to a sizeable transient camper community. The large employers in Nederland include the Boulder Valley School District, Eldora Mountain Ski Resort, the Town of Nederland, and the USDA Forest Service. Nederland also has a relatively large portion of residents who work from home, which is estimated at over 20% of the population.

Critical Infrastructure

The CWPP planning area has a mix of private and public lands. Aside from the obvious negative impacts to tourism from wildfire, there is additional infrastructure within the community that could be adversely affected. Barker Reservoir and Dam serves as both a source of hydroelectric energy and provides up to 40% of the drinking water for the City of Boulder. Ash, sediment, and associated runoff from a wildfire could reduce water quality and impact energy production. Other important sources of infrastructure include the Silver Lake Pipeline, Nederland's water treatment plant, an abundance of power lines, and transportation systems that include Regional Transportation District service sites, roads and highways, and an assortment of trails. The impact

of wildfire to infrastructure within the CWPP planning area must be a consideration for wildfire prevention and planning.

Railroads are both important infrastructure and a known source of ignition for wildfire. Sparks from the wheels, chains, or improperly maintained turbo chargers easily ignite fine flashy fuels along the sides of the tracks. Tracks generally run east-west, directly along the communities of Pinecliffe, Lazy Z, and Tungsten Mountain. The railroad line is south of the CWPP planning area boundary, but within the TFPD within Gilpin County. Mowing along railroad lines is imperative to reduce the risk of wildfire spreading into the surrounding communities. Within TFPD is a main gas line that runs along Magnolia Road. In general, gas lines are not considered to be at risk from wildfire, but do constitute an exposure during work/repair times.

Figure 8: Barker Dam and Reservoir. Photo Credit: Boulder Watershed Collective

Watershed and River Concerns

The CWPP planning area is within the Boulder Creek Watershed, which is a part of the larger South Platte Basin. Streams and tributaries within the planning area include the Middle and North Boulder Creeks, and Beaver, Coon Track, Sherwood, and Delonde Creeks. Stream flow starts off primarily as high-elevation snowmelt, and discharge varies seasonally depending on snowpack depth and sustained air temperatures. In order to protect water quality and supply, the City of Boulder owns and prohibits entry to nearly 8,000 acres in the headwaters of North Boulder Creek. Moreover, the adjacent Indian Peaks Wilderness Area is off-limits to all motorized equipment. The Town of Nederland is geographically situated near the top of the watershed, so minimizing impacts to stream and creek corridors is vital to protecting water quality and ensuring

appropriate water yields. As noted in the City of Boulder's Source Water Protection Plan 2023 update, wildfires can cause substantial erosion and sediment deposition, thereby significantly impacting aquatic and terrestrial life, creating filter clogging problems at water treatment plants and potentially shutting down hydroelectric power generation. For additional information on planning for post-wildfire impacts from sediment see the Sediment Source and Storage Study for Disaster Planning (2020).

The South Boulder Creek drainage begins along the Continental Divide from James Peak to near Corona Pass. Approximately 30% of the Boulder Creek Watershed is contained in this drainage. The South Boulder Creek flows into Gross Reservoir, where some water is stored and distributed by Denver Water for drinking water for numerous Front Range Municipalities. South Boulder Creek continues from Gross Reservoir through Eldorado Canyon State Park.

Wetland and riparian areas in the watershed are significant areas of biodiversity and provide valuable habitat for mammals, fishes, amphibians, reptiles and birds. The native greenback cutthroat trout *(Oncorrhyncus clarki stomias)*, a federally listed threatened species, is found within the watershed area. Additionally, there are 13 avian Species of Special Concern and several threatened mammal species, including lynx *(Felis canadensis)* and the state-listed endangered wolverine *(Gulo gulo)*.

Colorado ecosystems are adapted to fire and some plant and animal species benefit from fire effects. However, as wildfires intensify and fire seasons are prolonged, an increase in high severity wildfire across larger areas of the landscape can have negative effects on the ecosystem. Restoring meadows and reconnecting floodplains can reduce negative wildfire impacts in critical areas, and can help maintain biodiversity and ecosystem function.

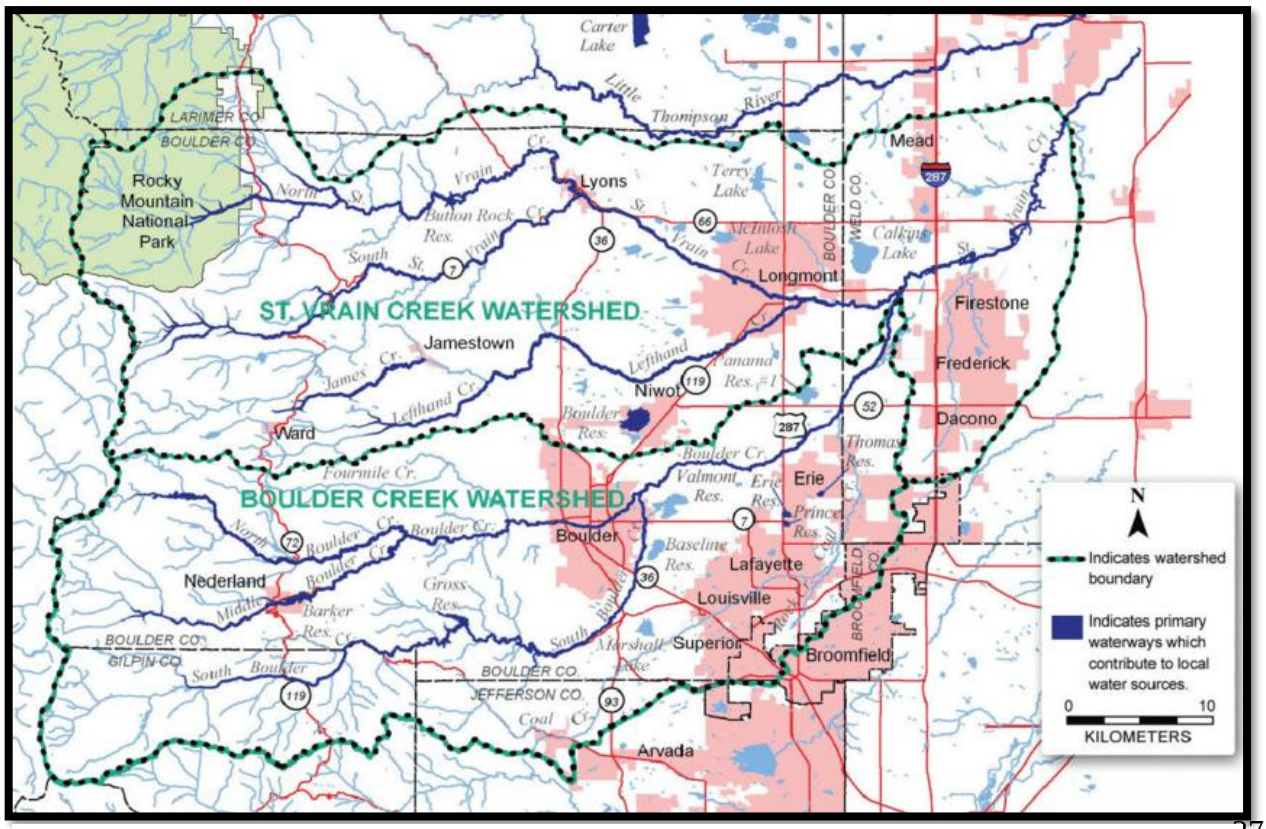


Figure 9: The Boulder Creek Watershed makes up the southern portion of the St Vrain Basin. Source: The St. Vrain Basin Watershed-Based Plan

CWPP Planning Units

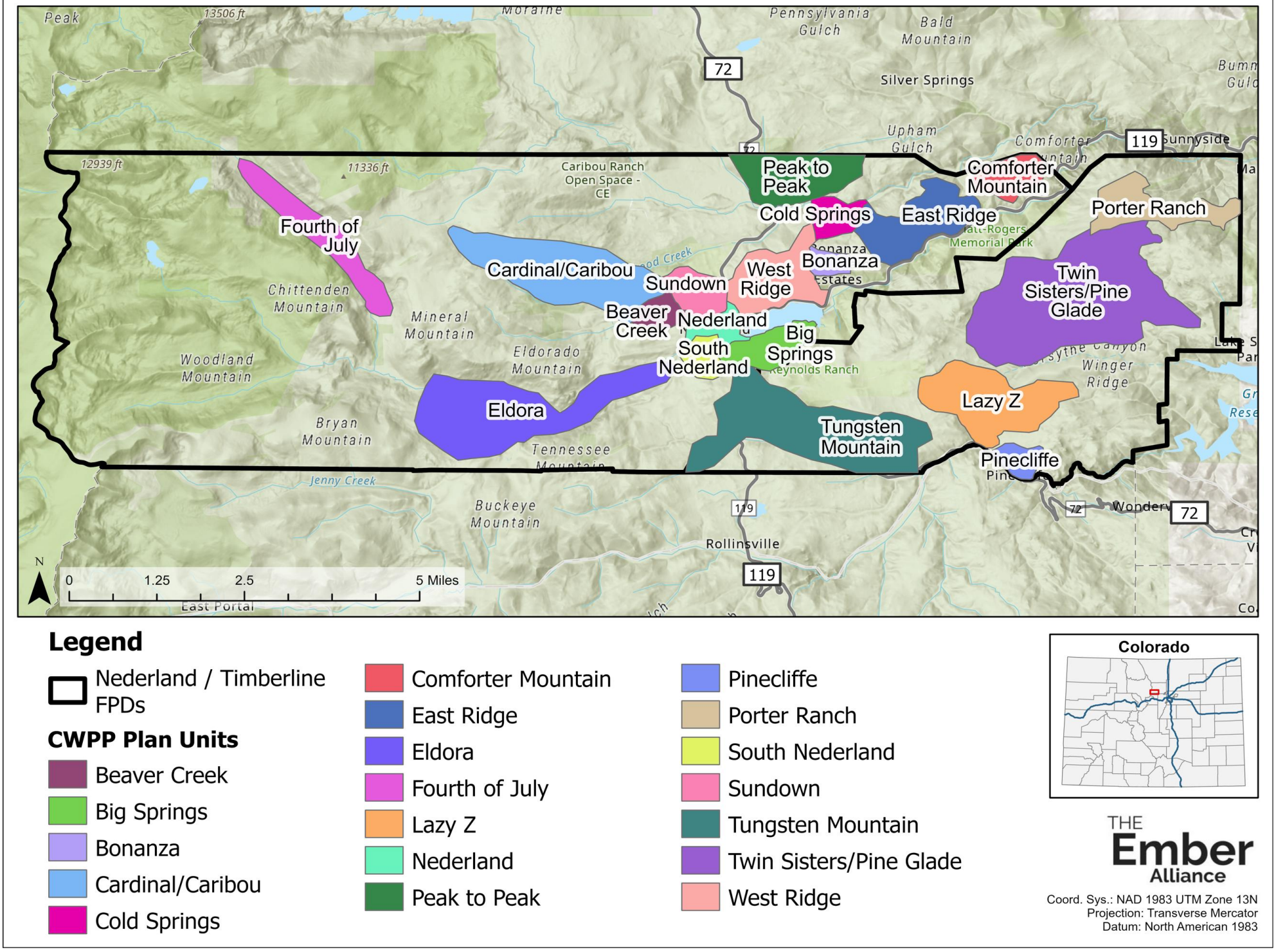
The CWPP core team identified 19 communities within the NFPD and TFPD response areas, 14 of which are in the NFPD and 5 in the TFPD (**Figure 10**). These communities represent the most densely populated neighborhoods within the project area, and help identify community response zones for building local, collaborative mitigation capacity.

Each community identified exhibits certain dominant hazards from a wildfire perspective. Fuels, topography, structural flammability, availability of water for fire suppression, ingress/egress and navigational difficulties, as well as other hazards, both natural and manmade, are considered in the overall hazard ranking of these communities.

Construction material type, condition, age, the fuel-load surrounding structures, the contents of homes, and position on the land are all contributing factors in making structures more susceptible to ignition under even moderate burning conditions. Wildfires are likely to grow and spread rapidly in areas with steep topography, fast-burning or flashy fuel components, and other topographic features that contribute to channeling winds and the promotion of extreme fire behavior.

The community-level assessment for the planning area has identified **13** of the **19** communities as being at extreme or high risk. In these communities, a parcel-level analysis should be implemented as soon as possible to ensure the ongoing safety of residents and survivability of structures. An effort should be made to connect residents in these communities to Boulder County Wildfire Partners for home ignition zone (HIZ) assessments, and to other wildfire preparedness resources. Finally, an attempt to mobilize members from each neighborhood planning area to take on leadership roles for fire preparedness and mitigation actions should be made.

Many neighborhoods in the planning area share similar wildfire hazards. General recommendations for preparing homes for wildfire can be found in **Section 3. Becoming a Fire Adapted Community.** A breakdown of each neighborhood's specific challenges and recommendations tailored to each community can be found in **Section 3.c. Plan Unit Assessments and Recommendations** of this document.



Legend

Nederland / Timberline FPDs

CWPP Plan Units

- Beaver Creek
- Big Springs
- Bonanza
- Cardinal/Caribou
- Cold Springs
- Comforter Mountain
- East Ridge
- Eldora
- Fourth of July
- Lazy Z
- Nederland
- Peak to Peak
- Pinecliffe
- Porter Ranch
- South Nederland
- Sundown
- Tungsten Mountain
- Twin Sisters/Pine Glade
- West Ridge

THE Ember Alliance

Coord. Sys.: NAD 1983 UTM Zone 13N
Projection: Transverse Mercator
Datum: North American 1983

Figure 10: CWPP Planning Units. This CWPP assesses relative risk among 19 plan units in Nederland/Timberline FPDs. To delineate plan units, we considered clusters of addresses, connectivity of roads, topographic features, land parcels, and local knowledge of community identification. Source: The Ember Alliance.

2.b. Fire District Capacity

The Nederland/Timberline CWPP planning area encompasses two fire protection districts: the Nederland FPD and the area Timberline FPD within Boulder County.

Nederland Fire Protection District

NFPD Station Locations & Apparatus

Station 1: 650 West 4th St., Nederland

Station 1 has the following equipment:

- 1 Type 1 4WD Engine (1250 gallons)
- 1 55' aerial ladder (500 gallons)
- 1 Rescue
- 1 Type 6 Engine (300 gallons)
- 2 Water Tenders (1,700 and 3,000 gallons), one of which is a CSFS 6x6 Tactical Tender

Station 2: 2815 Ridge Road, Nederland

Station 2 has the following equipment:

- 1 Type 1 AWD Engine (500 gallons)
- 1 Type 6 Engine (300 gallons)
- 1 Water Tender (3,000 gallons)

Station 3: 555 Eldorado Ave, Eldora
Station 3 has the following equipment:

1 Type 2 Engine (750 gallons)
1 Type 6 Engine (300 gallons)
1 Water Tender (1,000 gallons)

Staff
Nederland has a career Fire Chief, three Shift Captains, and a Fire Marshal, as well as numerous volunteer firefighters.

Training
Members of Nederland FPD participate in an active training program. All firefighters must take the entry-level wildland fires courses (S130/190), and annual wildland fire refresher training (RT-130) is required for all members. All department career firefighters and volunteers are also required to take an annual pack test at the arduous level. Trainings take place every other Thursday and Saturday throughout the year and often involve a degree of wildland training, especially in the spring and summer months.

Water Supply
The availability and location of water resources is a critical problem throughout the area. Because of the rural location of many communities, fire hydrants are few and far between, except in areas close to the Town of Nederland. While some homes have cisterns available for fire department use, they are often small in capacity. Creeks and ponds are available in many areas, but they require time and effort to draft water from them. Moreover, shuttle trips will need to be set up to bring water back to the fire area, which takes personnel and apparatus away from firefighting efforts. Currently larger community cisterns are located throughout the district, including Eldora (14,400 gallons), Haul Road (10,000 gallons), East Ridge Road (30,000 gallons), Five Points (30,000 gallons), and Stations 2 and 3 (10,000 and 5,000 gallons). Due to efforts to improve emergency water supply and enhance the tender fleet, all of Nederland FPD has an ISO rating of 4.

Timberline Fire Protection District

There are two Timberline Stations within Boulder County, Stations 1 and 2.

<u>TFPD Station Locations & Apparatus</u>

Station 1: 5927 Magnolia Road

Station 1 has the following apparatus:

1 Type 1 Engine
1 Type 6 Engine
2 Cisterns, 30,000 gallon and 9000 gallon capacity

Station 2: 3992 Colorado Highway 72

Station 4 has the following apparatus:

1 Type 6 Engine
1 Cistern, 8000 gallon capacity

Staff
Timberline FPD employs minimum staffing of at least two career firefighters, but the majority of their response force relies on volunteer firefighters living in the community. Historically, they have had a difficult time recruiting volunteers in and around the Boulder County portion of the district, and this still holds true today.

Training
Members of Timberline FPD participate in an active training program. All firefighters must take the entry-level wildland fires courses (S130/190), and annual wildland fire refresher training (RT-130) is required for all members. All department career firefighters and volunteers are also required to take an annual pack test at the arduous level. Trainings occur regularly, and often involve a degree of wildland training, especially in the spring and summer months.

Water Supply
Water availability and abundance is also a critical issue in the Magnolia area. Fire hydrants are nonexistent, and firefighters must rely on locally available water from home cisterns and adjacent water bodies. Cisterns usually have low capacities and may not provide adequate water in the event of a wildfire. Creeks and ponds exist through the Timberline FPD, but they require time-consuming shuttle trips and drafting. The district has identified water supplies within its boundaries by documenting latitude, longitude, type of supply and volume. At this point, this information needs to be moved from an Excel spreadsheet to a map so it is easily accessible by firefighters responding to calls.

2.c. Wildland Urban Interface

The Wildland-Urban Interface (WUI) describes any area where human infrastructure meets wildland vegetation. These areas are particularly relevant to wildfire preparedness as they are places where natural ecosystem processes (such as wildland fire) can come into contact with the built environment and thereby result in negative impacts to structures and communities.

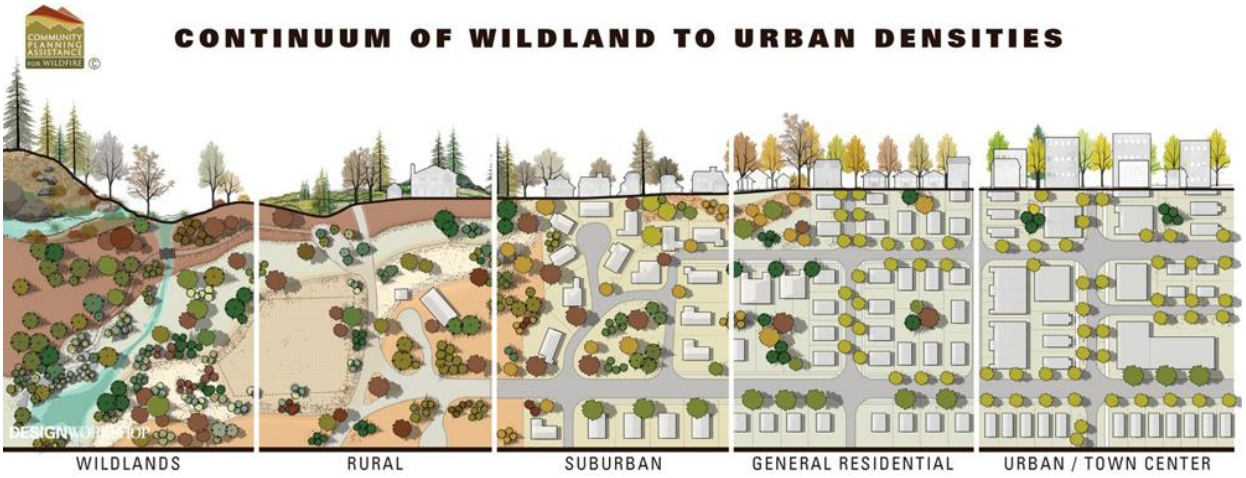


Figure 11: The wildland-urban interface exists along a continuum of wildland to urban densities. Source: Community Planning Assistance for Wildfire.

For the purpose of this CWPP, the WUI area of the NFPD/TFPD was determined through a modeling process that predicts the most likely spread pattern of 10,000 randomly assigned fire ignition points if left to burn for 4 hours. The WUI is defined as any area where a fire ignition could intersect with the plan units outlined. The pink area in **Figure 12** below delineates the WUI. All plan units in this CWPP are located within the WUI, and are subject to the increased fire awareness and responsibility that that entails.

The Town of Nederland has a high risk of wildfire, higher than 81% of communities across the U.S., according to the 2020 Wildfire Risk to Communities analysis by the US Forest Service. The built environment has expanded over the past decade to accommodate a growing tourist industry and a squeezed housing market that has affected many towns along the Front Range of Colorado. Development in the area necessarily pushes further into wildland areas, however, which increases the surface area of the WUI and therefore the likelihood of a wildland fire event affecting communities.

Strategic wildfire mitigation across the WUI can increase the safety of residents and wildland firefighters, and can reduce the chances of home loss due to wildfire. Ultimately, however, it is incumbent on residents in the WUI to acknowledge the increased level of risk that living and working in the WUI poses, and to take personal responsibility for their safety and the preparation of their property against those risks.

NFPD/TFPD Wildland Urban Interface

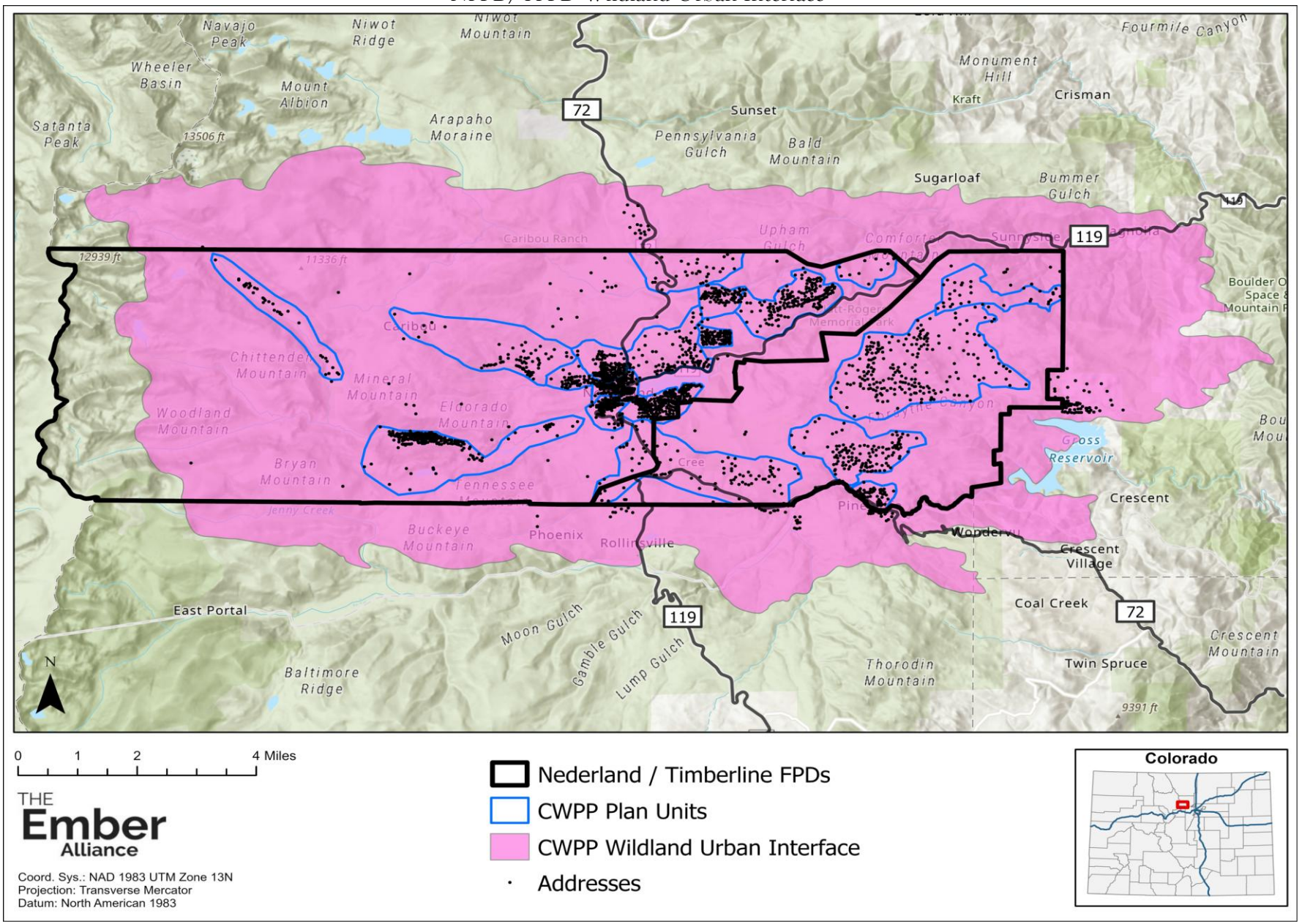


Figure 12: CWPP WUI Overlap. All residents of Nederland/Timberline FPDs live in the wildland-urban interface and/or intermix and are exposed to elevated wildfire risk. The WUI boundary for this CWPP includes all Nederland/Timberline FPDs and the surrounding landscape that could transmit wildland fire into any of the CWPP Plan Units (see methodology in Appendix A). Source: The Ember Alliance.

2.d. Fire History Along the Front Range

Natural fire regimes drove ecosystem processes along the Front Range for thousands of years, though history of wildfire in the planning area also includes the use of fire by native peoples such as the Arapaho, Ute, Shoshone, Cheyenne, and Lipan Apache. Fire was used as a tool for various purposes, including driving prey animals during hunts, and clearing land for farming, along with many other cultural uses. European invasion and settlement in the late 1850's began an era of fire suppression that has altered the historical structure and composition of forests throughout the Front Range.

The CWPP planning area contains three dominant forest vegetation types (see **Figure 6: Map of vegetation**), Ponderosa pine, Lodgepole pine, and Spruce-Fir mix. Each distinct forest type has adapted to wildfire differently, and has a unique historical disturbance regime. Modern forest management techniques aim to mimic disturbance patterns in these forests, restore historical density and composition, and prepare forests for wildfires and the impacts of climate change.

Ponderosa Pine and Mixed Conifer

Ponderosa pine forests predominate in the lower elevations (6000-8,000ft) of the planning area. Historically, these fire adapted forests had fire regimes that experienced wildfire in intervals of 7-50 years. Wildfires were usually of low severity, burning saplings and intermixed grasses and shrubs, but remained on the ground and typically were not hot enough to kill mature trees (Addington et al., 2018). As a result, Ponderosa pine forests were less dense, and did not build up ladder fuels that transition surface fires into crown fires (Matonis and Binkley, 2018). Since fire suppression activities altered the natural fire regimes of these ecosystems, Ponderosa pine forests have become denser, in many areas creating a continuous, uniform canopy that facilitates the spread of high-severity fire (Addington et al., 2018).

Management for Ponderosa pine forests aim to restore historical density levels, and promote meadow intermix. These forest characteristics help keep fire on the ground and reduce fire intensity to prevent tree mortality. Ponderosa pine ecosystems with fewer trees also support more abundant and 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; and Pilliod et al., 2006).

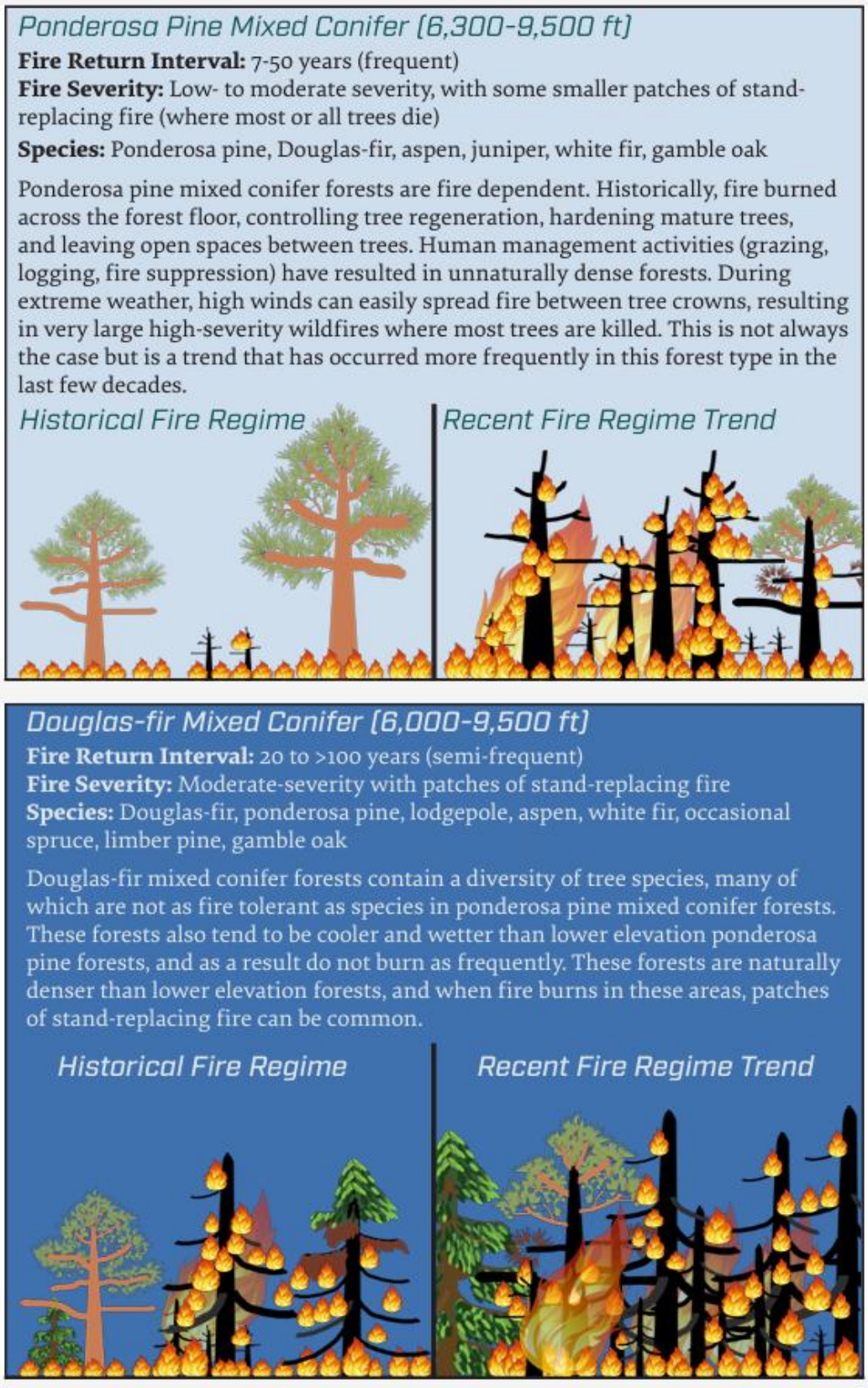
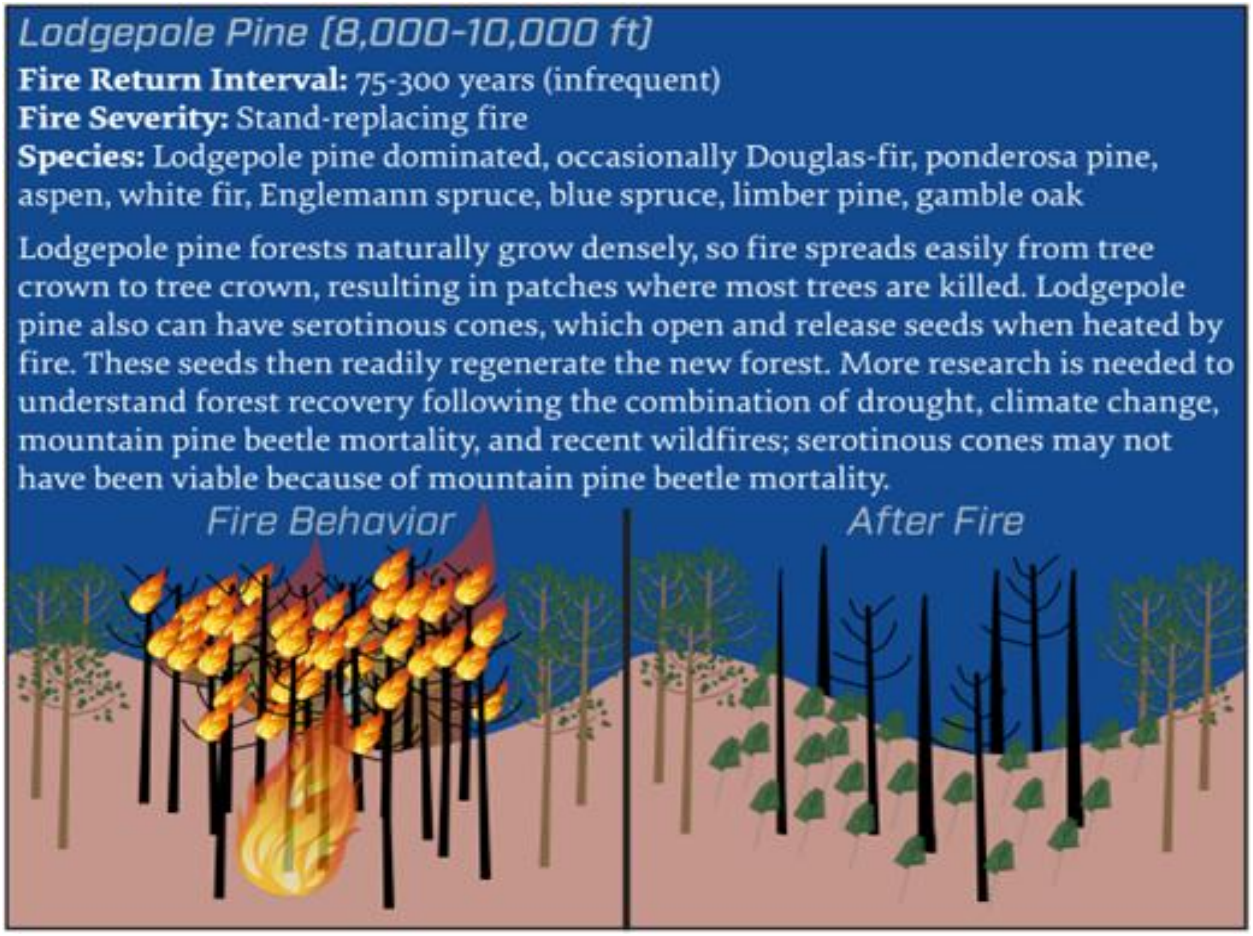


Figure 13: Fire regimes for lower elevation conifer forests found in the planning area. Source: The Colorado Forest Restoration Institute

Lodgepole pine

Lodgepole pine forests predominate in the middle elevations of the planning area (8,000-10,000ft). Lodgepole pine forests historically experienced mixed severity fire throughout its ranges. Low to moderate intensity surface fire could return every 25-50 years, while intense, stand replacing fires had a return interval of 200-300 years (Arno, 1980; Barrett et al., 1991). Lodgepole grow in dense clusters, and fire events in stands of Lodgepole can become intense running crown fires because of their close proximity. However, Lodgepole have adapted to infrequent, high-severity fire through their prodigious serotinous cones that open in response to the high heat of a wildfire, and their quick, vertical growth, that allows them to dominate access to light in forest areas that have been cleared by fire. Lodgepole pine forests in the planning area have been impacted by Mountain Pine Beetle epidemics, which can increase the potential for severe wildfire behavior that is both difficult to suppress and has the potential to cause severe soil damage (Dennis et al., 2009).



Lodgepole pine management aims to increase age, size, and species diversity in healthy stands, while reducing fuel loads. Cuttings are done to break up continuous stands across a landscape, and to remove dead and beetle-infested stands. Lodgepole pine can be cut in large patches that mimic the stand-replacing fires it has evolved with, or selectively thinned while young and maintained through adulthood to reduce density and fuel load, though this requires more consistent management to avoid blowdown from high winds (Dennis et al., 2009).

Spruce-Fir

Engelmann spruce and subalpine fir is the dominant vegetation type in the higher elevations (9,000-11,000ft) of the planning area. These forest systems historically experienced infrequent, stand-replacing fires with return intervals between 200-600 years (USDA Rapid Assessment LANDFIRE model, 2005). The increased moisture content in subalpine systems generally led to denser stands of trees, especially on north-facing slopes. Wildfires typically burned intensely, and contributed to patchwork ecosystems made of dense, unburned forests intermixed with clearings where intense burns led to high mortality (Higuera et al., 2021).

Spruce and Fir forests can be managed across a landscape for diversity in age, size, and intermixed species diversity. Reduced densities in subalpine spruce-fir forests can help reduce stress on trees, and make them more resilient to disease and the damaging effects of climate change (Lalande et al., 2020).

Promoting 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 landscape 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.

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 a neighborhood. It also creates a diversity of biomes that both residents and wildlife enjoy.

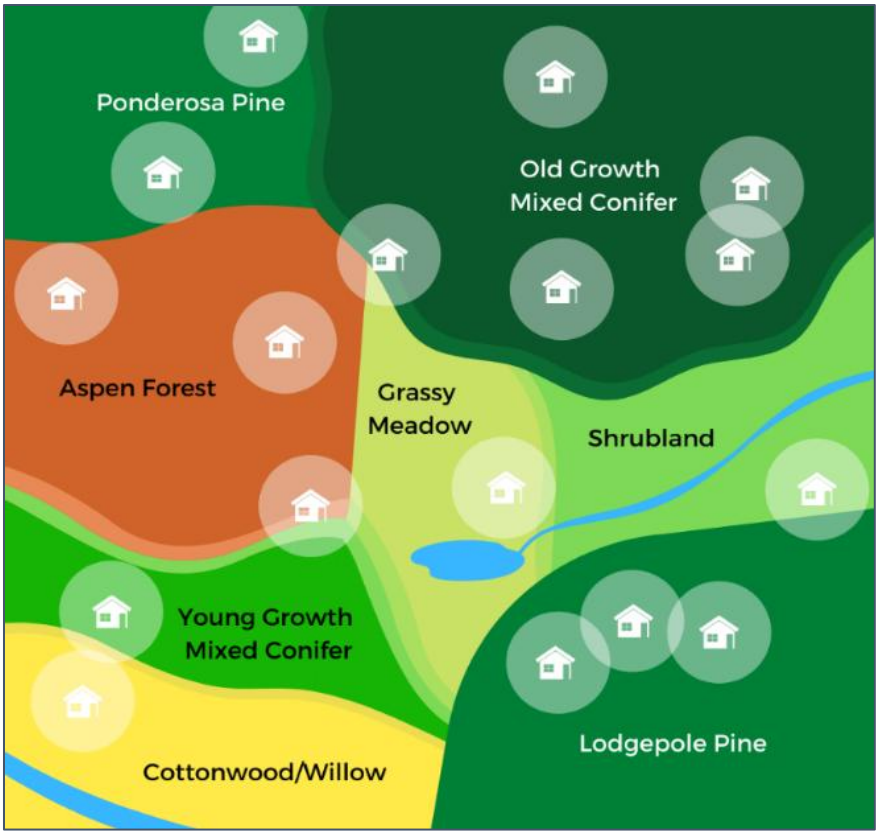


Figure 14: Example of a mosaic landscape. The landscape is varied throughout, providing tactical opportunities for firefighters working to defend homes. Source: The Ember Alliance

Fire History on the Front Range

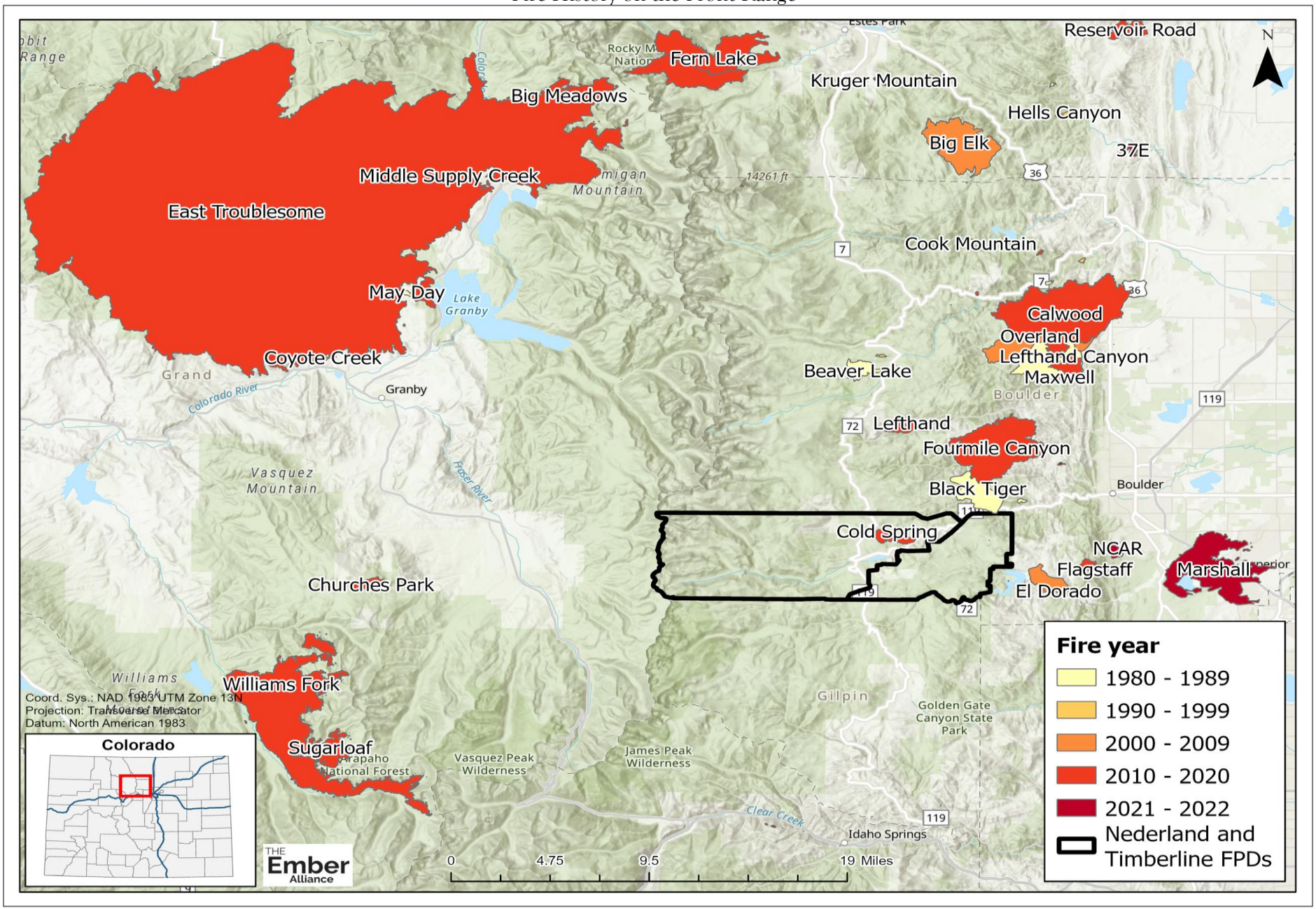


Figure 15: Wildfire History on the Front Range. The 2016 Cold Springs Fire spread across 525 acres in Nederland FPD, destroyed eight homes and seven outbuildings, and prompted evacuations for nearly 2,000 residents. Source: National Interagency Fire Center.

Climate Impacts on Fire Regimes

The CWPP planning area is populated by many fire-adapted ecosystems. The last century of fire suppression activities has allowed fuels to buildup in these ecosystems, altering the intensity and character of wildfires. The buildup of fuel combined with a hotter, dryer climate resulting from climate change, has dramatically increased the frequency and severity of wildland fires. In subalpine forest systems, which include lodgepole pine and spruce-fir forests, fire regimes have nearly doubled in frequency. In one study area, "just 5 years account for 99% of the total area burned since 1984, with shortening gaps between extreme years: 2002, 2012, 2016, 2018, and 2020" (Higuera et al., 2021).

Increased frequency and intensity of fire poses a great challenge to the regenerative capacity of forest ecosystems, especially lodgepole. Lodgepole rely on a large seed bank to regenerate after intense, stand replacing fires. However, if a wildfire passes through the same area before new growth has had a chance to mature and begin producing cones and seeds (around 30 years), then the stand will be less likely to regenerate. The cones and seeds that make up the seedbank do not have a chance to replenish before fire clears the area again, so the subsequent regrowth is sparser. Some forests are unable to regenerate after fire events like this, and transition to a different ecosystem entirely (Davis et al., 2023).

Catastrophic wildfire events are transforming western landscapes, and conifer forests may not be able to regenerate under an increasingly warm, dry climate and severe burning. Fortunately, targeted, appropriate land management practices can help counteract these long-term negative effects on forest systems. Management strategies that restore historical densities and forest compositions can reduce wildfire intensity, increase species diversity, and make forests more resilient to climate change. Through targeted management of these ecosystems, including reducing fire severity, land managers can improve forest regeneration post-fire and increase resilience to climate change (Davis et al., 2023; Lalande et al. 2020). The next few years are a window of opportunity for the protection and resilience of our communities and forests. A robust forest management regime is an integral part of seizing that window for our benefit and the benefit of our surrounding forest ecosystems.

2.e. Severe Fire Behavior Exposure in Nederland/Timberline FPD

Most neighborhoods in the CWPP planning area are at risk of extreme fire behavior that could place the lives of residents, visitors, and firefighters at risk. Steep slopes, dense forests, limited road access in and out of neighborhoods (ingress/egress), and flammable building material all contribute to this dangerous situation. There is an immediate need for proactive measures to mitigate wildfire risk in the planning area to prevent loss of life and property.

Although the planning area has had few wildland fires greater than 10 acres, the increasing frequency of extreme weather conditions and reduced moisture content increases the likelihood of severe wildfire events. Topography, fuel conditions, and the increasing frequency of extreme weather conditions in the planning area combine to create a very high risk-potential for wildfire behavior. The likelihood of rapid increases in wildfire intensity and spread within some of the communities is very high due to dense fuels, large quantities of ember-cast and other topographic features that contribute to channeling winds and promotion of extreme fire behavior. These areas may also represent a serious threat to life safety due to difficult access and the likelihood of heavy smoke, heat and/or long response times from suppression resources. As a result, wildfire is likely to impact homes and other structures in the coming years. Communities in the planning area urgently need to prepare to mitigate the effects of such wildfires.

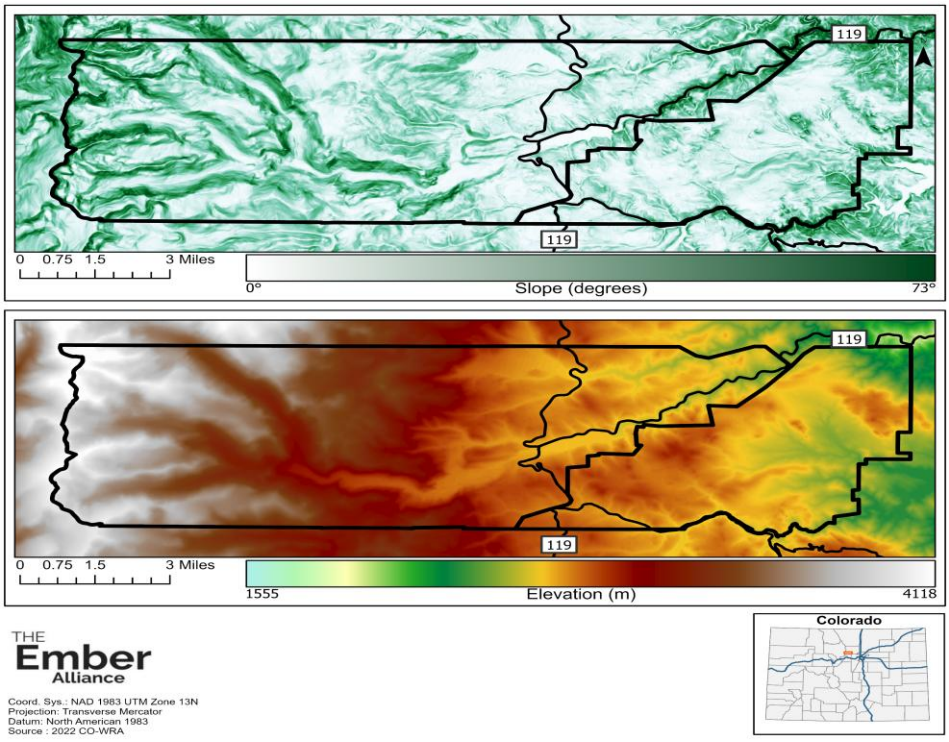


Figure 16: Slope and Elevation in the CWPP Planning area. Source: The Ember Alliance.

Topography

Elevation in the planning area varies from around 7,000ft to nearly 13,000 feet. Much of the area is mountainous, with steep, narrow canyons and drainages where a wildfire will move faster as it travels up steeper slopes and is driven by high winds. These narrow, steep chutes also funnel winds and further increase the rate of spread of a fire. Slopes in the planning area are often greater than 45 degrees.

The area has flat valley bottoms surrounded by steep, densely forested hillsides. Steep slopes increase wildfire behavior as a result of preheating of uphill fuels. A wildfire originating on the top of the slope can be expected to have the most minimal fire behavior, as it backs down the hill with low flame lengths and rates of spread. This is typically where lightning strikes and single tree ignitions occur but do not typically spread. The biggest concern would be a wildfire starting at the base of the slope and then spreading quickly uphill, especially under extreme weather conditions. Some of the areas that are of greatest concern are the communities uphill from Colorado Highway 119. Discarded cigarettes, dragging chains from trailers, and overheating cars can act as ignition sources. Some areas of the canyon have steep rock walls, which may prevent fire from running uphill, but vegetation is continuous from the highway in other areas.

Weather

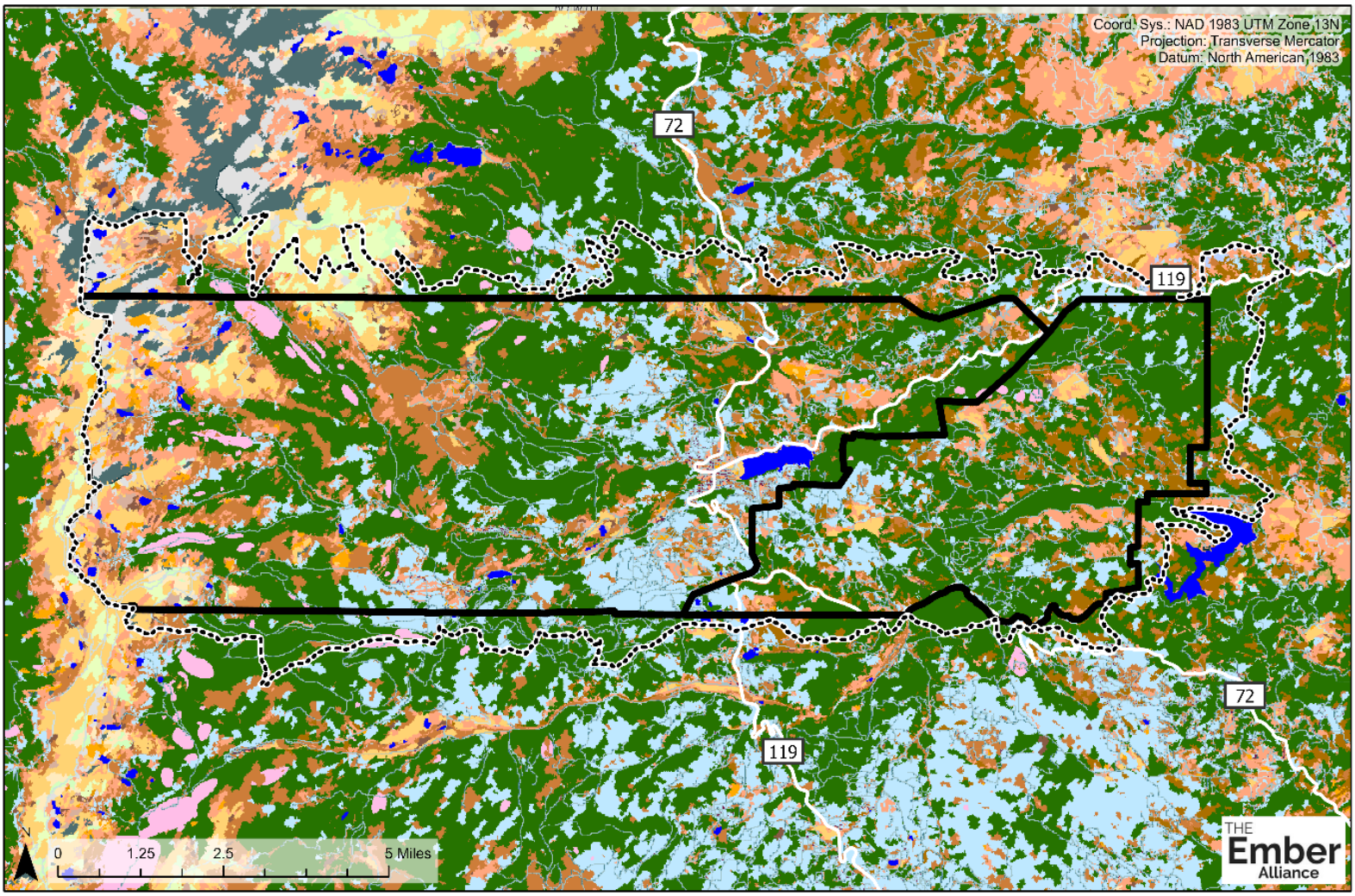
The weather analysis for the area shows that there are an increasing number of days that support large wildfire growth. At higher elevations, temperatures are lower and the relative humidity is higher. The daily window of opportunity for ignition is usually short. The season is also short, with winter snows coming earlier to these areas. However, drought and low snowpack are increasingly common, and coupled with high winds can lead to extreme wildfire weather events occurring more frequently in the CWPP planning area.

Generally, forests above 9,000 feet burn when there is prolonged drought. These conditions can also increase the chance of insect and disease outbreaks, which will further increase the likelihood of extreme fire behavior. Though historically these weather conditions have been uncommon, prolonged drought coupled with high winds are becoming more frequent as the effects of climate change begin to play out in the planning area.

High winds are the main cause of large wildfire events in Boulder County, and strong winds are common within the NFPD and TFPD area. The planning area is at the edge of the Continental Divide, and most weather events will create some level of wind as they crest over the mountains and move to the east. The planning area is known for gusty winds, with gusts exceeding 40 mph on a windy day. Strong, gusty winds can penetrate dense stands of forest, and transition a wildfire from the ground into tree canopies (known as a crown fire), and spread ember cast over great distances.

Fuel Conditions

Fuel loads in the planning area are variable. Vegetation ranges from sparse, grassy meadows to dense mixed conifer forests. Any vegetation that can burn is considered a fuel. Fuels are categorized into "fuel models," each with a unique set of characteristics when burned. The Colorado Wildfire Risk Assessment (CO-WRA), produced in 2022 by the Colorado State Forest Service provided an update to fuels characterization. **Figure 17: Fuel types in the CWPP planning area** displays the current fuel characterization of the planning area. The most prevalent fuels types consist of dynamic timber litter and timber understories within ponderosa, lodgepole, and other mixed conifer forests, and moderate to high load dry-climate grass and shrublands. For a description of each fuel model, see the 2022 CO-WRA Update.



Fire behavior fuel model

- Surrounding firesheds
- Nederland / Timberline FPDs
- NB2 (92)-Snow/ice
- NB9 (99)-Bare Ground
- GR1 (101)-Short, sparse dry-climate grass
- GR2 (102)-Low load, dry-climate grass
- GR1 (111)-Short, sparse dry-climate grass (alpine)
- GR2 (112)-Low load, dry-climate grass (alpine)
- GS1 (121)-Low load, dry-climate grass-shrub
- GS2 (122)-Moderate load, dry-climate grass-shrub
- GS1 (131)-Low load, dry-climate grass-shrub (alpine)
- SH1 (141)-Low load dry-climate shrub
- SH2 (142)-Moderate load dry-climate shrub
- SH4 (144)-Low load, humid-climate timber-shrub
- SH5 (145)-High load, dry-climate shrub
- SH7 (147)-Very high load, dry-climate shrub
- SH7 (157)-Very high load, dry-climate shrub (oak shrubland)
- TU1 (161)-Low load dry-climate timber-grass-shrub
- TUML1 (171)-Timber understory (dynamic)
- TL2 (182)-Low load broadleaf litter
- TL3 (183)-Moderate load conifer litter
- TLML1 (191)-Timber litter (dynamic)
- SB3 (203)-High load activity fuel or moderate load blowdown
- UCH (916)-Urban core surrounded by high-load fuels
- ASH (932)-Agricultural high load fuels (seasonally burnable)
- RNL (941)-Minor roads surrounded by low-load fuels
- RNH (942)-Minor roads surrounded by high-load fuels
- RML (943)-Major roads surrounded by low-load fuels
- RMH (944)-Major roads surrounded by high-load fuels
- RNB (949)-Roads surrounded by non-burnable fuels
- WBD (989)-Water bodies

Source: 2022 CO-WRA

Figure 17: Fuel types in the CWPP planning area are categorized by their fire behavior potential. See Appendix A for more information.
Source: 2022 Colorado Wildfire Risk Assessment, Colorado State Forest Service

Causes of Wildfire Ignition

Humans cause the majority of fire ignitions in the CWPP planning area. While most fires are extinguished before they can grow very large, there is always a potential for ignitions to become extreme wildfire events. Increased activity in the planning area from tourists and recreators, especially on National Forest Service property, increases the risk of ignitions. Educating recreators who use campgrounds and other forested sites, and monitoring these areas, will help reduce this risk.

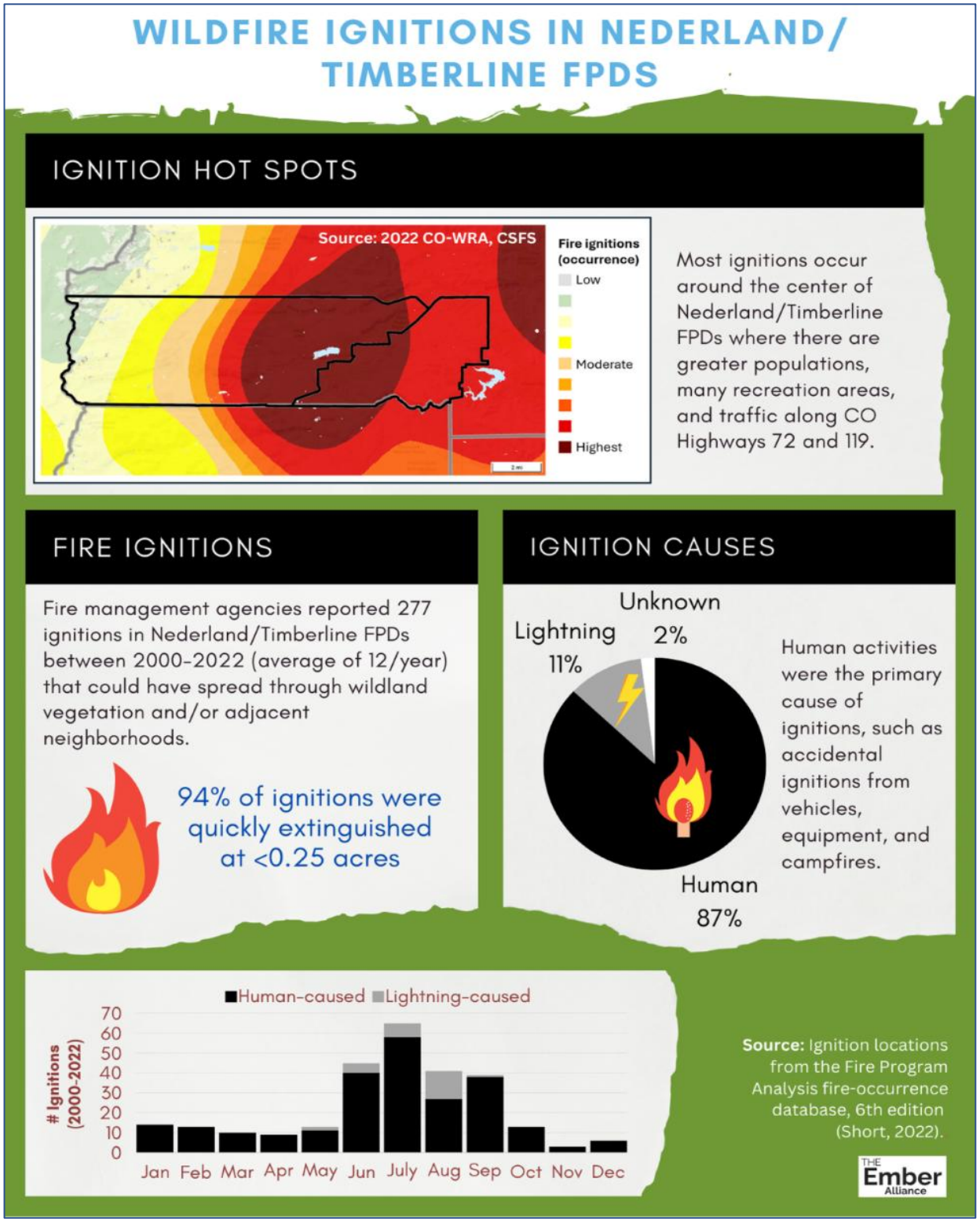


Figure 18: Wildfire ignition frequency and causes in Nederland/Timberline FPDs. Source: The Ember Alliance

Fire Behavior Class Under Moderate and Severe Weather
Fire behavior class was modeled at the 75th and 97th percentile weather conditions, in an attempt to keep fire behavior models relevant under expected future climate warming scenarios that are increasing the frequency of these dangerous weather events. Under both the 75th percentile and 97th percentile conditions, fire behavior is extreme for the majority of land in the planning area **(Figure 21: Fire Behavior Class)**.

High to extreme wildfire behavior with elevated winds includes ember production that ignites additional fires away from the main fire and improves the chances of movement of high intensity fire from treetop to treetop (known as a running crown fire) **(Figure 23: Predicted exposure to short-and long-range ember cast and radiant heat)**. Such fires are extremely dangerous, and challenging, if not impossible, to control until winds die down and fuel moisture increases. Wildfire growth could be extensive if wildland firefighters are unable to engage in fire suppression activities due to dangerous conditions **(Figure 22: Fire growth)**.

Impact to Roadways and Evacuation
High to extreme fire behavior can also create non-survivable conditions along roadways, which is of particular concern to many residents within the CWPP planning area where there are very few egress roads out of certain neighborhoods. **The neighborhoods most affected by the lack of appropriate egress routes are 4th of July, Comforter Mountain, Big Springs, Bonanza, Eldora, Porter Ranch, and Twin Sisters/Pine Glades.** Evacuation preparedness is of the utmost importance for residents in these neighborhoods.

Home Ignition
On days with moderate to extreme fire weather conditions, homes in the planning area could be exposed to embers from burning vegetation, regardless of vegetation in the immediate vicinity of the home. Homes serve as an additional source of fuel that could produce high-intensity flames, emit embers, and initiate home-to-home ignitions. Residents and business owners can complete home hardening practices to reduce the risk of embers penetrating their homes.

While it is always a good idea to invest in improving defensible space and home hardening for residents in the WUI, it is equally important to understand the limitations these steps have in certain environments. During extreme wildfire danger scenarios, it is not possible to rely solely on defensible space and home hardening actions or to expect the fire department to be able to protect your home and family. Major coordinated action, from forest fuel treatments to community preparedness, is needed to provide the protection against wildfire in these areas. Working with neighbors to create connected or extended fuel treatments, protected roadways, and diverse, mosaic landscapes all play a role in making the community safer for everyone.

Take Away Message

Residents of the NFPD and TFPD 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. **Proactive work by NFPD/TFPD, residents, and partners is imperative to protect lives and property.**

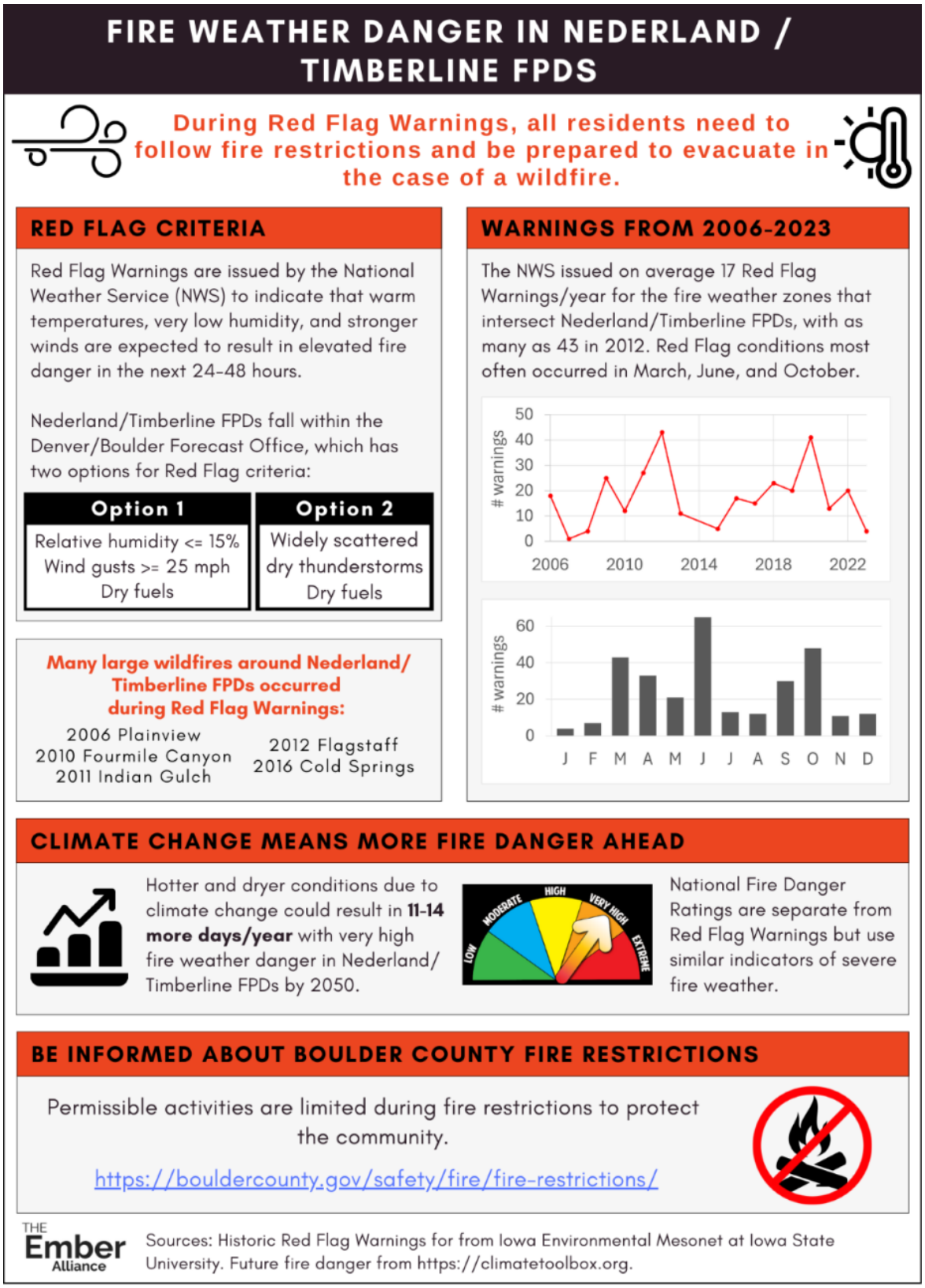


Figure 19: Pay attention to Red Flag warnings on days with increased fire weather danger. Source: The Ember Alliance

Figure 20: Fuel loads are variable across the planning area, ranging from dense lodgepole and ponderosa forests, to open mountain meadows where vegetation is continuous and dry. Fuel type and fuel loads greatly influence fire behavior, intensity, and rate of spread. Photo credit: The Ember Alliance.

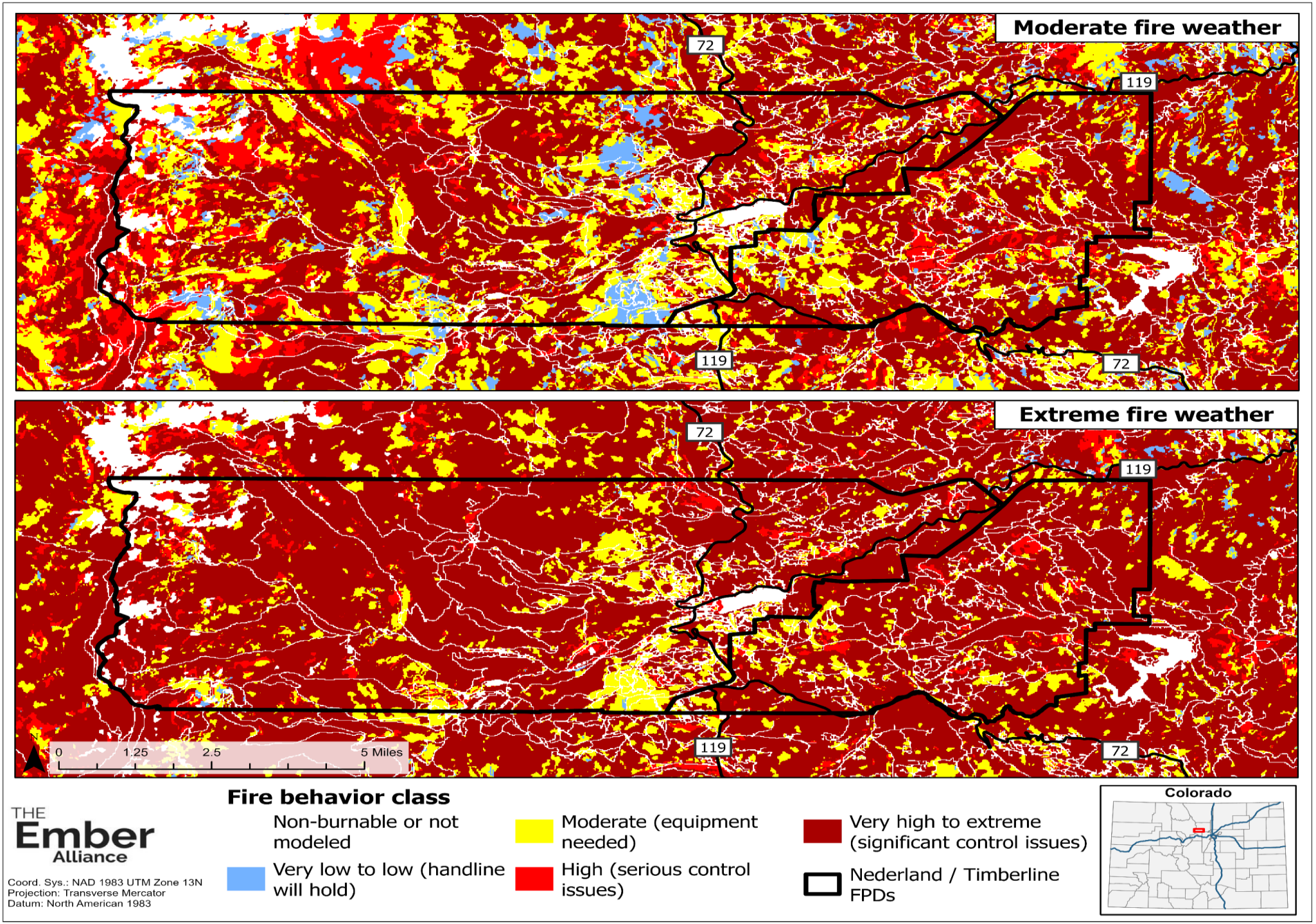


Figure 21: Fire Behavior Class. Under moderate fire weather conditions—conditions typical of a summer day in Nederland/Timberline FPD—64% percent of the area could experience high to extreme fire behavior, and this percentage increases to 77% under less common but more extreme, hot, dry, and windy conditions. 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. Source: The Ember Alliance.

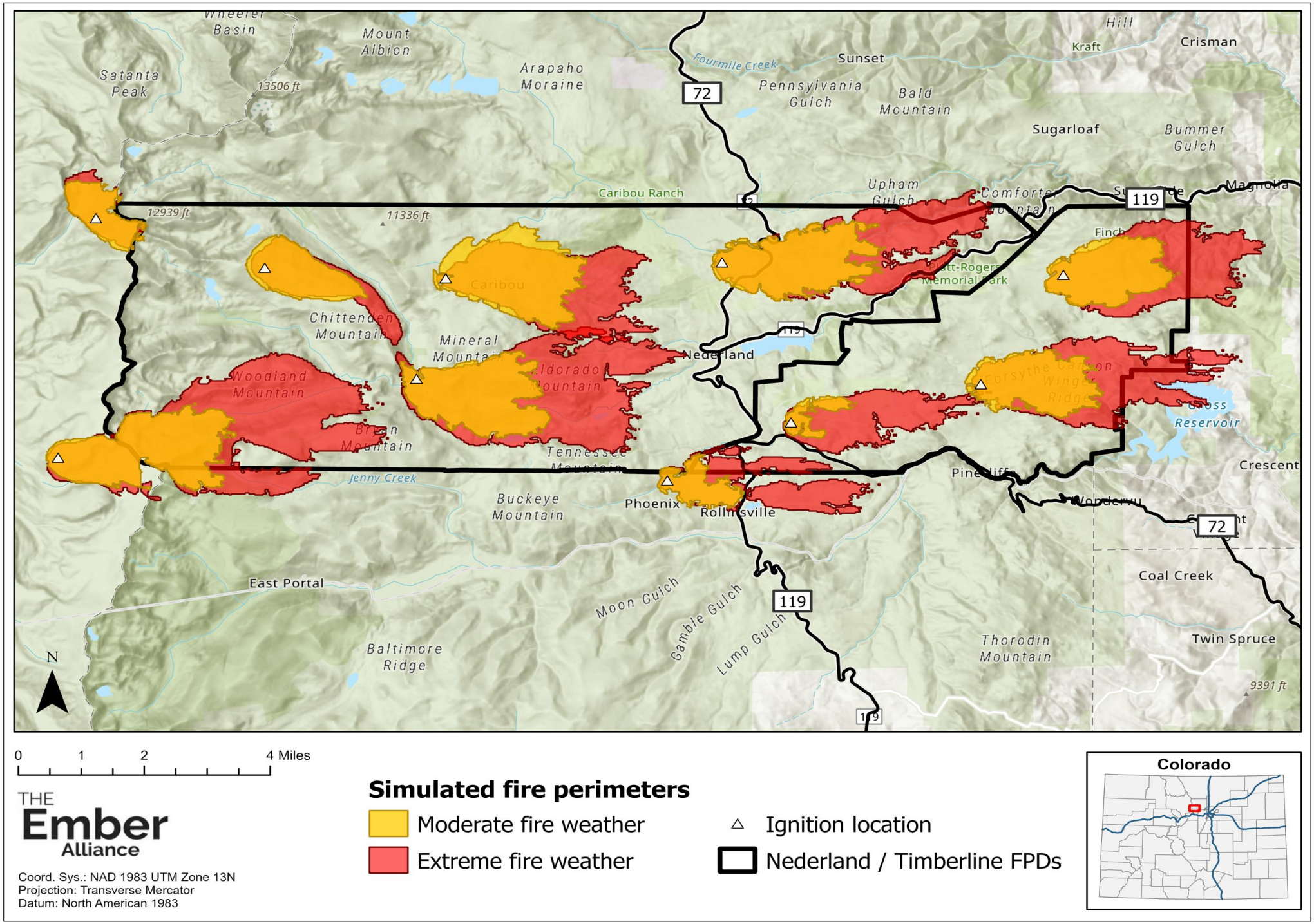


Figure 22: Fire growth could be extensive across Nederland/Timberline FPDs under extreme fire weather conditions if wildland firefighters cannot engage due to dangerous conditions from extreme fire behavior. Simulated fire perimeters were based on fire behavior predictions after 4-hours of fire growth 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 Nederland/Timberline FPDs under different fire weather conditions and wind directions. Source: The Ember Alliance

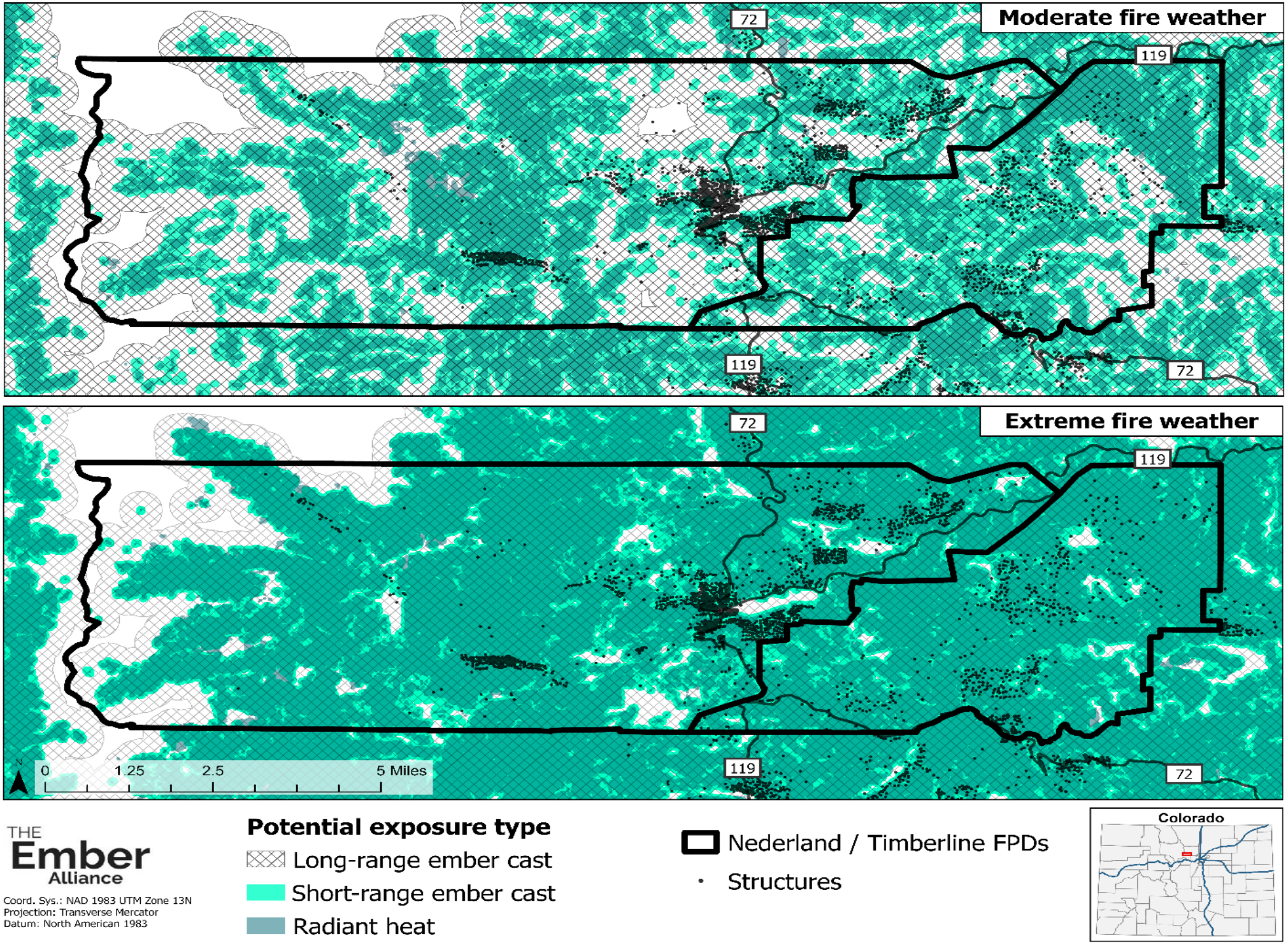


Figure 23: Predicted exposure to short-and long-range ember cast and radiant heat under moderate and extreme fire weather conditions in Nederland/Timberline FPDs. Source: The Ember Alliance

2.f. Fuel Treatment History in Nederland/Timberline FPD

Various agencies and private landowners have actively managed the land and fuel load in the CWPP planning area. City of Boulder, Boulder County, Denver Water, Colorado State Forest Service, and the U.S. Forest Service have all planned and completed projects. Some of these projects are multi-faceted and attempt to achieve multiple ecological outcomes at once, including the removal of invasive species, increase in wildlife habitat, and improvement of overall ecosystem function, alongside wildfire risk reduction.

While some progress has been made in reducing fuels in key locations in the planning area, many neighborhoods and community members remain at risk from high fuel loads. Fuel treatments reduce the amount of fuel in strategic locations, reducing wildfire risk to nearby communities and creating tactical opportunities for wildland firefighters to engage with and attempt to suppress wildland fires. An essential component of this CWPP was identifying locations for fuel treatments and forest restoration projects that most effectively protect the community. Section 4. outlines these priority locations and the land management agency that will be leading these efforts in the coming years.

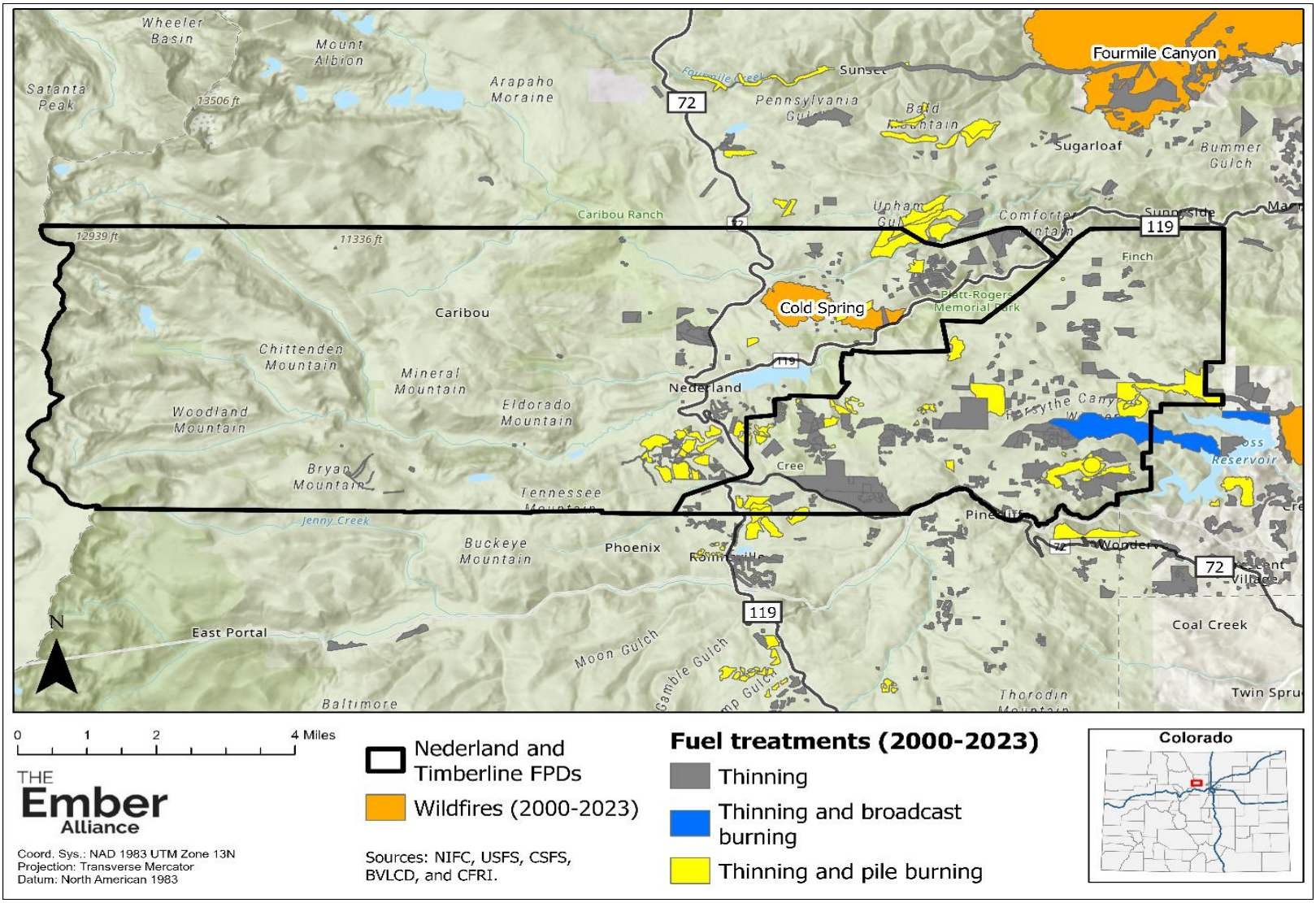


Figure 24: Fuel treatment history in and around Nederland and Timberline FPDs since 2000. Sources: USFS (data through 2023), CSFS (data through 2022), Boulder Valley & Longmont Conservation Districts (data through 2023), and CFRI for other agencies (data through 2018). Wildfire boundaries from the National Interagency Fire Center.

3. Becoming a Fire Adapted Community

The CWPP process provides a roadmap for communities to build wildfire resilience. Wildfire resilience refers to a suite of actions that help a community prepare for, recover from, and reduce the risks and impacts of wildfire events (The Nature Conservancy and The Aspen Institute, 2023). Wildfire resilience goes beyond wildfire prevention to incorporate all aspects wildfire preparedness, response, and recovery.

This CWPP uses the Fire Adapted Communities (FAC) model from the Fire Adapted Learning Network to guide residents, fire practitioners, and communities through a holistic approach to building wildfire resilience. A Fire Adapted Community 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".

Part of becoming a fire adapted community involves acknowledging both that wildfire is a natural and necessary part of local ecology, and that there will be wildland fire in the CWPP planning area in the future. The goal is not to prevent fire, but to minimize the potential negative effects of wildfire, and to recover after wildfire events. Your community's CWPP is one step in the ongoing process of fire adaptation, but becoming a fire adapted community takes a commitment to mitigate risk at all levels of the community, from individual homeowners, neighborhoods, and HOAs, to fire protection districts, land managers and other partners.

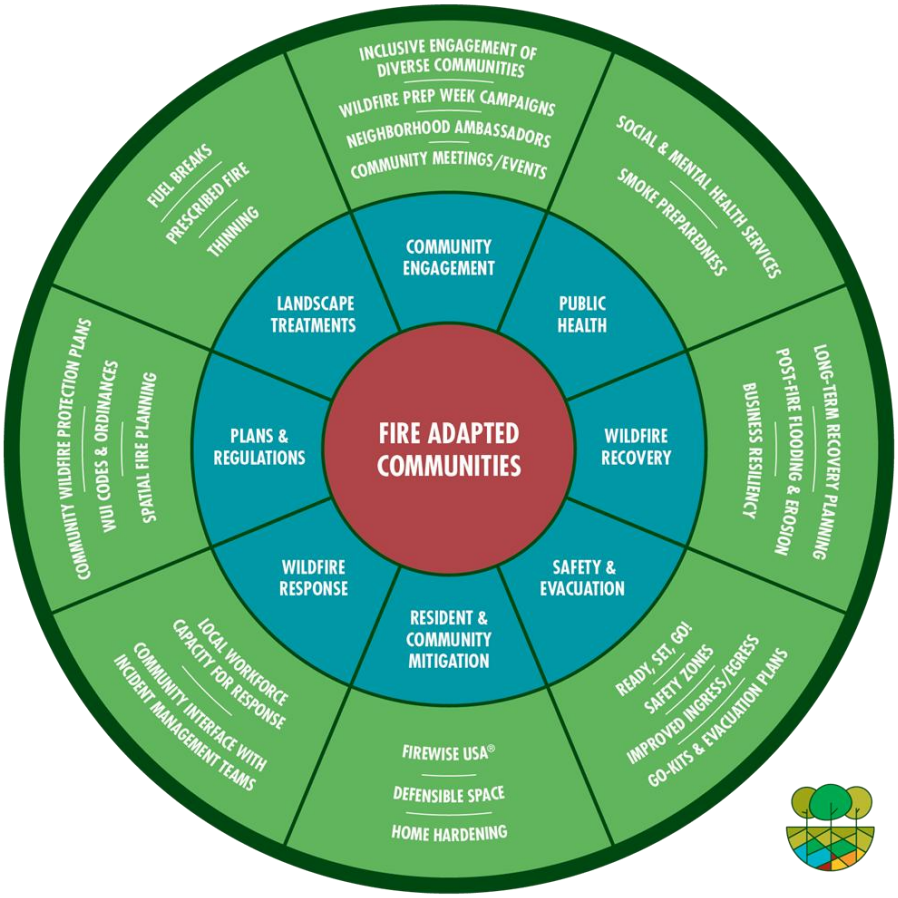


Figure 25: The Fire Adapted Communities graphic provides specific programs and activities that communities can take to reduce their wildfire risk and increase their resilience. Source: Fire Adapted Community Learning Network

3.a. Preparing Your Home for Wildfire: Resident and Community Mitigation

During catastrophic wildfires, property loss happens mostly due to conditions in the **Home Ignition Zone** (HIZ). The home ignition zone includes your home and other structures (e.g., sheds and garages) and the area within 100 feet of each structure. **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 updating building materials 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).

Wildfire preparedness in the HIZ is made up of **Home Hardening** and **Defensible Space**. **Defensible Space** is 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 residents 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.

Firefighter intervention, adequate defensible space, and home hardening measures were common factors for homes that have survived major wildfires (IIBHS, 2018; Maranghides et al., 2022). Research following the 2018 California 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 feet of the home, and when they had combustible materials (firewood or propane tanks) near the home (Knapp et al., 2021).

Wildfire preparedness must be community effort, as one resident's HIZ impacts all of their neighbors, just as their neighbors' HIZs impacts theirs. It is important for residents 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, especially in denser areas, such as Nederland's town center, where home-to-home ignitions could cause an urban conflagration fire. Neighbors can increase their homes' chances of survival during a wildfire if they work together to reduce hazards in their overlapping defensible space areas.

Your Actions Make a Difference

You can increase the likelihood that your home will survive a wildfire 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. Contact Boulder County's Wildfire Partners for a free home mitigation assessment.

Defensible Space

Defensible space creates a buffer between your home 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).

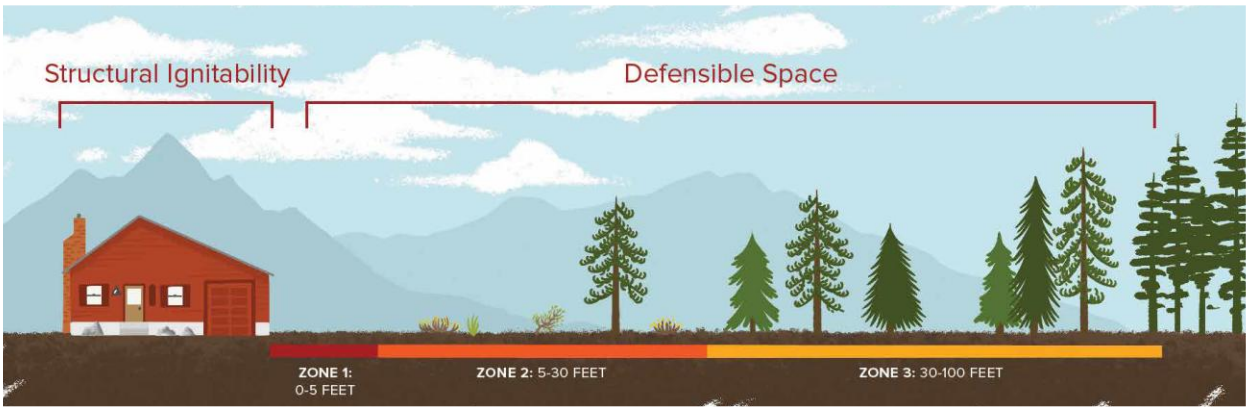
Do not count on firefighters staying to defend your home—your home should be able to survive a wildfire on its own. There are never enough firefighters to stay and defend every single home during large incidents. Properties that are not defensible will not often receive firefighter resources due to unsafe 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 HIZ 1 as 0 to 5 feet from a structure, HIZ 2 as 5 to 30 feet from a structure, and HIZ 3 as 30 to 100 feet from a structure. 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 zone one 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).

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 the CSFS publication The Home Ignition Zone Guide for recommendations.

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



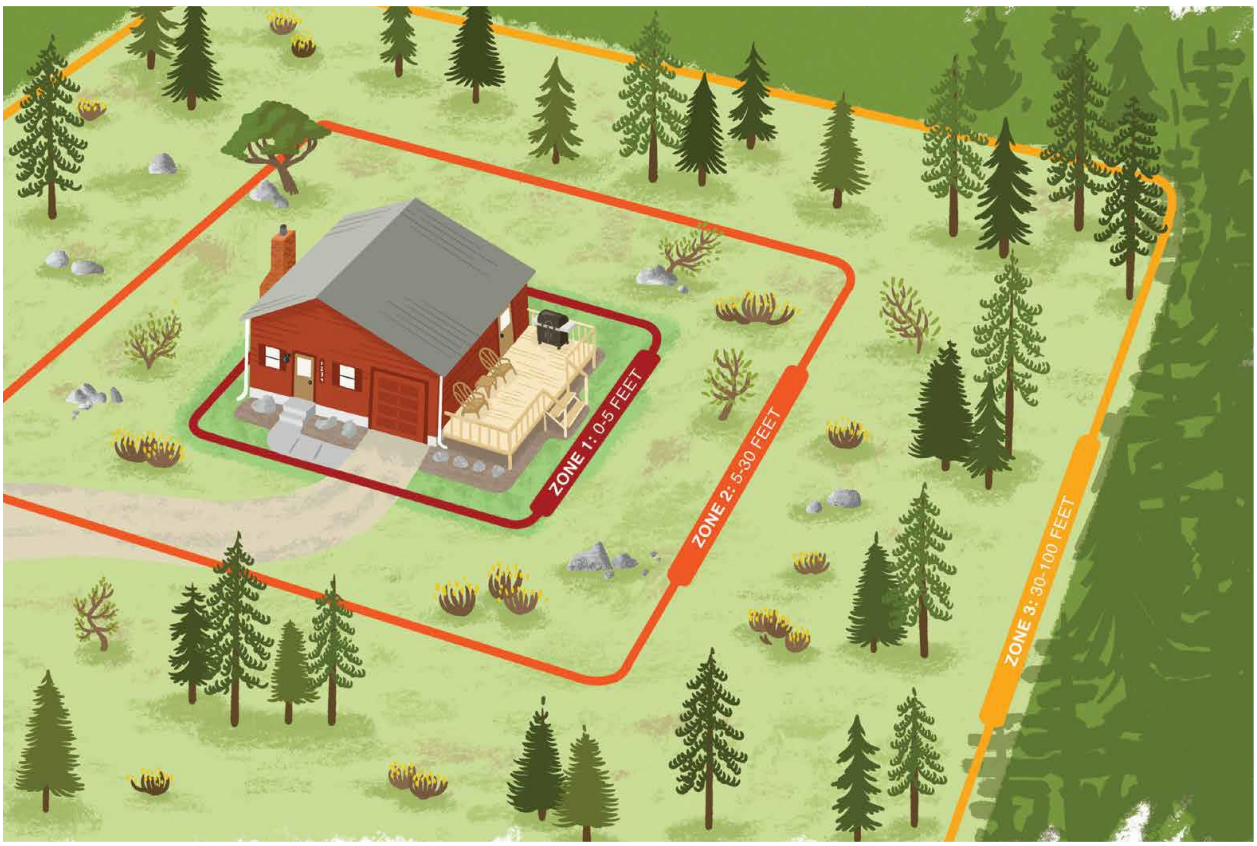


Figure 26: Home ignition zones recommended by the Colorado State Forest Service. Using ignition-resistant building materials and removing burnable fuel around primary structures, outbuilding such as sheds, and campers / RVs is crucial for increasing your home's chance of surviving a wildfire and creating safe conditions for wildland firefighters. Source: Colorado State Forest Service, The Home Ignition Zone

Table 2: Home Ignition Zone recommendations based on the CSFS publication The Home Ignition Zone. This is not an all-inclusive list of activities.

Zone 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**. Replace flammable materials such as wood chips or grass, 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 within 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 Zone 3. • Do not use space under decks for storage.
Zone 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.
• Irrigate and mow grasses to 4 inches tall or less. • **Use only Firewise Plant Materials plants for landscaping. Firewise plants are often more drought tolerant and have better fire-resistant attributes. Use these recommended plants to replace grass or other vegetation.** • 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. • Remove enough trees to create at least 10 feet of space between crowns on flat ground. 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. See **Figure 27** 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 10 feet above the ground. See **Figure 27: Spacing between tree crowns** 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 Zone 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.

Zone 3: 30 to 100 feet from your home

If you live on a slope, this zone should be larger due to the greater potential for extreme fire behavior.

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 zone 3 than zone 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. See **Figure 27** 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 27** 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 **Appendix C.**

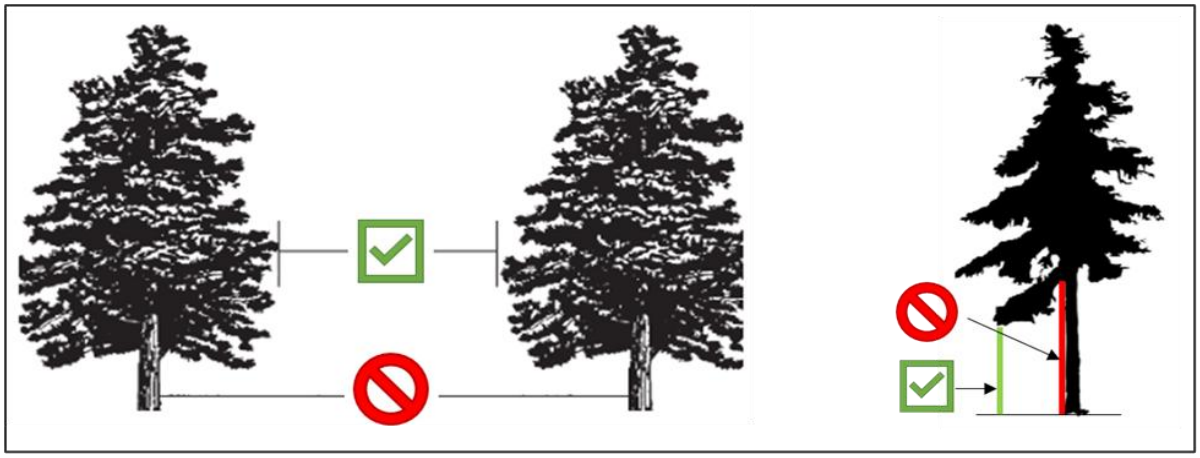


Figure 27: Spacing between tree crowns is measured from the edge of tree crown to tree crown, NOT from tree stem to tree stem (left). Height of limbs above the ground is measured from the ground to the lowest point of the limb, NOT from where the limb attaches to the tree (right). Source: The Ember Alliance

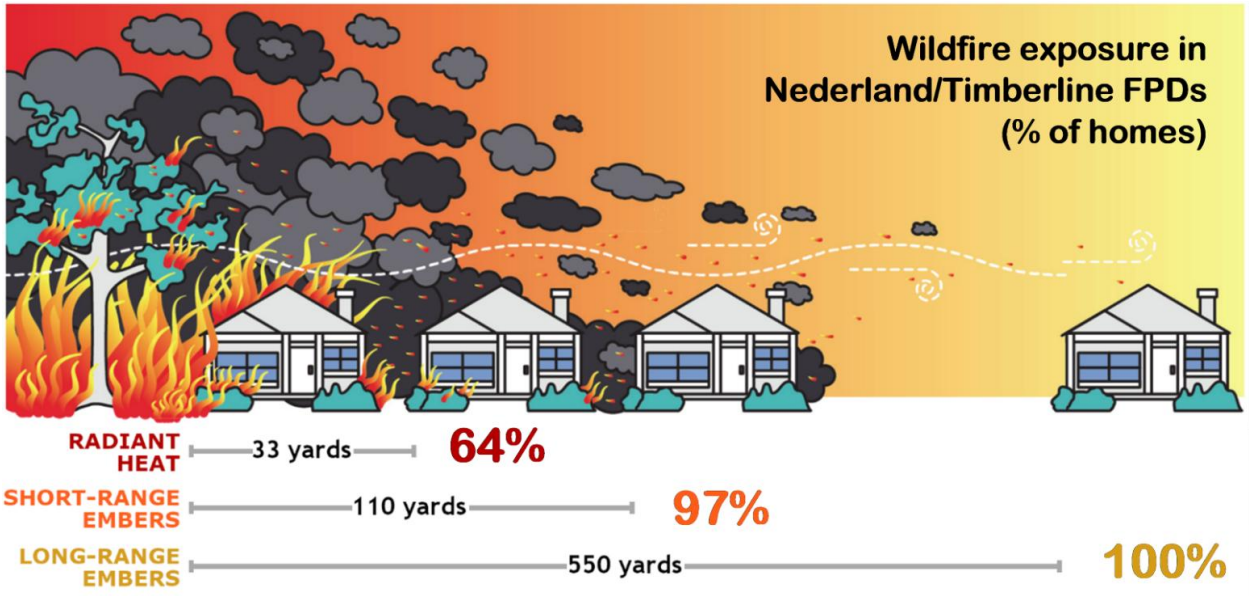


Figure 28: Radiant heat from burning vegetation can ignite nearby structures, and embers emitted from burning vegetation or other structures can travel long distances and ignite vegetation and structures far away from the main fire. Defensible space and home hardening reduces the risk of ignition from embers and radiant heat. Image modified from Reducing Brushfire Risks by the Victorian Auditor-General's Office.

Linked Defensible Space

Wildfire hazards on one property threaten adjacent properties. Structures that are on fire can emit significant radiant heat and embers and endanger homes and structures near them.

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. Defensible space projects that span ownership boundaries are also 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:

- Sign up with 5 or more neighbors for Wildfire Partners' community chipping program.
- 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.
- Educate your community about the benefits of defensible space and home hardening.
- Help organize walking tours in your neighborhood to visit the property of residents 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.

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 have become unhealthy as forest conditions diverged from historical conditions maintained by frequent wildfire. Many lodgepole and mixed conifer pine forests have also been severely affected by mountain pine beetle epidemics and dwarf mistletoe infestations that create significant deadwood within stands and are therefore highly prone to intense wildfire behavior.

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 29**).

Removing trees can open 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 widening the spaces between trees increases the chance that your home and your neighbors' homes will survive a wildfire. Importantly, it also increases the safety of wildland firefighters working to protect your community**.**

Figure 29: Grasses, shrubs, and wildflowers quickly respond to increased light availability after tree removal, resulting in beautiful ecosystems with lower fire risk. The green star in each photo indicates the same tree. Image sizes vary due to the use of different cameras over the years. Photo Credit: Jefferson Conservation District

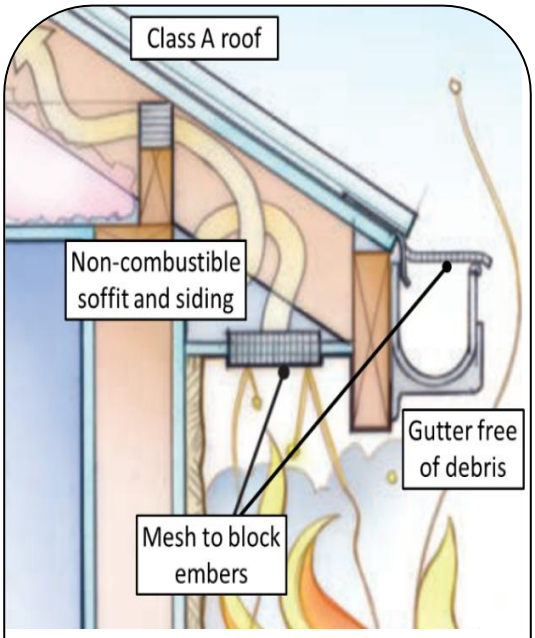
Home Hardening

Home hardening involves modifying your home to reduce the likelihood of structural ignition. Fire can threaten structures even from a distance, as embers can travel more than a mile and ignite vegetation or other material that upon landing. Homes in denser neighborhoods are also at risk of short-range embers from nearby homes, which could lead to structure-to-structure ignitions.

While buildings cannot be made fireproof, the chance of your home surviving wildfires increases when you reduce structural ignitability through home hardening and maintenance of defensible space. Figure 30 below 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). Multi-pane windows have greater resistance to radiant heat, and are important to install as windows often fail before a home ignites, providing a direct path for flames and airborne embers to enter the interior of a home (CSFS, 2021).

It is important to replace wood or shingle roofs with noncombustible materials[1] like, metal, tile, or composite blends. 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.

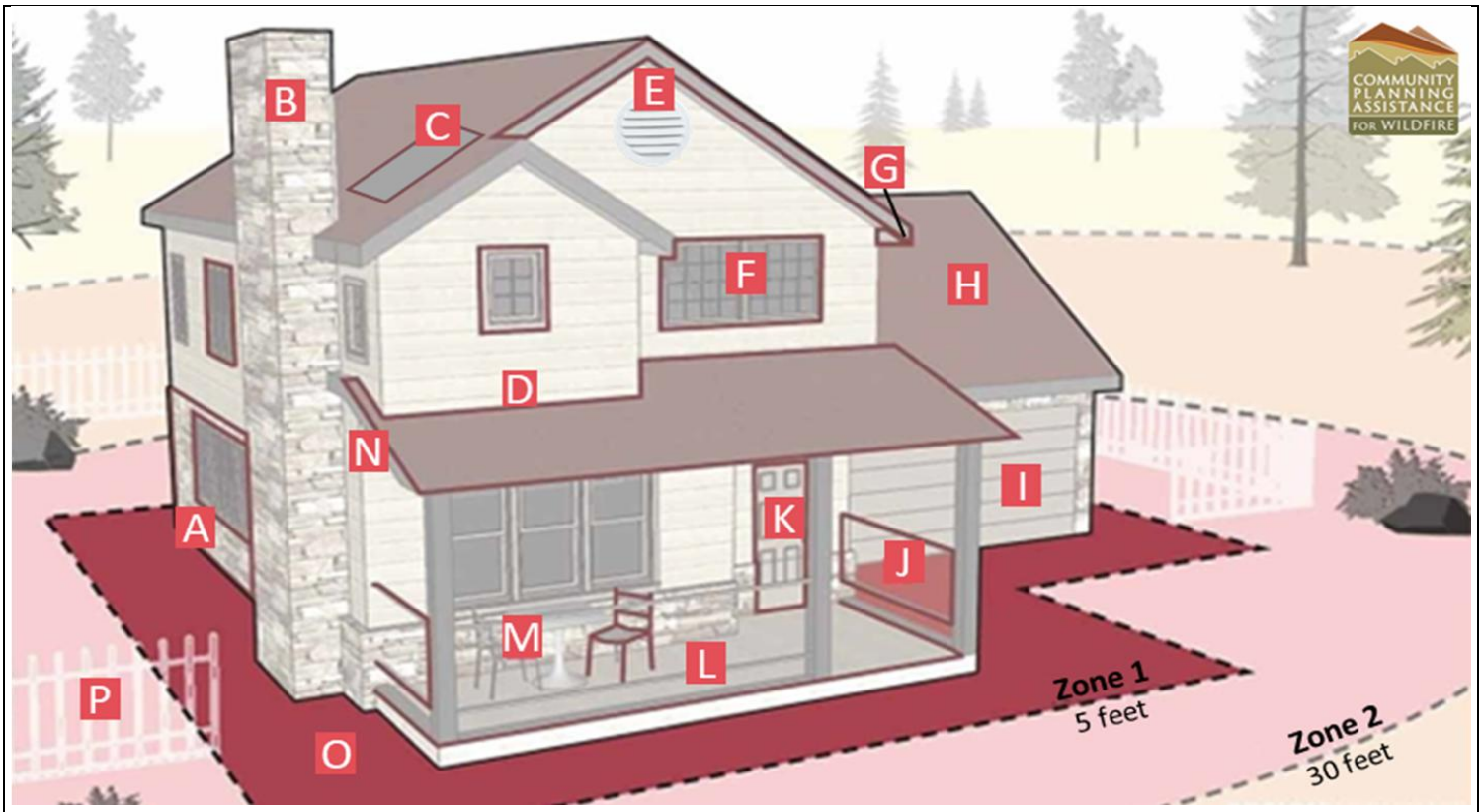


Residents can increase their homes' chance of survival by making it harder for embers to enter and ignite their homes (image from *Healthy Building Science*).

Residents should also consider replacing wooden fences with noncombustible materials, and keeping fences at least 8 ft away from the home. Keep double combustible fences at least 20 ft away from the home. Fences can serve as pathways for wildfire to travel between vegetation and structures and from structure to structure (Maranghides et al., 2021). Wooden fences attached to homes served as one of the leading causes of home loss during the Marshall fire (Marshall Fire FLA 2023).

There are many low-cost actions you can start with to harden your home. Keep home-hardening practices in mind and use ignition-resistant materials if you replace an old or damaged roof or if you remodel your home.

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



Low-cost actions:

B. Cover chimneys and stovepipe outlets 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.
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.
I. Install 1-hour fire rated garage doors.
K. Install 1-hour fire rated doors.
L. Use ignition-resistant or noncombustible decking. Enclose crawl spaces.
N. Install ignition-resistant or noncombustible roofs (composite, metal, or tile).
P. Replace wooden fences with noncombustible materials and keep at least 8 feet away from the home. Keep double combustible fences at least 20 feet away from the home.

Figure 30: 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. Source: The Ember Alliance

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 for emergency notifications.
- ✓ Review the contents of your "go-bag" and make sure it is packed and ready to go. 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 home ignition zones 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. If possible, keep your lawn irrigated, particularly within 30 feet of your home. 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 Nederland Sort Yard.
- ✓ 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.

Accessibility and Navigability for Firefighters

Address Signs

Installing reflective, non-combustible address numbers can save lives by making it easier for firefighters to navigate to your home at night and under smoky conditions. NFPD requires address signs to be

- Reflective
- 4-in characters with 1/2in stroke (thickness)
- White characters on green background
- Mounted on a metal post or other non-combustible material
- 4-6ft above the grade of the road
- Clearly visible from all directions of travel

In the town of Nederland, there is an exception that allows the placement of the sign directly on a structure, if the building is within 30ft of the public road and the sign is clearly visible from all directions of travel.

Reflective signs are available from local hardware stores, or can be found online. 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 facilitate access to your property. Make sure the numbers are visible from all directions on the roadway.

Figure 31: The new address sign out front of Station 1. Source: NFPD

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 NFPD/TFPD have accessibility and navigability issues. 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).

Where possible, residents 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. Others take time and investment, such as widening driveways to accommodate fire engines.

Figure 32: Many driveways within NFPD/TFPD do not meet current access requirements and pose safety issues that are difficult to mitigate. Long, narrow, and steep driveways lacking turnarounds, with dense trees overhanging the road, can create challenges for emergency response vehicles during wildfires. Photo Credit: The Ember Alliance

Cistern Requirements (NFPD)

The adopted fire code (International Fire Code 2018) requires every structure have adequate emergency water supply based on fire flow duration and the size of the home or structures to be protected. Most areas in the Town of Nederland meet this requirement with the hydrant system, as long as the hydrant is within the required distance from the home. In other areas this requirement can be met by installing a local cistern or contributing to the Community Cistern Fund.

If your building site is located in a remote area, or in an area with poor access to a water supply for firefighting, the Fire District may require you to install a local cistern.

In other cases, it is permissible to either install a local cistern or contribute to the Fire Department's Community Cistern Fund. Each option has its own pros and cons. If you choose to install a cistern, it cannot be used for livestock, agricultural, domestic storage or other uses.

Here are the cistern size and/or Community Cistern Fund contribution requirements:

House size	Community Cistern Contribution	Cistern Size
min – 1,600 sq.ft.	$10k (contribution preferred)	3,500 gallons (if required based on location)
1,601 – 3,600 sq.ft.	$15k	7,000 gallons
3,601 – max	$20k	NFPA 1142

On June 1, 2023, the NFPD Board of Directors approved using NFPA 1142 to determine fire flow duration, and to allow those requirements to match the cistern size requirements for the Fire Protection District.

Figure 33: Local cistern. Photo credit: The Ember Alliance

Some thoughts to consider:

1. Do you have physical room to place the cistern approximately 50-75 feet from your house and garage? Too close and the Fire Department cannot use it if the house is on fire, and too far and our initial attack lines will not reach all of the house.
2. Local cistern shall have approved fittings for connection. NFPD uses 6" NH Male with a strainer and cap. Most cistern suppliers are familiar with these requirements and where to obtain the fittings. The cistern will also need an appropriately sized vent and fill. Ensure the vent is covered with wire mesh or a similar protective covering.
3. Is there adequate space for an all-weather turnaround or pullout adjacent to the cistern?
4. Generally, the cost to install a 7,000-gallon cistern is roughly equal to the $15,000 donation to the community cistern fund. If blasting is required to get adequate burial depth (at least 4 feet of dirt on top of the tank) the cost to install a local cistern may be significantly higher.
5. The Fire District will prioritize which locations will receive community cisterns. It is likely that the money you contribute towards the cistern fund will not result in a community cistern directly in the area you are building. The placement is based on existing infrastructure, WUI impact, access, and risk, amongst other considerations.

For more information, see the Boulder County Emergency Water Supply for Firefighting requirements.

Further steps to enhance firefighter safety and access to your home:

- 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.
- 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 FIRE Safe 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. Evacuation Preparedness

The best way to get out quickly and safely during an evacuation is to be prepared with 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 are expected to do and make necessary plans for pets and/or livestock. Visit the Boulder County Office of Disaster Management's (ODM) Evacuation Preparedness site for information on evacuation planning. Signing up for emergency notifications can also help you leave quickly. Residents should register their cell phones and email addresses through BocoAlert, the official emergency notification system for Boulder County[2].

Evacuation preparedness is the responsibility of each resident in NFPD/TFPD. Spending some time to learn your specific risks and creating a plan can make all the difference in disaster situations. These are simple and crucial actions that save lives. Understand the types of emergency communications you might receive during an incident. The following definitions are provided by the ODM.

Emergency Notification Terminology: Boulder County
Source: Boulder County Disaster Management

Alert Severity	**Advisory**	Used to share information about an emergency situation that is likely to impact communities.
	Warning	Used to prepare you to take action or take immediate action if you need extra time to mobilize.
	Order	Used when you need to take immediate action due to an imminent life threat.
Alert Actions	***Climb to higher ground***	A directive to move to a location nearby that is higher than your current position.
	Evacuation	A directive to leave the area immediately.
	Shelter in place	A directive to remain indoors until the situation is resolved.
	Missing/endangered person	Information about a missing or endangered person is shared to increase community awareness.
	All clear	Follow-up information issued after officials have determined the hazard no longer presents a threat to the community.

Some residents have family members or neighbors with physical limitations who might struggle to evacuate in a timely manner. Individuals living alone also need to address the unique needs and vulnerabilities that arise from mobility or hearing impairments during an evacuation. Other residents 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 they were to be 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.

[2] BocoAlert is the official emergency notification system for Boulder County as of 2024.

Residents 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 residents 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.

Community Evacuation Planning and Capacity

There is a high likelihood of evacuation congestion and long evacuation times during a wildfire in NFPD/TFPD. Throughout the planning area roads can be narrow, steep, and poorly maintained, leading to slow evacuation and fire response times. Many neighborhoods lack adequate egress routes, or have only a single road that leads in and out of certain areas, and depending on fire location can lead to challenging evacuation conditions. The majority of roads within the project area have dense vegetation lining the edges of the road, which can lead to high-risk and potentially non-survivable conditions during evacuation.

Mitigation actions along sections of road with high risk for non-survivable conditions during a wildfire can increase the chances of survival for residents stranded in their vehicles, and decrease the chance that roadways become impassable due to flames.

The following steps are recommended for residents, HOA's, community groups, NFPD/TFPD, and the Boulder County Sheriff's Office to address evacuation concerns in the project area.

- 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 34**). See **Appendix C** for recommended approaches to reduce wildfire risk along roadways.
- Coordinate with the Boulder County Sheriff's Office to conduct evacuation drills to practice safe and effective evacuation for the entire FPD.
- Coordinate with Boulder County ODM to increase participation in the local emergency alert system, BocoAlert.
- Regularly test the alert system to ensure timely and accurate communication could occur during an evacuation.
- **Educate residents about 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.**
- Encourage residents to leave with one vehicle per household to reduce congestion for everyone.
- Encourage residents to evacuate whenever they feel unsafe, even before receiving mandatory evacuation orders. All residents 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.
- Evaluate the efficacy of alternate methods of warnings and alerts, such as warning sirens. Research suggests that individuals trust and are more likely to respond to sirens than other warning systems like social media (National Academies of Sciences, Engineering, and Medicine, 2018).

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

Coordinating with Local Schools

The Boulder Valley School District (BVSD) addresses wildfire preparedness in its Emergency Operations Plan (EOP). During rapid evacuations, BVSD will establish reunification sites for students to meet back up with caregivers. Reach out to your local school principal or administrator for more information on BVSD's wildfire preparedness planning.

Survivable Roadways	Potentially Non-Survivable Roadways
	
	

Figure 34: Some roads in NFPD/TFPD 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.

Potential Treatment Need for Non-Survivable Roads

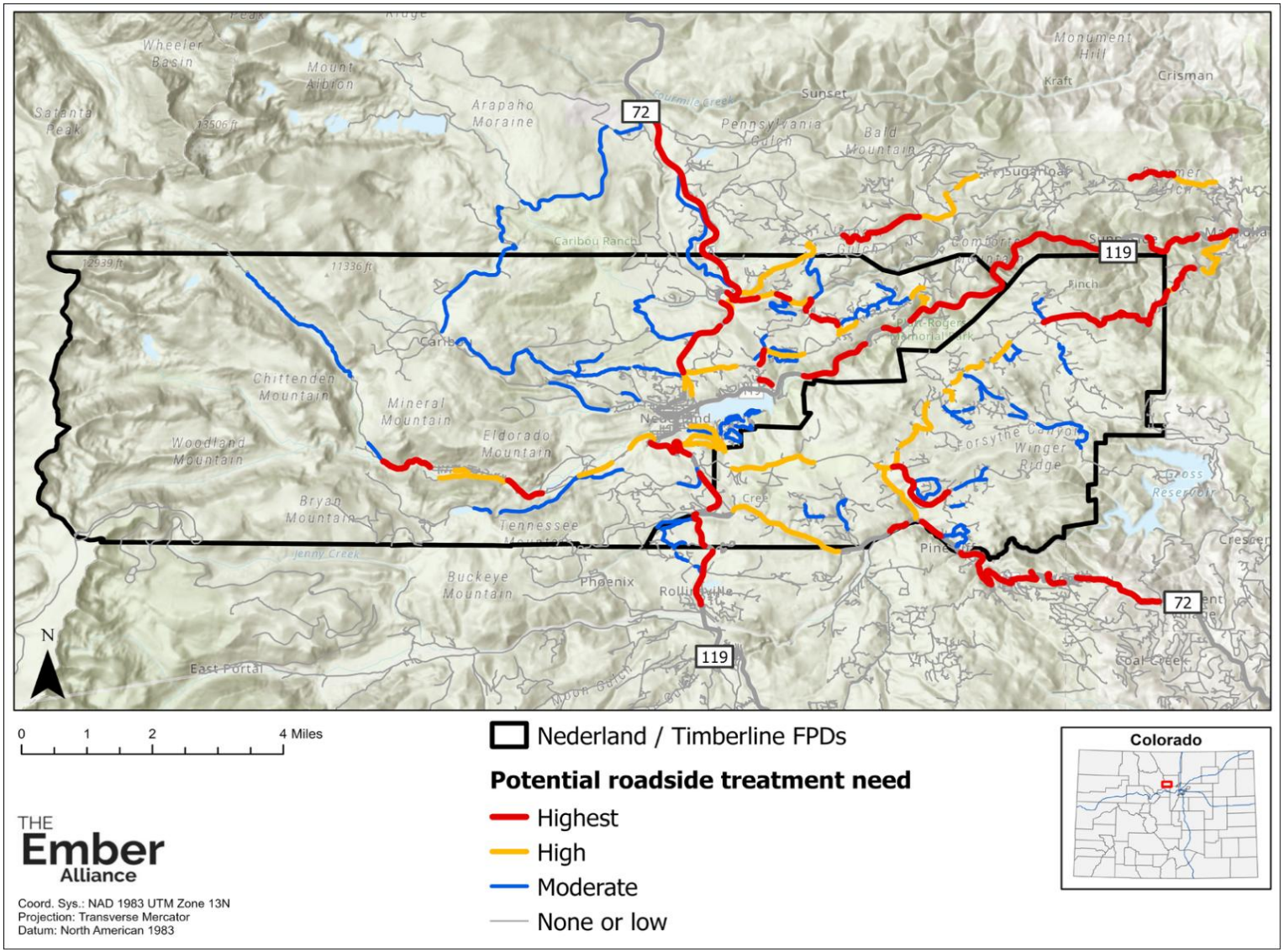


Figure 35: Potential need for roadside fuel treatments based on the potential for wildfire to create non-survivable conditions along roadways and the potential for congestion during evacuations. (Methodology provided in Appendix A). Credit: The Ember Alliance

3.c. Plan Unit Assessments and Recommendations

Wildfire preparedness is a responsibility shared by every community member. Fuel treatments and forest restoration projects on the broader landscape can help protect valuable resources such as drinking water, recreation areas, and wildlife, but the responsibility for maintaining defensible space and hardening resident homes against wildfire falls on each individual in the community.

This can seem an overwhelming task, both physically and financially. But it is important to remember that while the responsibility lies with each individual, collective action can be taken to reduce the labor and financial burdens. There are resources available to residents that range from education to financial aid to help accomplish specific wildfire preparedness tasks. For many activities, community organizing can help reduce the challenges that residents face by combining slash and vegetation management actions across multiple properties, pooling resources for economic efficiency in material acquisition, and providing labor for important fire preparedness actions. Your fire risk is intimately tied to your neighbors' fire risk, so one of the best ways to prepare yourself for wildfire is to help your neighbors prepare for wildfire.

This section outlines relative hazard ratings and specific recommendations for each CWPP planning area. Maps of individual planning units overlaid with recommended mitigation treatments and HIZ positions are also included. The recommendations included here can be used as a starting point for the community to address shared risk through strategic wildfire preparedness actions.

The CWPP Core Team identified 14 plan units in the NFPD and 5 plan units in TFPD, in which The Ember Alliance conducted on-the-ground assessments of wildfire risk, wildfire suppression challenges, evacuation hazards, and HIZ hazards. These assessments were combined with output from the fire behavior and evacuation modeling to produce relative risk ratings. See **Appendix B: Community Risk Assessment and Modeling Methodology** for a description of hazard rating methodology. Plan unit hazard ratings are specific to this CWPP planning area and not suitable for comparing to other communities in Colorado or the country.

The potential for wildfire to pose a threat to lives and property is high throughout the CWPP planning area. Plan units with higher relative risk are strong candidates for immediate action to mitigate hazardous conditions. However, plan units with moderate relative risk still require mitigation actions to improve the protection of life and property in the case of wildfire.

Across the planning area wildfire hazards are mostly consistent. Dense forests, steep slopes, and challenging roadways are features that occur throughout, affecting plan units only to different degrees. Most structures display HIZ hazards, and many are old builds that are highly susceptible to ignition.

Recommendations are provided for each planning unit to address the risk aspects that directly challenge that community. However, residents should take as many actions as possible to reduce fire risk to their property. General recommendations are covered in depth in **Section 3.a.** and **Appendix C: Objectives and Benefits of Fuel Treatments and Ecological Restoration.**

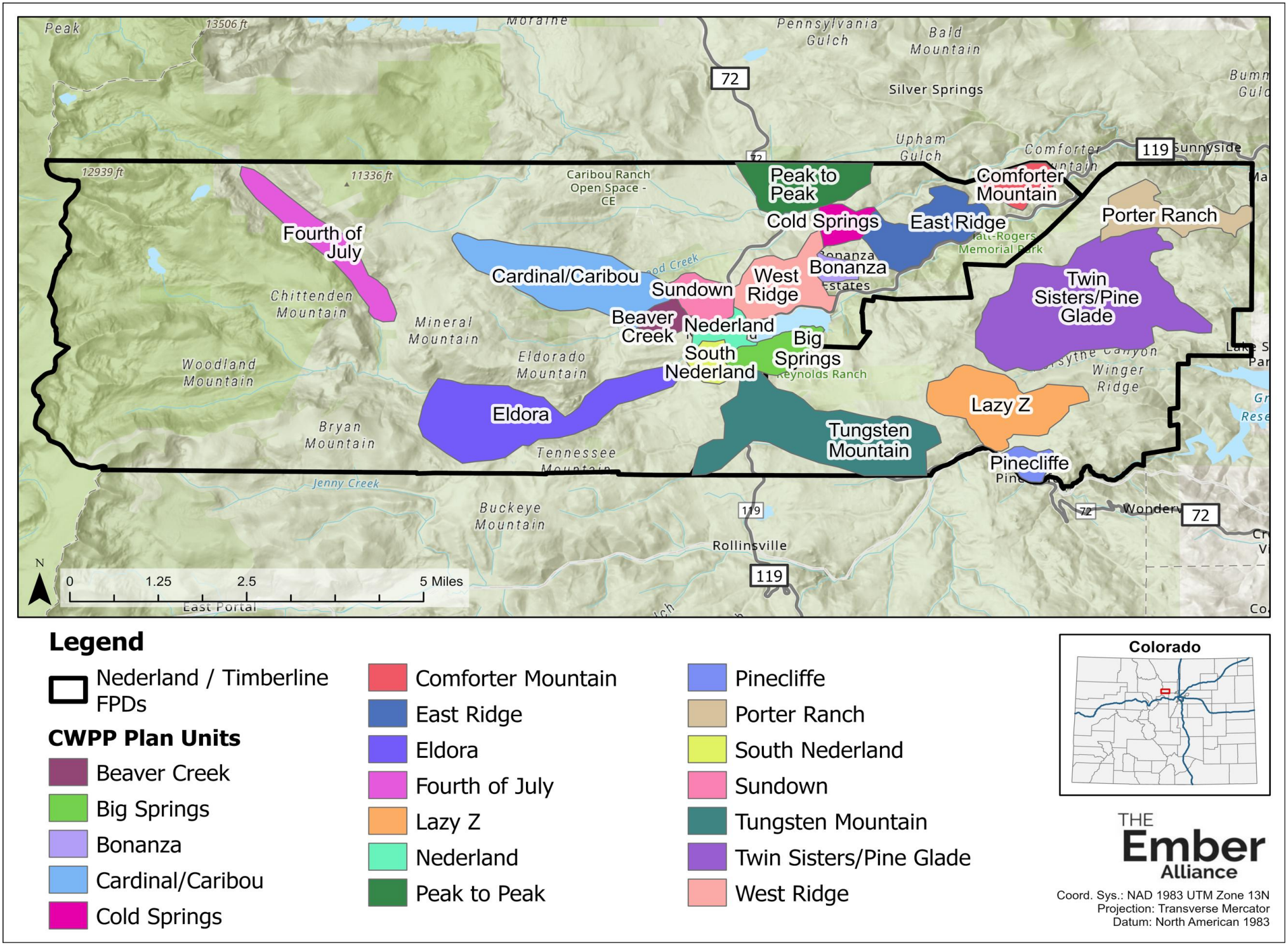


Figure 36: CWPP Plan Units. This CWPP assesses relative risk among 19 plan units in Nederland/Timberline FPDs. To delineate plan units, we considered clusters of addresses, connectivity of roads, topographic features, land parcels, and local knowledge of community identification. Source: The Ember Alliance

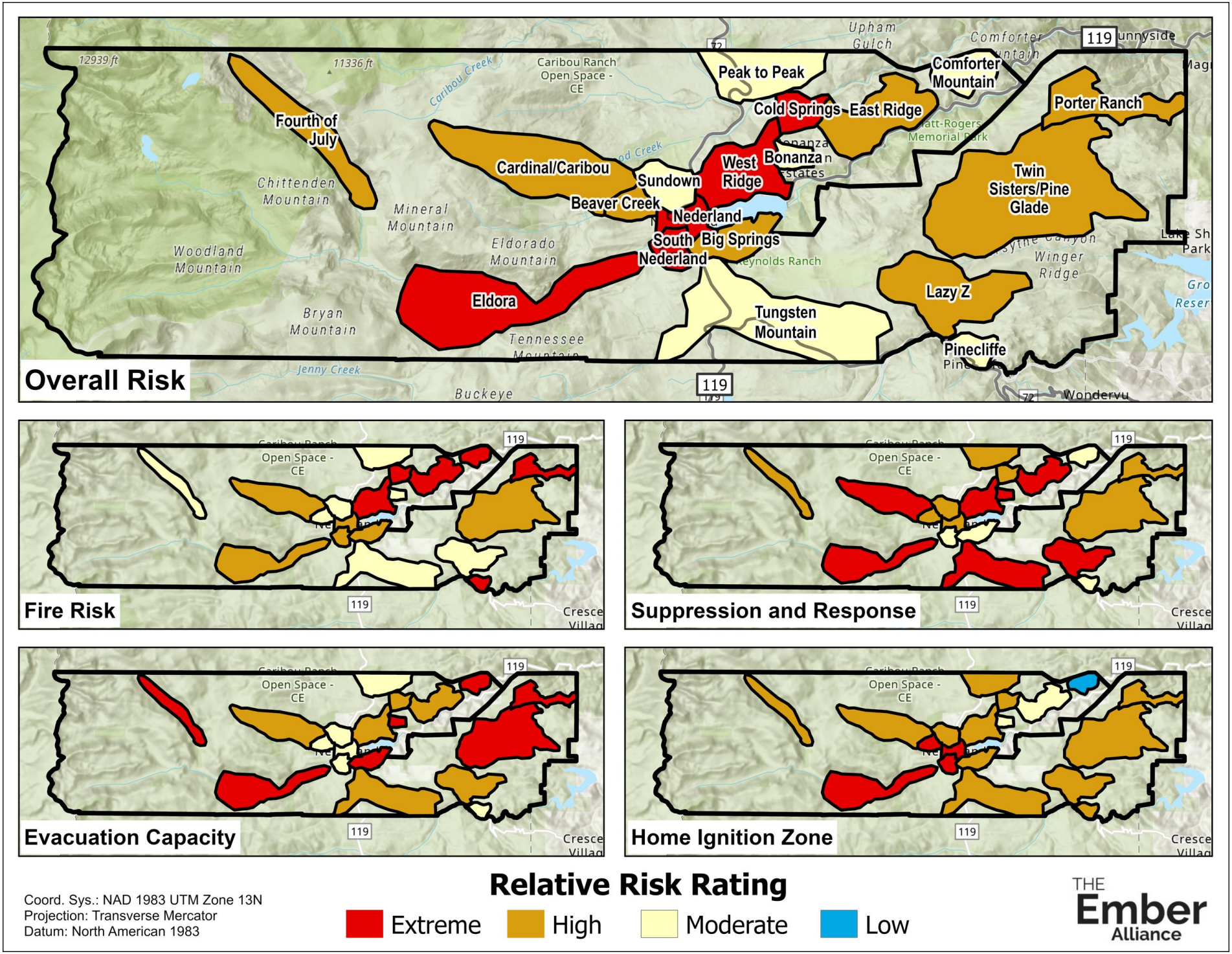


Figure 37: Plan Units Relative Risk Ratings. Overall risk rating for plan units across Nederland/Timberline FPDs, and plan unit relative risk for each component used to determine overall risk ratings in Nederland/Timberline FPDs. "Moderate" risk is a relative term – all residents within this area are exposed to elevated fire danger due to topography and fuels in this part of Colorado and should take recommended actions in this CWPP seriously. Credit: The Ember Alliance

Beaver Creek
Relative Risk Rating: High

Fuels and Fire Behavior Potential

Beaver Creek is northwest of downtown Nederland, behind Fire Station No. 1. The topography is generally flat, with steep north-facing slopes along the southern border. The north-facing slopes above the community are heavily forested with ponderosa, limber, and lodgepole pine, and remain unmitigated, while the valley area has a large grass component. Part of Beaver Creek sits in the bottom of a drainage which is wet and not as likely to burn, but homes upslope of the valley face greater risk in the dense trees. Drought conditions combined with extreme weather could generate long flame lengths in the timber, but it is unlikely to spread into the valley community. The grass fuels provide for fast rates of spread but lower flame lengths and less intensity than the forested areas. Fine grass fuels still pose a great threat to structures, especially if there is flammable material, such as pallets, firewood, or wood fencing and decking, directly abutting them.

Fire Suppression and Evacuation Capabilities

Roads within the community are narrow, frequently less than 20 feet across and are dirt. There is a riparian area through the valley, but it is too dense with willow and aspen to access for fire suppression. Some structures have individual cisterns, and most of the community is close to fire hydrants within the town of Nederland; however, hydrants are not always consistent in pressure and whether they function properly.

There are two ways in and out of the community, which provides more options for an evacuation during a wildfire. Intersections have reflective road signs, though many homes do not, with a few homes missing address signs altogether. Several of the address signs that are present are mounted on combustible posts made out of wood. Roads are generally accessible, but slow moving. At least

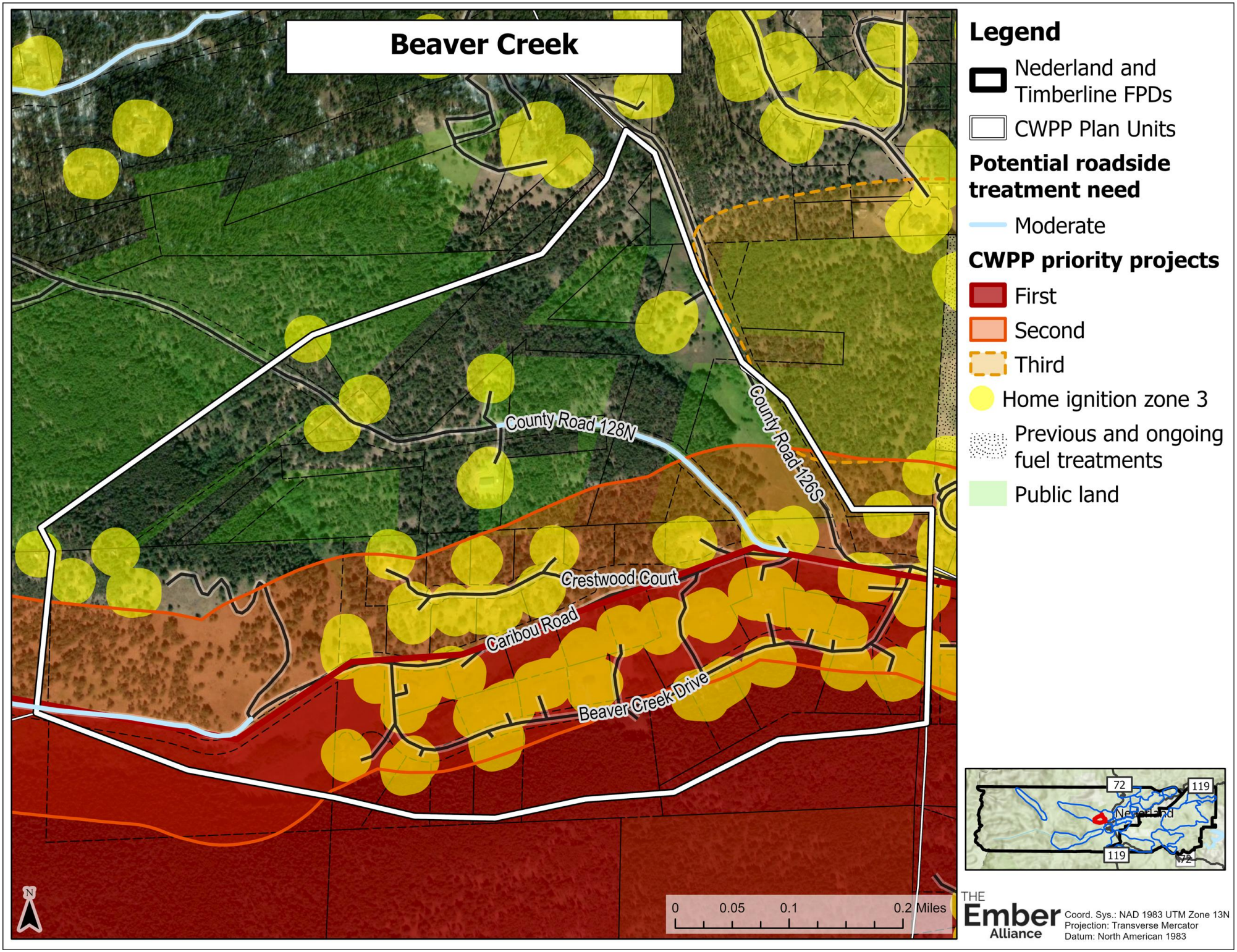
one home has a steep, gated driveway that could be problematic for fire suppression activities if left closed during an emergency. Lot sizes are larger in this community than many of the others within the NFPD, often more than an acre in size. Houses have asphalt shingle roofing, but combustible siding and decks. A few homes still have highly flammable shake shingle roofs and wood siding. Little work has been completed towards defensible space. Overhead utilities and propane tanks are found throughout the community.

Home Ignition Zone Hazards

Many homes are surrounded by aspens and willows in the valley, but still have dense conifers within 100ft. All homes out of the valley basin have unmitigated, dense conifers surrounding structures. Many homes have shake shingles or old untreated wood siding. Wood decking, wood fences, and firewood placed under decks or against homes contribute to home ignition risk.

Recommendations for residents in Beaver Creek:

- Contact Boulder County Wildfire Partners for a home assessment and recommendations tailored to your individual property.
- Defensible Space is recommended for all homes, with a particular focus on HIZ 1 and 2 (0-5ft and 5-30ft from home). Beaver Creek should focus on removing limbs overhanging roofs, removing conifers in direct contact with homes, and reducing density of trees surrounding zone 2 of homes on forested slopes. For general defensible space recommendations, please refer to **Section 3.a. Defensible Space** in this document or see the CSFS HIZ guidebook.
- Home hardening is recommended for all homes. Wood siding, wood decks, and shake shingle roofs should be replaced or treated until able to be replaced. Wooden fences and decks should be replaced or treated until able to be replaced, and other flammable materials moved away from homes. Open areas below decks should be enclosed or screened to prevent the ingress of embers and should be kept clean of flammable materials. For more recommendations refer to **Section 3.a. Home Hardening**, or see the CSFS HIZ guidebook.
- Work with neighbors to create linked defensible space. Projects that span multiple properties are more effective at reducing wildfire risk. Contractor costs can sometimes be shared among homeowners, reducing costs for everyone involved.
- Clear roadways. Remove trees, shrubs, and tall grasses along private roads and driveways to improve evacuation safety and firefighter access during a wildfire. This is especially important for narrow driveways and road segments.
- Add reflective, non-combustible address signs to all driveways and homes. NFPD is working to secure local suppliers for reflective addressing, but they can also be purchased inexpensively online at safetysign.com. Place address signs on non-combustible posts.
- Develop an evacuation plan for your family, sign up for emergency notifications from Boulder County ODM, and coordinate with neighbors who may need additional support during an emergency.
- Organize community action around educating neighbors and implementing defensible space and home hardening activities including grass/weed management, slash removal, and the removal of flammable materials away from structures.
- Replace non-native conifers and other flammable vegetation with drought tolerant, fire-adapted local species. See CSU's FireWise Plant Materials list for more information.


Beaver Creek
County Road 128N
County Road 126S
Crestwood Court
Caribou Road
Beaver Creek Drive
Legend
Nederland and Timberline FPDs
CWPP Plan Units
Potential roadside treatment need
Moderate
CWPP priority projects
First
Second
Third
Home ignition zone 3
Previous and ongoing fuel treatments
Public land
0 0.05 0.1 0.2 Miles
N
72
119
Nederland
THE Ember Alliance
Coord. Sys.: NAD 1983 UTM Zone 13N
Projection: Transverse Mercator
Datum: North American 1983

Big Springs
Relative Risk Rating: High

Fuels and Fire Behavior Potential

Steep slopes, ravines and small chimneys are all topographic features that increase the risk of wildfire in the Big Springs community. Lodgepole pine is the dominant species in the community, with mixed conifer, aspen, and riparian vegetation intermixed throughout. Mountain pine beetle activity is visible on the larger diameter trees, and pitch tube and red needles are present. Engelmann spruce is found in drainages. Because the community is situated on a north aspect, it does not receive as much sunlight and fuels dry slower. Shade-tolerant understory fuels are dense, especially in ravines, and could foster the spread of fire into tree canopies. While the community has a lot of vegetation accumulation, north-facing slopes limit the drying, and as a result, extreme fire behavior is expected in the most extreme weather conditions and during drought. The combination of ladder fuels, mountain pine beetle mortality and dense stands could support active crown fire during high temperatures, low relative humidity, and high winds. A fire starting in this drainage would limit access and egress and would likely spread onto federal lands to the west.

Fire Suppression and Evacuation Capabilities

Big Springs is one of the largest planning areas/defined communities in the NFPD response area. The area contains homes tucked within dense forest on north-facing slopes. Dense vegetation along roads could lead to potentially non-survivable conditions during evacuation. Lakeview Drive and Peakview Road act as access and egress routes in the west, but further east in the neighborhood, ingress and egress become very limited. Evacuation is a huge concern in this neighborhood, and a process for adding a secondary egress route east of Big Springs is underway. Driveways to homes are very steep and narrow, making structure protection more difficult for

firefighters. Addresses are not marked by reflective signage. There are many fire hydrants scattered throughout the community, but spacing is greater than 1,000 feet and some have thick vegetation surrounding them.

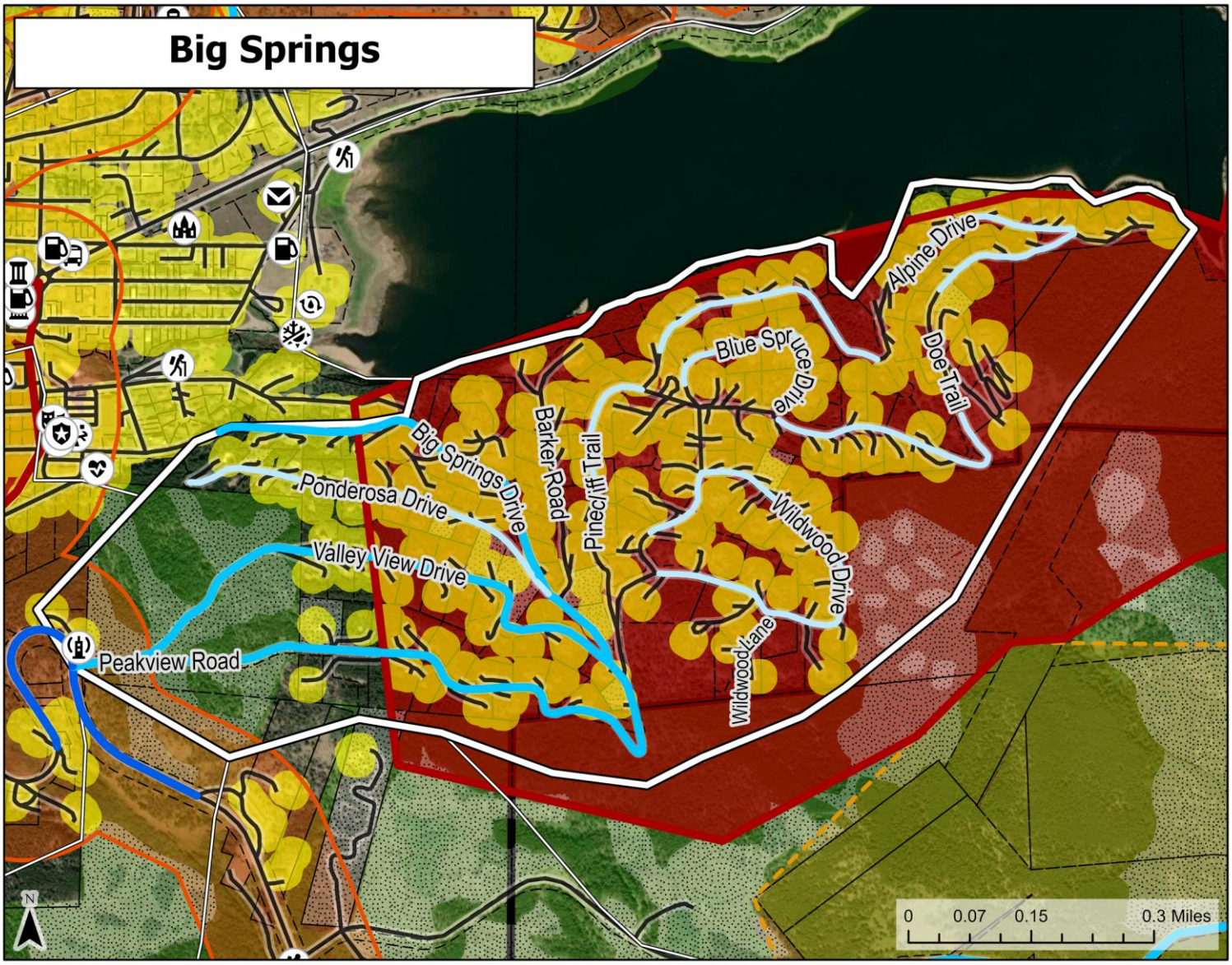
Home Ignition Zone Hazards

Home hardening is mixed in this community. Many structures have asphalt or metal roofs, though decking and wooden siding are made from combustible materials. Some of the newer homes have non-combustible siding and roofing, such as stucco and metal, but are relatively few in number. A couple homes have had defensible space cutting around them, though most structures have not. Open decks are common, with firewood and other debris stored underneath or within 30ft of homes. Utility lines are above ground and residents use propane for central heating.

Recommendations for Residents in Big Springs

- Contact Boulder County Wildfire Partners for a home assessment and recommendations tailored to your individual property. Some of your neighbors have participated in this program.
- Defensible space is recommended for all homes, throughout all three HIZs. Big Springs should focus on removing conifers in direct contact with homes, removing trees in zone 1 and 2, and reducing density of trees in zone 3, as well as reducing vegetation along driveways and roads. For general defensible space recommendations, please refer to **Section 3.a. Defensible Space** in this document or see the CSFS HIZ guidebook.
- Home hardening is recommended for all homes. Wood siding and shake shingle roofs should be replaced. Wooden fences and decks should be replaced or treated until able to be replaced. Open areas below decks should be enclosed or screened to prevent the ingress of embers, and should be kept clean of flammable materials. Clean leaf and needle litter from roofs and gutters and away from foundations. For more recommendations refer to **Section 3.a. Home Hardening**, or see the CSFS HIZ guidebook.
- Coordinate with Town of Nederland and Boulder County to create a secondary egress route for the Big Springs neighborhood. Participate in the ongoing process for the Big Springs Egress Project.
- Work with neighbors to create linked defensible space. Projects that span multiple properties are more effective at reducing wildfire risk. Contractor costs can sometimes be shared among homeowners, reducing costs for everyone involved.
- Clear roadways. Remove trees, shrubs, and tall grasses along private roads and driveways to improve evacuation safety and firefighter access during a wildfire. This is especially important for narrow driveways and road segments.
- Where possible, add pullouts for emergency apparatus on driveways and private roads longer than 300 ft. Turnarounds should be constructed at the end of all driveways and dead-end roads.
- Add reflective, non-combustible address signs to all driveways and homes. NFPD is working to secure local suppliers for reflective addressing, but they can also be purchased inexpensively online at safetysign.com. Place address signs on non-combustible posts.
- Replace non-native conifers and other flammable vegetation with drought tolerant, fire-adapted local species. See CSU's FireWise Plant Materials list for more information.
- Develop an evacuation plan for your family, sign up for emergency notifications from Boulder County ODM, and coordinate with neighbors who may need additional support during an emergency.
- Organize community action around educating neighbors and implementing defensible space and home hardening activities including grass/weed management, slash removal, and the removal of flammable materials away from structures.

Big Springs



- Nederland and Timberline FPDs
- CWPP Plan Units

Potential roadside treatment need

- Highest
- High
- Moderate

CWPP priority projects

- First
- Second
- Third

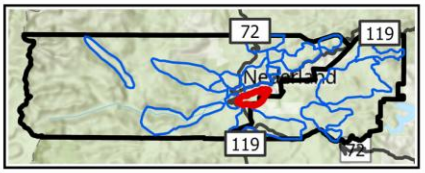
- Home ignition zone 3
- Previous and ongoing fuel treatments
- Public land

Non-residential highly valued resources

- Place of worship
- Child care center
- Recreation area
- Cemetery
- Museum/historic site
- Entertainment
- Retail gas / propane
- Water treatment plant
- Weather station
- Communication tower
- Bus station
- Local law enforcement
- Local government
- Post office
- Health and medical

THE Ember Alliance

Coord. Sys.: NAD 1983 UTM Zone 13N
Projection: Transverse Mercator
Datum: North American 1983



Bonanza
Relative Risk Rating: Moderate

Fuels and Fire Behavior Potential
The vegetation in Bonanza is denser than other communities. Ponderosa pines are found in the overstory with Douglas fir regeneration in the understory. Lodgepole pine is common. The smaller Douglas firs will act as ladder fuels, carrying fire into the ponderosa, especially when wind speeds and temperatures are high. Under moderate conditions torching may occur, and active crown fires are possible during extreme conditions. A fire could move quickly up the steep hillsides, but is less likely to move quickly elsewhere due to the lack of surface vegetation.

Fire Suppression and Evacuation Capabilities
Ridge Road is the main thoroughfare through the Bonanza community. The other main roads include Bonanza Drive, Sky View Drive South, Valley Road and Blue Spruce Road. For the most part, structures are located on the top of hillsides. Some structures, however, are situated in-line with ravines and along the middle of the slope. Lot sizes are under an acre, but the structures are fairly dispersed. Long driveways provide access to many of the homes. Similar to other communities in the planning area, home addresses are present but not reflective. There are overhead utility lines and liquid propane tanks, all which need to be considered for mitigation.

Within the community, Ridge Road is the only paved road. There are two ways in and out of the community along Ridge Road, but most of the inner roads are narrow and rough, making it impossible for emergency vehicles to enter while residents are leaving. The lack of turnarounds and non-reflective or absent road signs also make emergency response difficult. The steep roads on the bottom of the hill might be inaccessible due to a lack of turnarounds and would not be

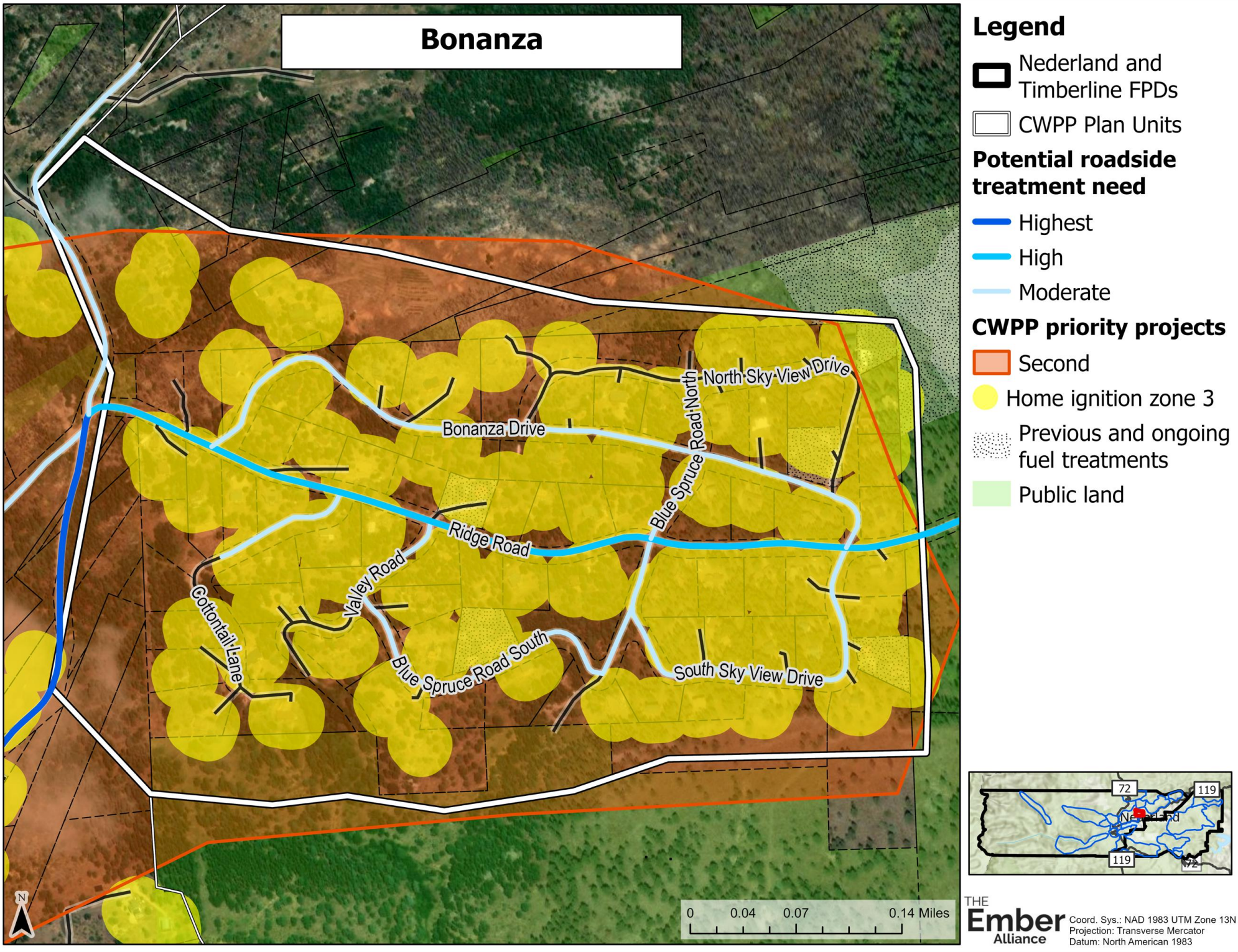
accessible until all residents have evacuated. There are no hydrants present, but there is a cistern within the community.

Home Ignition Zone Hazards

Many homes in this area are Wildfire Partners certified. HIZ 1 and 2 are addressed on some properties, though almost no properties have worked on defensible space in HIZ 3. Most homes have some home hardening done. The majority of roofs have high fire resistance since they are asphalt shingle; though siding and decks are frequently constructed with combustible materials.

Recommendations for Residents in Bonanza

- Talk to your neighbors and other community members about becoming Wildfire Partners certified.
- Defensible space is recommended for all homes, throughout all three HIZs. Bonanza should focus on reducing density of trees in zone 3, as well as reducing vegetation along driveways and roads. For general defensible space recommendations, please refer to **Section 3.a. Defensible Space** in this document or see the CSFS HIZ guidebook.
- Home hardening is recommended for all homes. Wood siding and decking should be replaced. Hardscape should be added to HIZ 1 around structures. Open areas below decks should be enclosed or screened to prevent the ingress of embers, and should be kept clean of flammable materials. All flammable materials, including firewood and old pallets, should be moved 30ft away from structures. Clean leaf and needle litter from roofs and gutters and away from foundations. For more recommendations refer to **Section 3.a. Home Hardening**, or see the CSFS HIZ guidebook.
- Work with neighbors to create linked defensible space. Projects that span multiple properties are more effective at reducing wildfire risk. Contractor costs can sometimes be shared among homeowners, reducing costs for everyone involved.
- Clear roadways. Remove trees, shrubs, and tall grasses along private roads and driveways to improve evacuation safety and firefighter access during a wildfire. This is especially important for narrow driveways and road segments.
- Where possible, add pullouts for emergency apparatus on driveways and private roads longer than 300 ft. Turnarounds should be constructed at the end of all driveways and dead-end roads.
- Add reflective, non-combustible address signs to all driveways and homes. NFPD is working to secure local suppliers for reflective addressing, but they can also be purchased inexpensively online at safetysign.com. Place address signs on non-combustible posts.
- Replace non-native conifers and other flammable vegetation with drought tolerant, fire-adapted local species. See CSU's FireWise Plant Materials list for more information.
- Develop an evacuation plan for your family, sign up for emergency notifications from Boulder County ODM, and coordinate with neighbors who may need additional support during an emergency.
- Organize community action around educating neighbors and implementing defensible space and home hardening activities including grass/weed management, slash removal, and the removal of flammable materials away from structures.


Bonanza
Bonanza Drive
North Sky View Drive
Blue Spruce Road North
Ridge Road
Valley Road
Cottontail Lane
Blue Spruce Road South
South Sky View Drive
N
0 0.04 0.07 0.14 Miles
Legend
Nederland and Timberline FPDs
CWPP Plan Units
Potential roadside treatment need
Highest
High
Moderate
CWPP priority projects
Second
Home ignition zone 3
Previous and ongoing fuel treatments
Public land
72
119
Nederland
119
72
THE Ember Alliance
Coord. Sys.: NAD 1983 UTM Zone 13N
Projection: Transverse Mercator
Datum: North American 1983

Cardinal/Caribou (Previously Five Points)
Relative Risk Rating: High

Fuels and Fire Behavior Potential

The Cardinal/Caribou planning unit centers on the intersection of five roads: CR 128, CR128N, CR 128W, CR 126 and Caribou Road. Lodgepole pines and other dense conifer stands are prevalent throughout the area with some aspen intermixed moving to patchy spruce/fir at higher elevations. Understory vegetation is thick, which would act as a ladder fuel, potentially carrying fire into the crowns of the lodgepole. Other areas have lighter, flashier fuels in the mountain meadows. Surface fire and small areas of torching are predicted with both moderate and extreme weather events. Rates of spread would be higher on the grassy south aspect than in timber. Along the steepest southwest drainages, long flame lengths, greater than what could be approached by firefighters, would be expected during extreme weather conditions. These weather conditions would also promote torching and active crown fire. Extreme wildfire behavior is possible.

Fire Suppression and Evacuation Capabilities

None of the roads are paved but the level of road maintenance is generally good, and includes many gravel roads. The wider roads are 20-24 feet across and have less tree cover encroaching the right-of-way. Roads are labeled clearly, and many areas have added turnaround locations. A few of the narrower roads have dense trees on either side, and are less than 20 feet across, making access difficult, though there are very few residences that would need to evacuate. There is a 30,000-gallon cistern located at the intersection of the five major roads mentioned above. There is a local mining facility that contains potentially hazardous materials on site.

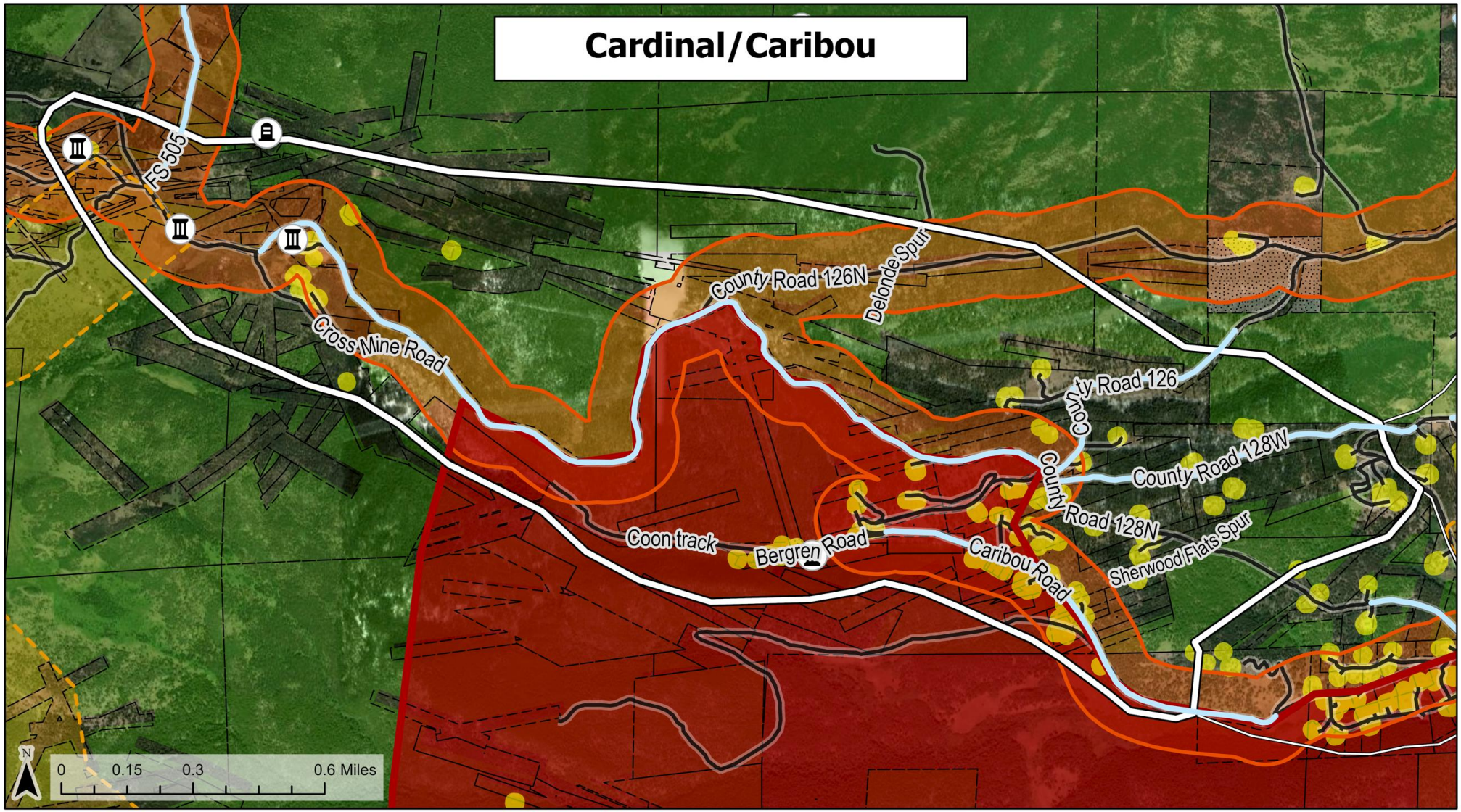
Home Ignition Zone Hazards

The housing density within the community is low, but there are a few clusters of homes with variable construction. Newer structures are much larger, fire hardened, and have some defensible

space; older homes/trailers do not. Many of the older structures are trailers that have been brought onto the property. The siding on some houses is combustible, and there are some open decks, but the roofs are asphalt shingle. Utility lines run above ground over the roads. Liquid propane tanks are an additional hazard within the community, especially since not all are stored clear of vegetation.

Recommendations for Residents in Cardinal/Caribou

- Contact Boulder County Wildfire Partners for a home assessment and recommendations tailored to your individual property. Some of your neighbors have participated in this program.
- Defensible space is recommended for all homes, throughout all three HIZs. Cardinal/Caribou should focus on removing trees within zone 1 and 2, and reducing density of trees in zone 3. Vegetation should be managed and reduced around all structures on the property, including propane tanks, and cars and trailers that will not be moved in an emergency. For general defensible space recommendations, please refer to **Section 3.a. Defensible Space** in this document or see the CSFS HIZ guidebook.
- Home hardening is recommended for all homes. Wood siding and decking should be replaced. Hardscape should be added to HIZ 1 around structures, including propane tanks and sheds. Open areas below decks should be enclosed or screened to prevent the ingress of embers, and should be kept clean of flammable materials. For more recommendations refer to **Section 3.a. Home Hardening**, or see the CSFS HIZ guidebook.
- Work with neighbors to create linked defensible space. Projects that span multiple properties are more effective at reducing wildfire risk. Contractor costs can sometimes be shared among homeowners, reducing costs for everyone involved.
- Add reflective, non-combustible address signs to all driveways and homes. NFPD is working to secure local suppliers for reflective addressing, but they can also be purchased inexpensively online at safetysign.com. Place address signs on non-combustible posts.
- Replace non-native conifers and other flammable vegetation with drought tolerant, fire-adapted local species. See CSU's FireWise Plant Materials list for more information.
- Organize community action around educating neighbors and implementing defensible space and home hardening activities, including grass/weed management, slash removal, and the removal of flammable materials away from structures.



Nederland and Timberline FPDs

CWPP Plan Units

Potential roadside treatment need

Moderate

CWPP priority projects

First

Second

Third

Home ignition zone 3

Previous and ongoing fuel treatments

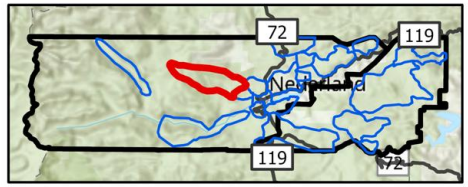
Public land

Non-residential highly valued resources

Cemetery

Museum/historic site

Communication tower



THE Ember Alliance

Coord. Sys.: NAD 1983 UTM Zone 13N
Projection: Transverse Mercator
Datum: North American 1983

Cold Springs
Relative Risk Rating: Extreme

Fuels and Fire Behavior Potential

The community of Cold Springs is east of Peak to Peak Highway and has Cold Springs Drive (CR 128E) as its northern border and an unnamed road north of Sherwood Road for its southern border. Fire behavior in the Cold Springs community is likely to include surface fire under moderate weather conditions. Higher wind speeds, lower relative humidity and high temperatures typical of increasingly frequent extreme weather events would support fire transitioning from the surface fuels into the tree canopies. The north-facing slope between CR 128E and Hummer Drive is an area of special concern from a fire behavior perspective. The steeper slope and dense cover would likely produce active crown fire and longer flame lengths more than anywhere else in the community.

Fire Suppression and Evacuation Capabilities

The community has narrow (<20 feet) dirt roads with slopes of 10% or greater in some areas. Hummer Drive winds through the middle of the community, and many of the structures are accessed via this road. Addresses are marked on homes but aren't reflective, which would make it difficult to identify homes in smoky conditions or at night. Driveways are often steep and narrow, creating issues for apparatus access. Fuel is dense throughout the plan unit, and the steepness of the slopes contribute to a challenging fire suppression response.

Utility lines run above ground over the roads and are buried from the road to structures. Power lines are in danger of coming down because of encroaching trees in several places along the main roads. Wooden road signs are combustible, not reflective and not always present. Road names are confusing because map names are not necessarily what the road is referred to locally, and intersections and forks are not consistently marked. Turnarounds are not possible in some private drives. Individual home cisterns provide water, as there are no hydrants within the community. A

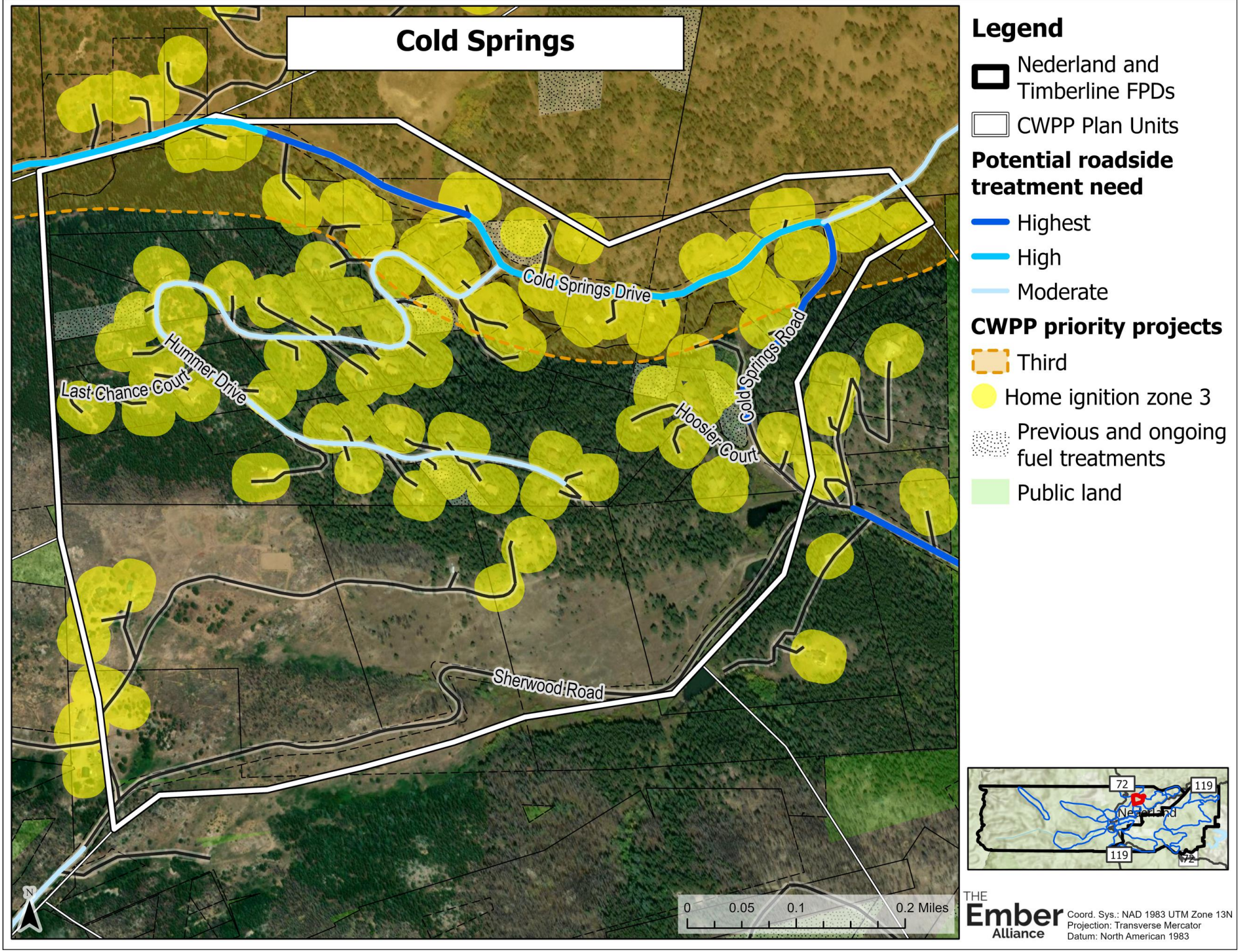
15,000-gallon cistern, supplied from the City of Boulder's Lakewood raw water line, is piped to a hydrant located on Cold Springs Drive, approximately 1/4 mile west of Hummer Drive. A dry hydrant is located on North Boulder Creek at Hummer Drive but is limited due to seasonal water flows. There is potential water access from the bridge over the creek.

Home Ignition Zone Hazards

Newer construction has been ongoing within the community, so some of the homes have defensible space in zones 1 and 2, but lack effective defensible space in zone 3. Defensible space is not linked between homes, however. Older homes in the community have trees directly in contact with the structures, so they do not have adequate defensible space. Older and newer homes have been built using asphalt roofs and combustible wood or vinyl, siding. Propane tanks pose an additional risk, especially if surrounding vegetation has not been cleared. Some homes have wood and other combustible material piled against the side of the home. Few homes have wood fences.

Recommendations for Residents in Cold Springs

- Contact Boulder County Wildfire Partners for a home assessment and recommendations tailored to your individual property.
- Defensible space is recommended for all homes, throughout all three HIZs. Cold Springs should focus on reducing density of trees in zone 3, and linking defensible space projects between properties. Grasses and other vegetation should be managed and reduced around all structures on the property, including around propane tanks. Firewood and other flammable material such as pallets should be moved at least 30ft away from homes. For general defensible space recommendations, please refer to **Section 3.a. Defensible Space** in this document or see the CSFS HIZ guidebook.
- Home hardening is recommended for all homes. Wood siding and decking should be replaced, or treated until able to be replaced. Hardscape should be added to HIZ 1 around structures, including propane tanks and sheds. Open areas below decks should be enclosed or screened to prevent the ingress of embers, and should be kept clean of flammable materials. All flammable materials should be removed from direct contact with homes and kept at least 30ft away from structures. For more recommendations refer to **Section 3.a. Home Hardening**, or see the CSFS HIZ guidebook.
- **Work with NFPD and Boulder County to create a secondary egress route out of the community, running from Hummer Drive to Sherwood Road.**
- Work with neighbors to create linked defensible space. Projects that span multiple properties are more effective at reducing wildfire risk. Contractor costs can sometimes be shared among homeowners, reducing costs for everyone involved.
- Add reflective, non-combustible address signs to all driveways and homes. NFPD is working to secure local suppliers for reflective addressing, but they can also be purchased inexpensively online at safetysign.com. Place address signs on non-combustible posts.
- Where possible, add pullouts for emergency apparatus on driveways and private roads longer than 300 ft. Turnarounds should be constructed at the end of all driveways and dead-end roads.
- Replace non-native conifers and other flammable vegetation with drought tolerant, fire-adapted local species. See CSU's FireWise Plant Materials list for more information.
- Develop an evacuation plan for your family, sign up for emergency notifications from Boulder County ODM, and coordinate with neighbors who may need additional support during an emergency.
- Organize community action around educating neighbors and implementing defensible space and home hardening activities, including grass/weed management, slash removal, and the removal of flammable materials away from structures.


Cold Springs
Cold Springs Drive
Hummer Drive
Last Chance Court
Cold Springs Road
Hoosier Court
Sherwood Road
N
0
0.05
0.1
0.2 Miles
Legend
Nederland and Timberline FPDs
CWPP Plan Units
Potential roadside treatment need
Highest
High
Moderate
CWPP priority projects
Third
Home ignition zone 3
Previous and ongoing fuel treatments
Public land
72
119
Nederland
119
72
THE Ember Alliance
Coord. Sys.: NAD 1983 UTM Zone 13N
Projection: Transverse Mercator
Datum: North American 1983

Comforter Mountain
Relative Risk Rating: Moderate

Fuels and Fire Behavior Potential
There is low housing density in the Comforter Mountain community at this point; lots have been platted but homes have not yet been built. Most of the community is within the Nederland Fire Protection District, but a section is part of Sugarloaf Fire's response area. Because access to Comforter Mountain is from Ridge Road, it is being included as part of this CWPP. Structures are positioned on the top of the hill, with continuous grass fuels below.

Comforter Mountain experienced a 256-acre fire in June of 1976. The eastern area is still mainly void of ponderosa pines and the vegetation is almost exclusively grass. Under moderate weather conditions, the rate of spread is expected to be slow. However, this continuous grass layer could allow fire to spread much more quickly across the landscape, especially with strong winds, which are common in the area. Surface fire is likely in the grass vegetation, and individual trees may torch. With hotter conditions, higher winds and lower fuel moistures, increased flame lengths are possible, and it is likely that fire could travel into the tree crowns. There is potential for torching and active crown fire, especially in the more densely forested western part of the community.

Fire Suppression and Evacuation Capabilities
The road into the community is narrow; there are no turnarounds except at the driveways. Inbound fire engines and outbound cars would have a difficult time passing each other on the roads. There is only one way in and out of the community, so access could be compromised if

there were a fire. The road signage is inconsistent and often posted on flammable posts or signs made of wood. Addresses are present but non-reflective. Utilities to the lots are buried.

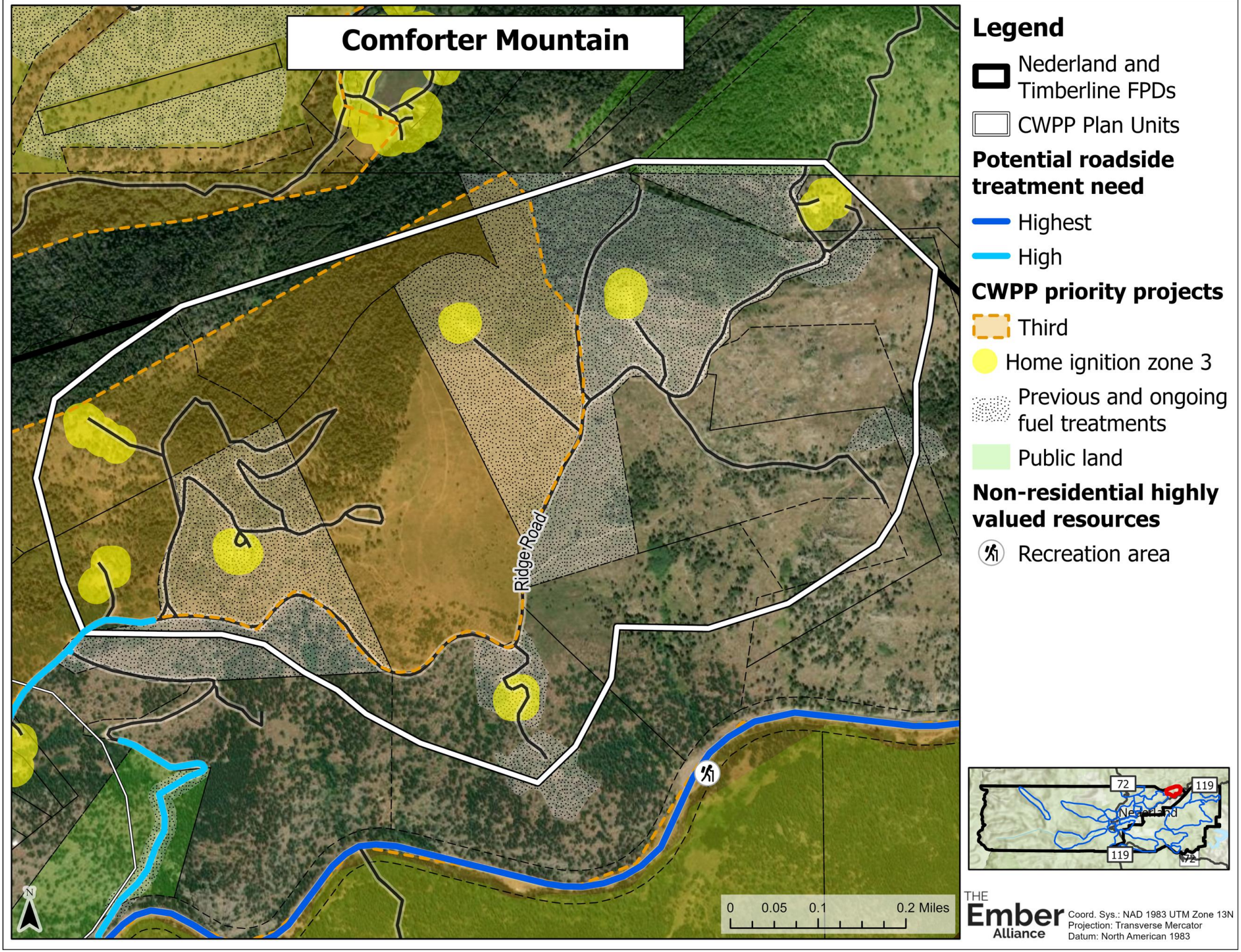
No hydrants are close by, but there is a cistern within the community. The 30,000-gallon cistern on the east end of Ridge Road is well marked but is the only water access. This community is one of the furthest away from a staffed fire station. Combined with the difficulty of traveling on the roads, response times are expected to be longer than 10 minutes. Almost all homes have horses or livestock, which complicates evacuations, and contributes to the already challenging access for fire suppression vehicles. However, roads in this neighborhood are generally clear of dense vegetation, and would remain survivable longer than other roads in the FPD.

Home Ignition Zone Hazards

Home hardening is excellent in this neighborhood. The homes are constructed with fire-resistant roofs, and there is good defensible space. Very few trees within 100ft of homes.

Recommendations for Residents in Comforter Mountain

- Talk to your neighbors and other community members about becoming Wildfire Partners certified.
- Defensible space is recommended. Comforter Mountain should focus on HIZ 1, adding hardscape and managing grass and other vegetation directly against structures. Grasses and other vegetation should be kept low in zone 2. For general defensible space recommendations, please refer to **Section 3.a. Defensible Space** in this document or see the CSFS HIZ guidebook.
- Home hardening is recommended. Wood siding and decking should be replaced. Hardscape should be added to HIZ 1 around structures, including propane tanks and sheds. For more recommendations refer to **Section 3.a. Home Hardening**, or see the CSFS HIZ guidebook.
- Work with NFPD and Boulder County to create a secondary egress route out of the community, or shelter-in-place zones. Roads should be widened to accommodate simultaneous inbound and outbound travel.
- Work with NFPD and Boulder County to thin trees along north edge of Ridge Road, and along Summer Road. Improving the road will provide for safer ingress and egress for residents and firefighters.
- Develop an evacuation plan for your family and any livestock that requires extra time to move. Sign up for emergency notifications from Boulder County ODM, and coordinate with neighbors who may need additional support during an emergency.
- Add reflective, non-combustible address signs to all driveways and homes. NFPD is working to secure local suppliers for reflective addressing, but they can also be purchased inexpensively online at safetysign.com. Place address signs on non-combustible posts.
- Organize community action around educating neighbors and implementing defensible space and home hardening activities, including grass/weed management, and slash removal. Organize tours of properties with exemplary defensible space and home hardening for other NFPD community members.
- Where possible, add pullouts for emergency apparatus on driveways and private roads longer than 300 ft. Turnarounds should be constructed at the end of all driveways and dead-end roads.


Comforter Mountain
Ridge Road
Legend
Nederland and Timberline FPDs
CWPP Plan Units
Potential roadside treatment need
Highest
High
CWPP priority projects
Third
Home ignition zone 3
Previous and ongoing fuel treatments
Public land
Non-residential highly valued resources
Recreation area
N
0 0.05 0.1 0.2 Miles
72
119
Nederland
119
72
THE Ember Alliance
Coord. Sys.: NAD 1983 UTM Zone 13N
Projection: Transverse Mercator
Datum: North American 1983

East Ridge
Relative Risk Rating: High

Fuels and Fire Behavior Potential

The East Ridge planning unit combines three neighborhoods from the previous CWPP, St Antons, St Antons West, and Shady Hollow. The new plan unit boundary incorporates Ridge Road, structures on Cougar Run and Rocky Knob Lane, structures located on top of the hill along Boulder Canyon, and north along shady hollow road.

The fuels in the community are variable. Along Ridge Road and downhill to the south, trees are less dense and there is a higher grass component. The area north of Ridge Road has denser stands of trees, including ponderosa pine and some lodgepole. Dwarf mistletoe is causing deformation on many of the ponderosa pines, so these are likely candidates for removal from a forest health perspective. Increased mountain pine beetle presence is possible in this area. Ignitions may occur from the highway, but the cliff walls of the canyon limit fire spread. A fire starting near one of the homes on the slope could allow flames to spread quickly to uphill structures through ember cast. Under extreme weather conditions, increased rates of spread and flame lengths are predicted, especially north of Ridge Road.

The vegetation in the community northwest of Ridge Road is primarily lodgepole pine, ponderosa pine, and aspen. Surface vegetation is discontinuous, so fire spread across the forest floor would be limited. Predicted fire behavior is not as extreme as because there are not as many steep slopes and ravines. The flatter topography of this area would limit the rate of spread. Ladder fuels in the understory provide extension into the tree canopies throughout the community. Tree torching is likely even under moderate weather conditions, and as a result, a wind-driven fire could spread from this direction into the community.

To the northeast, Douglas firs are growing in the understory, and there are patches of aspen throughout. Ground cover is sparse, consisting of needle litter and some common juniper. The flatter sections of the community have continuous canopy cover except for around structures. South-facing slopes have higher grass components and more light, flashy fuels, capable of higher rates of spread than the forested areas. High winds and low relative humidity is expected to drive fires along Shady Hollow Drive as it turns north. Drainages to the east and north could generate significant fire behavior, capable of either spreading directly into the community or through ember cast.

Fire Suppression and Evacuation Capabilities

There are three ways in and out of East Ridge, but they are along narrow (less than 20 feet) dirt roads. Summer Road, to the east of the community, is a major commuter route and is maintained by an HOA. As a result, it is an important evacuation route that the community is likely to use. Because of the dense vegetation along the side of the road, however, it should not be relied upon as a secondary evacuation route unless the trees are limbed and thinned. Narrow roads would make turning around difficult for fire apparatus. Adequate turnarounds are frequently only available by using private driveways and intersections; they are not provided along the smaller side-roads.

Parcels are forested and under an acre. Address markers are not reflective. Some areas have group addressing that is reflective, but it is difficult to assess which house corresponds to what address. As with addresses, street signs are often not reflective. Because of the narrow roads and inadequate signage, it is difficult to determine roads from driveways. Utility lines run above ground, often hanging low across roads. Homes have liquid propane gas tanks used for central heating.

No fire hydrants are present, though in some areas, individual home cisterns are. There is also a 30,000-gallon cistern along Ridge Road, but it also serves Comforter Mountain area, not just the East Ridge community. A 2,400-gallon cistern is also located on Cougar Drive. Water supply and turn-around time for fire equipment may be long.

Home Ignition Zone Hazards

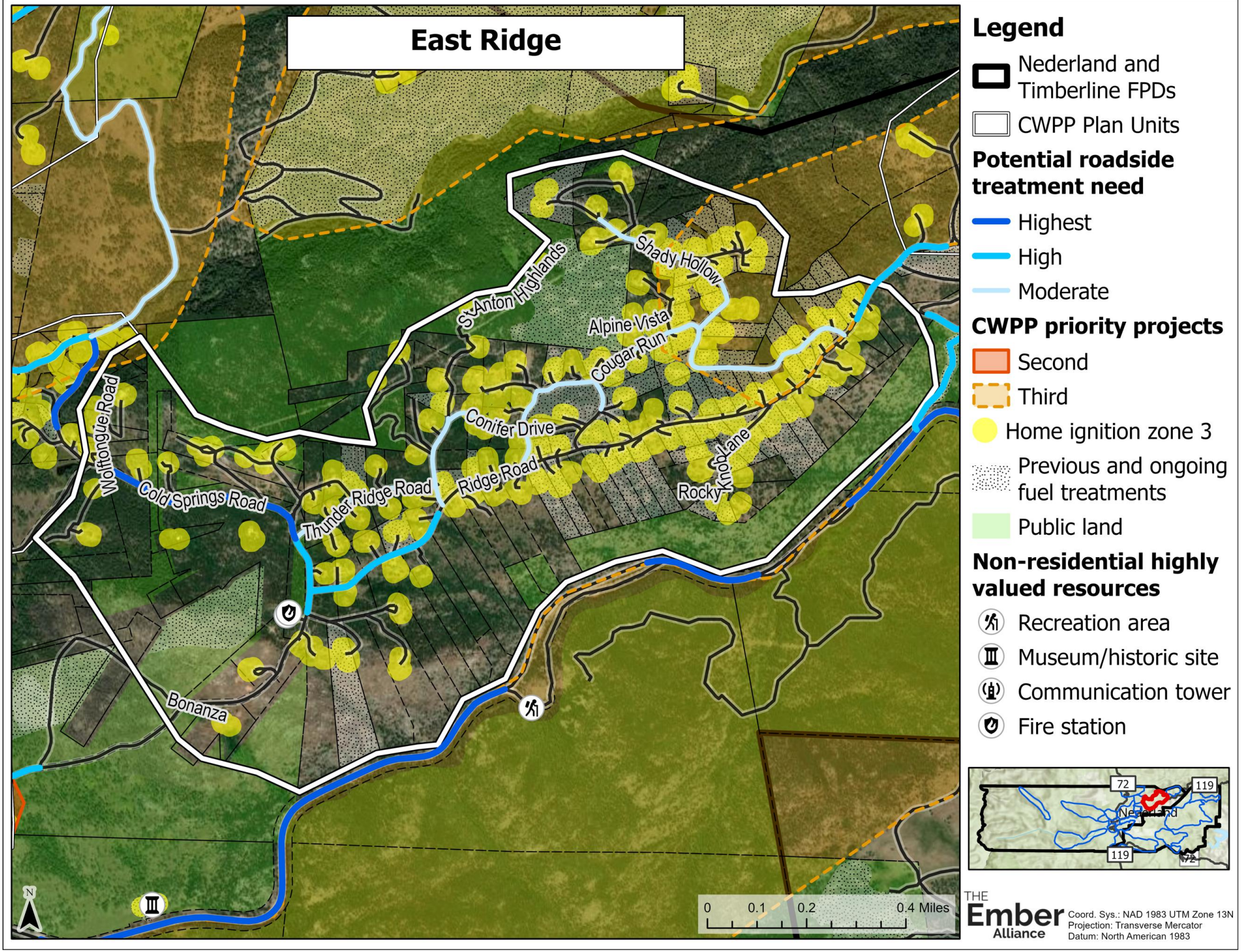
Overall, home hardening is good in East Ridge. The structures are well built, having high fire-resistant asphalt roofs, and decent mitigation in HIZ1. Many structures have combustible siding, however, and combustible decks have open space underneath that should be cleaned out regularly. Defensible space has been completed for some of the homes, but in general, it is lacking, especially in zone 3. There has been some cutting for development, but solid defensible space work has not been completed for most structures. Many structures also have wood stacked close to them.

Recommendations for Residents in East Ridge

- Contact Boulder County Wildfire Partners for a home assessment and recommendations tailored to your individual property.
- Defensible space is recommended. East Ridge should focus on HIZ 2 and 3, reducing density of trees 30ft-100ft from homes, and regularly clearing flammable material away from decks, fences, and the side of homes. Grasses and other vegetation should be kept low in zone 2. For general defensible

space recommendations, please refer to **Section 3.a. Defensible Space** in this document or see the CSFS HIZ guidebook.

- Home hardening is recommended. Wood siding and decking should be replaced, and flammable materials cleared away from homes. Hardscape should be added to HIZ 1 around structures, including propane tanks and sheds. For more recommendations refer to **Section 3.a. Home Hardening**, or see the CSFS HIZ guidebook.
- **Work with NFPD, Boulder County, and the local HOA to thin trees along Summer Road and other main roads, and add turnarounds to important evacuation routes. Improving the road conditions will provide for safer ingress and egress for residents and firefighters during a wildfire event.**
- Work with neighbors to create linked defensible space. Projects that span multiple properties are more effective at reducing wildfire risk. Contractor costs can sometimes be shared among homeowners, reducing costs for everyone involved.
- Develop an evacuation plan for your family and any livestock that requires extra time to move. Sign up for emergency notifications from Boulder County ODM, and coordinate with neighbors who may need additional support during an emergency.
- Add reflective, non-combustible address signs to all driveways and homes. NFPD is working to secure local suppliers for reflective addressing, but they can also be purchased inexpensively online at safetysign.com. Place address signs on non-combustible posts.
- Where possible, add pullouts for emergency apparatus on driveways and private roads longer than 300 ft. Turnarounds should be constructed at the end of all driveways and dead-end roads.
- Organize community action around educating neighbors and implementing defensible space and home hardening activities, including grass/weed management, and slash removal. Organize tours of properties with exemplary defensible space and home hardening for other NFPD community members.



Legend

- Nederland and Timberline FPDs
- CWPP Plan Units

Potential roadside treatment need

- Highest
- High
- Moderate

CWPP priority projects

- Second
- Third
- Home ignition zone 3
- Previous and ongoing fuel treatments
- Public land

Non-residential highly valued resources

- Recreation area
- Museum/historic site
- Communication tower
- Fire station

THE Ember Alliance

Coord. Sys.: NAD 1983 UTM Zone 13N
Projection: Transverse Mercator
Datum: North American 1983

Eldora
Relative Risk Rating: Extreme

Fuels and Fire Behavior Potential

The town of Eldora sits at the bottom of Happy Valley along Middle Boulder Creek; steep, heavily forested walls rise to the north and south. There is dense forest surrounding Eldora. Within the valley bottom, small groves of small-diameter aspen line many of the streets, and much of the area is grass. Within the town, some conifer trees have been planted in yards and directly impinge upon the cabins. The slopes to the north, south and west are heavily forested with various conifer species, including ponderosa pine, lodgepole pine, Engelmann spruce and Douglas fir. The topographic position of the community makes for a wet valley bottom. Lack of ground fuels and ladder fuels reduce the risk of torching and active crown fire. Grass may burn under moderate or extreme weather scenarios, but the mostly flat aspect would limit the rate of spread. High winds and steep topography could lead to extreme fire behavior on the slopes around the town.

Fire Suppression and Evacuation Capabilities

There is only one way in and out of the town of Eldora, a paved road that turns to narrow dirt. Side streets are unpaved, often with cars parked on the side of the road and have no turnarounds. In addition to being less than 20 feet wide, the roads through town are not always maintained. Some road markers are metal and reflective, but others are wood and non-reflective. This, in combination with poor road conditions, could make travel through town slow and difficult for fire apparatus. Although there is a fire station on Eldorado Avenue, it is staffed with volunteers only. Response time to a wildland fire could be prolonged, since the on-duty crews would be responding from Nederland, and would be further hindered during an evacuation, as most roads are not wide enough to allow cars and fire apparatus to pass at once. There are no municipal hydrants in the town of Eldora. Drafting from Middle Boulder Creek may be an option, and a 15,000-gallon

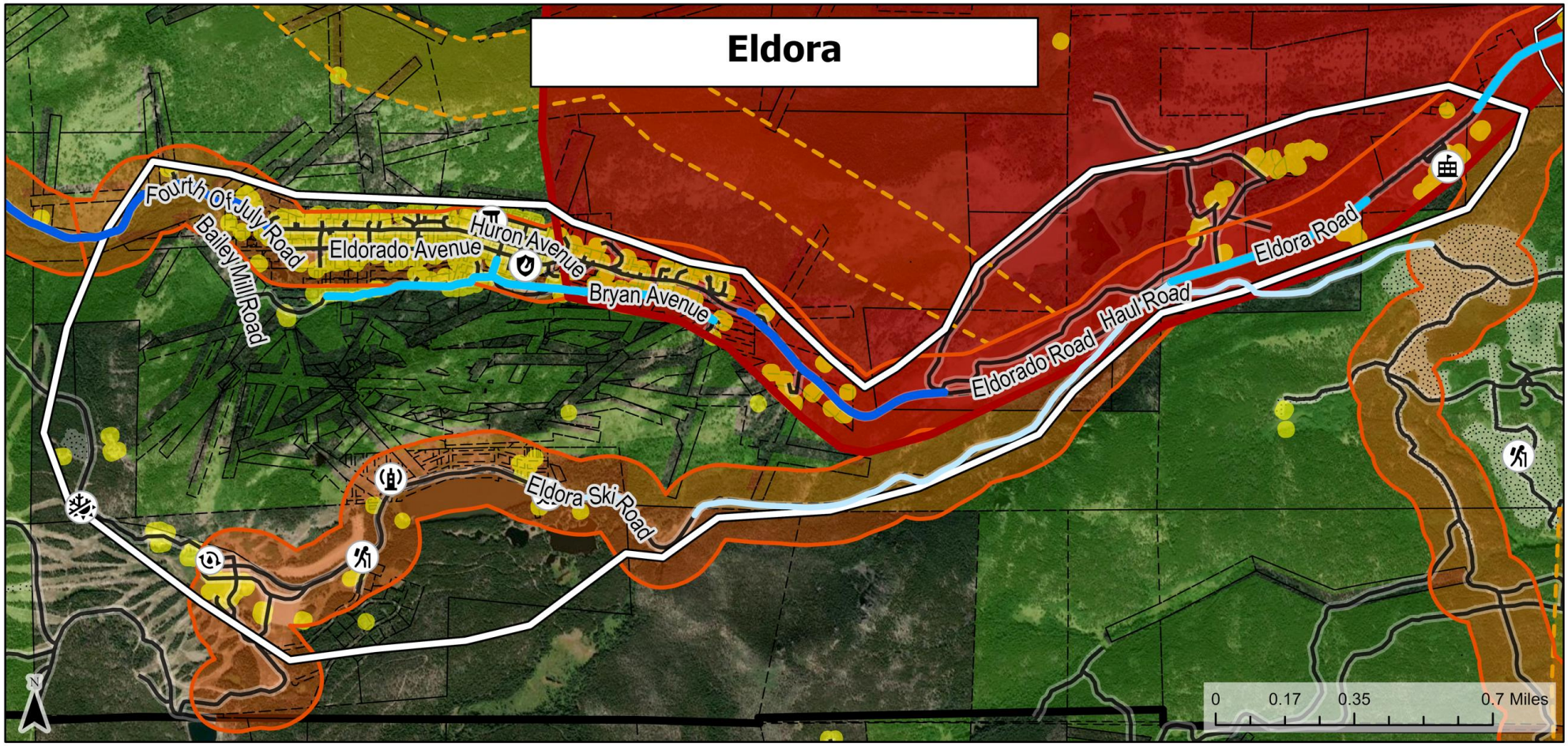
cistern is attached to a hydrant on the western end of the paved portion of the main road. Address markers are non-reflective and difficult to see.

Home Ignition Zone Hazards

Many of the cabins and buildings are quite old, dating back to the late 1890s. Historical standing needs to be considered when work is done to improve structures, including new roofs, windows or siding. Defensible space is non-existent. Old wooden fences attach directly to homes on many properties, and old, cedar shake or barked wood siding and log construction is common, especially with historic buildings. Dilapidated outbuildings are common and have no defensible space. Some of the roofs have been replaced and are fire-resistant asphalt or metal, but further home hardening measures are severely lacking. Lot sizes under an acre are a result of larger mining claims being subdivided and sold to individuals as mining prospects diminished. The structures are therefore close together and often have dense trees and vegetation between them. Home-to-home ignition is a major concern because of the proximity and lack of defensible space.

Recommendations for Residents in Eldora

- Contact Boulder County Wildfire Partners for a home assessment and recommendations tailored to your individual property.
- Defensible space is recommended. Eldora should focus on all HIZs. Remove trees in zone 1, keep grasses and other vegetation low in zone 2, and reduce the density of trees in zone 3. Heavily reduce vegetation between homes to prevent home-to-home ignitions, and regularly clear flammable material away from decks, fences, outbuildings, and the side of homes. For general defensible space recommendations, please refer to **Section 3.a. Defensible Space** in this document or see the CSFS HIZ guidebook.
- Home hardening is recommended. Wood roofs, shake-shingle siding and other exposed old-wood structures attached to homes such as decking and fencing should be replaced with fire-resistant materials as soon as possible. For more recommendations refer to **Section 3.a. Home Hardening**, or see the CSFS HIZ guidebook.
- There are many challenges to creating a secondary egress route in this community. Work with NFPD, Boulder County, and your neighbors to determine whether Shelter-in-Place zones might be created where residents can safely gather in the event of a wildfire.
- Work with neighbors to create linked defensible space. Projects that span multiple properties are more effective at reducing wildfire risk. Contractor costs can sometimes be shared among homeowners, reducing costs for everyone involved.
- Replace non-native conifers and other flammable vegetation with drought tolerant, fire-adapted local species. See CSU's FireWise Plant Materials list for more information.
- Where possible, add pullouts for emergency apparatus on driveways and private roads longer than 300 ft. Turnarounds should be constructed at the end of all driveways and dead-end roads.
- Add reflective, non-combustible address signs to all driveways and homes. NFPD is working to secure local suppliers for reflective addressing, but they can also be purchased inexpensively online at safetysign.com. Place address signs on non-combustible posts.
- Organize community action around educating neighbors and implementing defensible space and home hardening activities, including grass/weed management, and slash removal. Organize tours of properties with exemplary defensible space and home hardening for Eldora community members.



Nederland and Timberline FPDs

CWPP Plan Units

Parcels

Potential roadside treatment need

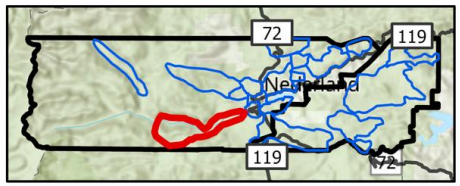
- Highest
- High
- Moderate

CWPP priority projects

- First
- Second
- Third
- Home ignition zone 3
- Previous and ongoing fuel treatments
- Public land

Non-residential highly valued resources

- School
- Recreation area
- Museum/historic site
- Dam
- Water treatment plant
- Weather station
- Communication tower
- Fire station



THE Ember Alliance

Coord. Sys.: NAD 1983 UTM Zone 13N
Projection: Transverse Mercator
Datum: North American 1983

Fourth of July
Relative Risk Rating: High

Fuels and Fire Behavior Potential
Fourth of July neighborhood runs along 4th of July Road, northwest of Eldora. The road runs along a long, narrow canyon, with dense conifer forests, including lodgepole, spruce and fir, covering much of the hillsides. Most homes sit in the bottom of the valley, where some areas have aspen and grassland coverage. These homes are less likely to be impacted by a fire that starts upslope of them, however, there are a few homes mid-slope, and these are at greater risk of fire running up the densely covered hillsides.

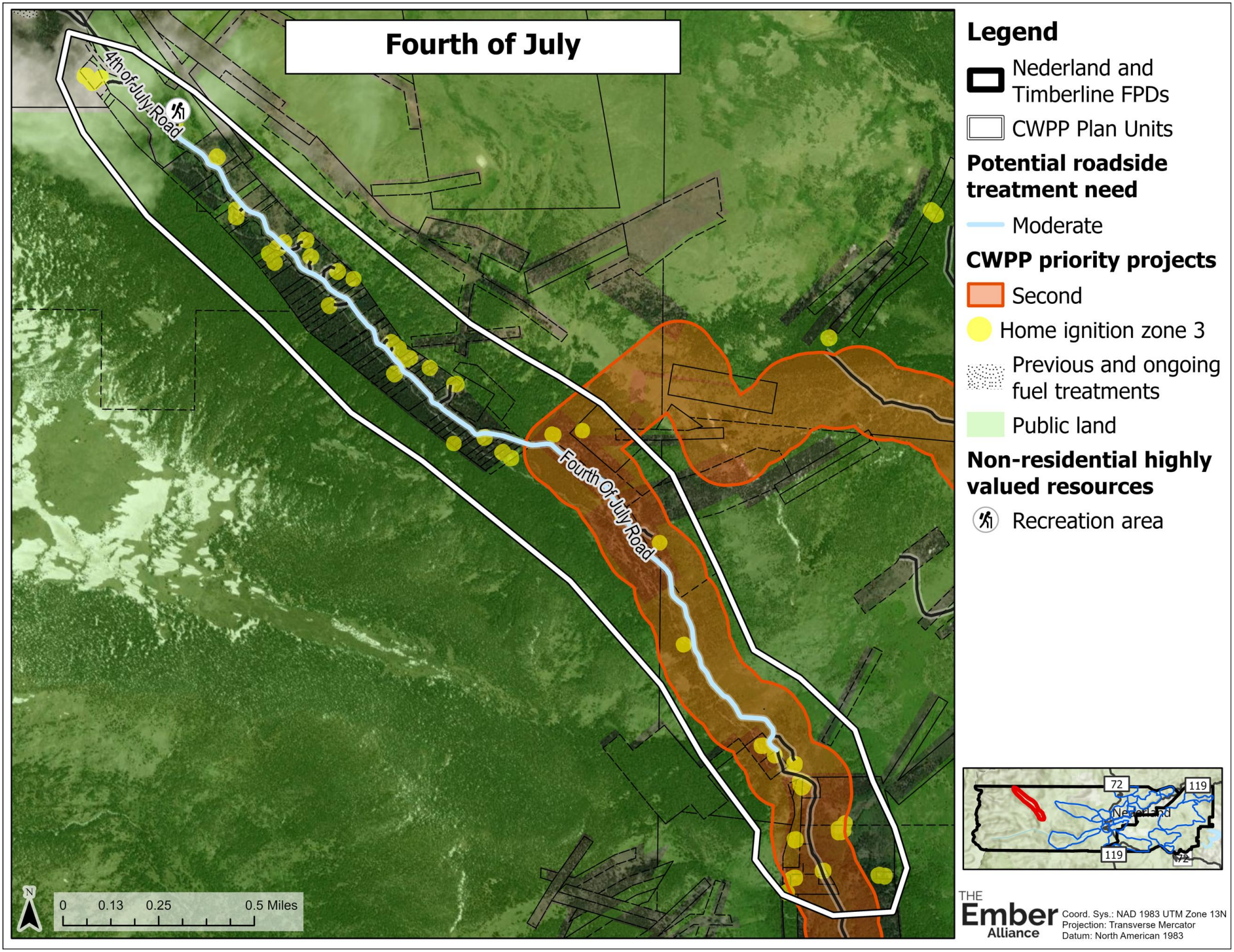
Fire Suppression and Evacuation Capabilities
The Fourth of July neighborhood runs along a single rough dirt road, and is too far out for a quick, effective fire suppression response. The road is too narrow to accommodate a smooth two-way flow of traffic. There is a bus that drops off and picks up hikers during the summer months, that would need to run to safely evacuate hikers. An evacuation would be slow and complicated as a result. **Fire suppression support in this area is unlikely, and residents and hikers should plan accordingly.**

Home Ignition Zone Hazards
Some residents have installed metal roofs on their homes and structures, but defensible space and other home hardening measures are lacking. Most homes still have wood siding, and occasionally

wood fencing attached to homes. Defensible space is minimal, with dense conifer trees surrounding homes in all three HIZs.

Recommendations for Residents in Fourth of July

- Contact Boulder County Wildfire Partners for a home assessment and recommendations tailored to your individual property.
- Defensible space is recommended. Fourth of July should focus on all HIZs. Remove trees in zone 1, keep grasses and other vegetation low in zone 2, and reduce the density of trees in zone 3. Regularly clear flammable material away from outbuildings and the side of homes. For general defensible space recommendations, please refer to **Section 3.a. Defensible Space** in this document or see the CSFS HIZ guidebook.
- Home hardening is recommended. Wood siding and wood fences should be replaced with fire-resistant materials, and hardscape added to HIZ 1. For more recommendations refer to **Section 3.a. Home Hardening**, or see the CSFS HIZ guidebook.
- Replace non-native conifers and other flammable vegetation with drought tolerant, fire-adapted local species. See CSU's FireWise Plant Materials list for more information.
- Work with NFPD and Boulder County to thin trees along Fourth of July road, and consider widening to allow for smooth two-way travel.
- Develop an evacuation plan for your family and any livestock that requires extra time to move. Sign up for emergency notifications from Boulder County ODM, and coordinate with neighbors who may need additional support during an emergency.
- Add reflective, non-combustible address signs to all driveways and homes. NFPD is working to secure local suppliers for reflective addressing, but they can also be purchased inexpensively online at safetysign.com. Place address signs on non-combustible posts.
- Organize community action around educating neighbors and implementing defensible space and home hardening activities, including grass/weed management, and slash removal. Organize tours of properties with exemplary defensible space and home hardening for Fourth of July community members.


Fourth of July
4th of July Road
Fourth Of July Road
Legend
Nederland and Timberline FPDs
CWPP Plan Units
Potential roadside treatment need
Moderate
CWPP priority projects
Second
Home ignition zone 3
Previous and ongoing fuel treatments
Public land
Non-residential highly valued resources
Recreation area
N
0 0.13 0.25 0.5 Miles
72
119
Nederland
119
72
THE Ember Alliance
Coord. Sys.: NAD 1983 UTM Zone 13N
Projection: Transverse Mercator
Datum: North American 1983

Lazy Z
Relative Risk Rating: High

Fuels and Fire Behavior Potential
The Lazy Z community is located between Magnolia Road and Coal Creek Canyon. Vegetation varies throughout the community. Dense areas of homogenous lodgepole pine predominate, though open areas consisting of ponderosa pine and grasses also exist. There are some meadows and areas of dense aspen in the community, however, many aspen sprouts have been crowded out by coniferous trees.

There are many steep slopes throughout the plan unit, but few homes were built on the steep slopes (-25% mid-slope homes). The center of the community, where roads and houses encircle a steep central point, is especially susceptible to wildfire. Fire behavior under moderate weather conditions is likely to support surface fire with some areas of torching. More extreme weather, with higher wind speeds and temperatures, lower humidity and fuel moisture, will allow for more extreme fire behavior. The most intense fire behavior would be expected along the ridge that begins in the community and extends to the east. This area is likely to exhibit active crown fire and flame lengths exceeding 10 feet.

Fire Suppression and Evacuation Capabilities
Despite accessing both major roads, the community has only one way in and out and numerous secondary roads. Steep slopes and ravines are present throughout the community. Roads vary in condition and width, though most are wide and well-maintained. There are few adequate

turnarounds and pull-offs. Many driveways are extremely steep and narrow and do not have adequate space for staging and turning around vehicles. Several homes keep livestock.

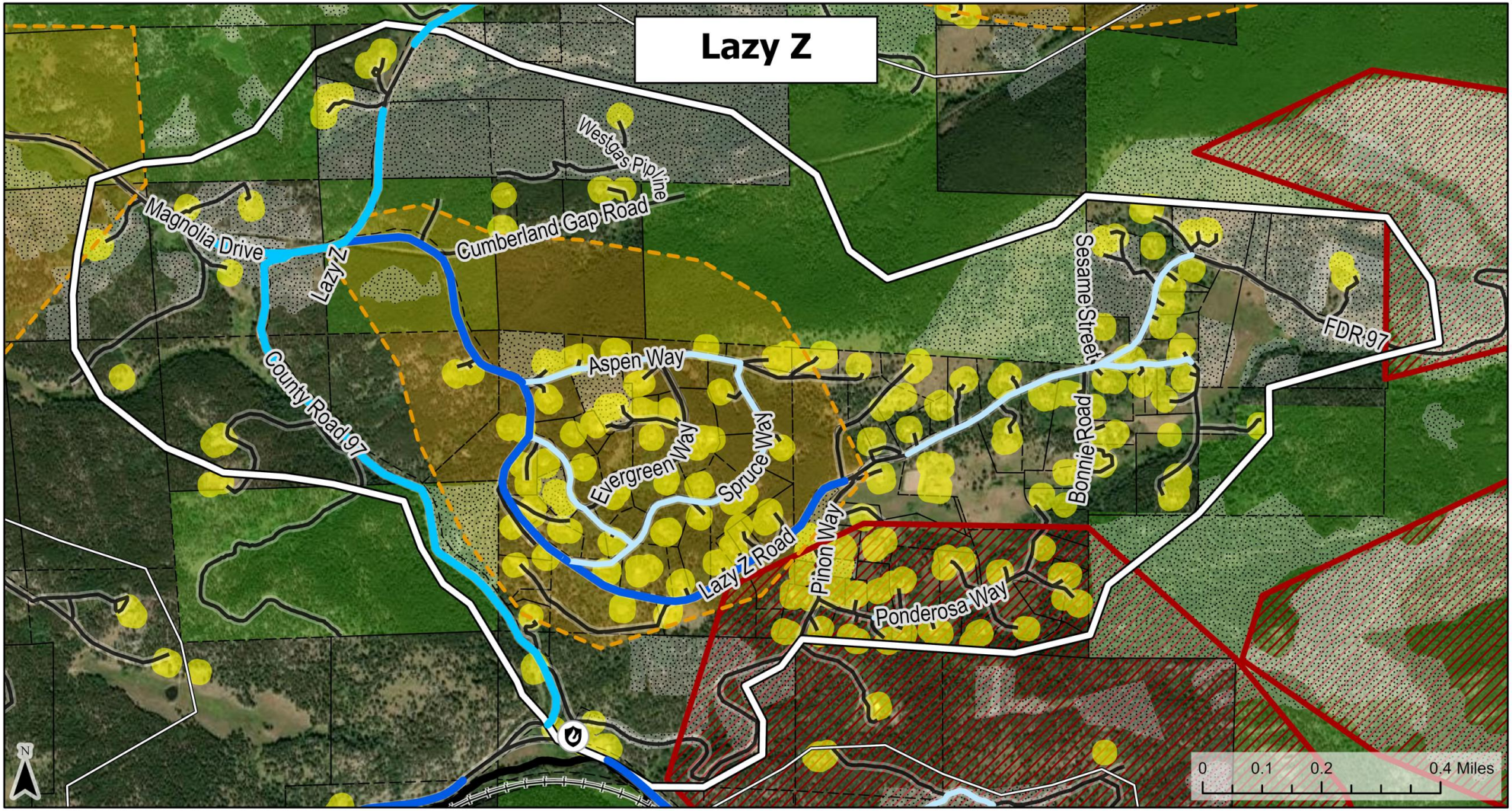
Addresses and road signs are inconsistent, sparse, and in many areas where they do exist, they are difficult to see. There are individual cisterns present, though overall water availability is limited. As with many communities in the Magnolia area, many residents are not present year-round.

Home Ignition Zone Hazards

Most homes lack any defensible space. A few homes had completed some work in HIZ 1, but these were fewer than half of all homes in the plan unit. There are homes with combustible siding and decks, and certain areas with large buildups of flammable vegetation surrounding houses, but there are also several newer builds that incorporate ignition resistant materials, and some wildfire partners certified homes too. Parcels are large, but close enough together for neighbors to coordinate on linked defensible space. There is a buried gas line running through the community that must be identified to residents and firefighters in the event of a wildfire.

Recommendations for Residents in Lazy Z

- Talk to your neighbors and other community members about becoming Wildfire Partners certified.
- Defensible space is recommended. Lazy Z should focus on HIZ 1 and 2, removing vegetation directly around homes (0-5ft) and reducing the density of trees near structures (5-30ft). Reduce other vegetation, such as shrubs, and keep grasses low in zone 2. For general defensible space recommendations, please refer to **Section 3.a. Defensible Space** in this document or see the CSFS HIZ guidebook.
- Home hardening is recommended. Homes that still have wood siding and decking should replace these for non-combustible materials, or treat them until able to replace them. Flammable materials and vegetation should be cleared from under decks, and metal mesh installed to prevent embers from entering. For more recommendations refer to **Section 3.a. Home Hardening**, or see the CSFS HIZ guidebook.
- Replace non-native conifers and other flammable vegetation with drought tolerant, fire-adapted local species. See CSU's FireWise Plant Materials list for more information.
- Work with neighbors to create linked defensible space. Projects that span multiple properties are more effective at reducing wildfire risk. Contractor costs can sometimes be shared among homeowners, reducing costs for everyone involved.
- Develop an evacuation plan for your family and any livestock that requires extra time to move. Sign up for emergency notifications from Boulder County ODM, and coordinate with neighbors who may need additional support during an emergency.
- Add reflective, non-combustible address signs to all driveways and homes. NFPD is working to secure local suppliers for reflective addressing, but they can also be purchased inexpensively online at safetysign.com. Place address signs on non-combustible posts.
- Clear roadways. Remove trees, shrubs, and tall grasses along private roads and driveways to improve evacuation safety and firefighter access during a wildfire. This is especially important for narrow driveways and road segments.
- Organize community action around educating neighbors and implementing defensible space and home hardening activities, including grass/weed management, and slash removal. Organize tours of properties with exemplary defensible space and home hardening for community members.



Nederland and Timberline FPDs

CWPP Plan Units

Parcels

Railway

Potential roadside treatment need

Highest

High

Moderate

CWPP priority projects

First-in progress

Third

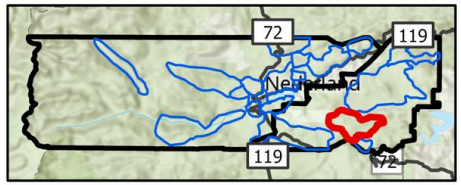
Home ignition zone 3

Previous and ongoing fuel treatments

Public land

Non-residential highly valued resources

Fire station



THE Ember Alliance

Coord. Sys.: NAD 1983 UTM Zone 13N
Projection: Transverse Mercator
Datum: North American 1983

Nederland
Relative Risk Rating: Extreme

Fuels and Fire Behavior Potential

The area delineated as Nederland comprises the more developed area within the NFPD. The Sunny Side subdivision is further to the north, and the bridge delineates its southern boundary. There are both homes and commercial buildings within the area, but some of the overall building characteristics between the two are similar. Lot sizes are typically under an acre, and the homes are some of the oldest constructions in the CWPP planning area.

While the surrounding slopes are steep and have dense mixed conifer and lodgepole stands, an extreme fire event is likely to run up-slope and away from the town center. However, ponderosa pine, blue spruce and other conifers have been planted in yards between houses, and vegetation and wood fences connect many homes in the town. A house fire could ignite vegetation surrounding the house and spread easily to the adjacent structure. As a result, home-to-home ignitions are of great concern. Though wildfire is less likely to spread directly into town, ember cast from a nearby fire has the potential to ignite the older wood on unmitigated homes in the area and spread structure to structure from there. The southwest portion of Nederland does have fewer commercial buildings and development, so the forest vegetation is denser. In these areas, longer flame lengths are predicted, as well as more intense fires and more potential for torching and active crown fire.

Fire Suppression and Evacuation Capabilities

In the Nederland plan unit, there are several paved roads, but most are well-maintained dirt. Road widths are generally 20-24 feet, which can create access and egress issues, especially during the summer months when there are a significant number of people recreating in the area. Nederland plan unit has one main road running north-south through the town center, where the majority of tourist traffic funnels through. During peak times, this road can become excessively clogged, preventing movement on the part of emergency providers and possibly hindering fire suppression activities as well as any potential evacuation efforts. An evacuation of this plan unit and many other surrounding plan units would necessarily run along this one main road, making it a choke point not just for Nederland town center, but for evacuations from neighborhoods throughout the FPD.

Paved roads are well-marked with 4-inch reflective road signs. In contrast, dirt roads are regularly marked with wooden signs that are not visible at night, especially in smoky conditions. Addressing for all structures is generally non-reflective and built using combustible materials. Unlike many other plan units, reliable hydrants are present throughout the Nederland plan unit.

Home Ignition Zone Hazards

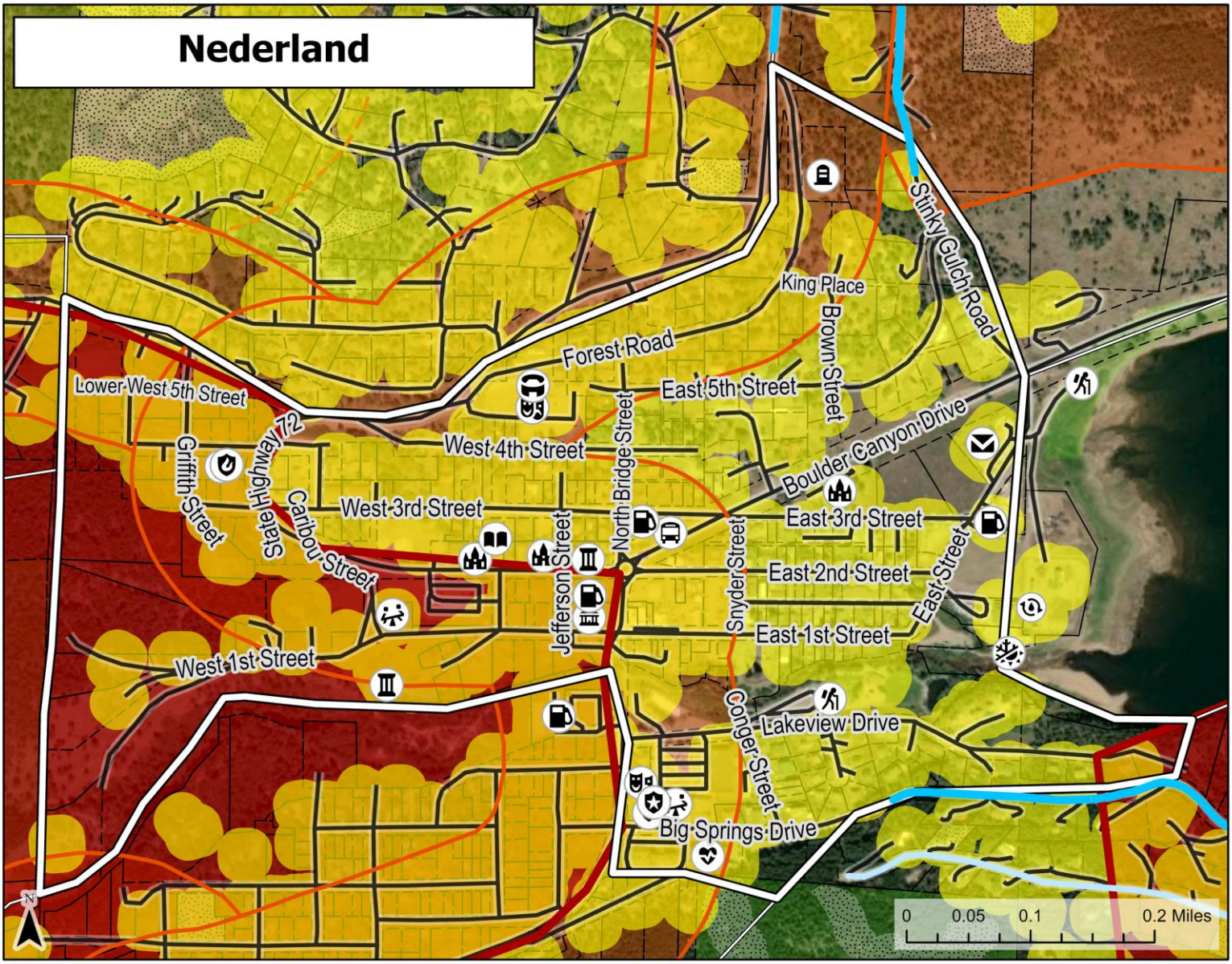
Homes are older, and mostly wood builds. They are built relatively close together. Many roofs are asphalt shingle, but there are still structures with wood roofs. The siding is wood, as are most of the decks and fences. Defensible space work has not been completed, there are many wood piles and other flammable materials placed against or near homes. Trees surround and overhang structures, and many homes have attached wooden fences. Utilities to the homes and businesses are run above ground.

Recommendations for Residents in Nederland

- Contact Boulder County Wildfire Partners for a home assessment and recommendations tailored to your individual property.
- Defensible space is recommended. Nederland should focus on HIZ 1 and 2, removing overhanging limbs and trees directly in contact with homes, and reducing the density of trees and vegetation near structures (5-30ft). Remove wood pallets and other flammable material piled against homes. For general defensible space recommendations, please refer to **Section 3.a. Defensible Space** in this document or see the CSFS HIZ guidebook.
- Home hardening is recommended. Homes that still have wood roofs, siding, and decking should replace these for non-combustible materials, or treat them until able to replace them. Replace wooden fences or remove from contact with homes. Flammable materials and vegetation should be cleared from under decks, and metal mesh installed to prevent embers from entering. For more recommendations refer to **Section 3.a. Home Hardening**, or see the CSFS HIZ guidebook.
- Work with neighbors to create linked defensible space. Projects that span multiple properties are more effective at reducing wildfire risk. Contractor costs can sometimes be shared among homeowners, reducing costs for everyone involved.
- **Work with NFPD and Town of Nederland to add a secondary road through Nederland town center. This will help alleviate egress and evacuation congestion during peak visiting hours for the town of Nederland.**
- Replace non-native conifers and other flammable vegetation with drought tolerant, fire-adapted local species. See CSU's FireWise Plant Materials list for more information.

- Develop an evacuation plan for your family and any livestock that requires extra time to move. Sign up for emergency notifications from Boulder County ODM, and coordinate with neighbors who may need additional support during an emergency.
- Add reflective, non-combustible address signs to all driveways and homes. They can be purchased inexpensively online at safetysign.com. Place address signs on non-combustible posts.
- Organize community action around educating neighbors and implementing defensible space and home hardening activities, including grass/weed management, and slash removal. Organize tours of properties with exemplary defensible space and home hardening for community members.

Nederland



Nederland and Timberline FPDs

CWPP Plan Units

Potential roadside treatment need

- High
- Moderate

CWPP priority projects

- First
- Second
- Third

Home ignition zone 3

Previous and ongoing fuel treatments

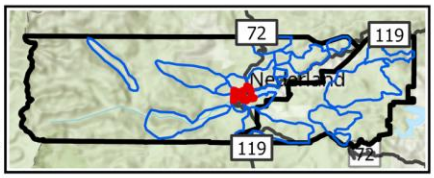
Public land

Non-residential highly valued resources

- Place of worship
- Community center
- Child care center
- Library
- Recreation area
- Cemetery
- Museum/historic site
- Entertainment
- Retail gas / propane
- Water treatment plant
- Weather station
- Communication tower
- Bus station
- Fire station
- Local law enforcement
- Local government
- Post office
- Health and medical

THE Ember Alliance

Coord. Sys.: NAD 1983 UTM Zone 13N
Projection: Transverse Mercator
Datum: North American 1983



Peak to Peak
Relative Risk Rating: Moderate

Fuels and Fire Behavior Potential
Peak to Peak plan unit encompasses the neighborhood at the north end of the highway within the NFPD. It has a high fuel load of mixed conifer and lodgepole forests, with grassland meadows and some aspen and riparian areas. There are many dead and downed trees, and fuels often crowd roads.

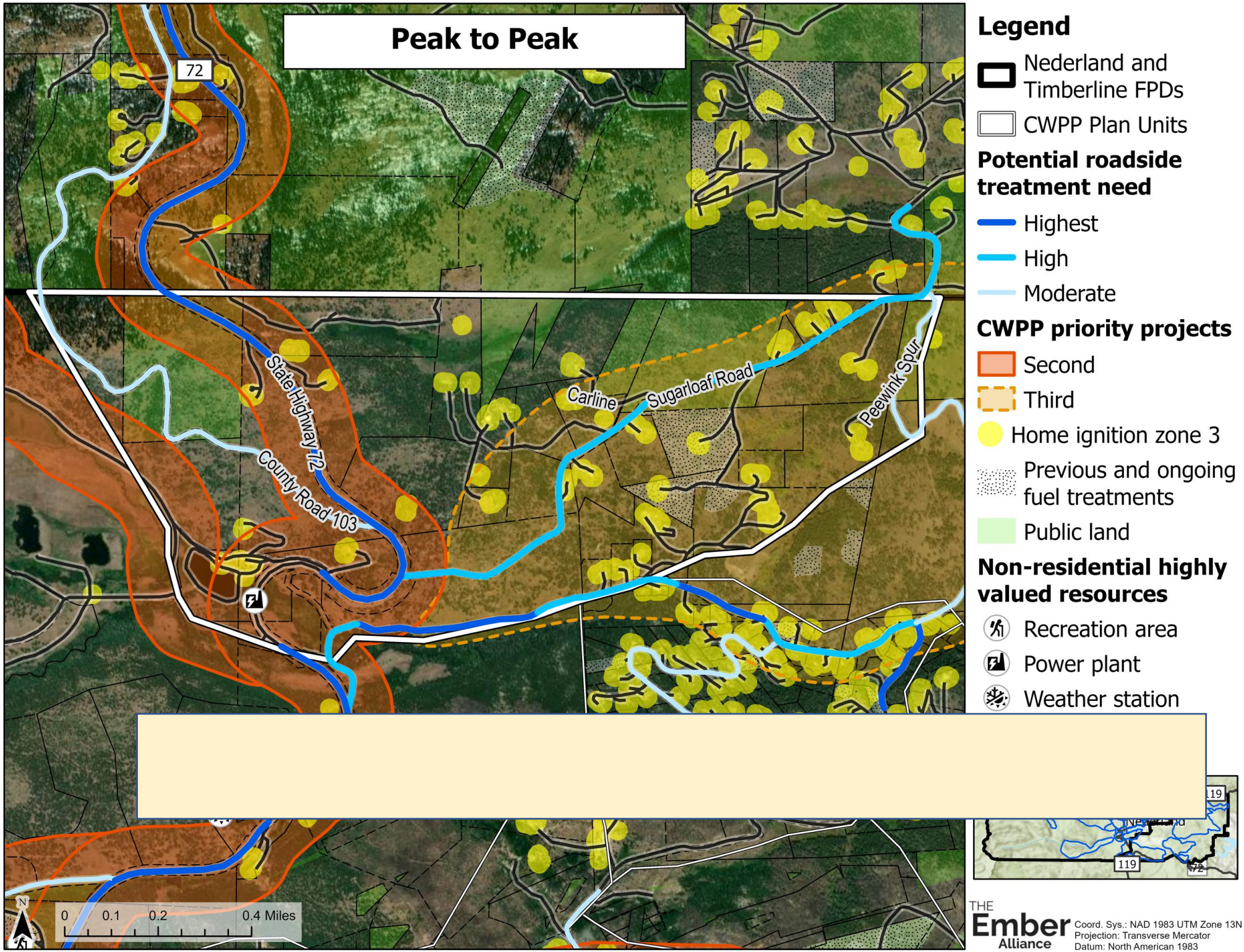
Fire Suppression and Evacuation Capabilities
The roads are accessible and large enough to accommodate ingress and egress together. Peak to Peak Highway provides good access to the plan unit to the north and south, ensuring smooth evacuations and response. Road signage is good along the highway, but less consistent within the neighborhood. Address signs are not reflective and often placed on combustible posts. Water is hard to access.

Home Ignition Zone Hazards
Few homes have implemented defensible space or home hardening measures. Wood and other fuels are frequently piled near or against homes, and many homes still have old wood siding.

Recommendations for Residents in Peak to Peak

- Contact Boulder County Wildfire Partners for a home assessment and recommendations tailored to your individual property.

- Defensible space is recommended. Peak to Peak should focus on HIZ 1 and 2, removing overhanging limbs and trees directly in contact with homes, and reducing the density of trees and vegetation near structures (5-30ft). Remove wood pallets and other flammable material piled against homes. For general defensible space recommendations, please refer to **Section 3.a. Defensible Space** in this document or see the CSFS HIZ guidebook.
- Home hardening is recommended. Homes that still have wood roofs, siding, and decking should replace these for non-combustible materials, or treat them until able to replace them. Replace wooden fences or remove from contact with homes. Flammable materials and vegetation should be cleared from under decks, and metal mesh installed to prevent embers from entering. For more recommendations refer to **Section 3.a. Home Hardening**, or see the CSFS HIZ guidebook.
- Replace non-native conifers and other flammable vegetation with drought tolerant, fire-adapted local species. See CSU's FireWise Plant Materials list for more information.
- Develop an evacuation plan for your family and any livestock that requires extra time to move. Sign up for emergency notifications from Boulder County ODM, and coordinate with neighbors who may need additional support during an emergency.
- Add reflective, non-combustible address signs to all driveways and homes. NFPD is working to secure local suppliers for reflective addressing, but they can also be purchased inexpensively online at safetysign.com. Place address signs on non-combustible posts.
- Clear roadways. Remove trees, shrubs, and tall grasses along private roads and driveways to improve evacuation safety and firefighter access during a wildfire. This is especially important for narrow driveways and road segments.
- Organize community action around educating neighbors and implementing defensible space and home hardening activities, including grass/weed management, and slash removal. Organize tours of properties with exemplary defensible space and home hardening for community members.


Peak to Peak
72
State Highway 72
County Road 103
Carline
Sugarloaf Road
Peewink Spur
Legend
Nederland and Timberline FPDs
CWPP Plan Units
Potential roadside treatment need
Highest
High
Moderate
CWPP priority projects
Second
Third
Home ignition zone 3
Previous and ongoing fuel treatments
Public land
Non-residential highly valued resources
Recreation area
Power plant
Weather station
119
72
N
0 0.1 0.2 0.4 Miles
THE Ember Alliance
Coord. Sys.: NAD 1983 UTM Zone 13N
Projection: Transverse Mercator
Datum: North American 1983

Pinecliffe
Relative Risk Rating: Moderate

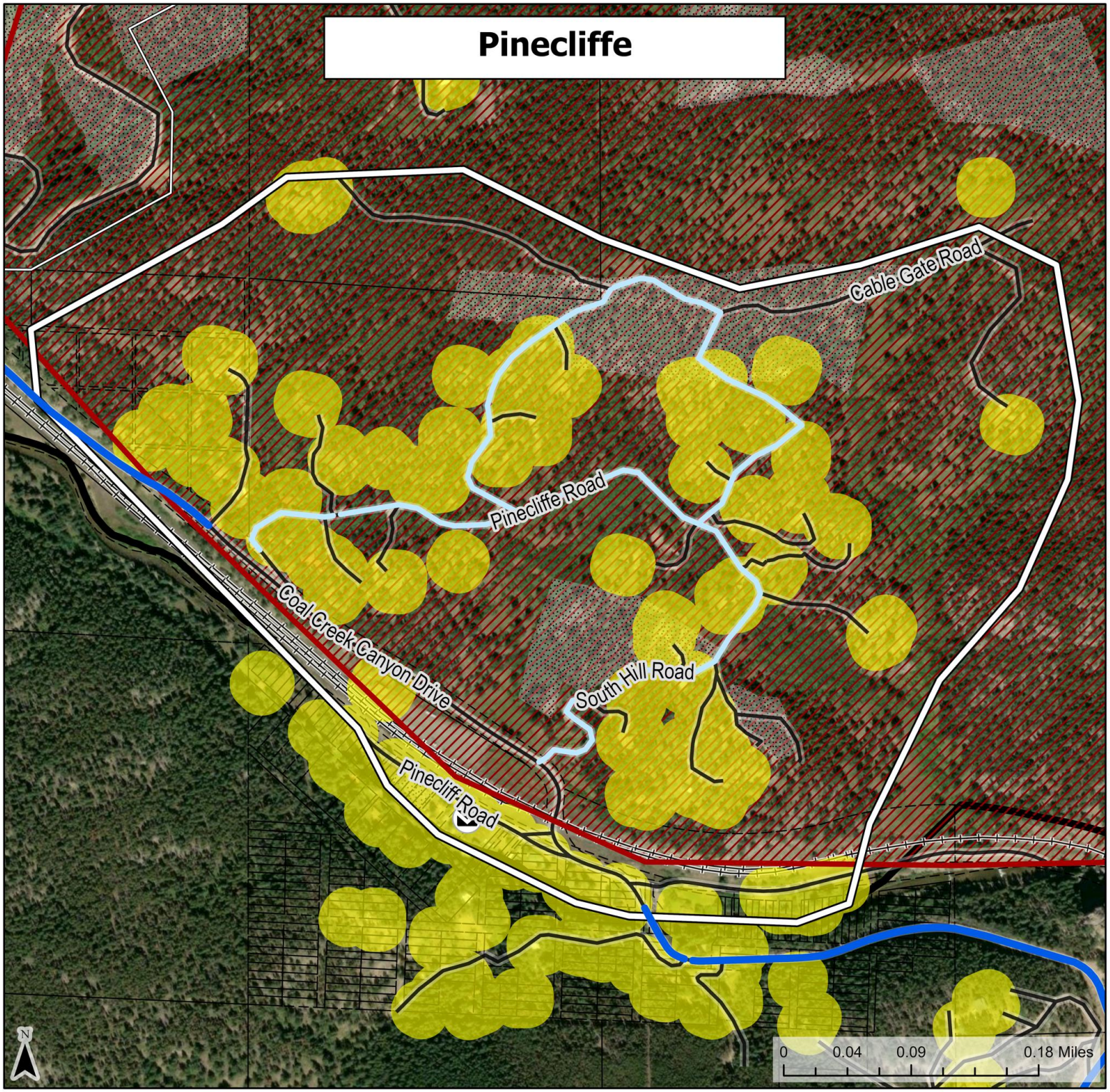
Fuels and Fire Behavior Potential
There have been several forest treatments within this plan unit, and as a result, significant aspen regeneration has led to large stands of young aspen prevalent throughout the community. There are still many dense mixed conifer and ponderosa forests, and some lodgepole stands. Slopes are not as steep as in other neighborhoods.

Fire Suppression and Evacuation Capabilities
Roads are narrow, though many have pullouts for traffic, and driveways have loops for turnarounds. Trees crowd many of the roads, creating pinch points where evacuation would be more challenging. Overall, an evacuation would not take long, as there are only about 40 homes in the neighborhood, with many of them not occupied year-round. Addresses are reflective and placed on non-combustible posts.

Home Ignition Zone Hazards
It should be noted that extensive forestry work has been done within the community, including defensible space and forest health thinning. Propane tanks and firewood are mostly kept away from structures. That said, there are still wooden fences attached to a few homes, and more defensible space actions needed in zone 3 and on many mid-slope homes. Pinecliffe should continue with efforts to decrease risk and promote forest health.

Recommendations for Residents in Pinecliffe

- Talk to your neighbors and other community members about becoming Wildfire Partners certified.
- Defensible space is recommended. Pinecliffe should focus on HIZ 3, reducing density of trees 30-100ft away from structures. Grasses and vegetation should be kept low in zone 2. For general defensible space recommendations, please refer to **Section 3.a. Defensible Space** in this document or see the CSFS HIZ guidebook.
- Home hardening is recommended. Hardscape should be implemented in zone 1. Vegetation should be cleared from under decks, and metal mesh installed to prevent embers from entering. For more recommendations refer to **Section 3.a. Home Hardening**, or see the CSFS HIZ guidebook.
- Work with neighbors to create linked defensible space. Projects that span multiple properties are more effective at reducing wildfire risk. Contractor costs can sometimes be shared among homeowners, reducing costs for everyone involved.
- Develop an evacuation plan for your family and any livestock that requires extra time to move. Sign up for emergency notifications from Boulder County ODM, and coordinate with neighbors who may need additional support during an emergency.
- Clear roadways. Remove trees, shrubs, and tall grasses along private roads and driveways to improve evacuation safety and firefighter access during a wildfire. This is especially important for narrow driveways and road segments.
- Organize community action around educating neighbors and implementing defensible space and home hardening activities, including grass/weed management, and slash removal. Organize tours of properties with exemplary defensible space and home hardening for community members.



Legend

- Nederland and Timberline FPDs
- CWPP Plan Units
- Parcels
- Railway

Potential roadside treatment need

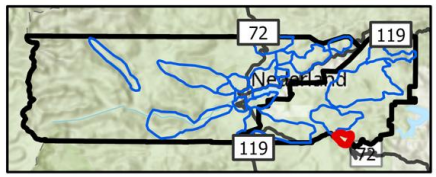
- Highest
- Moderate

CWPP priority projects

- First-in progress
- Home ignition zone 3
- Previous and ongoing fuel treatments

Non-residential highly valued resources

- Post office



THE Ember Alliance

Coord. Sys.: NAD 1983 UTM Zone 13N
Projection: Transverse Mercator
Datum: North American 1983

Porter Ranch
Relative Risk Rating: High

Fuels and Fire Behavior Potential
Formerly Porter Ranch and Twin Sisters, the Twin Sisters neighborhood was combined with the Pine Glade community. The Porter Ranch community is the eastern-most portion of the Magnolia area and consists of a web of intersecting roads and driveways. The majority of the community is situated on south- and west-facing aspects. It is heavily vegetated, with ponderosa pine and Douglas fir the predominant species. While Porter Ranch may have some individual cisterns, it would benefit from additional water sources. Fire behavior runs indicate a potential for rapid rates of spread and active crown fire in the plan unit.

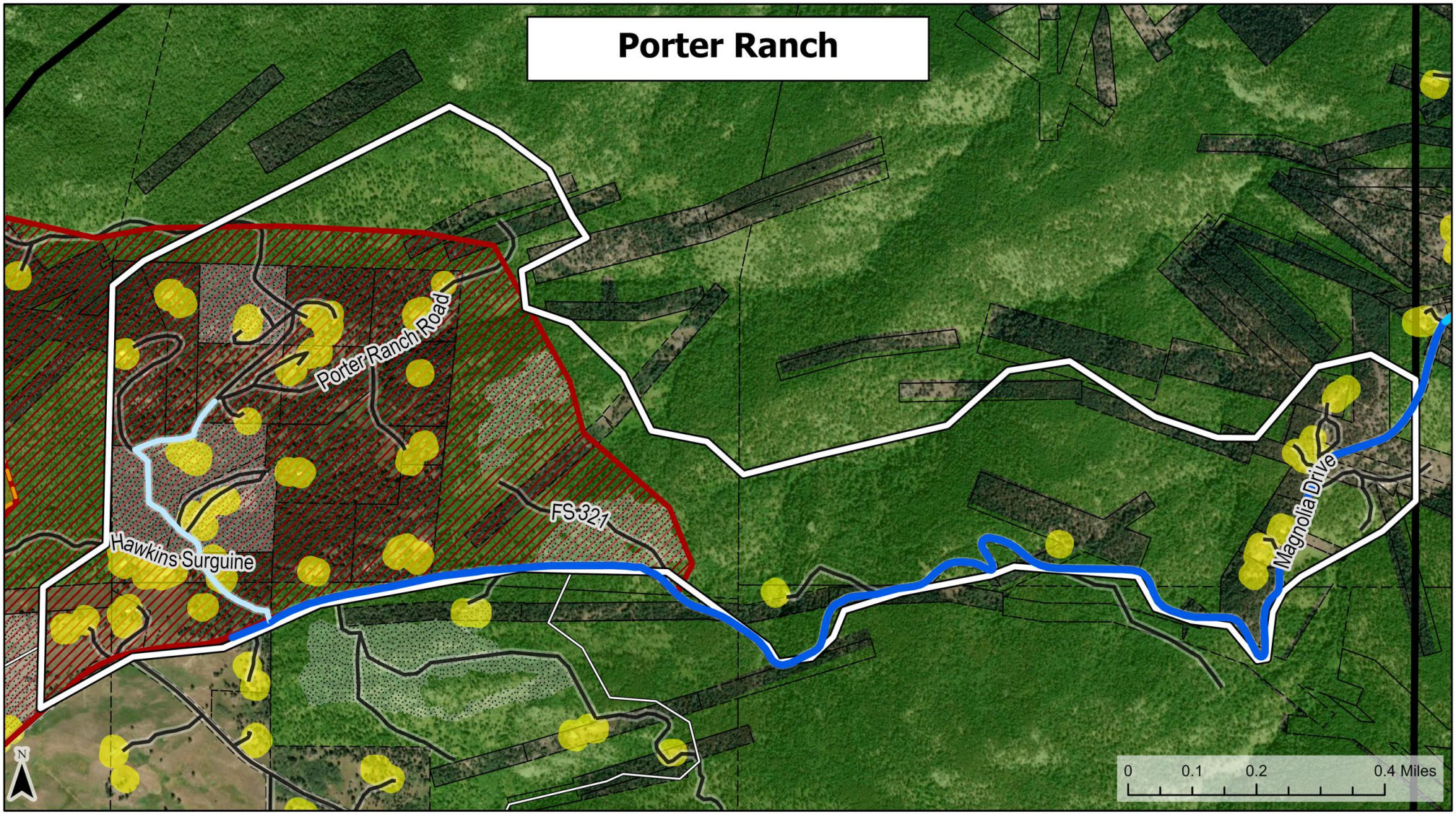
Fire Suppression and Evacuation Capabilities
Addressing and signing in the community is very poor, and firefighters could have a difficult time locating and evacuating individual homeowners. Porter Ranch could drastically benefit through the improvement of primary and secondary egress routes, especially to the east, where an unmaintained and unofficial road could be improved for use as a secondary evacuation route. Roads and driveways within the community are primarily steep, narrow and unmaintained, creating a significant concern for incoming fire apparatus. Moreover, in many areas there is a lack of pull-offs and turnarounds. Nearby recreation areas and frequent lightning provide potential ignition sources.

Home Ignition Zone Hazards

Some defensible space work has been done within the community, though in most cases significant vegetation is present adjacent to homes and other structures. Old construction homes have flammable materials for roofs and siding, and other areas of concern include propane tanks and firewood stored near homes, and structures with combustible decking.

Recommendations for Residents in Porter Ranch

- Contact Boulder County Wildfire Partners for a home assessment and recommendations tailored to your individual property.
- Defensible space is recommended. Porter Ranch should focus on HIZ 1 and 2. Removing overhanging limbs around structures, reducing density of conifers within 30ft of homes, and moving firewood, propane tanks, and other flammable materials away from structures. Grasses and vegetation should be removed from zone 1 and should be kept low in zone 2. For general defensible space recommendations, please refer to **Section 3.a. Defensible Space** in this document or see the CSFS HIZ guidebook.
- Home hardening is recommended. Wood roofs, siding, and decking should be replaced, or treated until able to be replaced. Vegetation should be cleared from under decks, and metal mesh installed to prevent embers from entering. Wooden fences should be replaced with noncombustible materials, and hardscape added to zone 1 around structures. For more recommendations refer to **Section 3.a. Home Hardening**, or see the CSFS HIZ guidebook.
- Work with neighbors to create linked defensible space. Projects that span multiple properties are more effective at reducing wildfire risk. Contractor costs can sometimes be shared among homeowners, reducing costs for everyone involved.
- Develop an evacuation plan for your family and any livestock that requires extra time to move. Sign up for emergency notifications from Boulder County ODM, and coordinate with neighbors who may need additional support during an emergency.
- Clear roadways. Remove trees, shrubs, and tall grasses along private roads and driveways to improve evacuation safety and firefighter access during a wildfire. This is especially important for narrow driveways and road segments.
- Organize community action around educating neighbors and implementing defensible space and home hardening activities, including grass/weed management, and slash removal. Organize tours of properties with exemplary defensible space and home hardening for community members.



Nederland and Timberline FPDs

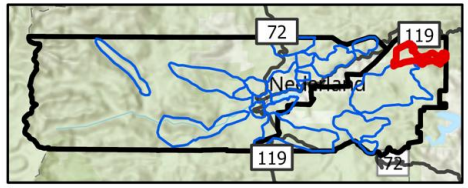
CWPP Plan Units

Potential roadside treatment need

- Highest
- High
- Moderate

CWPP priority projects

- First-in progress
- Third
- Home ignition zone 3
- Previous and ongoing fuel treatments
- Public land



THE Ember Alliance

Coord. Sys.: NAD 1983 UTM Zone 13N
Projection: Transverse Mercator
Datum: North American 1983

South Nederland
Relative Risk Rating: High

Fuels and Fire Behavior Potential
Middle Boulder Creek forms the north border of this community. South Nederland, commonly referred to as "Old Town," is more developed than other planning units and has some of the oldest structures. Houses are built extremely close to one another, frequently with less than 10 feet between them. The largest concern in the community stems from a combination of dense lots and lack of vegetation clearing; a wildland or structure fire could easily ignite neighboring homes.

Fuels are not continuous within the community. Ponderosa pines, blue spruce and other conifers have been planted in yards between houses, and dense mixed conifer stands come right up against homes. A house fire could ignite vegetation surrounding houses and spread easily to adjacent structures. As a result, home-to-home ignitions are a great concern. The northwest portion of the community is less developed and has more forested areas, including a riparian corridor. Fire behavior within the non-riparian stands will likely have longer flame lengths and a higher probability of torching and active crowning, and is expected to be extreme due to the high density of vegetation in the planning unit.

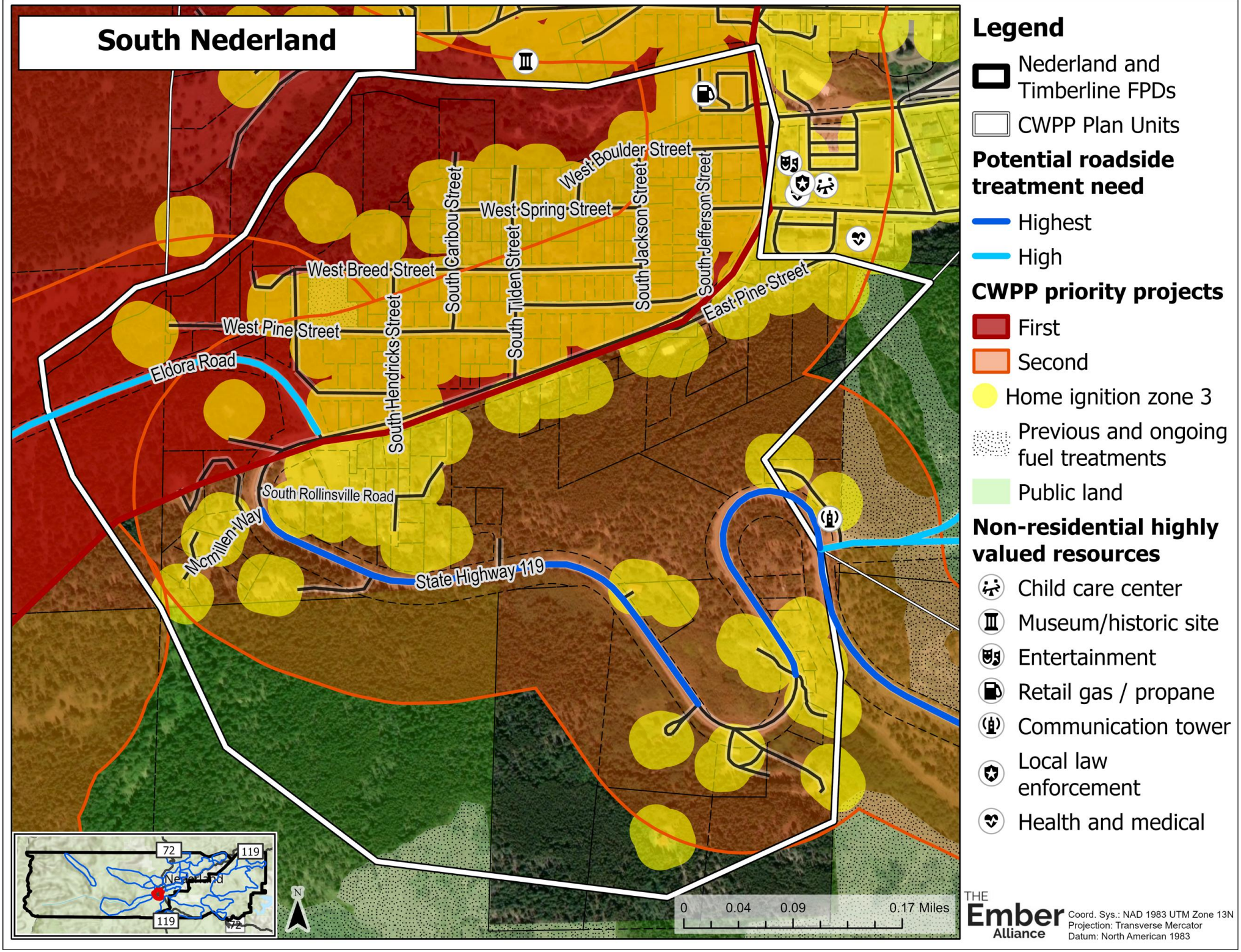
Fire Suppression and Evacuation Capabilities
Addresses are difficult to read and sometimes not present, though street signs are reflective. Although this area is considered more developed than many of the other communities in the district, the roads are dirt, and only passable if wide and well maintained. In general, the area is flat, with most homes clustered in the central area, providing many egress routes. Water supply is available via fire hydrants spaced throughout the community.

Home Ignition Zone Hazards

Homes are mostly old wood construction, with many shake shingle roofs, wood siding and old wood decks. Some roofs are asphalt shingle, but most homes have not been updated from wood construction. No defensible space has been completed on any of the properties. There are many hazards within 30ft of homes, and ground vegetation has typically not been cleared around homes or propane tanks.

Recommendations for Residents in South Nederland

- Contact Boulder County Wildfire Partners for a home assessment and recommendations tailored to your individual property.
- Defensible space is recommended. South Nederland should focus on HIZ 1 and 2. Removing overhanging limbs around structures, reducing density of conifers within 30ft of homes, and moving firewood, propane tanks, and other flammable materials away from structures. Grasses and vegetation should be removed from zone 1 and should be kept low in zone 2. For general defensible space recommendations, please refer to **Section 3.a. Defensible Space** in this document or see the CSFS HIZ guidebook.
- Home hardening is recommended. Wood roofs, siding, and decking should be replaced, or treated until able to be replaced. Vegetation should be cleared from under decks, and metal mesh installed to prevent embers from entering. Wooden fences should be replaced with noncombustible materials, and hardscape added to zone 1 around structures. For more recommendations refer to **Section 3.a. Home Hardening**, or see the CSFS HIZ guidebook.
- Work with neighbors to create linked defensible space. Projects that span multiple properties are more effective at reducing wildfire risk. Contractor costs can sometimes be shared among homeowners, reducing costs for everyone involved.
- Replace non-native conifers and other flammable vegetation with drought tolerant, fire-adapted local species. See CSU's FireWise Plant Materials list for more information.
- Add reflective, non-combustible address signs to all driveways and homes. NFPD is working to secure local suppliers for reflective addressing, but they can also be purchased inexpensively online at safetysign.com. Place address signs on non-combustible posts.
- Develop an evacuation plan for your family and any livestock that requires extra time to move. Sign up for emergency notifications from Boulder County ODM, and coordinate with neighbors who may need additional support during an emergency.
- Organize community action around educating neighbors and implementing defensible space and home hardening activities, including grass/weed management, and slash removal. Organize tours of properties with exemplary defensible space and home hardening for community members.


South Nederland
West Boulder Street
West Spring Street
West Breed Street
West Pine Street
East Pine Street
South Caribou Street
South Tilden Street
South Jackson Street
South Jefferson Street
South Hendricks Street
Eldora Road
South Rollinsville Road
Mcmillen Way
State Highway 119
72
119
Nederland
0
0.04
0.09
0.17 Miles
N
Legend
Nederland and Timberline FPDs
CWPP Plan Units
Potential roadside treatment need
Highest
High
CWPP priority projects
First
Second
Home ignition zone 3
Previous and ongoing fuel treatments
Public land
Non-residential highly valued resources
Child care center
Museum/historic site
Entertainment
Retail gas / propane
Communication tower
Local law enforcement
Health and medical
THE Ember Alliance
Coord. Sys.: NAD 1983 UTM Zone 13N
Projection: Transverse Mercator
Datum: North American 1983

Sundown
Relative Risk Rating: Moderate

Fuels and Fire Behavior Potential
The community referred to as Sundown combines Sunnyside and Indian Peaks communities outlined in the previous CWPP. The Sundown plan unit encompasses the denser builds and neighborhoods north of Nederland Town Center, and is bordered by Peak to Peak highway to the east and County Road 126 S to the west.

Because the area to the south of the community is developed, vegetation is not continuous, and would not allow for active crown fire to spread into the community. Lodgepole and ponderosa pine are the most common species, with some interspersed aspen. Ground vegetation is sparse. The understory in ponderosa forests is largely native grasses and shrubs like common juniper, typical of south-facing slopes. Both ponderosa and lodgepole forests are dense, though fuel continuity is patchy. There are multiple ravines and chimneys that have heavier fuels, including regeneration that could funnel fire to structures. Many homes sit along the ridge top of the sloped hill. It would be difficult for fire to get enough momentum to spread into the community, but higher wind speeds and higher temperatures may allow for active crowning and long flame lengths that would threaten structures. Boulder County Parks and Open Space has done extensive mitigation work adjacent to the community in the Mud Lake project area, which could help reduce the wildfire risk to the northern area of Sundown.

Fire Suppression and Evacuation Capabilities
There are multiple ways in and out of Sundown. Road widths are 20-24 feet and provide adequate turnarounds for fire equipment if driveways are utilized. The road network consists of some paved roads, but many are well-maintained dirt, though some roads need grading. Road navigation in the community can be difficult due to steep grades and vague road signage. Road signs are 4 inches high and reflective at some intersections, but completely absent, or made of wood in others. Home

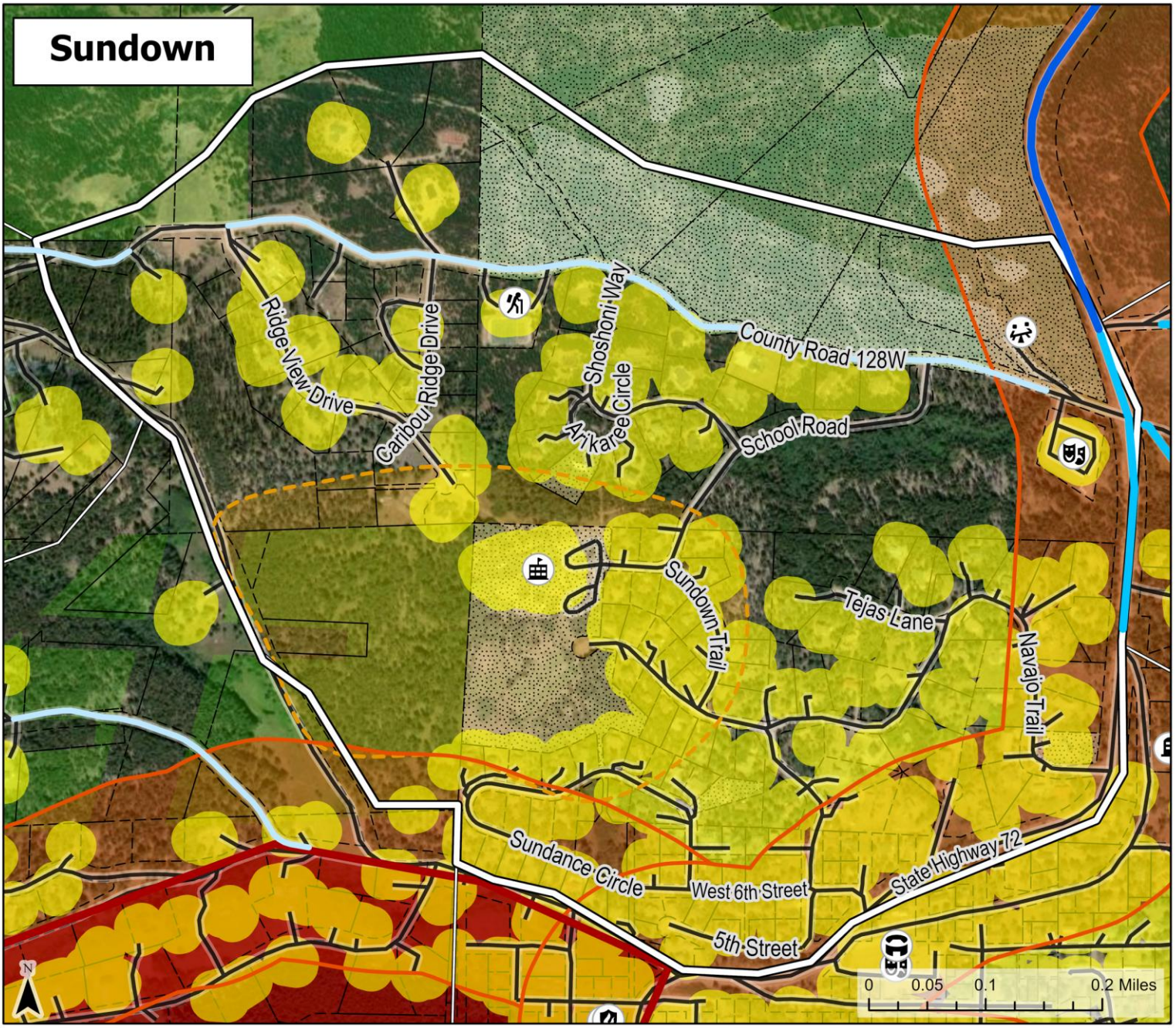
addresses also may be difficult to read at night or in smoky conditions because they are not reflective. Unlike many of the communities in the planning area, Sundown has water available via hydrants, though these are not located near every home. One of the greatest values-at-risk in this area is the elementary school. Evacuation for the school is critical. Congestion near the school has the potential to slow evacuation times. Depending on the location of a wildfire, the school may also be used as an evacuation center.

Home Ignition Zone Hazards

Defensible space and home hardening are mixed in this community. A couple of homes have achieved good defensible space, and a few residents have completed additional forest health thinning. A few exemplary homes use non-combustible materials for decking, siding and roofing; however, many others lack defensible space and have wooden fencing and decking attached to homes, and combustible siding. Most homes at least have asphalt shingle roofing. Other problems include areas under decks that are open with flammable vegetation and storage, and firewood stored nearby structures. Utilities to the structures are above ground, often hanging over the roads. Liquid propane gas tanks are present, so vegetation should be cleared around the tanks.

Recommendations for Residents in Sundown

- Contact Boulder County Wildfire Partners for a home assessment and recommendations tailored to your individual property.
- Defensible space is recommended. Sundown should focus on HIZ 2 and 3. Grasses and vegetation should be removed from zone 1 and should be kept low in zone 2. Reduce conifer density 5-100ft away from homes, and remove vegetation around propane tanks. For general defensible space recommendations, please refer to **Section 3.a. Defensible Space** in this document or see the CSFS HIZ guidebook.
- Home hardening is recommended. Wood siding and decking should be replaced, or treated until able to be replaced. Vegetation and other flammable materials should be cleared from under decks, and metal mesh installed to prevent embers from entering. Wooden fences attached to structures should be replaced with noncombustible materials, and hardscape added to zone 1 around structures. For more recommendations refer to **Section 3.a. Home Hardening**, or see the CSFS HIZ guidebook.
- Work with neighbors to create linked defensible space. Projects that span multiple properties are more effective at reducing wildfire risk. Contractor costs can sometimes be shared among homeowners, reducing costs for everyone involved.
- Clear roadways. Remove trees, shrubs, and tall grasses along private roads and driveways to improve evacuation safety and firefighter access during a wildfire. This is especially important for narrow driveways and road segments.
- Replace non-native conifers and other flammable vegetation with drought tolerant, fire-adapted local species. See CSU's FireWise Plant Materials list for more information.
- Add reflective, non-combustible address signs to all driveways and homes. NFPD is working to secure local suppliers for reflective addressing, but they can also be purchased inexpensively online at safetysign.com. Place address signs on non-combustible posts.
- Develop an evacuation plan for your family, and leave early if your evacuation route runs by the elementary school. Sign up for emergency notifications from Boulder County ODM, and coordinate with neighbors who may need additional support during an emergency.
- Organize community action around educating neighbors and implementing defensible space and home hardening activities, including grass/weed management, and slash removal. Organize tours of properties with exemplary defensible space and home hardening for community members.



Nederland and Timberline FPDs

CWPP Plan Units

Potential roadside treatment need

- Highest
- High
- Moderate

CWPP priority projects

- First
- Second
- Third

Home ignition zone 3

Previous and ongoing fuel treatments

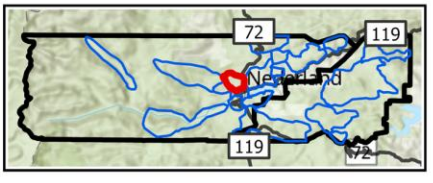
Public land

Non-residential highly valued resources

- Community center
- School
- Child care center
- Recreation area
- Cemetery
- Entertainment
- Communication tower
- Fire station

THE Ember Alliance

Coord. Sys.: NAD 1983 UTM Zone 13N
Projection: Transverse Mercator
Datum: North American 1983



Tungsten Mountain
Relative Risk Rating: Moderate

Fuels and Fire Behavior Potential

The Tungsten Mountain Plan Unit spreads across Nederland and Timberline FPDs. It incorporates communities along North Beaver and County Road 99 in TFPD and neighborhoods west of Highway 119 along Haul Road and Aspen Road. Both fuels and topography are highly variable in this plan unit, as it is one of the largest plan units identified in this CWPP. Dense mixed conifer and lodgepole stands predominate and show signs of both mistletoe and mountain pine beetle infestations; pitch tubes and red needles are present. There are also significant areas of riparian vegetation along Beaver creek, as well as aspen and open areas of meadow. Fast rates of spread should be expected through these meadow grasses. There is potential for extreme fire behavior in the dense mixed conifer and lodgepole forests, especially along the CR 99 drainage in the eastern part of the community, which can funnel fire towards structures. There have been some forest treatments in the area on both forest service and private lands, and lodgepole regeneration is showing in many places throughout the planning area. Frequent lightning, adjacent camping areas, and pile-burning create potential ignition sources.

Fire Suppression and Evacuation Capabilities

Roads throughout the community are in overall good condition, though grades can be steep for driveways, which are often narrow, long, and crowded with thick vegetation along the side of the road. It is unlikely that an engine would go up the driveways in a wildfire due to the thick

vegetation and an inability to see the homes at the end of the driveway. Signs and address markers are non-reflective and combustible. Water availability is insufficient.

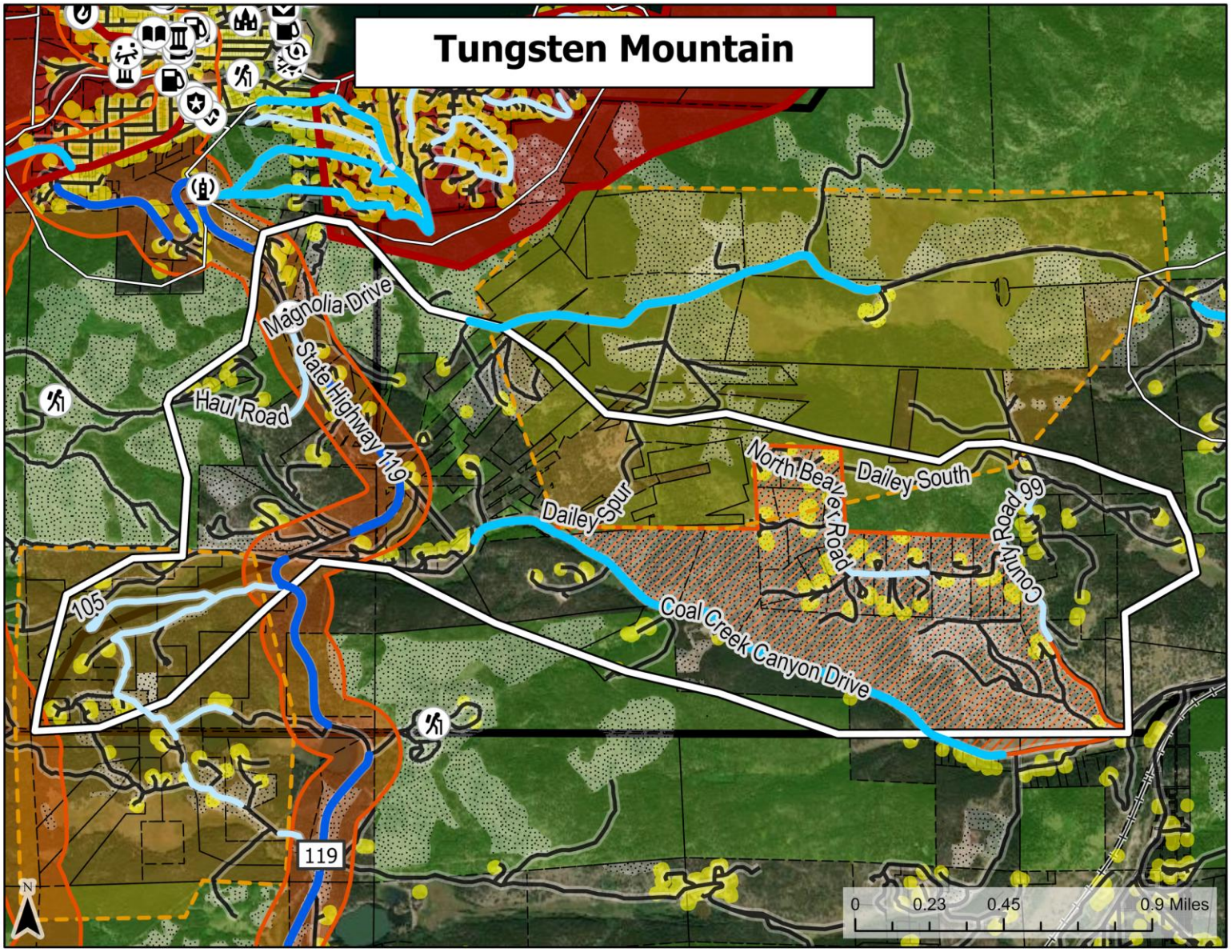
The homes concentrated off CR 99 lack an official secondary egress route. The road is narrow at the intersection of CR 99 and Highway 72, and could create a choke point during evacuation. There is a potentially viable secondary egress through Reynolds Ranch, however this route would need work, permission from the owners, and the gate opened during evacuation.

Home Ignition Zone Hazards

Some residents have done work around their houses, but more mitigation should be done. Fewer than 50% of homes have adequate defensible space in zones 1 and 2. Because homes are often far apart from each other, there is not much opportunity for linked defensible space here. There is a mix of construction materials. Some homes have metal roofs, some asphalt, and a couple still have cedar shake. Home siding and deck materials are made of combustible materials on most houses.

Recommendations for Residents in Tungsten Mountain

- Contact Boulder County Wildfire Partners for a home assessment and recommendations tailored to your individual property.
- Defensible space is recommended. Sundown should focus on HIZ 1 and 2. Remove overhanging limbs, and reduce conifer density 5-30 ft from homes. Grasses and vegetation should be removed from zone 1 and should be kept low in zone 2. Remove vegetation around propane tanks and outbuilding structures. For general defensible space recommendations, please refer to **Section 3.a. Defensible Space** in this document or see the CSFS HIZ guidebook.
- Home hardening is recommended. Cedar shake roofing, wood siding, and decking should be replaced, or treated until able to be replaced. Vegetation and other flammable materials should be cleared from under decks, and metal mesh installed to prevent embers from entering. Wooden fences attached to structures should be replaced with noncombustible materials, and hardscape added to zone 1 around structures. For more recommendations refer to **Section 3.a. Home Hardening**, or see the CSFS HIZ guidebook.
- **Work with TFPD and local landowners to improve road conditions along CR 99 where it meets Coal Creek Canyon Dr, to allow for safer, smoother 2-way travel. Work with Reynolds Ranch to create an official secondary egress route for community members in the CR 99 area.**
- Clear driveways and roadways. Remove trees, shrubs, and tall grasses along private roads and driveways to improve evacuation safety and firefighter access during a wildfire. This is especially important for narrow driveways and road segments.
- Replace non-native conifers and other flammable vegetation with drought tolerant, fire-adapted local species. See CSU's FireWise Plant Materials list for more information.
- Add reflective, non-combustible address signs to all driveways and homes. NFPD is working to secure local suppliers for reflective addressing, but they can also be purchased inexpensively online at safetysign.com. Place address signs on non-combustible posts.
- Develop an evacuation plan for your family, and any livestock that requires extra time to move. Sign up for emergency notifications from Boulder County ODM, and coordinate with neighbors who may need additional support during an emergency.
- Organize community action around educating neighbors and implementing defensible space and home hardening activities, including grass/weed management, and slash removal. Organize tours of properties with exemplary defensible space and home hardening for community members.



Nederland and Timberline FPDs

CWPP Plan Units

Parcels

Railway

Potential roadside treatment need

Highest

High

Moderate

CWPP priority projects

First

Second

Second-in progress

Third

Home ignition zone 3

Previous and ongoing fuel treatments

Public land

Non-residential highly valued resources

Place of worship

Community center

Child care center

Library

Recreation area

Museum/historic site

Entertainment

Retail gas / propane

Water treatment plant

Weather station

Communication tower

Bus station

Fire station

Local law enforcement

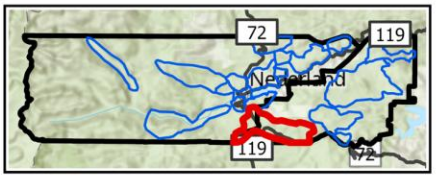
Local government

Post office

Health and medical

THE Ember Alliance

Coord. Sys.: NAD 1983 UTM Zone 13N
Projection: Transverse Mercator
Datum: North American 1983



Twin Sisters/Pine Glades
Relative Risk Rating: High

Fuels and Fire Behavior Potential

The Twin Sisters and Pine Glade community is dominated by drainages running southeast to northwest. These drainages create an environment primed for rapid rates of spread. Homes located in saddles, atop steep slopes and near chimneys further exacerbate the fire risk. Vegetation is variable throughout the community. To the west, rolling hills and some steep topography combine with forested areas composed primarily of lodgepole pine, mixed conifer, and spruce and fir to create the potential for extreme fire behavior. The northern section has large aspen stands and meadows and is thus less of a fire risk in certain areas. To the east, along Twin Sisters Road there is primarily open meadow and grassland, supporting ranches and grazing cattle. Throughout, there are also open, park-like stands of ponderosa pine with a grass understory component. Average weather conditions are most likely to support surface fire with some areas of torching. Under hot and dry weather conditions, higher winds and low fuel moistures, extreme rates of spread are possible in the lighter fuels, as is active crown fire, especially in the northwest of the community.

Fire Suppression and Evacuation Capabilities

The community does benefit from relatively wide, maintained roads, especially county roads. There are multiple egress points in the western area, though there are few turnarounds for fire apparatus. Driveways are long, narrow, and steep, and could be challenging for a type 1 engine to access. Residents along Twin Sisters Road only have one way in and out of their neighborhood. While the roads are wide and can accommodate 2-way traffic, there are many ranches with livestock in this area, and evacuation capacity could range from challenging to impossible.

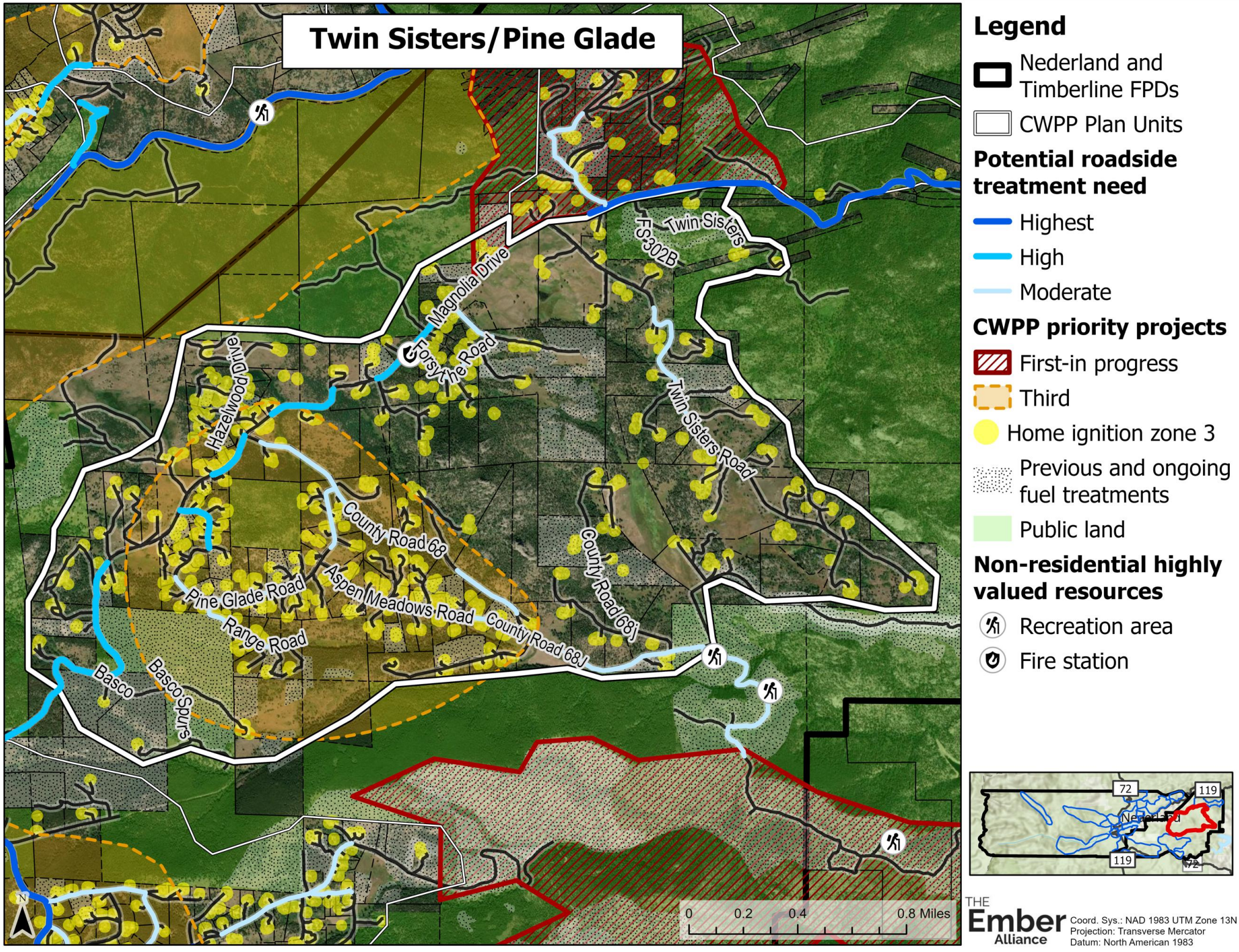
Addressing and signing is non-reflective, inconsistent and combustible. There are a handful of potential water supplies, including cisterns and ponds, but the volumes are limited and sometimes unknown. The ponds in the community's northern section could serve as viable water sources and should be noted in the event of a wildfire. Adequate water supply is an important consideration when addressing the fire risk to this community and must be part of any effort to reduce that risk.

Home Ignition Zone Hazards

Most homes lack any defensible space implementation and have combustible siding and decks. Roofs are typically asphalt shingle. Many homes had hazards such as old dilapidated wooden sheds and wood piles in zones 2 and 3. There is some potential for residents to create linked defensible space in the western part of the plan unit, but to the east homes are far apart, and therefore must focus on improving their own home hardening and defensible space.

Recommendations for Residents in Twin Sisters/Pine Glades

- Contact Boulder County Wildfire Partners for a home assessment and recommendations tailored to your individual property.
- Defensible space is recommended. Twin Sisters/Pine Glades should focus on HIZ 1 and 2. Remove overhanging limbs, and reduce conifer density 5-30 ft from homes. Grasses and vegetation should be removed from zone 1 and should be kept low in zone 2. Remove vegetation around propane tanks and outbuilding structures. For general defensible space recommendations, please refer to **Section 3.a. Defensible Space** in this document or see the CSFS HIZ guidebook.
- Home hardening is recommended. Cedar shake roofing, wood siding, and decking should be replaced, or treated until able to be replaced. Vegetation and other flammable materials should be cleared from under decks, and metal mesh installed to prevent embers from entering. Wood and other flammable materials should be moved at least 50ft away from structures. Wooden fences attached to structures should be replaced with noncombustible materials, and hardscape added to zone 1. For more recommendations refer to **Section 3.a. Home Hardening**, or see the CSFS HIZ guidebook.
- **Work with TFPD and Boulder County to create a secondary egress route for residents along Twin Sisters Road.**
- Clear driveways and roadways. Remove trees, shrubs, and tall grasses along private roads and driveways to improve evacuation safety and firefighter access during a wildfire. This is especially important for narrow driveways and road segments.
- Replace non-native conifers and other flammable vegetation with drought tolerant, fire-adapted local species. See CSU's FireWise Plant Materials list for more information.
- Add reflective, non-combustible address signs to all driveways and homes. NFPD is working to secure local suppliers for reflective addressing, but they can also be purchased inexpensively online at safetysign.com. Place address signs on non-combustible posts.
- Develop an evacuation plan for your family, and any livestock that requires extra time to move. Sign up for emergency notifications from Boulder County ODM, and coordinate with neighbors who may need additional support during an emergency.
- Organize community action around educating neighbors and implementing defensible space and home hardening activities, including grass/weed management, and slash removal. Organize tours of properties with exemplary defensible space and home hardening for community members.


Twin Sisters/Pine Glade
Legend
Nederland and Timberline FPDs
CWPP Plan Units
Potential roadside treatment need
Highest
High
Moderate
CWPP priority projects
First-in progress
Third
Home ignition zone 3
Previous and ongoing fuel treatments
Public land
Non-residential highly valued resources
Recreation area
Fire station
Magnolia Drive
Forsythe Road
Hazelwood Drive
FS-302B
Twin Sisters
Twin Sisters Road
County Road 68
County Road 68J
Aspen Meadows Road
Pine Glade Road
Range Road
Basco
Basco Spurs
N
0 0.2 0.4 0.8 Miles
72
119
Nederland
THE Ember Alliance
Coord. Sys.: NAD 1983 UTM Zone 13N
Projection: Transverse Mercator
Datum: North American 1983

West Ridge
Relative Risk Rating: Extreme

Fuels and Fire Behavior Potential

The community of West Ridge incorporates two communities identified in the previous CWPP as Whispering Pines and Hurricane Hill. It is north of Barker Reservoir with neighborhoods surrounding County Highway 103 as its northern border.

The south aspect of the West Ridge community receives sunlight for most of the day, leading to high quantities of grassy fuels and dispersed ponderosa pines. Patches of forest vegetation are connected by these grasses, making fuels continuous throughout the community. Dense stands of mixed conifer where Douglas firs grow from the understory and act as ladder fuels could allow fire transition into the tree crowns of the larger, more mature trees. Douglas fir and aspen are intermixed in the drainages; however, much of the aspen is small and diseased. At higher elevations, dense areas of lodgepole pine are present. Mistletoe is visible in both the lodgepole and ponderosa pines. Wildfire spread is likely to be fast uphill, though ignitions from Boulder Canyon are less of a concern because of cliff faces void of vegetation which may prevent fire moving uphill. The most extreme fire behavior would be expected at the top of hill along the Switzerland Trail road: higher flame lengths, greater rates of spread and more crown fire activity are expected in this area.

Fire Suppression and Evacuation Capabilities

The road network consists of both narrow, steep, dirt roads that are not graded regularly, and dirt and paved roads that are 20-24ft wide. Some road sections have slopes greater than 10%. There are adequate turnarounds for emergency vehicles, but some sections are not well-maintained. A few driveways are inaccessible due to steep, narrow roads. Structures sit at the top of steep hills and in saddles. Most street signs are reflective, but addressing is not always present, and when it is, is often non-reflective and created out of combustible materials. While there are many roads in and

out of the plan unit, some smaller neighborhoods have only one road leading to a few homes. Private drives are occasionally only one lane. Low-hanging utility lines and vegetation directly along the roadway pose an additional threat for emergency response and for residential egress. There are hazmat concerns at the forest sort yard and the bus depot. Water supply is available through individual cisterns for the homes, and from Barker Reservoir to the south, but there are no hydrants.

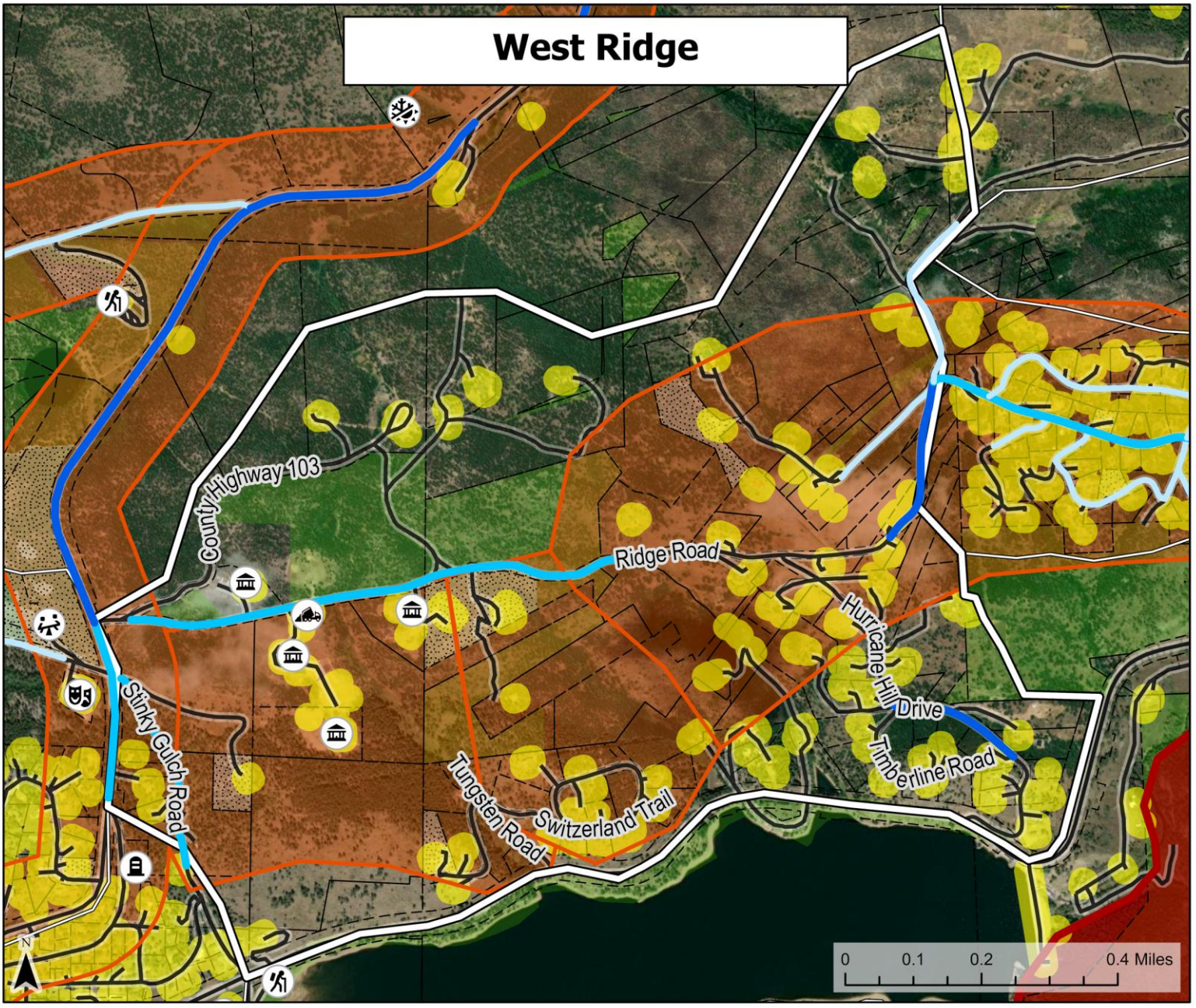
Home Ignition Zone Hazards

Many of the homes in the community have been built more recently compared to other areas in Nederland. As a result, the roofs are typically metal or other materials that are highly resistant to burning, and some homes have adequate defensible space. The siding and decks are made of combustible materials, but some homes have non-combustible siding, such as stucco. The decks are open below and some have flammable materials stored underneath. Newer structures have some defensible space, but older homes typically do not. Liquid propane gas tanks provide an additional risk when vegetation is not cleared around them.

Recommendations for Residents in West Ridge

- Contact Boulder County Wildfire Partners for a home assessment and recommendations tailored to your individual property.
- Defensible space is recommended. West Ridge should focus on HIZ 1. Remove overhanging limbs, and reduce conifer density 0-30ft from homes. Grasses and vegetation should be removed from zone 1 and should be kept low in zone 2. Remove vegetation around propane tanks and outbuilding structures. For general defensible space recommendations, please refer to **Section 3.a. Defensible Space** in this document or see the CSFS HIZ guidebook.
- Home hardening is recommended. Wood siding and decking should be replaced, or treated until able to be replaced. Vegetation and other flammable materials should be cleared from under decks, and metal mesh installed to prevent embers from entering. Wood and other flammable materials should be moved at least 50ft away from structures, and hardscape added to zone 1. For more recommendations refer to **Section 3.a. Home Hardening**, or see the CSFS HIZ guidebook.
- Work with neighbors to create linked defensible space. Projects that span multiple properties are more effective at reducing wildfire risk. Contractor costs can sometimes be shared among homeowners, reducing costs for everyone involved.
- Clear driveways and roadways. Remove trees, shrubs, and tall grasses along private roads and driveways to improve evacuation safety and firefighter access during a wildfire. This is especially important for narrow driveways and road segments.
- Replace non-native conifers and other flammable vegetation with drought tolerant, fire-adapted local species. See CSU's FireWise Plant Materials list for more information.
- Add reflective, non-combustible address signs to all driveways and homes. NFPD is working to secure local suppliers for reflective addressing, but they can also be purchased inexpensively online at safetysign.com. Place address signs on non-combustible posts.
- Develop an evacuation plan for your family, and any livestock that requires extra time to move. Sign up for emergency notifications from Boulder County ODM, and coordinate with neighbors who may need additional support during an emergency.
- Organize community action around educating neighbors and implementing defensible space and home hardening activities, including grass/weed management, and slash removal. Organize tours of properties with exemplary defensible space and home hardening for community members.

West Ridge



Nederland and Timberline FPDs

CWPP Plan Units

Potential roadside treatment need

- Highest
- High
- Moderate

CWPP priority projects

- First
- Second
- Home ignition zone 3

Previous and ongoing fuel treatments

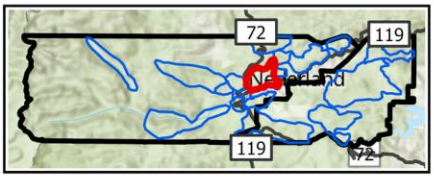
Public land

Non-residential highly valued resources

- Child care center
- Recreation area
- Cemetery
- Entertainment
- Solid waste landfill facility
- Weather station
- Local government
- Post office

THE Ember Alliance

Coord. Sys.: NAD 1983 UTM Zone 13N
Projection: Transverse Mercator
Datum: North American 1983



4. Implementation Recommendations for Fuel Treatments, Ecological Restoration, and Community Resilience

Blending Community Values and Core Team Expertise

The following recommendations have come out of a unique process that incorporated both community priorities and core team expertise to prioritize fuel treatments and fire resilience actions proposed here.

Through the fall and winter of 2023-2024, the NFPD/TFPD and representatives from land management agencies and other partner groups met to refine project areas and assign project leads. Projects were prioritized through a process that involved ranking each project for both feasibility and impact. Projects include roadside fuel treatments, **ecological restoration**, and stand-level fuel reduction treatments within and around NFPD/TFPD to be implemented in the next 5 years. These project areas cross ownership boundaries and require community-wide commitment, coordination, and collaboration among public and private landowners, to create successful outcomes.

A community engagement process called Public Participatory Geospatial Information System (PPGIS) was used to solicit community input. Four workshops were held with the primary objective of spatializing community members' personal values as they relate to wildfire, and generating a list of commonly described project priorities from community members. Community members were asked to draw polygons on a map and describe how the polygon is associated with 1) fire resilient landscapes, 2) fire adapted communities, 3) safe and effective fire response, and 4) personal values. Participants were asked to describe those values as they relate to the polygon, and provide specific actions they recommended to support those values. For example, a participant might circle Barker Reservoir and note "access to clean water" in the circle, and then name a specific action to support that value, such as "reduce erosion from roadway". After participants had marked as many areas as they could in the time allowed, participants were then told to rank the actions and areas identified by their fellow participants, in order to identify both the frequency (i.e. number of people supporting that action) and intensity levels (i.e. amount of imaginary money out of $100 allocated to that action) of those recommendations. Projects that were ranked highest reflected community member's top priorities.

These workshops identified community priorities and recommendations for location-specific actions ("place-based" actions), and generalizable actions that were not connected to specific locations ("non-place-based" actions). In addition, community input was solicited in 2022 by a team of University of Colorado graduate students. This initial community input was documented from 38 interviews and three community visioning workshops, providing non-place-based actions for wildfire resilience. All community recommendations from 2022 and 2023 were discussed with the core team and went through a ranking process for feasibility and impact.

The results of the prioritization process have been organized following the National Cohesive Wildland Fire Management Strategy goals. Recommendations for actions that prepare community members for wildfire are organized under Fire Adapted Communities, while recommendations for agencies and organizations are organized under Safe and Effective Wildfire Response. Place-based fuels treatments and ecological restoration projects are covered under Resilient Landscapes.

Implementation Phases

Short-term actions	Mid-term actions	Long-term actions
• Can be implemented within the remainder of 2024. • Can be accomplished within the current funding capacity for the fire district, and residents. • Can occur within the context of the current FPD staffing, with modest expansion. • Can capitalize on current relationships with emergency response partners and land managers.	• Can be implemented within 18-24 months, generally in 2025 and 2026. • Will require expansion of the current volunteer base. • Requires new cooperative relationships with emergency response partners, land managers, and non-profit organizations. • Actions that are already in the planning stages and have some portion of funding already identified.	• Require planning to start within 18-24 months so implementation can occur after 2025. • Requires multi-year planning and funding. • Requires extensive grant funding. • Requires local staffing beyond volunteers.

4.a. Fire Adapted Communities

The following actions are the top priority actions, as ranked by community members and the core team for their feasibility and perceived impact, for community preparedness and adaptation.

1. Communication and outreach campaigns (tailored to the community)

There is a strong desire among Nederland, Timberline, and other community members to be engaged in the process of preparing for wildfire. A robust engagement program, that includes tailored events, messaging, and engagement opportunities in multiple mediums (online, in print, or in person) can build community capacity and the wildfire-informed public required for maintaining a Fire Adapted Community.

Community engagement campaigns should educate the community about wildfire topics. A successful campaign should consider diversity, equity and inclusion by including variable engagement methods, and the cultivation of an inclusive environment, that makes meetings, events, and educational materials accessible to everyone. Wildland fire impacts increase existing systemic inequities, resulting unevenly distributed impacts to historically marginalized, underserved, impoverished, and excluded populations. These education and communication campaigns mainly center around:

- Home hardening and defensible space
- Evacuation and emergency preparedness planning
- Forest and fire ecology
- Renter and new resident education
- Smoke communications

Rihanna Truex

From 2022 community engagement work and the PPGIS mapping workshops in 2023, community members provided a list topics of interest for outreach campaigns:

- Plan evacuation and emergency preparedness education events with fire professionals to increase preparedness levels of the community. Share through many channels including the local newspaper, social media sites and other online services, and events such as school programs to increase awareness among youth.
- Host a series of workshops that tailor education at the neighborhood level on what to prioritize from home assessment programs and building codes related to wildfire. Host training courses for chainsaw skills from fire professionals using previous models like Saws and Slaws.
- Provide resource packets to all homeowners about available resources to help overcome barriers such as the lack of funding, time, or skills. Provide residents with information on local wildfire planning, home hardening and defensible space, emergency preparedness and evacuation, and smoke readiness education.

2. Increased fire ban signage

Reducing the prevalence of human-caused wildfires is an important step towards becoming a Fire Adapted Community. The Peak to Peak area receives tourists from all across the country, who may not be informed about wildfire risk or fire bans. Campfires and other ignition sources from tourism pose a great risk to the community. Wildfire-informed visitors can help prevent unwanted ignitions.

Fire ban signs should be placed at each entrance into the Town of Nederland (and other critical locations), and should be updated regularly to reflect wildfire risk information and whether a fire ban is in effect. Further educational efforts should be made to reach non-resident recreators and visitors, to help prevent accidental ignitions.

3. Create a Community Leader Program (for community members and professionals to work together)

Wildfire Community Leader Programs (CLP) are a coalition of community members, local non-profits, and other local organizations that share a common goal of mitigating the impacts of wildfire. CLPs are dedicated to improving community preparedness, tackling hyper-local obstacles to home and landscape mitigation, and educating residents about wildfire preparedness actions, organized at the neighborhood scale.

Modeled off national Wildfire Community Leader Programs like Fire Adapted New Mexico Learning Network and Tahoe Network of Fire Adapted Communities, a wildfire neighborhood leader program in the Peak to Peak area would connect residents and agencies doing wildfire mitigation and education work. The CLP would act as resident-centered network designed to help mobilize other community members to help protect lives, property, and other community values from wildfire impacts.

Neighborhood ambassadors take an active role in community engagement campaigns, help design informational events, and act as a liaison between wildfire organizations and their neighbors. An

active, organized, and dedicated community working to prepare their homes and neighborhoods for wildfire can significantly decrease wildfire impacts in their community.

The following is a list of ways that community members envisioned a community leader program being utilized.

- Connect with neighborhood organizations and work together to implement home mitigation and emergency response efforts. This can include helping residents who need extra aid during a wildfire, coordinating phone chains during an evacuation, or coordinating assistance for mitigation projects.
- Maintain open lines of communication between the community and wildfire professionals, such as through text chains that provide information on fire bans, forest management, or evacuation status.
- Coordinate meetings between neighborhoods to share knowledge and/or labor, and engage the community through social media, local news outlets, or events connected with other local organizations.
- Coordinate mitigation work through programs to collect slash, collectively hire labor, or organize chipping days.

4. Town Codes that require fuels treatments along public roadways

Many roads in the FPD are crowded by dense conifer trees that overhang the roads. During a wildfire scenario, these roads could become non-survivable roads, blocking off important egress or evacuation routes. Treatments along roadways can help keep residents and first responders safe and can act as fuel breaks to strategically slow fire in certain places, giving firefighters more time to protect lives and property. Fuels along roadsides fall under the jurisdiction of Boulder County Land Use Planning (BCLUP). Collaborate with BCLUP to create Town Codes that require adequate mitigation along public roads in order to help improve many neighborhoods' egress and evacuation routes. See the recommendations for Roadside Fuels Treatment in **Appendix C: Objectives and Benefits of Fuel Treatments and Ecological Restoration**.

5. Increased sort yard availability

The community forestry sort yard located in Nederland and run by Boulder County serves a large community of front range residents, including people who live outside of the CWPP project area. It is a valuable resource to anyone taking mitigation actions on their property. The capacity and availability of this sort yard must keep pace with the growing effort to reduce wildfire risk around residents' homes and properties.

Wildfire season, once defined as the late summer and fall months, is now all year long. The sort yard should expand its hours, seasonal availability, and capacity to accept slash and wood material to reflect the expanding need of residents. An air curtain burner may be an asset to increase the sort yard's capabilities.

Table 3: Prioritized List of Recommended Actions for Community Preparedness

Recommendation	Priority	Responsibility	Timeline
Category: Fire Adapted Communities			
Communication and outreach campaigns (tailored to community)	1	NFPD/TFPD, BWC, CSFS, Wildfire Partners (WP)	Ongoing
Increased fire ban signage	1	NFPD, USFS, Boulder County Sheriff's Office (BCSO), Town of Nederland	Short-term
Wildfire community leader program	1	BWC, Residents, NFPD/TFPD	Short-term
Create codes for roadway fuel mitigation	1	Town of Nederland, Boulder County Land Use Planning (BCLUP)	Long-term
Expanded sort yard availability/capability	1	Boulder County Parks and Open Space (BCPOS)	Long-term
Funding/support for mitigation especially for low-income residents	1	Town of Nederland, WP, CSFS	Short-term
Landscaper training for HIZ work (community priority)	1	WP	Long-term
Enhance wildfire resistant building codes (community priority)	1	Town of Nederland, BCLUP, NFPD	Long-term
Better communication about forestry projects, transparency about wildlife/water impacts (community priority)	1	USFS, CSFS, BWC, Town of Nederland, Boulder Valley and Longmont Conservation Districts (BVLCD)	Short-term
Recreation restrictions - manage 4th of July trails shuttle for traffic management (community priority)	1	BCSO, USFS, City of Boulder	Short-term

Plan for elderly and unhoused population support during evacuation	2	BCSO, Town of Nederland, NFPD, TFPD, BWC, Community, Boulder County Office of Disaster Management (ODM)	Long-term
Local pile-burning cooperative	2	USFS, NFPD/TFPD, TEA, CSFS, Division of Fire Prevention and Control (DFPC), Community	Long-term
Funding for slash removal	2	NFPD/TFPD, CSFS, BWC	Long-term
Emergency preparedness campaign for businesses	2	Town of Nederland	Long-term
Resources webpage/mailer provided to community	2	WP, Town of Nederland, NFPD/TFPD, BWC	Short-term
Local mitigation team	2	Community, NFPD/TFPD, Town of Nederland, BWC	Long-term
Realtor, renter, & short-term rental education campaign	2	Community, NFPD/TFPD, Town of Nederland	Long-term
Research & use resources such as Smoke Ready Communities	3	WP, NFPD/TFPD, Town of Nederland	Long-term
Public smoke tracking resources	3	CSFS, BCSO, Colorado Department of Public Health (CDPH)	Long-term
Purchase air curtain burner	3	Boulder County, Town of Nederland, NFPD/TFPD	Long-term
Improve insurance coverage in wildfire areas - (legislation)	3	Community, Town of Nederland, Boulder County	Long-term
HIZ labor support (Saws & Slaws, etc.)	3	NFPD/TFPD, BWC, Town of Nederland, Boulder County	Mid-term
Reduce smoke impacts	3	Boulder County, CSFS, Community, NFPD/TFPD, USFS	Long-term
Historic structure hardening support	3	Town of Nederland, Boulder County	Long-term

4.b. Safe, Effective, Risk-based Wildfire Response

Four Mile Fire

The NFPD, TFPD and other wildfire response agencies strive to ensure the safety and wellbeing of the community. Community support is vital to the success of local fire protection districts. Both the NFPD and TFPD are supported by volunteers who respond to emergencies such as fires, medical emergencies, and rescues. The local community can further support their fire districts by signing up to volunteer, attending events, and seeking out information to protect their homes from fire danger.

1. Roadside mitigation on evacuation routes
Agencies should collaborate to accomplish roadside mitigation on major evacuation routes. The primary evacuation routes out of the project area are Hwy 119 that runs from Boulder, through Nederland and south to Rollinsville, and Peak to Peak Highway that runs north to Ward. These primary roads should be mitigated to improve roadway survivability. Recommendations for how to conduct roadway treatments can be found in **Appendix C: Objectives and Benefits of Fuel Treatments and Ecological Restoration**.

Many more roads besides these main highways in the FPDs also require mitigation. Access roads that connect neighborhoods to these main lines of evacuation should be prioritized first, and then other roads treated as needed. See the included Roadside Fuels Treatments map to help plan and execute recommended treatments.

Survivable roadways are necessary for protecting resident and responder lives. Firefighters' lives are prioritized over property, so ensuring that roadways are safe and accessible for wildfire response means that more homes and structures may be defended, and that firefighters are not put in unnecessarily risky situations.

2. Improve ingress/egress routes throughout the community
Agencies and communities should collaborate to improve roads in key places within neighborhoods. Many neighborhoods throughout the CWPP project area have only a single access road that is not wide enough for two-way travel. Some roads can be steep, winding, or poorly maintained dirt roads that are not level. In places where poor road conditions impact singular or secondary egress routes, these roads should be improved to allow for smooth and effective evacuations and wildfire response.

Where feasible, the number of egress routes from a community should be increased. Plan units that would benefit from improved or secondary egress routes are:

- Big Springs (secondary egress)
- Bonanza (improved egress)
- Cold Springs (secondary egress)
- Comforter Mountain (secondary egress)
- East Ridge (improved egress)
- Eldora (improved egress)
- Fourth of July (improved egress)
- Lazy Z (secondary egress)
- Nederland (second bridge on Snyder and First)

- Pinecliffe (improved egress)
- Porter Ranch (secondary egress)
- Tungsten Mountain (improved egress, secondary egress)
- Twin Sisters/Pine Glades (secondary egress)

3. Increase joint trainings between local emergency response agencies
Mutual aid agreements between fire departments are an effective way to increase the speed and capability of a fire response team. Pooled resources improve efficiency, response times, and available personnel. NFPD and TFPD already have mutual aid agreements in place, but there are opportunities to increase the number of joint trainings to improve interdepartmental coordination. Drills that incorporate the use of local district tactical maps are important so that both departments are familiar with the local terrain. Additionally, trainings between neighboring fire protection districts such as Sugarloaf, Coal Creek Canyon, and Indian Peaks Fire Protection Districts could provide increased capacity that would benefit all districts.

4. Funding for Type 3 Engine for NFPD
The NFPD requires appropriate tools and firefighting apparatus to effectively protect the community. There is a need for another Type 3 Wildland Firefighting Apparatus at the NFPD. The NFPD and Town of Nederland should develop a funding plan for this needed purchase. Funding can come from grants like the Assistance to Firefighters Grants (AFG), which provide critical response resources for firefighters and emergency responders, or local initiatives to help fund crucial fire department needs.

5. Improve and diversify emergency communications
Not all residents and community members in the project area have easy access to the internet and cell service. Tourists, including hikers, backpackers, campers, and others, also may not have access to internet and cell-based notification systems. It is important, especially during the crucial period at the start of a wildfire, to have a quick, widespread system for disseminating emergency notifications that could potentially save lives. Redundancy in evacuation and emergency notifications are necessary, as it is possible for any one method to fail to reach residents for a variety of reasons. Investment in other notification systems that can reach people out of internet or cellular range is therefore recommended. Options include HAM radio networks, weather radios, alert systems run through landlines, call-in hotlines, local radio announcements, sirens, and others. Conduct a strong outreach campaign to ensure that residents have at least one, if not multiple, methods to receive alert notifications, so that there is less chance of community members missing alerts. Informational signs for hikers and other transient populations can help educate people who are not plugged into the alert infrastructure to be aware of the possibility of the need to evacuate in the case of a wildfire.

Table 4: Priorities for Safe and Effective Fire Response

Recommendation	Priority	Responsibility	Timeline
Safe, Effective, Risk-based Wildfire Response			
Roadside mitigation on evacuation routes	1	Town of Nederland, Boulder County Road and Bridge (BCRB), CDOT	Long-term
Improve ingress/egress routes throughout community	1	Town of Nederland, BCRB and ODM, Community	Long-term
Increase joint training between local emergency response agencies	2	NFPD/TFPD, DFPC	Mid-term
Funding for Type 3 engine for NFPD	2	NFPD, Town of Nederland	Short-term
Improve and diversify emergency communications	2	ODM, Town of Nederland,	Long-term
Cistern installment/ improvement	2	Town of Nederland, NFPD/TFPD	Long-term
Increase the number of career FPD staff	3	NFPD/TFPD, Community	Long-term
Improve public messaging during wildfire incidents, make consistent and accessible	3	NFPD/TFPD, BCSO and ODM, USFS, Town of Nederland	Short-term
Town evacuation drills	3	Town of Nederland, NFPD/TFPD	Mid-term

4.c. Resilient Landscapes

Resilient landscapes are defined by the National Cohesive Wildland Fire Management Strategy as landscapes that are resilient to fire, insects, disease, invasive species, and climate change disturbances. The priorities for achieving resilient landscapes outlined in this section are place-based treatment plans for key areas. These treatments cover a wide range of goals for protecting the community, including wildfire risk reduction, egress route improvement, and ecological restoration. Each treatment will be designed differently based on the specific desired outcomes, forest type, and other project specific needs. A description of goals and treatment types is provided in **Appendix C**.

In addition to place-based priorities for creating resilient landscapes, the core team also identified strategies to help guide land management actions.

1. Cross-boundary Forest Management

Wildfire risk is distributed across landscapes without respect to ownership boundaries. Cross-boundary forest management, across public and private ownership, can be more effective, efficient, and cost-reasonable. When planning and designing fuel reduction treatments to reduce wildfire risk and/or improve forest health it is best to evaluate projects first from environmental and topographical perspectives and then consider ownership boundaries. Cross-agency and cross-neighbor projects can often be more effective at accomplishing specific objectives, like reducing wildfire risk, than single landowner projects.

Across larger areas of land, usually owned by local, state, and federal agencies, cross boundary forest management can provide wildfire risk reduction, as well as create opportunities for meeting ecological objectives. Treatments that are designed to follow landscape contours and natural ecosystem boundaries across many ownership ranges are better able to capitalize on opportunities to combine risk reduction and forest health benefits than those that must treat each parcel of land individually (Schulte et al., 2008).

Partnership agreements such as the Good Neighbor Authority (GNA)- which allows state agencies to manage projects on federal lands - are integral to the success of wildfire risk reduction activities in WUI areas such as the NFPD/TFPD where land ownership is a patchwork of private, municipal, county, and federal land. Community members looking to complete wildfire mitigation on their property should also consider partnering with other community members, or reaching out to local agencies to see if their land can be incorporated into larger wildfire mitigation and ecological restoration projects.

Figure 38: The aftermath of the 2021 Bootleg Fire in Oregon. The Klamath Tribes, working with the USFS, applied prescribed fire to only part of the forest before this area burned in the Bootleg Fire. Thinning was more effective at reducing wildfire severity when combined with prescribed fire. Photo Credit: Steve Rondeau, Klamath Tribes Natural Resources Director.

2. Plan fuels treatments with the goal of restoring natural fire regimes

Ecological restoration is the process of assisting the recovery of an ecosystem that has been degraded or damaged or destroyed (SER 2024). In the Peak to Peak area, the colonization of Native Land by Euro-American settlers had multiple effects. Many mountain wetlands were built over or otherwise altered or destroyed, and the historical fire regime was altered, in part due to fire suppression. In many areas, forests are denser, more homogenous across the landscape, lacking aspen stands, meadows and other first successional species. Ecological restoration in this context can include restoring wet meadow systems to improve hydrology, sediment storage, and biodiversity, reconnecting floodplains to reduce negative impacts from post-wildfire flooding and sediment transport, and preparing forests to receive fire (wildfire or prescribed fire) to harness its regenerative effects with less damage to human values.

The combination of dense forests and a changing climate with drier conditions have increased the size, duration and severity of wildfires in the West. In some areas, high severity wildfires are causing forested landscapes to transition into grasslands as overstory seed sources are lost.

Fuel treatments include hand thinning, mechanical fuel reduction and prescribed fire like slash pile burning and broadcast burning. In many areas it is necessary to reduce the fuel load through

thinning or mechanical treatment first, before prescribed fire can safely be applied to the landscape.

There are many benefits to using prescribed fire as a forest management tool. These include improving wildlife habitat by creating a more diverse mosaic of habitat, reducing wildfire hazards, reducing forest density and removing surface fuels, increasing meadow opening sizes and prevalence on the landscape, regenerating fire-dependent herbs, forbs, and shrubs, and increasing species diversity.

"Prescribed fire is an important element of restoration in Colorado's Front Range because burning influences nutrient cycling and cues germination and resprouting of some fire-adapted understory plant species. Without this burning, needle litter and wood builds up on the forest floor, creating high levels of surface fuels." (USFS Rocky Mountain Research Station, 2018)

3. Post-fire recovery plans specific to Nederland area
Wildfire is inevitable in the project area and can have damaging impacts on landscapes, water quality, and the built environment. Rather than assume wildfire will not impact your community, it is better to plan for the possible effects of wildfire and prepare to mitigate those impacts.

The Colorado Post Fire Recovery Playbook is an excellent resource for planning ahead to address wildfire impacts. The NFPD/TFPD and Town of Nederland should commit to filling out section 1 of the playbook annually, to ensure that the networks and partnerships required for effective response are up to date and aware of their individual roles and responsibilities in the case of a wildfire.

Wildfire Insurance:
Wildfire insurance is an important part of post-fire recovery where fire has impacted structures and human communities. However, wildfire-specific insurance is becoming more inaccessible for WUI communities as the impacts of wildfire grow year after year. Resources to help residents with their wildfire insurance plans include United Policyholders and the Colorado Department of Regulatory Agencies (DORA). Further work should be done to improve insurance accessibility and affordability for homeowners.

4.d. Place-based Priorities for Resilient Landscapes

Project areas were identified by assessing potential need for treatment based on fire behavior, home exposure, infrastructure and values, evacuation hazards, past fuel treatments and future work, potential funding sources, connection with community members, 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 mitigation and decision making and tactical operations during wildfire events.

The section below delineates focus areas with potential treatment recommendations, objectives and benefits, potential project leads, and relative importance. These resilient landscape priorities all need further community engagement, planning, and project development in order to define on-the-ground work. This includes a host of strategies that will be considered - where, how, (e.g. mechanical or manual), when, and who will implement, maintain, and monitor these projects. Other considerations include: wildlife habitat, riparian and wetland areas, and water quality. Attention to long-term monitoring should be a component in project development. See the Monitoring Handbook created by the Colorado Forest Restoration Institute for guidelines and best practices when designing monitoring programs for forest projects.

The CWPP implementation plan for stand-level and roadside treatments focuses on high-priority locations, but this does not discourage ecological restoration and fuel reduction 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. NFPD, TFPD, local organizations, residents, and land managers should reevaluate fire risks and reprioritize treatment units as conditions change over time.

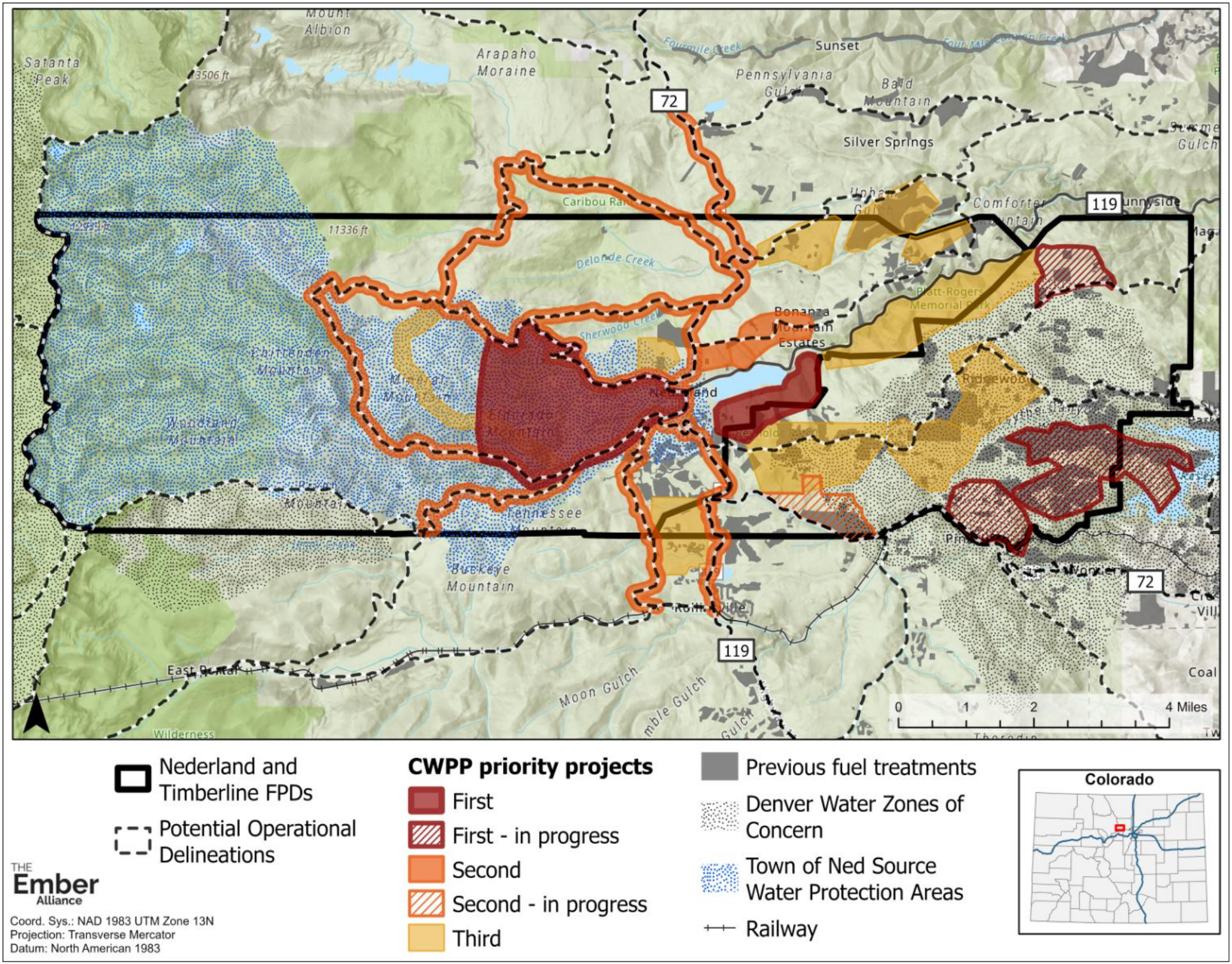


Figure 39: Prioritized treatment recommendations for fuel reduction and maintenance of resilitient landscapes. Source: The Ember Alliance

Forsythe

Treatment is ongoing at the Forysthe project site, which ranges over 1,360 acres in an area that encompasses forested terrain partially located within TFPD along Winiger Ridge and within Roosevelt National Forest. The majority of the land is owned by USFS. Broadcast burn treatments have been applied to some parts of the Forsythe project, but need to be maintained and reapplied as needed. This project is critical to the protection of Gross Reservoir and lies within Denver Water's Zone of Concern. The terrain in this area is steep, and fire behavior is expected to be extreme without treatment.

Treatment Objectives

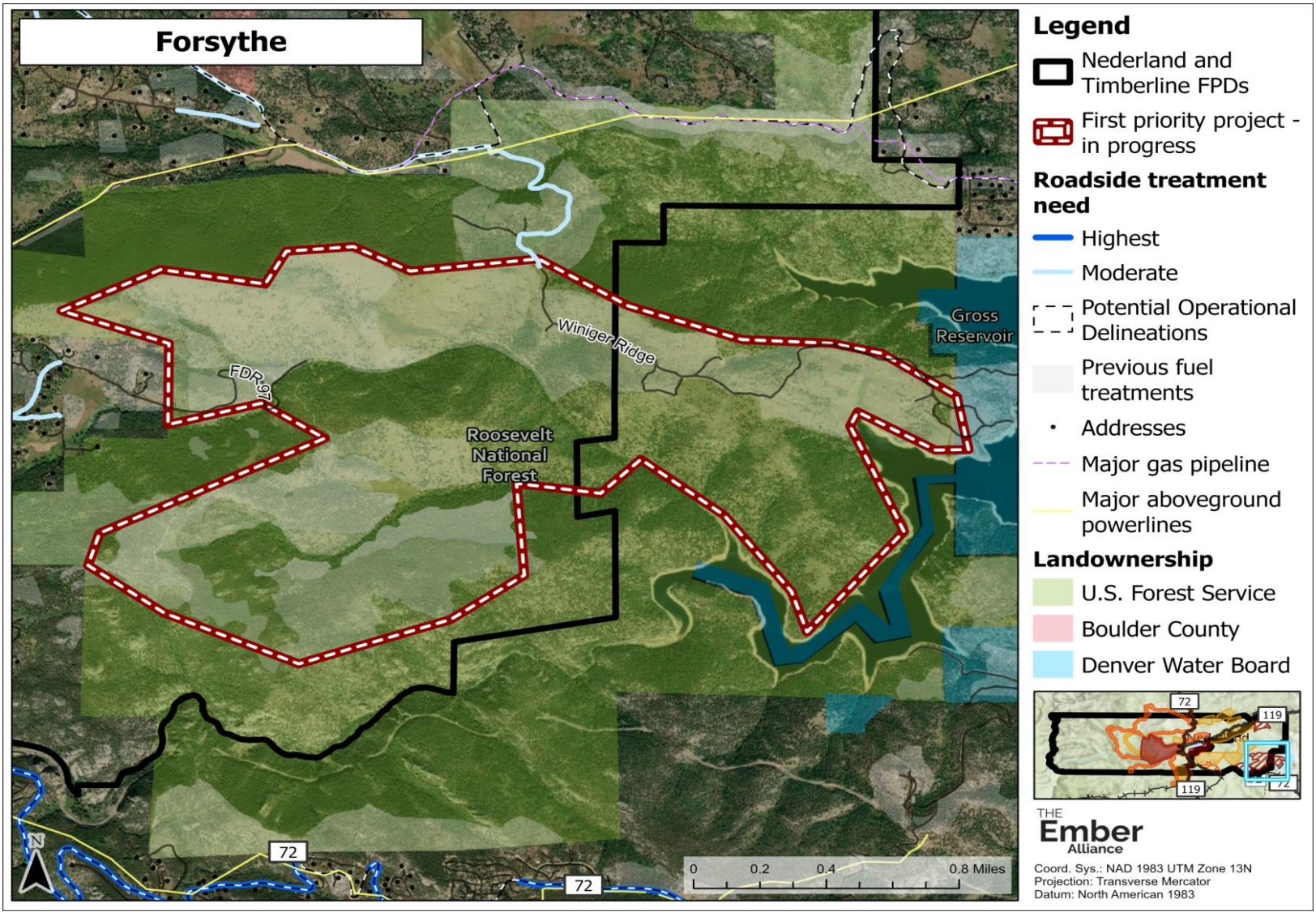
- The primary treatment objective is to maintain ongoing controlled burn treatments to keep fire intensity levels low. Benefits of reducing fire intensity in this area include protecting water quality and water resources for Denver and Boulder.

Treatment Type

- Broadcast burning, in multiple applications; reentry as needed

Potential Lead Organizations

The USFS leads this project.



Middle Magnolia

Middle Magnolia project covers 381 acres, and is located in TFPD north of Magnolia Drive. A Good Neighbor Authority (GNA) would be appropriate for this project. Forests in this project area are primarily composed of dense ponderosa stands, with some lodgepole pine stands. Trees crowd roads and could create potentially non-survivable road conditions. The project area sits within Denver Water's Zone of Concern.

Treatment Objectives

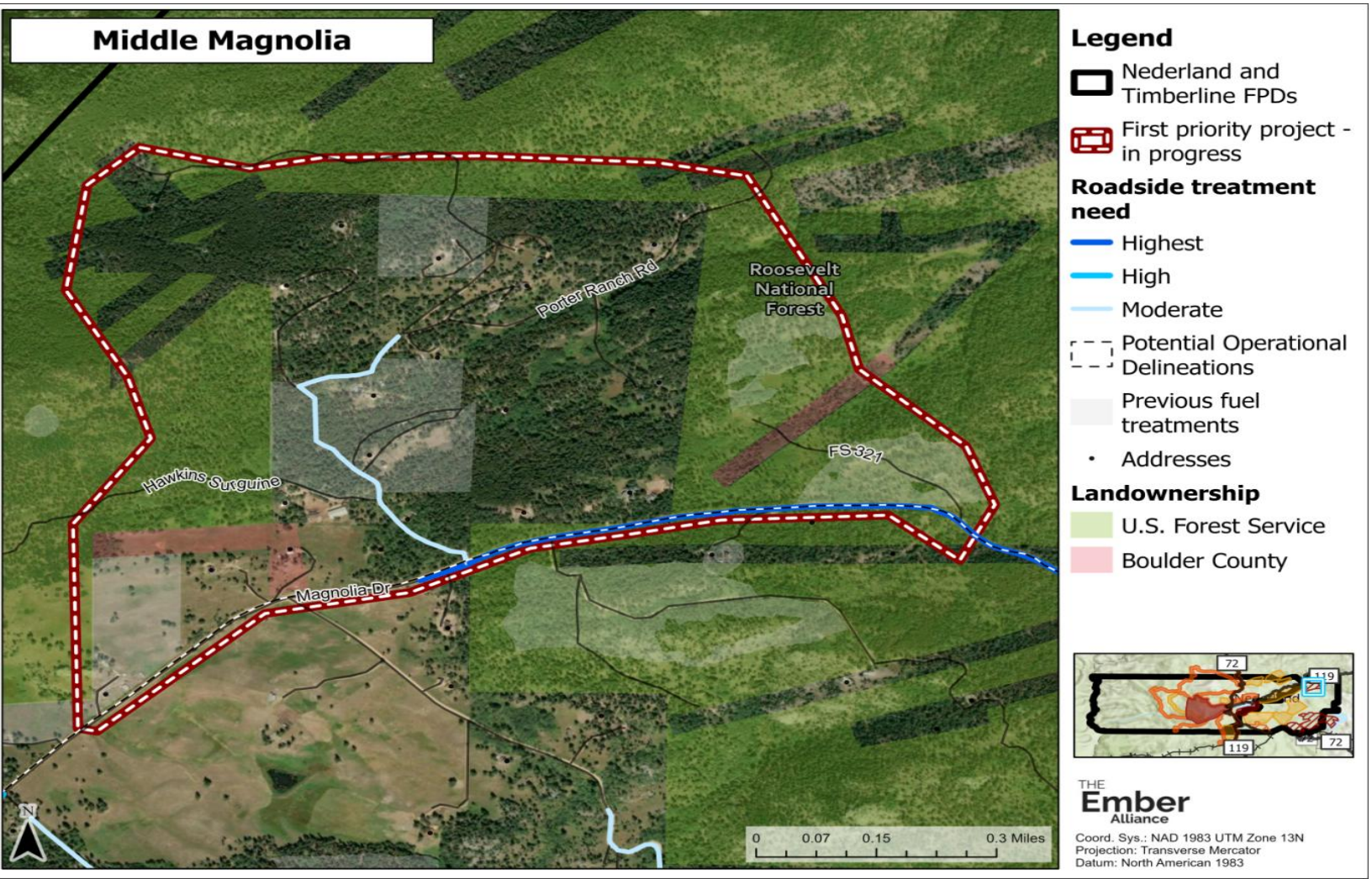
- The primary treatment objective is to protect homes and structures in the project area, and improve forest health.
- Other objectives include protecting the primary egress route in the area, and creating a secondary egress route for residents in this neighborhood.

Treatment Type

- Hand thinning for defensible space and forest health protection
- Chipping for slash management
- Mechanical cutting for egress routes

Potential Lead Organizations

The TFPD is the lead organization, with CSFS and BWC providing support.



Pinecliffe

The Pinecliffe project covers 533 acres, located in a remote neighborhood in TFPD at the southern border of Boulder County. The homes in this area run along a loop of road that lacks a good secondary egress route. The forests are primarily dense ponderosa stands, with some lodgepole and aspen, and tend to run all the way up to homes. Slopes are not as steep, allowing easier access to machinery. The project area sits within Denver Water's Zone of Concern.

Treatment Objectives

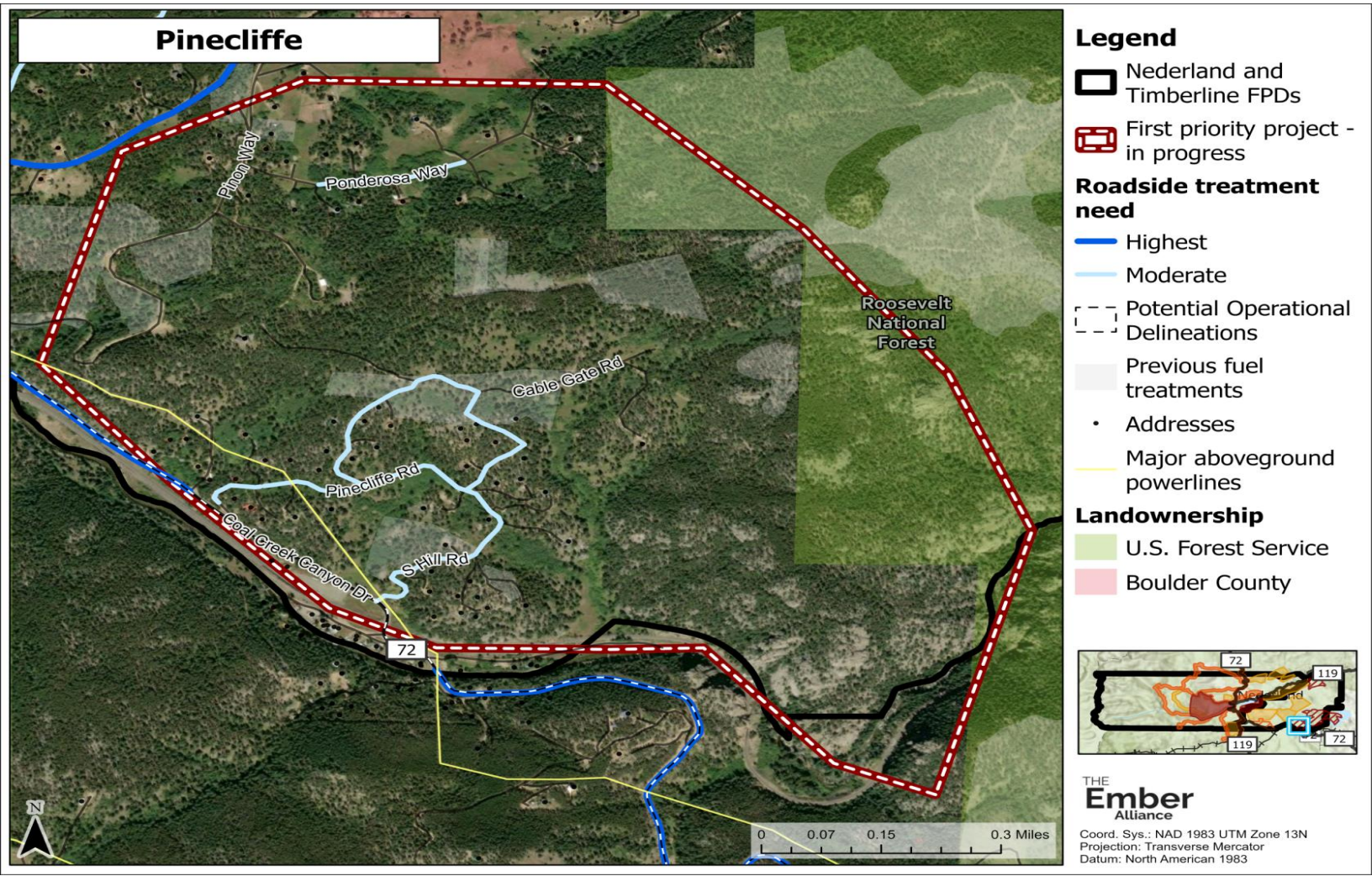
- The primary treatment objective is to create a secondary egress route that connects the Pinecliffe neighborhood with Lazy Z neighborhood. Two-way access along this route would benefit both Pinecliffe and Lazy Z communities.
- Secondary priorities include reducing the density of stands in HIZ 3 of homeowners in this area, creating linked defensible space, and reducing fire intensity to protect water resources.

Treatment Type

- Hand thinning for linked defensible space
- Mechanical thinning and shaded fuelbreaks along egress routes
- Controlled pile burns to manage slash

Potential Lead Organizations

BWC is lead, and should coordinate with TFPD and Wildfire Partners for defensible space recommendations for residents. CSFS and the Pinecliffe Association are supporting partners.



Tucker Ranch

The Tucker Ranch project covers 2,684 acres across a range of land owned by private landowners, USFS, and Boulder County. Nederland High School is to the south of the forested area, and Nederland town center to the east, making this a highly strategic area for fire risk reduction that protects numerous structures and other Values at Risk. Tucker Ranch lies within Town of Nederland's Water Protection Area, the City of Boulder's Source Water Protection Area, and overlaps with five of the City of Boulder's 2024 CWPP priority projects (RMV-05, HT-08,OT-07, and OT-08).

Treatment Objectives

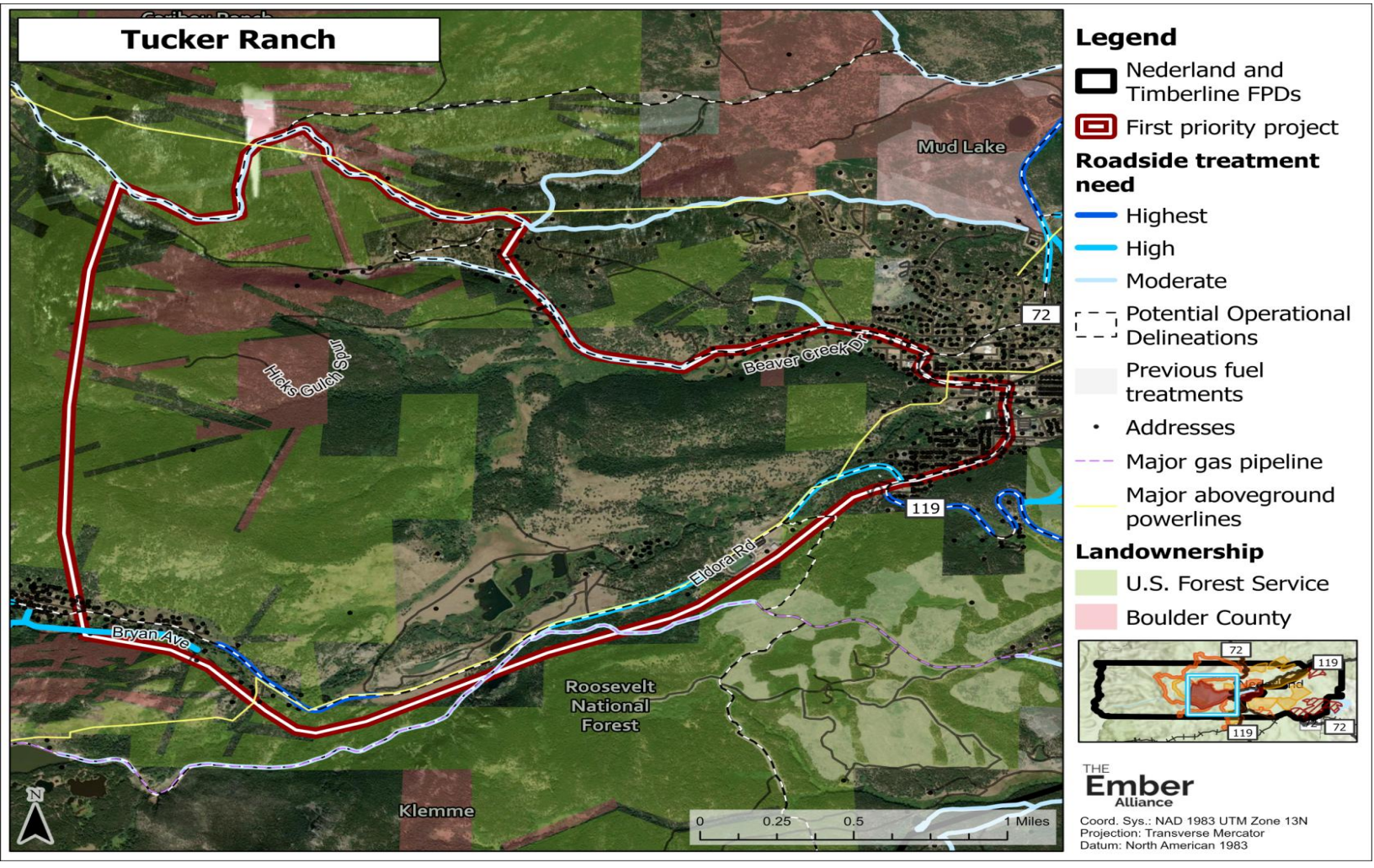
- The primary treatment objective is to reduce the risk of intense, rapidly spreading wildfire directly west of the most densely populated area in these districts.
- Secondary objectives include protecting key drinking water infrastructure, watershed health, and a known elk migration corridor.

Treatment Type

- Hand thinning and mechanical thinning
- Chipping, hauling, and pile burning are options for slash management
- In some areas, there is a possibility that wetland restoration work would be compatible

Potential Lead Organizations

Boulder County Parks and Open Space and the BWC are lead collaborators on this project. BVSD and USFS are partner organizations providing support.



West Boulder Canyon Phase 1

The West Boulder Canyon project is 581 acres and incorporates the Big Springs neighborhood south of Barker Reservoir and forested slopes on the south side of Hwy 119 leading into Nederland town center. The forests are dense stands of primarily lodgepole, with some mixed conifer and aspen that run up steep slopes to the homes in Big Springs. There is a lot of dead and downed slash in this area, and removing these fuels is an easy way to reduce fuel hazards. This project lies within City of Boulder's Source Water Protection Area, overlaps with one of the City of Boulder's 2024 CWPP priority projects (DST-11), and was identified by the community as a priority project.

Treatment Objectives

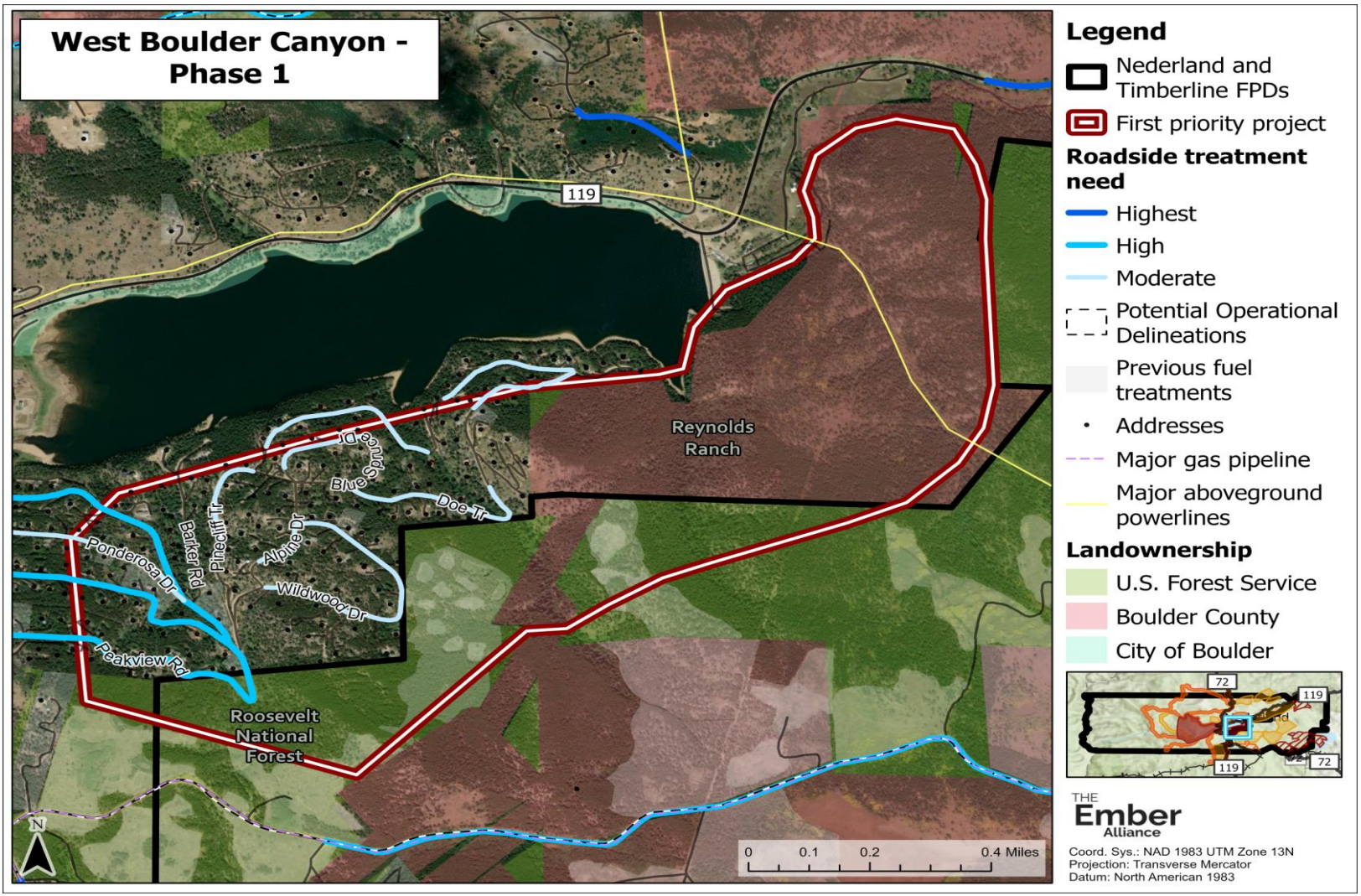
- The primary treatment objective is to reduce hazardous fuel loads to protect homes in Big Springs neighborhood, and water quality in Barker Reservoir.
- Secondary objectives include connecting fuels treatments between public and private lands, and preparing for the creation of a secondary egress route for the Big Springs neighborhood.

Treatment Type

- Hand thinning and mechanical thinning, clumping trees as ecologically appropriate.
- Chipping, hauling, and pile burning are options for slash management.

Potential Lead Organizations

Boulder County is lead and will partner with Town of Nederland and the USFS.



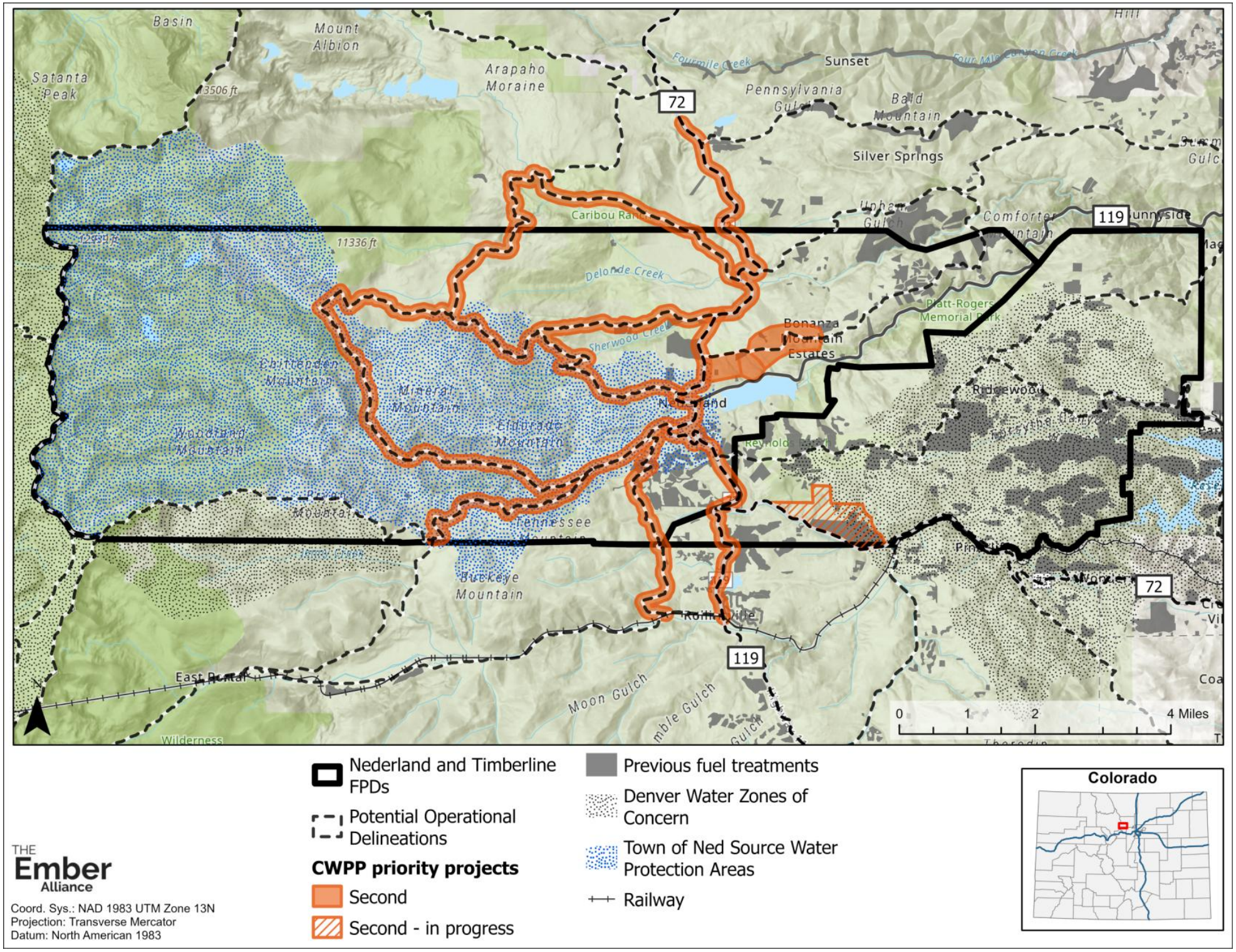


Figure 40: Second priority treatments. Source: The Ember Alliance

North Beaver Road

North Beaver Road project covers 428 acres within the Tungsten Mountain plan unit. It lies within Denver Water's Zone of Concern.

Treatment Objectives

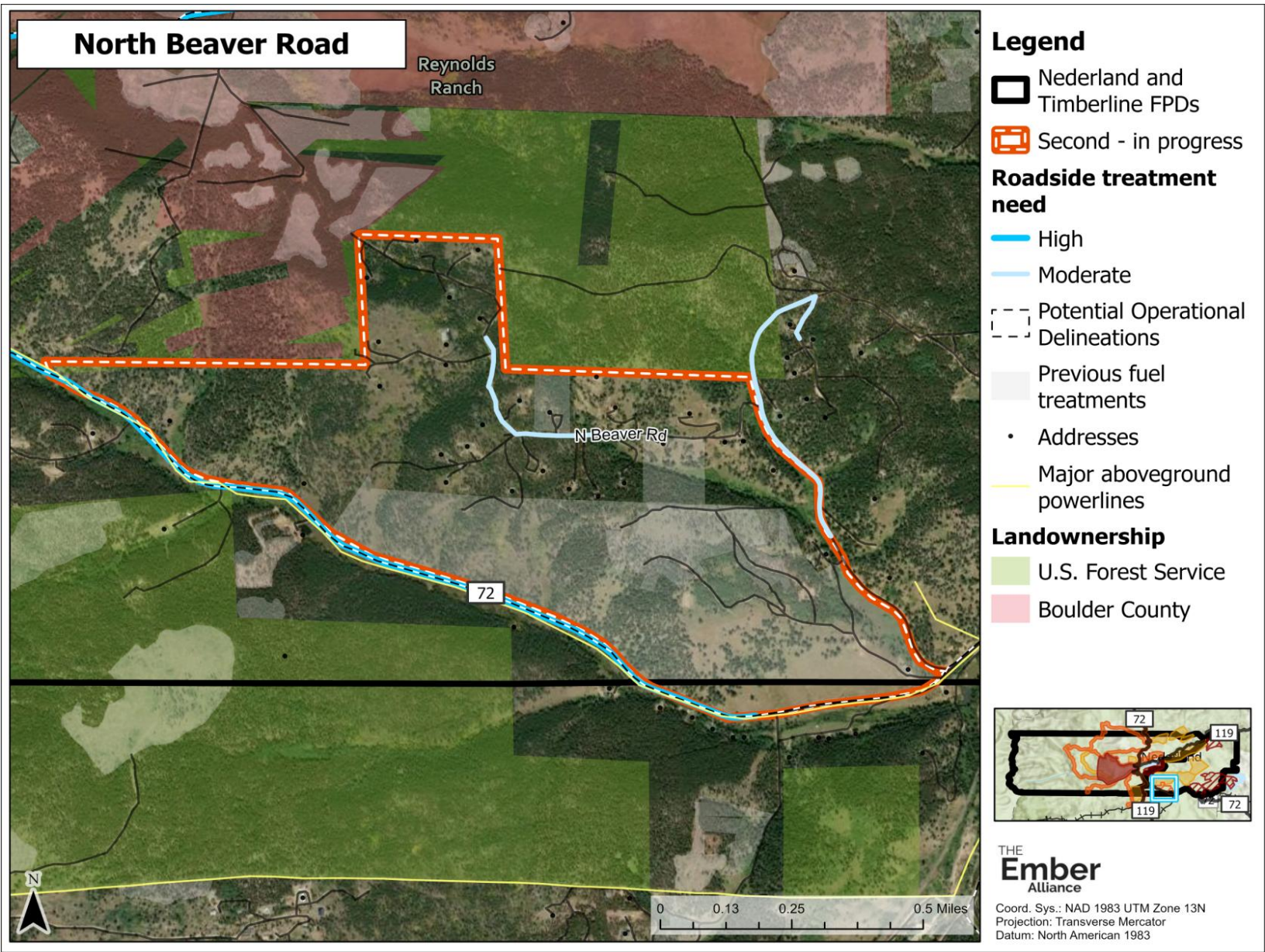
- The primary treatment objective is to reduce hazardous fuel loads to protect homes in Tungsten Mountain neighborhood.
- Secondary objectives include improving egress routes and protecting water resources.

Treatment Type

- Hand thinning and mechanical thinning
- Pile burning for slash management

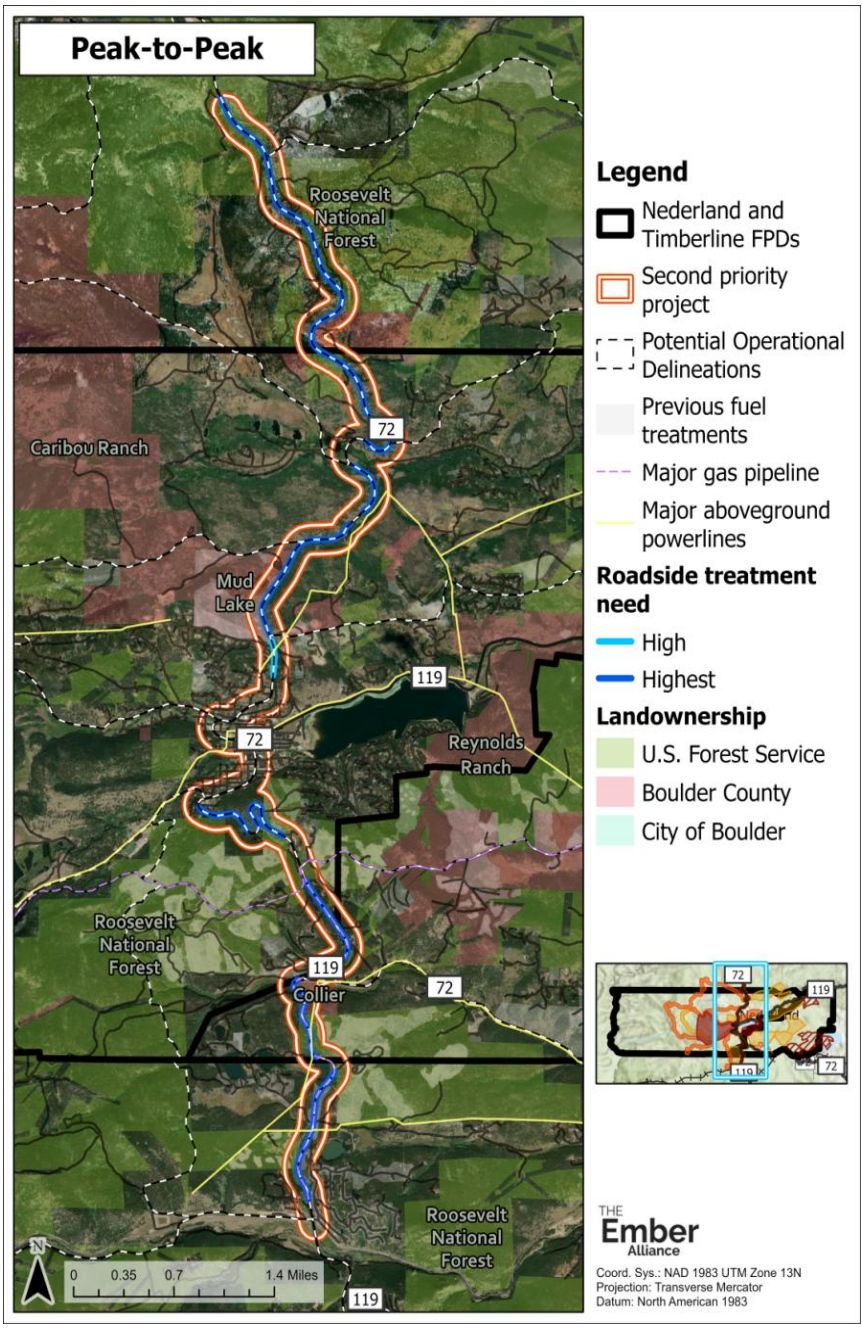
Potential Lead Organizations

BWC is lead with Boulder Valley and Longmont Conservation Districts (BVLCD) and CSFS as partners.



Peak to Peak

Peak-to-Peak Highway is a major highway that runs through the FPDs. The project area spans over 11 miles alongside the highway and includes roadway outside of the NFPD. Peak-to-Peak road is a major evacuation route for many neighborhoods, and the forests that run along the edge of the highway are frequently dense and crowded against the road. During a wildfire, conditions could become non-survivable due to the density and proximity of forest stands. This project covers a State of Colorado Scenic Byway and should be planned with the appropriate Commission to ensure the processes and objectives align with their work. The Peak-to-Peak Scenic Byway runs through Town of Nederland's Water Protection Area and the City of Boulder's Source Water Protection Area.



Treatment Objectives

- The primary objective for roadside treatments along the Peak-to-Peak Highway is to protect a major evacuation route for residents and community members in the FPD.
- Secondary objectives include strategic treatments to improve firefighting capabilities during a fire.

Treatment Type

- Linear fuel reduction - reducing quantity of conifer trees within 20ft of the road
- Cutting to create a shaded fuel break extending 100-150ft from the edge of the road as ecologically appropriate
- Thinning and tree removal in specific areas to create tactical opportunities for firefighters, and further roadside thinning along switchbacks help reduce the potential of non-survivability during a wildfire

Lead Organizations

Town of Nederland and CDOT own the majority of land along the highway, and should partner to link treatments on their respective properties. Colorado Scenic & Historic Byways Commission should be engaged for planning and support of this project.

West Ridge - Ridge Road

Ridge Road project area covers 288 acres north of Barker Reservoir. Roads in this area are potentially non-survivable due to tree crowding and steep slopes. It lies within City of Boulder's Source Water Protection Area.

Treatment Objectives

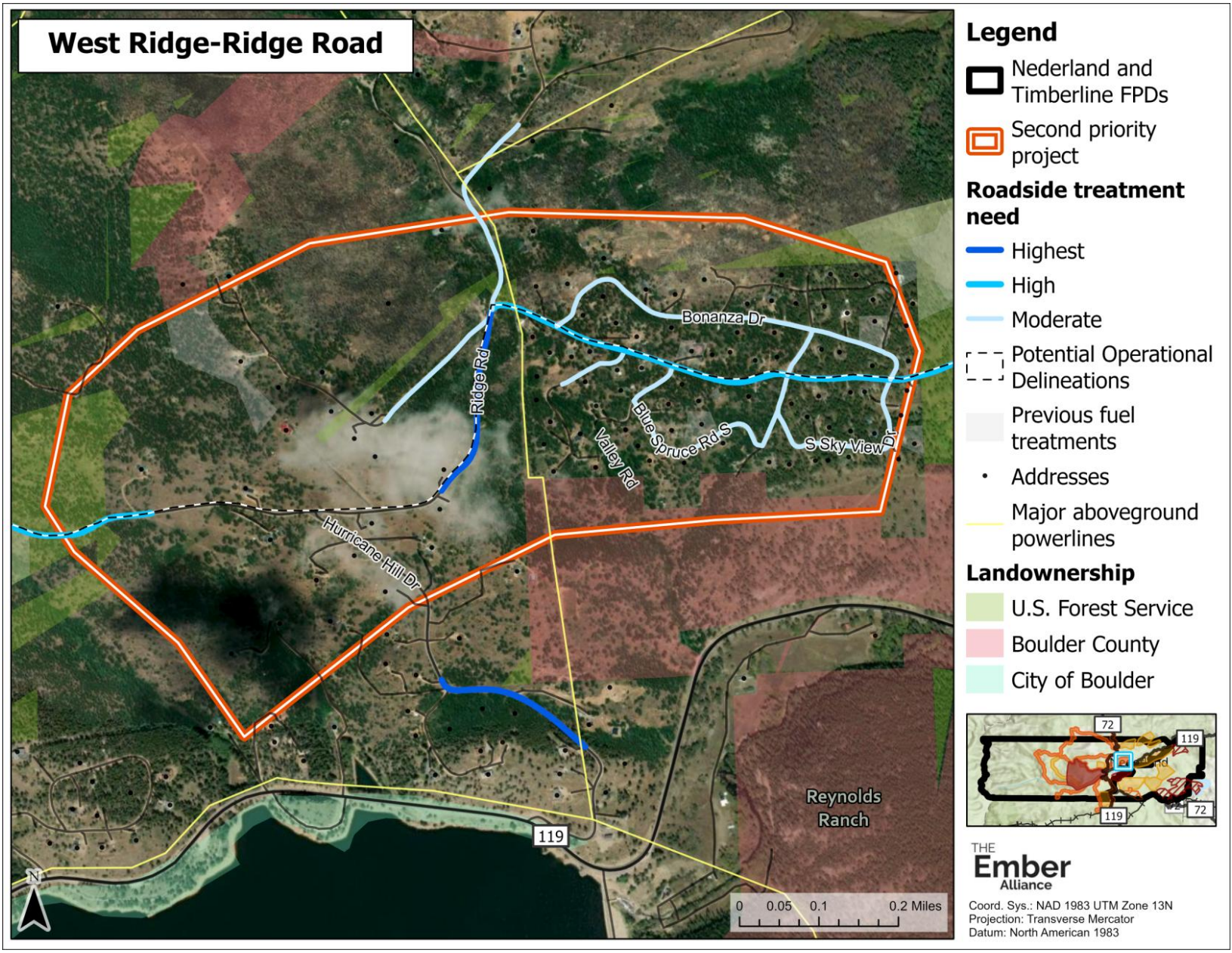
- The primary treatment objective is to reduce hazardous fuel loads to protect homes in the West Ridge Plan Unit.
- Secondary objectives include improving egress routes and creating fuelbreaks.

Treatment Type

- Hand thinning
- Mechanical thinning for roadside fuelbreaks

Potential Lead Organizations

NFPD and BWC lead this project, with support from USFS and local residents.



West Ridge - Stinky Gulch

The Stinky Gulch project covers 129 acres north of Hwy 119 and Barker Reservoir. Many important structures reside within this project area including a CDOT facility, transfer station, and Boulder County Road Maintenance Facility. Slopes are fairly steep and dense forests threaten the primary egress route of Nederland Town Center. It lies within the City of Boulder Source Water Protection Area.

Treatment Objectives

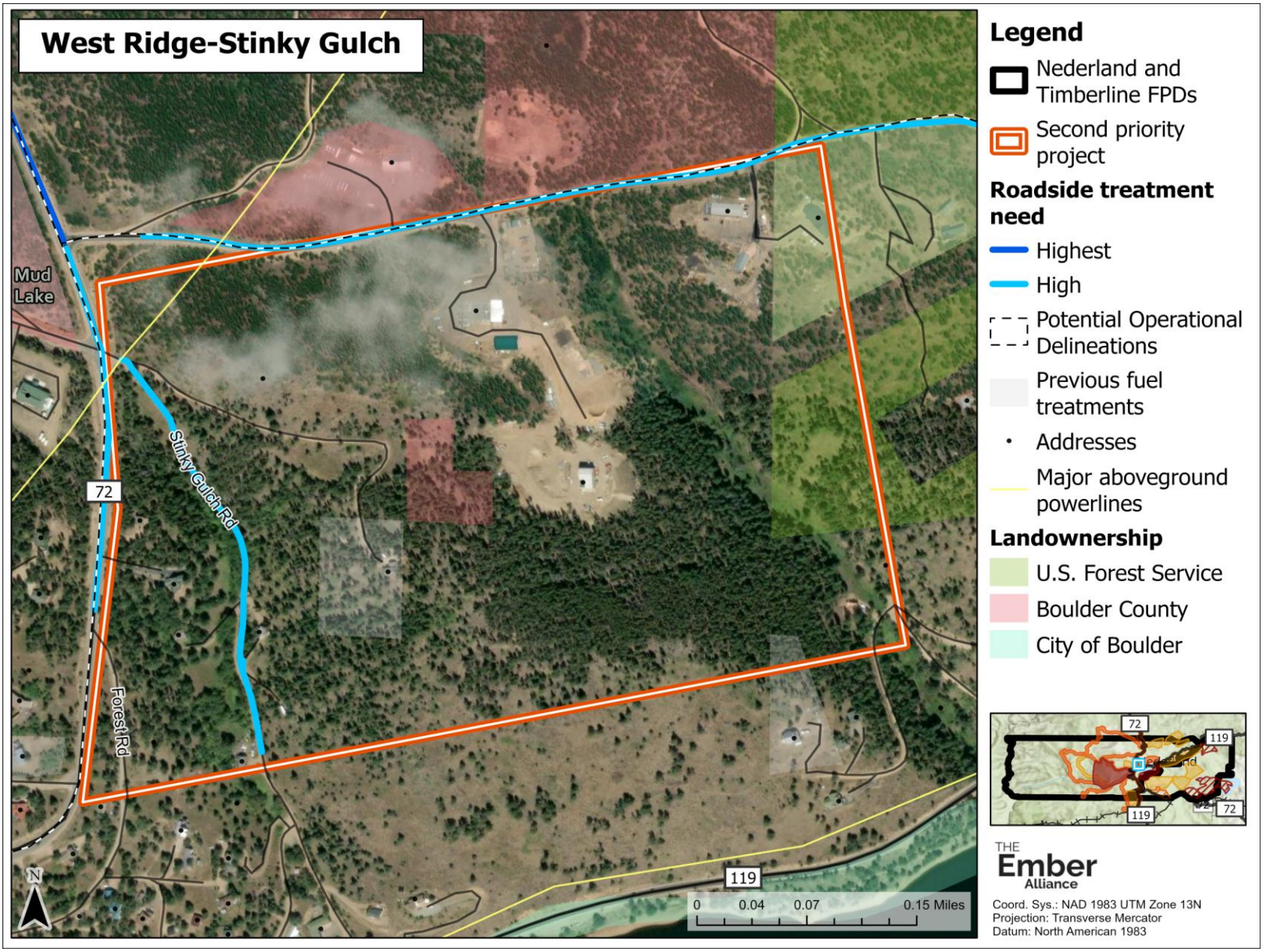
- The primary treatment objective is to protect important structures within the project area.
- Secondary objectives include improving road conditions for Hwy 119, a primary egress route for Nederland Town Center, and protecting Barker Reservoir.

Treatment Type

- Mechanical thinning for fire risk reduction

Potential Lead Organizations

NFPD is lead, with support from Town of Nederland, Boulder County, USFS and CDOT.



West Ridge - Whispering Pines

The Whispering Pines project covers 75 acres north of Hwy 119 and Barker Reservoir. Land ownership is a mix of USFS land and private land. Slopes are steep and vegetation is dense adjacent to the primary egress route for Nederland Town Center. This project lies within the City of Boulder's Source Water Protection Area.

Treatment Objectives

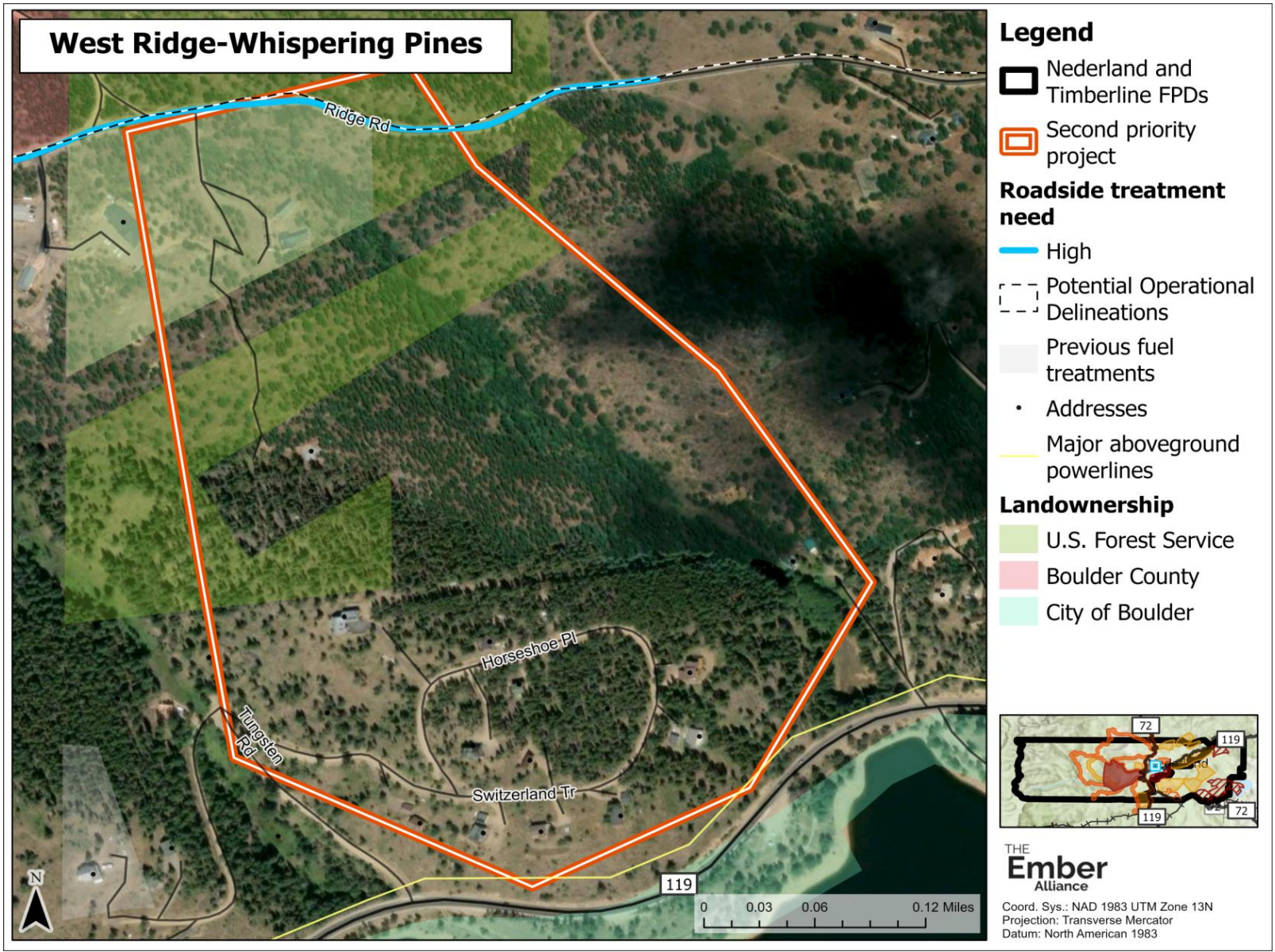
- The primary treatment objective is to reduce hazardous fuels on USFS and private lands.
- Secondary objectives include protecting structures, Barker Reservoir, and the primary egress route for Nederland Town Center.

Treatment Type

- Mechanical thinning for fire risk reduction

Potential Lead Organizations

The NFPD and BWC are lead organizers, with support from USFS and private landowners.



West Side POD Boundaries - Phase 1

The West Side POD Boundary project is a tactical fuel treatment to improve firefighting capabilities against wildfire, especially in the Eldora plan unit. Secondary egress in this neighborhood is not feasible, so increased defensible space and primary egress protection is required. The treatment will create strategic fuel break and starting point for firefighting operations in the event of a wildfire, with the aim of improving residents' ability to evacuate. This project lies within the Town of Nederland's Water Protection Area, the City of Boulder's Source Water Protection Area, and overlaps with one of the City of Boulder's 2024 CWPP priority project areas (RMV-05).

Treatment Objectives

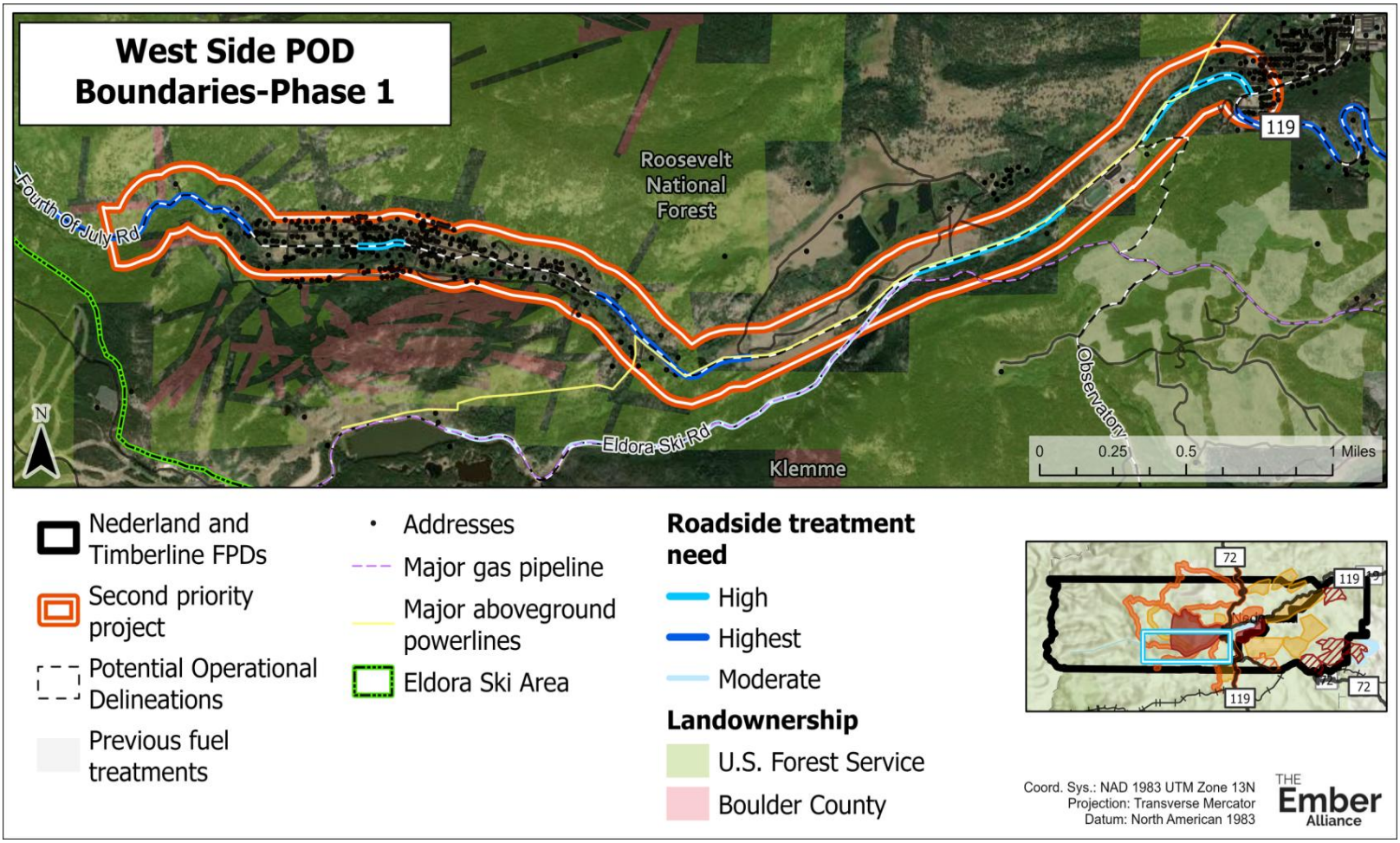
- The primary objective of the west side POD boundary project aims to define a POD boundary, secure funding, and complete a linear fuel treatment along that boundary to provide a tactical feature that protects Eldora residents and values at risk.

Treatment Type

- Strategic, linear fuel break extending 500ft either side of the identified road
- Chipping, hauling, and pile burning are options for slash management

Potential Lead Organizations

USFS is lead, and will partner with Boulder County, Northern Colorado Fireshed Collaborative, and Boulder Fireshed.



West Side POD Boundaries - Phase 2

The West Side POD Boundary project is a tactical fuel treatment to improve firefighting capabilities against wildfire, especially originating from forests west of the Town of Nederland. It is a strategic fuel break attempting to slow a wildfire progressing from west to east, and can be a starting point for firefighting operations in the event of a wildfire. This project lies within the Town of Nederland's Water Protection Area, the City of Boulder's Source Water Protection Area, and overlaps with one of the City of Boulder's 2024 CWPP priority project areas (FB-02).

Treatment Objectives

- The primary objective of phase 2 of the west side POD boundary project aims to define a POD boundary, secure funding, and complete a linear fuel treatment along that boundary to provide a tactical feature that lies entirely west of the Town of Nederland. This can reduce the speed of wildfires approaching Nederland Town Center from the west, and improve firefighting capabilities in the event of a wildfire.

Treatment Type

- Strategic, linear fuel break extending 500ft either side of the identified road
- Chipping, hauling, and pile burning are options for slash management

Potential Lead Organizations

USFS is lead, and will partner with Boulder County, Northern Colorado Fireshed Collaborative, and Boulder Fireshed.

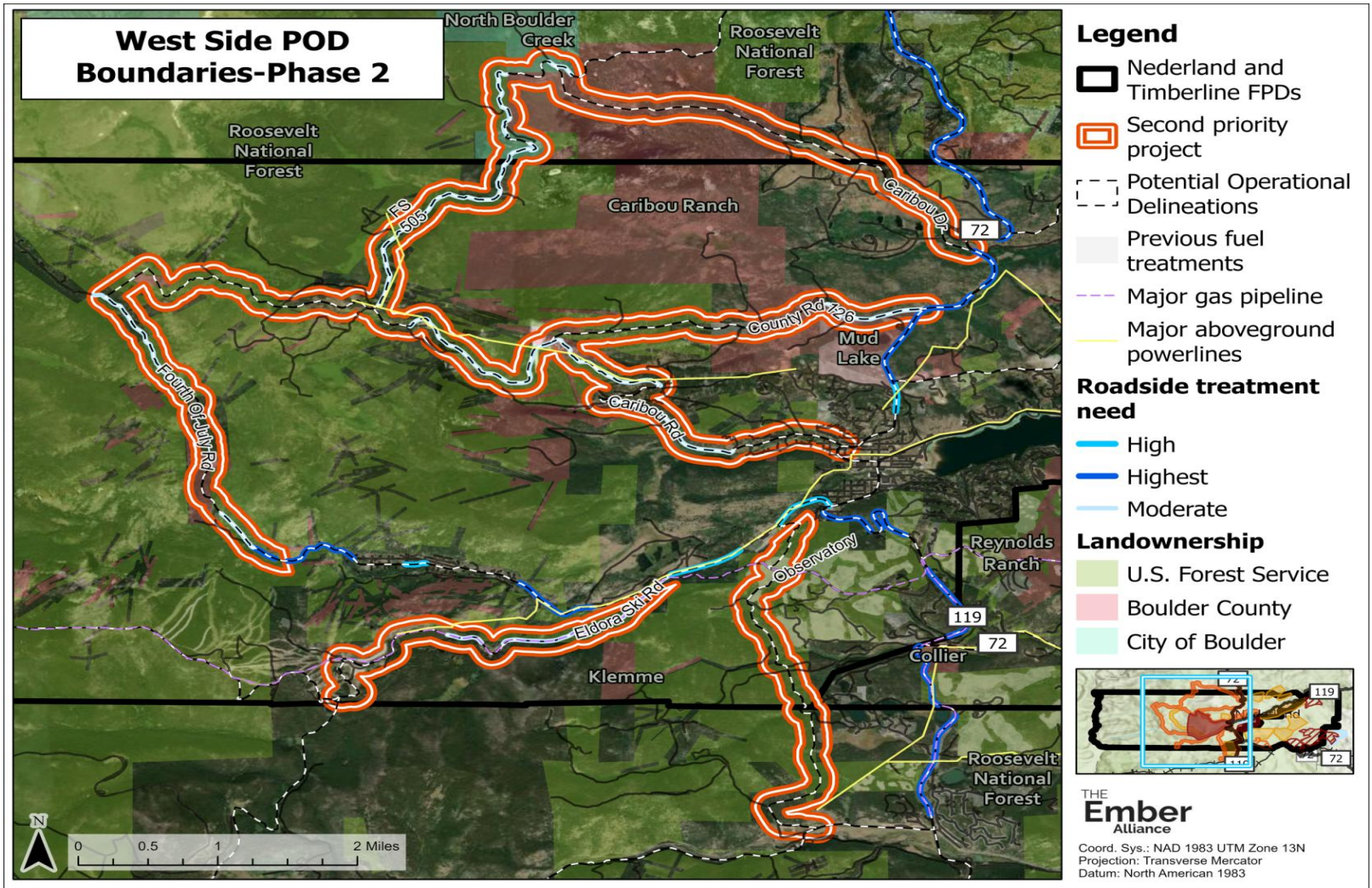


Table 5: Prioritized Recommendations for Creating and Maintaining Resilient Landscapes. First and second priority place-based landscape treatment recommendations are described above and have therefore been left out of this table.

Recommendation	Priority	Responsibility	Timeline
Resilient Landscapes			
Cross-boundary forest management - public/private partnerships for mitigation	1	CSFS, USFS, WP, City of Boulder, BWC, Town of Nederland, Community	Long-term
Tailor fuel reduction methods to meet ecologically appropriate forest health and wildfire mitigation objectives (community priority)	1	USFS, CSFS, BCPOS and WP, City of Boulder, BWC, Town of Nederland.	Short-term
Post-fire recovery plan for revegetation, erosion control, etc., specific to Nederland area	1	BWC, USFS, Burned Area Emergency Response (BAER), Colorado Forest Restoration Institute (CFRI)	Short-term
Reintroduce beavers to the landscape (community priority)	1	BWC, USFS, CSFS, BCPOS	Long-term
Work with Wildfire Ready Watersheds to develop plans for post-fire impacts to water infrastructure	2	BWC, Town of Nederland, Boulder County, City of Boulder	Mid-term
Improve slash management, including innovative solutions (fungi inoculation, biochar, etc.)	3	BWC, CSFS, Office of Sustainability, Climate Action, and Resilience (OSCAR), and BCPOS	Mid-term
Landscape Treatment: West Boulder Canyon Phase 2	3	BCPOS, USFS	Long-term
Landscape Treatment: Peewink	3	USFS	Long-term
Landscape Treatment: Los Lagos	3	BWC, CSFS	In progress

Landscape Treatment: Elementary School	3	BVSD	Long-term
Landscape Treatment: Comforter Mountain	3	USFS, BCPOS	Long-term
Landscape Treatment: Cold Springs	3	NFPD	Long-term
Landscape Treatment: East Hessie	3	USFS	Long-term
Landscape Treatment: West Magnolia	3	TFPD, BWC	Long-term
Landscape Treatment: Lazy Z	3	USFS, TFPD, BVLCD	Long-term
Landscape Treatment: Tungsten Mountain	3	BCPOS, USFS	Long-term

4.e. Funding Opportunities

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 fire district. Residents and partners must put forth funds and time to complete this work. Below is a non-comprehensive list of grants and funding opportunities available as of early 2024.

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.
- The State of Colorado developed the Colorado Strategic Wildfire Action Program (COSWAP) grant program in 2021 to distribute over $17 million to fuels reduction, mitigation, education, and capacity building in the state.
- CSFS offers the Wildfire Mitigation Incentives for Local Government Grant Program to match locally-raised funding for mitigation and management efforts.
- Colorado Water Plan Grants from the Colorado Water Conservation Board includes a category for watershed health & recreation that can support planning and action to protect critical drinking water, infrastructure, and overall watershed health from post-fire impacts.
- Colorado Water Conservation District also offers the Wildfire Ready Watersheds program that focuses on projects designed to mitigate post-fire watershed impacts.
- 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 residents, agencies, and other partners find funding for natural resource projects.
- The Colorado Department of Revenue provides a Wildfire Mitigation Measures Subtraction and State income tax credit for wildfire mitigation (HB22-1007) whereby individuals, estates, and trusts may claim a subtraction on their Colorado income tax return or receive a state income tax credit for certain costs incurred in performing wildfire mitigation measures on property in the WUI.
- The Boulder Valley-Longmont Conservation District helps landowners navigate forestry projects to promote forest health and complete wildfire mitigation projects.
- Boulder County offers their Strategic Fuels Mitigation Grant Program to support community partnerships and programs to help residents prepare for wildfires including projects on private lands.
- Residents in Boulder County can apply for financial incentives as part of the Wildfire Mitigation Sales Tax Program.

Funding from Federal Agencies

- Community Wildfire Assistance Program from the Bureau of Land Management supports activities such as hazardous fuels reduction, thinning, chipping, outreach, and education on non-federal lands.
- Community Wildfire Defense Grants (CWDG) are funded annually through the National Forest Service and help communities take action on implementation projects from their local CWPP.
- 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.
- Environmental Quality Incentives Program (EQIP) from the Natural Resources Conservation Service can support private landowners and Tribes conducting forest management, prescribed burning, or prescribed grazing to reduce fire risk.

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.
- Stewardship Impact Grants from Great Outdoors Colorado fund local agencies, tax districts, political subdivisions, and non-profit organizations for wildfire mitigation work that aligns with resource conservation or outdoor stewardship objectives.
- Conservation Service Corps Grants from Great Outdoors Colorado fund chainsaw crews to support local agencies, tax districts, political subdivisions, and non-profit with fuel mitigation projects.
- 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.

Capacity for Fire Protection Districts

- Staffing for Adequate Fire and Emergency Response Grants (SAFER) from FEMA directly fund fire departments and volunteer firefighter organizations to help increase their capacity.

- Assistance to Firefighters Grants (AFG) from FEMA 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 from FEMA support projects that enhance the safety of the public and firefighters from fire and related hazards, such as carrying out fire prevention education and training, fire code enforcement, fire/arson investigation, firefighter safety and health programming, strategic national projects, prevention efforts, and research and development.

4.f. CWPP as a Living Document

It is recommended that this CWPP is updated every 5 years. CWPP's 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 should include:

- A description of progress made since 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 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

This CWPP is a **call to action!** Becoming a fire adapted community and decreasing wildfire risk takes concerted effort, time, and coordination. Use it 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.

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, 2018b).

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).

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

Canopy cover: The ground area covered by the crowns of all trees in an area as delimited by the vertical projection of their outermost crown perimeters (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 height: The average height of the top of the vegetated canopy (NWCG, 2019).

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 residents 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 2024). 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).

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—residents, 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 (Bennet et al., 2010; 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).

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 ember cast (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).

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).

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).

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).

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).

Roadside 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).

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 is defined in **Figure 12: CWPP WUI Overlap..** Strategic wildfire mitigation across the WUI can increase the safety or residents and wildland firefighters and reduce the chances of home loss.

References

Addington, R.N., Aplet, G.H., Battaglia, M.A., Briggs, J.S., Brown, P.M., 2018. Principles and practices for the restoration of ponderosa pine and dry mixed-conifer forests of the Colorado Front Range (General Technical Report No. RMRS-GTR-373). U.S. Department of Agriculture, U.S. Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

Agee, J.K., 1996. Fire Ecology of Pacific Northwest Forests, 2nd ed. Island Press, Washington, DC.

Agee, J.K., Skinner, C.N., 2005. Basic principles of forest fuel reduction treatments. Forest Ecology and Management 211, 83–96.

Arno, S. F. 1980. Forest fire history in the Northern Rockies. Journal of Forestry. 78: 460-465.

Arno, S. F.; Reinhardt, E.; Scott, J. H. 1993. Forest structure and landscape patterns in the subalpine lodgepole pine type: A procedure for quantifying past and present conditions. Gen. Tech. Rep. INT-294. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station. 17 p.

Avitt, A., 2021. Cameron Peak: Fighting fire together. U.S. Forest Service Feature Stories.

Babrauskas, V., 2018. Firebrands and embers, in: Manzello, S. (Ed.), Encyclopedia of Wildfires and Wildland-Urban Interface (WUI) Fires. Springer, Cham, Switzerland. https://doi.org/10.1007/978-3-319-51727-8_3-1.

Barrett, S. W.; Arno, S. F.; Key, C. H. 1991. Fire regimes of western larch–lodgepole pine forests in Glacier National Park, Montana. Canadian Journal of Forest Research. 21: 1711-1720.

Barrett, S. W. 1993. Fire history of Tenderfoot Creek Experimental Forest, Lewis and Clark National Forest. Unpublished final report on file at the Missoula Fire Sciences Laboratory. Missoula, Montana: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 23 p.

Bennett, M., Fitzgerald, S., Parker, B., Main, M., Perleberg, A., Schnepf, C., Mahoney, R., 2010. Reducing fire risk on your forest property (Pacific Northwest Extension Publication No. PNW 618). Oregon State University, University of Idaho, and Washington State University.

Beverly, J.L., Bothwell, P., Conner, J., Herd, E., 2010. Assessing the exposure of the built environment to potential ignition sources generated from vegetative fuel. International journal of wildland fire 19, 299–313.

Brenkert-Smith, H., Champ, P.A., Telligman, A.L., 2013. Understanding change: Wildfire in Larimer County, Colorado (Research Note No. RMRS-RN-58). U.S. Department of Agriculture, U.S. Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

Brown, K., 1994. Structure triage during wildland/urban interface/intermix fires: Strategic analysis of fire department operations. U.S. Fire Administration, National Fire Academy, Executive Fire Officer Program, Emmitsburg, MD.

California Fire Safe Council, 2020. Fire safety information for residents. California Fire Safe Council. URL https://cafiresafecouncil.org/resources/fire-safety-information-for-residents/.

Caton, S.E., Hakes, R.S.P., Gorham, D.J., Zhou, A., Gollner, M.J., 2016. Review of pathways for building fire spread in the wildland urban interface part I: Exposure conditions. Fire Technology 54, 429–473.

Crowley, J., 2020. Social Vulnerability Factors and Reported Post-Disaster Needs in the Aftermath of Hurricane Florence. International Journal of Disaster Risk Science 13–23. https://doi.org/10.1007/s13753-020-00315-5

CSFS, 2021. The home ignition zone: A guide to preparing your home for wildfire and creating defensible space. Colorado State University, Colorado State Forest Service, Fort Collins, CO.

CSFS, 2010. Forestry best management practices to protect water quality in Colorado. Colorado State University, Colorado State Forest Service, Fort Collins, CO.

Cutter, S.L., Boruff, B.J., Shirley, W.L., 2003. Social Vulnerability to Environmental Hazards*. Social Science Quarterly (Wiley-Blackwell) 84, 242–261. https://doi.org/10.1111/1540-6237.8402002

Davis, K. T., Robles, M. D., Kemp, K. B., Higuera, P. E., Chapman, T. B., Metlen, K. L., Peeler, J. L., Rodman, K. C., Woolley, T. J., Addington, R. N., Buma, B., C. Alina Cansler, Case, M. J., Collins, B. M., Coop, J. D., Dobrowski, S. Z., Gill, N. S., Haffey, C., Harris, L. B., & Harvey, B. (2023). Reduced fire severity offers near-term buffer to climate-driven declines in conifer resilience across the western United States. *Proceedings of the National Academy of Sciences of the United States of America*, *120*(11). https://doi.org/10.1073/pnas.2208120120

Davies, I.P., Haugo, R.D., Robertson, J.C., Levin, P.S., 2018. The unequal vulnerability of communities of color to wildfire. PLoS One 13, e0205825. https://doi.org/10.1371/journal.pone.0205825

Dennis, F.C., Burke, J., Duda, J., Green, C., Hessel, D., Kaufmann, M., Lange, D., Lee, B., Rinke, H., Sheppard, W., Sturtevant, B., Thinnes, J., Underhill, J., Woodmansee, B., 2009. Lodgepole pine management guidelines for land managers in the wildland-urban interface. Colorado State Forest Service, Colorado State University, Fort Collins, CO.

Dennis, F.C., 2005. Fuelbreak guidelines for forested subdivisions and communities. Colorado State University, Colorado State Forest Service, Fort Collins, CO.

Dennis, F.C., 2003. Creating wildfire-defensible zones (Natural Resources Series No. 6.302). Colorado State University, Cooperative Extension, Fort Collins, CO.

Dether, D.M., 2005. Prescribed fire lessons learned: Escaped prescribed fire reviews and near miss incidents (Report for the Wildland Fire Lessons Learned Center).

Duncan, B.W., Schmalzer, P.A., Breininger, D.R., Stolen, E.D., 2015. Comparing fuels reduction and patch mosaic fire regimes for reducing fire spread potential: A spatial modeling approach. Ecological Modelling 314, 90–99.

Emrich, C.T., Tate, E., Larson, S.E., Zhou, Y., 2020. Measuring social equity in flood recovery funding. Environmental Hazards 19, 228–250. https://doi.org/10.1080/17477891.2019.1675578

Evans, A.M., Wright, C.S., 2017. Unplanned wildfire in areas with slash piles (Unpublished report for the Joint Fire Science Program No. 11-1-8–4).

Finney, M.A., 2006. An overview of FlamMap fire modeling capabilities, in: In: Andrews, Patricia L.; Butler, Bret W., Comps. 2006. Fuels Management-How to Measure Success: Conference Proceedings. 28-30 March 2006; Portland, OR. Proceedings RMRS-P-41. Fort Collins, CO: US Department of Agriculture, Forest Service, Rocky Mountain Research Station. p. 213-220.

Forge, P., 2018. Basics of wildland fire behavior & the wildland-urban interface (CPAW Planner Training Materials). Community Planning Assistance for Wildfire, Bozeman and Helena, MT.

Fulé, P.Z., Crouse, J.E., Rouccaforte, J.P., Kalies, E.L., 2012. Do thinning and/or burning treatments in western USA ponderosa or Jeffrey pine-dominated forests help restore natural fire behavior? Forest Ecology and Management 269, 68–81.

Gannon, B.M., Wei, Y., MacDonald, L.H., Kampf, S.K., Jones, K.W., Cannon, J.B., Wolk, B.H., Cheng, A.S., Addington, R.N., Thompson, M.P., 2019. Prioritising fuels reduction for water supply protection. International Journal of Wildland Fire 28, 785–803. https://doi.org/10.1071/WF18182_CO

Gropp, C., 2019. Embers cause up to 90% of home & business ignitions during wildfire events (News Release No. 12 March 2019). Insurance Institute for Business & Home Safety, Richburg, SC.

Hakes, R.S., Caton, S.E., Gorham, D.J., Gollner, M.J., 2017. A review of pathways for building fire spread in the wildland urban interface part II: response of components and systems and mitigation strategies in the United States. Fire technology 53, 475–515.

Hansson, L., Fahrig, L., Merriam, G. (Eds.), 1995. Mosaic Landscapes and Ecological Processes. Springer, Dordrecht, Netherlands.

Harper, J.M., 2011. Benefits of grazing and wildfire risk. University of California, Agriculture and Natural Resources. URL https://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=5463

Hartsough, B.R., Abrams, S., Barbour, R.J., Drews, E.S., McIver, J.D., 2008. The economics of alternative fuel reduction treatments in western United States dry forests: Financial and policy implications from the National Fire and Fire Surrogate Study. Forest Policy & Economics 10, 344–354.

Hewitt, K., 2013. Environmental disasters in social context: toward a preventive and precautionary approach. Nat Hazards 66, 3–14. https://doi.org/10.1007/s11069-012-0205-6

Higuera, P.E., Shuman, B.N., Wolf, K.D., 2021. Rocky Mountain subalpine forests now burning more than any time in recent millennia. Proceedings of the National Academy of Sciences 118, e2103135118.

Hunter, M.E., Shepperd, W.D., Lentile, L.B., Lundquist, J.E., Andreu, M.G., Butler, J.L., Smith, F.W., 2007. A comprehensive guide to fuel treatment practices for ponderosa pine in the Black Hills, Colorado Front Range, and Southwest (General Technical Report No. RMRS-GTR-198). U.S. Department of Agriculture, U.S. Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

IIBHS, 2019. California Wildfires of 2017 and 2018 [WWW Document]. Insurance Institute for Business & Home Safety. URL https://ibhs.org/wildfire/ibhs-post-event-investigation-california-wildfires-of-2017-2018/

Jain, T., Sikkink, P., Keffe, R., Byrne, J., 2018. To masticate or not: Useful tips for treating forest, woodland, and shrubland vegetation (General Technical Report No. RMRS-GTR-381). U.S. Department of Agriculture, U.S. Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

Jolley, A., 2018. Is investing in defensible space worth it? Six examples point to yes! [WWW Document]. Fire Adapted Communities Learning Network. URL https://fireadaptednetwork.org/is-investing-in-defensible-space-worth-it-six-examples-point-to-yes/

Jones, K.W., Cannon, J.B., Saavedra, F.A., Kampf, S.K., Addington, R.N., 2017. Return on investment form fuel treatments to reduce severe wildfire and erosion in a watershed investment program in Colorado. Journal of Environmental Management 198, 66–77.

Kalies, E.L., Kickson, B.G., Chambers, C.L., Covington, W.W., 2012. Small mammal community occupancy responses to restoration treatments in ponderosa pine forests, northern Arizona, USA. Ecological Applications 22, 204-217.

Keane, R.E., Agee, J., Fulé, P., Keeley, J.E., Key, C., Kitchen, S.G., Miller, R., Schulte, L.A., 2008. Ecological effects of large fires in the United States: Benefit or catastrophe? International Journal of Wildland Fire 17, 696–712.

Knapp, E.E., Valachovic, Y.S., Quarles, S.L., Johnson, N.G., 2021. Housing arrangement and vegetation factors associated with single-family home survival in the 2018 Camp Fire, California. Fire Ecology 17, 1–19.

Kreye, J.K., Brewer, N.W., Morgan, P., Varner, J.M., Smith, A.M.S., Hoffman, C.M., Ottmar, R.D., 2014. Fire behavior in masticated fuels: A review. Forest Ecology and Management 314, 193–207.

Lalande, B. M., Hughes, K., Jacobi, W. R., Tinkham, W. T., Reich, R., & Stewart, J. E. (2020). Subalpine fir mortality in Colorado is associated with stand density, warming climates and interactions among fungal diseases and the western balsam bark beetle. *Forest Ecology and Management*, *466*, 118133. https://doi.org/10.1016/j.foreco.2020.118133

Laska, S., Morrow, B., 2006. Social Vulnerabilities and Hurricane Katrina: An Unnatural Disaster in New Orleans. Marine Technology Society Journal 40, 16–26. https://doi.org/10.4031/002533206787353123

Loomis, J., Sánchez, J.J., González-Cabán, A., Rideout, D., Reich, R., 2019. Do fuel treatments reduce wildfire suppression costs and property damages? Analysis of suppression costs and property damages in U.S. National Forests, in: Proceedings of the Fifth International Symposium on Fire Economics, Planning, and Policy: Ecosystem Services and Wildfires. General Technical Report PSW-GTR-261. U.S. Department of Agriculture, U.S. Forest Service, Pacific Southwest Research Station, Albany, CA, pp. 70–84.

Maranghides, A., Link, E.D., Hawks, S., McDougald, J., Quarles, S.L., Gorham, D.J., Nazare, S., 2022. WUI structure/parcel/community fire hazard mitigation methodology (NIST Technical Note No. 2205). Department of Commerce, National Institute of Standards and Technology, Washington, DC.

Martinuzzi, S., Stewart, S.I., Helmers, D.P., Mockrin, M.H., Hammer, R.B., Radeloff, V.C., 2015. The 2010 wildland-urban interface of the conterminous United States (Research Map No. NRS-RM-8). U.S. Department of Agriculture, U.S. Forest Service, Northern Research Station, Newtown Square, PA.

Matonis, M.S., Binkley, D., 2018. Not just about the trees: Key role of mosaic-meadows in restoration of ponderosa pine ecosystems. Forest Ecology and Management 411, 120-131.

McIver, J.D., Stephens, S.L., Agee, J.K., Barbour, J., Boerner, R.E.J., Edminster, C.B., Erickson, K.L., Farris, K.L., Fettig, C.J., Fiedler, C.E., Haase, S., Hart, S.C., Keeley, J.E., Knapp, E.E., Lehmkuhl, J.F., Moghaddas, J.J., Otrosina, W., Outcalt, K.W., Schwilk, D.W., Skinner, C.N., Waldrop, T.A., Weatherspoon, C.P., Yaussy, D.A., Youngblood, A., Zack, S., 2013. Ecological effects of alternative fuel-reduction treatments: highlights of the National Fire and Fire Surrogate study (FFS). International Journal of Wildland Fire 22, 63–82.

Mell, W.E., Manzello, S.L., Maranghides, A., Butry, D., Rehm, R.G., 2010. The wildland–urban interface fire problem – current approaches and research needs. International Journal of Wildland Fire 19, 238–251.

Méndez, M., Flores-Haro, G., Zucker, L., 2020. The (in)visible victims of disaster: Understanding the vulnerability of undocumented Latino/a and indigenous immigrants. Geoforum 116, 50–62. https://doi.org/10.1016/j.geoforum.2020.07.007

Miller, S., 2015. Slash from the past: Rehabilitating pile burn scars (Science You Can Use Bulletin No. Issue 15). U.S. Department of Agriculture, U.S. Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

Moriarty, K., Cheng, A.S., Hoffman, C.M., Cottrell, S.P., Alexander, M.E., 2019. Firefighter observations of "surprising" fire behavior in mountain pine beetle-attacked lodgepole pine forests. Fire 2, 34.

National Academies of Sciences, Engineering, and Medicine, 2018. Emergency Alert and Warning Systems: Current Knowledge and Future Research Directions. The National Academies Press, Washington, DC. https://doi.org/10.17226/24935

Nature Conservancy, The & The Aspen Institute. (2023). *Roadmap For Wildfire Resilience: Solutions For A Paradigm Shift*. URL: https://www.nature.org/content/dam/tnc/nature/en/documents/Wildfire_Resilience_Roadmap.pdf

NOAA, 2021. What is a watershed? [WWW Document]. U.S. Department of Commerce, National Oceanic and Atomspheric Administration, National Ocean Service. URL https://oceanservice.noaa.gov/facts/watershed.html

NRCS, 2017. Glossary of landforms and geologic terms, in: National Soil Survey Handbook. U.S. Department of Agriculture, National Resources Conservation Service, Washington, DC, p. Part 629.

NWCG, 2021. Midflame windspeed. Section 8.2 [WWW Document]. Firefighter Math, National Wildfire Coordinating Group. URL https://www.nwcg.gov/course/ffm/fire-behavior/82-midflame-windspeed

NWCG, 2019. Fire behavior field reference guide.

NWCG, 2018a. Incident Response Pocket Guide (No. PMS 461 / NFES 001077). National Wildfire Coordinating Group.

NWCG, 2018b. NWCG glossary of wildland fire.

NWCG, 2008. S-190: Introduction to wildland fire behavior. National Wildfire Coordinating Group, Training Development Program, Boise, ID.

O'Connor, B., 2021. Fire apparatus access roads [WWW Document]. National Fire Protection Association. URL https://www.nfpa.org/News-and-Research/Publications-and-media/Blogs-Landing-Page/NFPA-Today/Blog-Posts/2021/01/08/Fire-Apparatus-Access-Roads

Ojerio, R.S., Lynn, K., Evans, A., DeBonis, M., Gerlitz, W., 2008. Resource Innovations, University of Oregon Forest Guild, New Mexico Watershed Research and Training Center, California 24.

Parsons, R., Jolly, M., Langowski, P., Matonis, M.S., Miller, S., 2014. Post-epidemic fire risk and behavior [Chapter 3], in: Matonis, M.S., Hubbard, R., Gebert, K., Hahn, B., Miller, S., Regan, C. (Eds.), Proceedings RMRS-P-70. Presented at the Future Forests Webinar Series, U.S. Department of Agriculture, U.S. Forest Service, Rocky Mountain Research Station, Fort Collins, CO, pp. 19–28.

Pausas, J.G., Parr, C.L., 2018. Towards an understanding of the evolutionary role of fire in animals. Evolutionary Ecology 32, 113–125.

Paysen, T.E., Ansley, R.J., Brown, J.K., Gotffried, G.J., Haase, S.M., Harrington, M.G., Narog, M.G., Sackett, S.S., Wilson, R.C., 2000. Chapter 6: Fire in western shrubland, woodland, and grassland ecosystems (General Technical Report No. RMRS-GTR-42-vol 2.). U.S. Department of Agriculture, U.S. Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

Pilliod, D.S., Bull, E.L., Hayes, J.L., Wales, B.C., 2006. Wildlife and invertebrate response to fuel reduction treatments in dry coniferous forests of the Western United States: A synthesis (General Technical Report No.

RMRS-GTR-173). U.S. Department of Agriculture, U.S. Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

Plucinski, M.P., 2019. Contain and control: Wildfire suppression effectiveness at incidents and across landscapes. Current Forestry Reports 5, 20–40.

Prichard, S.J., Povak, N.A., Kennedy, M.C., Peterson, D.W., 2020. Fuel treatment effectiveness in the context of landform, vegetation, and large, wind-driven wildfires. Ecological Applications 30, e02104.

Quarles, S.L., 2019. Fire ratings for construction materials [WWW Document]. eXtension Foundation. URL https://surviving-wildfire.extension.org/fire-ratings-for-construction-materials/

Quarles, S.L., Pohl, K., 2018. Building a wildfire-resistant home: Codes and costs. Headwaters Economics, Bozeman, MT.

Reinhardt, E.D., Keane, R.E., Calkin, D.E., Cohen, J.D., 2008. Objectives and considerations for wildland fuel treatments in forested ecosystems of the interior western United States. Forest Ecology and Management 256, 1997–2006.

Romme, W.H., 1982. Fire and landscape diversity in subalpine forests of Yellowstone National Park. Ecological Monographs 52, 199–221.

Schulte, L.A., Rickenbach, M., Merrick, L.C. Ecological and economic benefits of cross-boundary coordination among private forest landowners. *Landscape Ecol* **23**, 481–496 (2008). https://doi.org/10.1007/s10980-008-9207-x

Scott, J.H., Burgan, R.E., 2005. Standard fire behavior fuel models: a comprehensive set for use with Rothermel's surface fire spread model. US Department of Agriculture, Forest Service, Rocky Mountain Research Station.

SER, 2004. SER International Primer on Ecological Restoration. Society of Ecological Restoration, Washington, DC.

Shahabi, K., Wilson, J.P., 2014. CASPER: Intelligent capacity-aware evacuation routing. Computers, Environment and Urban Systems 46, 12–24. https://doi.org/10.1016/j.compenvurbsys.2014.03.004.

Sherriff, R.L., Platt, R.V., Veblen, T.T., Schoennagel, T.L., Gartner, M.H., 2014. Historical, observed, and modeled wildfire severity in montane forests of the Colorado Front Range. PLoS One 9, e106971.

Simpkins, K., 2021. Mountain residents underestimate wildfire risk, overestimate preparedness. CU Boulder Today.

Stephens, S.L., Moghaddas, J.J., Edminster, C., Fiedler, C.E., Haase, S., 2009. Fuel treatment effects on vegetation structure, fuels, and potential fire severity in western U.S. forests. Ecological Applications 19, 305–320.

Syphard, A.D., Brennan, T.J., Keeley, J.E., 2014. The role of defensible space for residential structure protection during wildfires. International Journal of Wildland Fire 23, 1165–1175.

Syphard, A.D., Keeley, J.E., 2019. Factors associated with structure loss in the 2013-2018 California wildfires. Fire 2, 2030049. https://doi.org/10.3390/fire2030049.

Thompson, M.P., O'Connor, C.D., Gannon, B.M., Caggiano, M.D., Dunn, C.J., Schultz, C.A., Calkin, D.E., Pietruszka, B., Greiner, S.M., Stratton, R., Morisette, J.T., 2022. Potential operational delineations: new

horizons for proactive, risk-informed strategic land and fire management. Fire Ecology 18, 17. https://doi.org/10.1186/s42408-022-00139-2

Tinkham, W.T., Hoffman, C.M., Ex, S.A., Battaglia, M.A., Saralecos, J.D., 2016. Ponderosa pine forest restoration treatment longevity: Implications of regeneration on fire hazard. Forests 7, 137.

USFS, 2021a. Wildfire risk to communities [WWW Document]. U.S. Department of Agriculture, U.S. Forest Service, Washington, DC. URL https://wildfirerisk.org/

USFS, 2021b. Glossary of forest engineering terms [WWW Document]. U.S. Department of Agriculture, U.S. Forest Service, Southern Research Station, Forest Operations Research. URL https://www.srs.fs.usda.gov/forestops/glossary/

Weir, J.R., Kreuter, U.P., Wonkka, C.L., Twidwell, D., Stroman, D.A., Russell, M., Taylor, C.A., 2019. Liability and prescribed fire: Perception and reality. Rangeland Ecology & Management 72, 533–538.

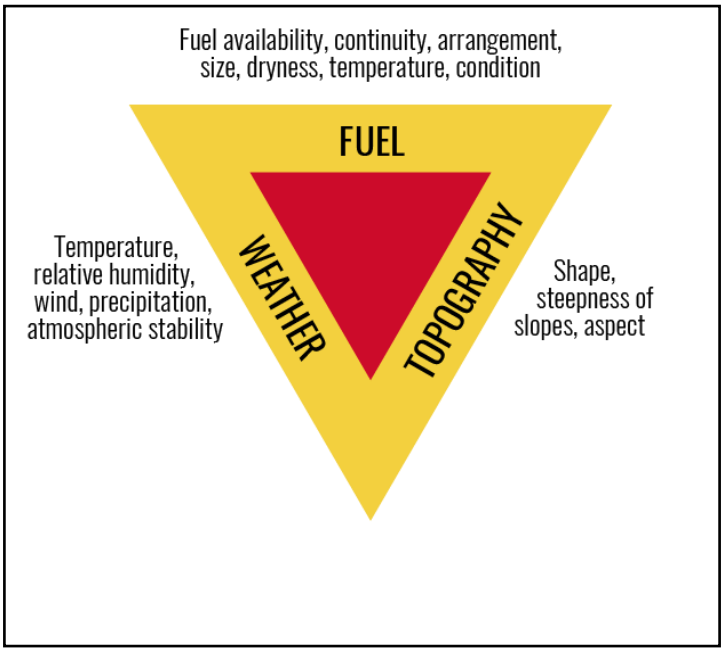
Wildfire Adapated Partnership, 2018. Fire adapted communities neighborhood ambassador approach: Increasing preparedness through volunteers. Wildfire Adapted Partnership, Durango, CO.

Wright, C.S., Evans, A.M., Grove, S., Haubensak, K.A., 2019. Pile age and burn season influence fuelbed properties, combustion dynamics, fuel consumption, and charcoal formation when burning hand piles. Forest Ecology and Management 439, 146–158.

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. If you think of a campfire, flashy fuels are the kindling that you use to start the fire. Flashy fuels dry out faster than other fuel types when relative humidity drops or when exposed to radiant and convective heat[3]. 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 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).

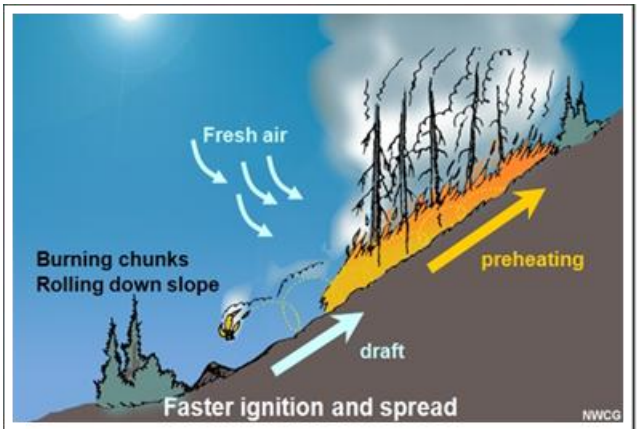
[3] Radiant heat transfer occurs by short-wavelength energy traveling through air. Radiant heat is what you feel when sitting in front of a fire. Radiant heat preheats and dries fuels adjacent to a wildfire, which initiates combustion by lowering the fuel's ignition temperature. Convective heat transfer 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.

Topography

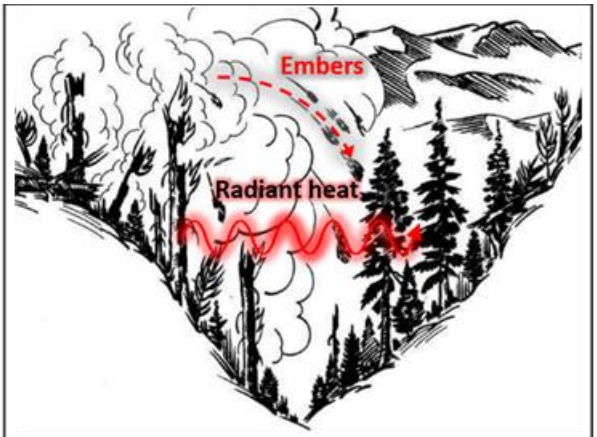
Topography (slope and aspect) influences fire intensity, speed, and spread. In the northern hemisphere, north-facing slopes experience less sun exposure during the day, resulting in higher fuel moistures. Tree density is often higher on north-facing slopes due to higher soil moisture. South-facing slopes 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 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.**). 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 – [insert your location] 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	[change these based on your local forecast office]

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

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

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 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, that can serve as a strategic location for wildland firefighting, and that 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 of residents and wildland firefighters and reduce the chances of home loss.

We delineated the WUI for Nederland/Timberline FPDs to include any area that could transmit wildland fire into the CWPP Plan Units within a 4-hour period in the absence of firefighter suppression and control measures under extreme fire weather conditions. We conducted fire modeling with FlamMap and assumed 25 mph winds blowing out of the west (see below).

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 Nederland/Timberline FPDs 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.

Important Considerations about 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. Models also struggle to capture impacts of structures on wildfire spread and home-to-home ignitions. It is recommended to use fire behavior analyses at a landscape scale to assess relative risk across the entire Nederland/Timberline FPDs.
Exceptional hot, dry, and windy conditions are increasingly common due to climate change and could result in even more extreme fire behavior across Nederland/Timberline FPDs than predicted by this analysis.

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.

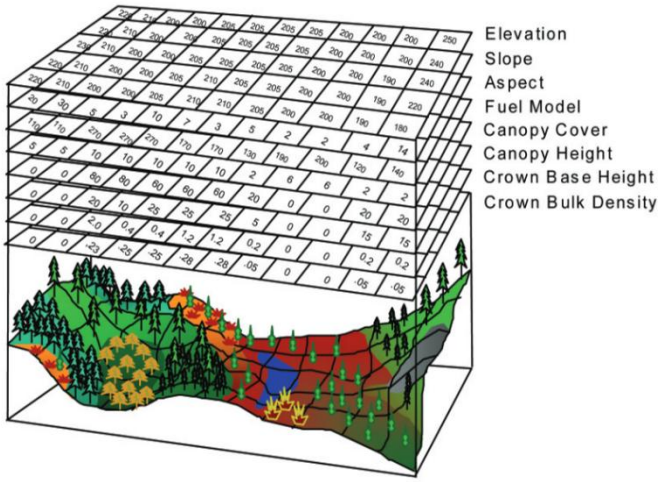


Figure B.1. FlamMap requires a variety of information about topography and fuels. Image from Finney (2006).

We used surface and canopy fuel data from the 2022 Colorado Wildfire Risk Assessment from CSFS as the basis for our modelling. The 2022 CO-WRA, available through the Colorado Forest Atlas, is the most recent and advanced version of the assessment. CSFS and Technosylva made impressive improvements in methodology for the 2022 update, notably greater ground-truthing of input data, new approaches for predicting wildfire spread into suburban and urban areas, and a higher spatial resolution (CSFS and Technosylva, 2023a, 2023b).

Methodology for creating the surface and canopy fuel layers are provided by (CSFS and Technosylva, 2023a). Fuel models are a stylized set of fuel bed characteristics used as input for a variety of wildfire modeling applications to predict fire behavior. **Figure B.2** depicts the fire behavior fuel models present across Nederland/Timberline FPDs. The most dominant fuel models in Nederland/Timberline FPDs are the custom timber understory model (TUML1) and the custom timber litter model (TLM1) from the 2022 CO-WRA. Areas at higher elevation in the western portion of Nederland FPD are above tree line and covered in low load, dry-climate grass (GR2), moderate load, dry-climate grass-shrub (GS2), and snow/ice (NB2).

We quality controlled fuel data and worked with Nederland/Timberline FPDs to assess the reasonableness of model predictions. We reduced crown base height by 30% for areas covered by lodgepole following the approach used by the Colorado Forest Restoration Institute. Reducing crown base height helps replicate observed crown fire activity in this forest type.

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 (75th percentile) and extreme (97th percentile) fire weather conditions (**Table B.2**). Weather conditions came from historic observations collected at the Pickel Gulch and Sugar Loaf RAWS and analyzed using FireFamilyPlus. 75th percentile conditions are like a normal summer day, whereas 97th percentile conditions are extremely hot, dry days—days that would qualify for Red Flag Warnings and could result in large-fire growth, for example, weather conditions in July 2016 during the Cold Springs Fire.

Winds across the Front Range of Colorado are unpredictable and can be extremely gusty in mountainous areas. We modeled 20-foot windspeeds of 20 mph for moderate fire weather conditions and 30 mph for extreme fire weather conditions. Wind speeds of 25 mph qualify as Red Flag Warnings when coinciding with low relative humidity and dry fuels. We modeled potential fire spread under winds blowing out of the west (270°) based on observations from the Pickel Gulch and Sugar Loaf RAWS and observations of local firefighters.

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). Conditional burn probability is calculated as the percentage of simulated fires that burn each 20-meter by 20-meter (0.1 acre) area under specified fire weather conditions, wind directions, and wind speeds.

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 6,500 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 several times larger than Nederland/Timberline FPDs to capture the landscape-scale movement of fire.

Table B.1. Model specifications used for fire behavior analyses with FlamMap for the 2024 Nederland/Timberline FPDs CWPP.

Model specification	Value
Crown fire calculation method	Scott/Reinhardt (2001)
Wind options	Gridded winds
Wind grid resolution	20 meters
Number of random ignitions	6,500*
Resolution of calculations	20 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 moderate and extreme fire weather conditions.

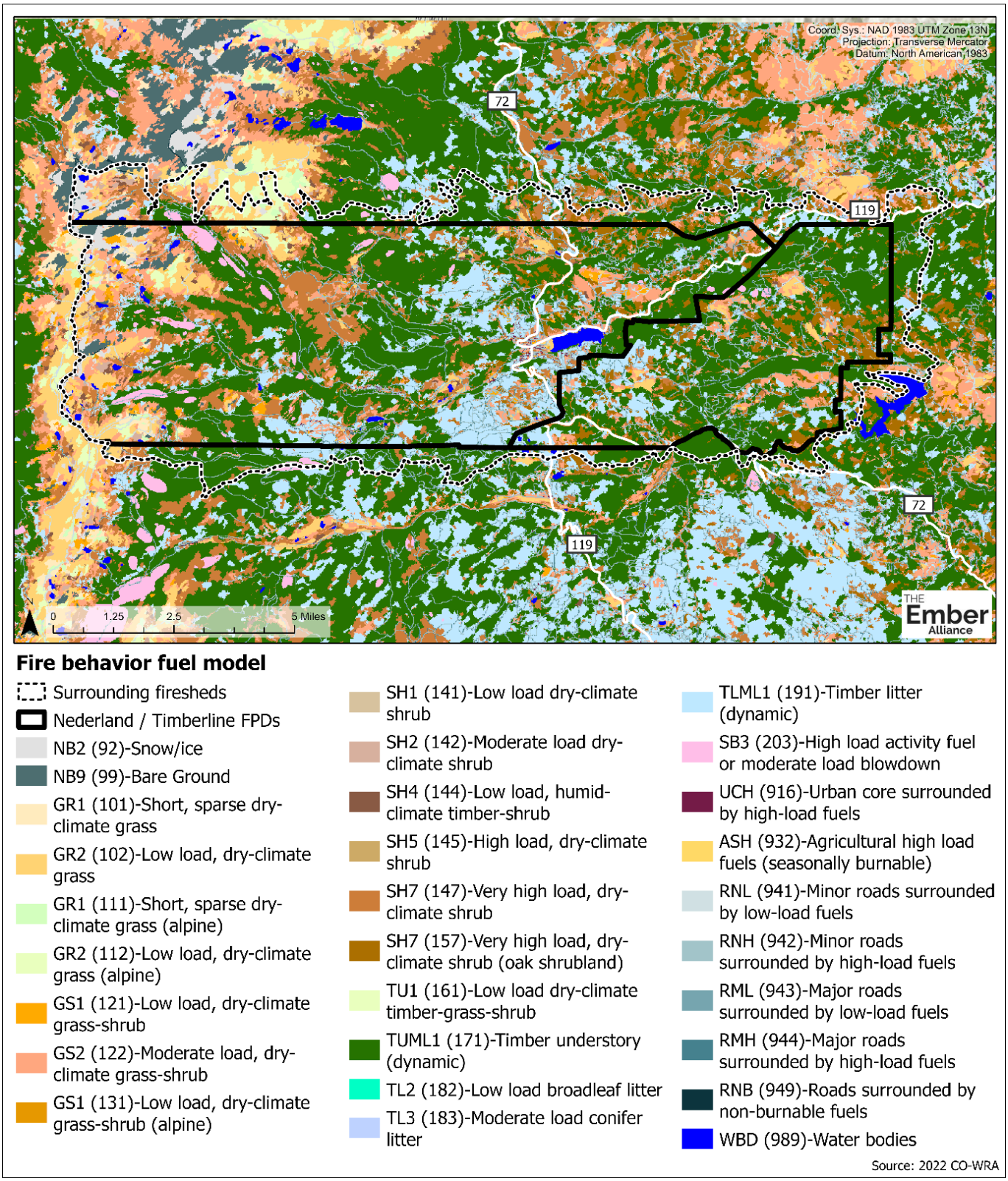


Figure B.2. Fire behavior fuel models are an important input for making fire behavior predictions. See (CSFS and Technosylva, 2023a) for a description of each fuel model. Fire behavior was summarized for Nederland/Timberline FPDs and adjacent "firesheds"—areas bounded by topographic features, water bodies, rivers, or roads that could transmit wildfire to or receive wildfire from Nederland/Timberline FPDs, shown in the dashed black line. Source: 2022 Colorado Wildfire Risk Assessment, Colorado State Forest Service

Table B.2. Fire weather conditions utilized for fire behavior modeling are based on weather observations from the Pickle Gulch and Sugar Loaf Remote Automatic Weather Stations between June 15-October 15, 2014-2022 and fuel moisture predictions from FireFamilyPlus. Weather conditions on July 9-10, 2016, during the Cold Springs Fire in Nederland, CO are presented for comparison.

Variable	Moderate fire weather (75th percentile)	Extreme fire weather (97th percentile)	Cold Springs Fire (for comparison)
Temperature	84°F	92°F	92°F
Relative humidity	18%	9%	10%
Wind direction	270° (west)	270° (west)	282° (west)
20-foot wind speed[1]	20 mph	30 mph	Gusts up to 35 mph
Fuel moisture[2]			
1-hour	5	3	2.8%
10-hour	8	6	6.6%
100-hour	10	8	9.4%
1,000-hour[3]	11	10	12.2%
Live woody	30	30	
Live herbaceous	62	60	
Crown foliage			

[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]1,000-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 pay attention to 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 at 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 Nederland/Timberline FPDs.

Figure B.4 shows the occurrence of torching (aka, passive crown fire) and active crown fire in Nederland/Timberline FPDs, which 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 residents and can destroy homes through radiant and convective heating and ember production. Active crown fires could occur in parts of Nederland/Timberline FPDs even under moderate fire weather conditions. Active crown fire is possible in areas with dense forest cover and steep slopes, particularly when the aspect of the slope aligns with the direction of strong winds, and, for example, the area around Chittenden Mountain, Boulder County Hill, Eldorado Mountain, Park Hill, Forsythe Canyon, and along the steep slope south of Colorado Highway 119.

Fire behavior class was determined for Nederland/Timberline FPDs 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 Nederland/Timberline FPDs—about 64% percent of Nederland/Timberline FPDs could experience high to extreme fire behavior, and this percentage increases to 77% under less common but more extreme, hot, dry, and windy conditions (**Figure B.5**). 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.

Figure B.6 shows rates of spread for the head of a fire that is spreading with winds blowing out of the west. Rapid rates of spread are possible across much of the FPDs, even under moderate fire weather conditions. Areas predicted for very low rates of spread are those in lodgepole pine forests that have very little understory, high crown base heights, and occur on slopes facing away from prevailing winds (in the case of this fire behavior modeling, winds out of the west). These conditions occur in the area east of Tennessee Mountain and east of Boulder County Hill, and east of Tungsten Mountain.

Firefighters could struggle to suppress fires across Nederland/Timberline FPDs under hot, dry, and windy conditions due to extreme flame lengths, ember production, and rapid rates of spread in different parts of the landscape. Exceptional hot, dry, and windy conditions are increasingly common due to climate change and could result in even more extreme fire behavior across Nederland/Timberline FPDs than predicted by this analysis.

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 distance. 1 chain / hour = 1.1 feet / minute.

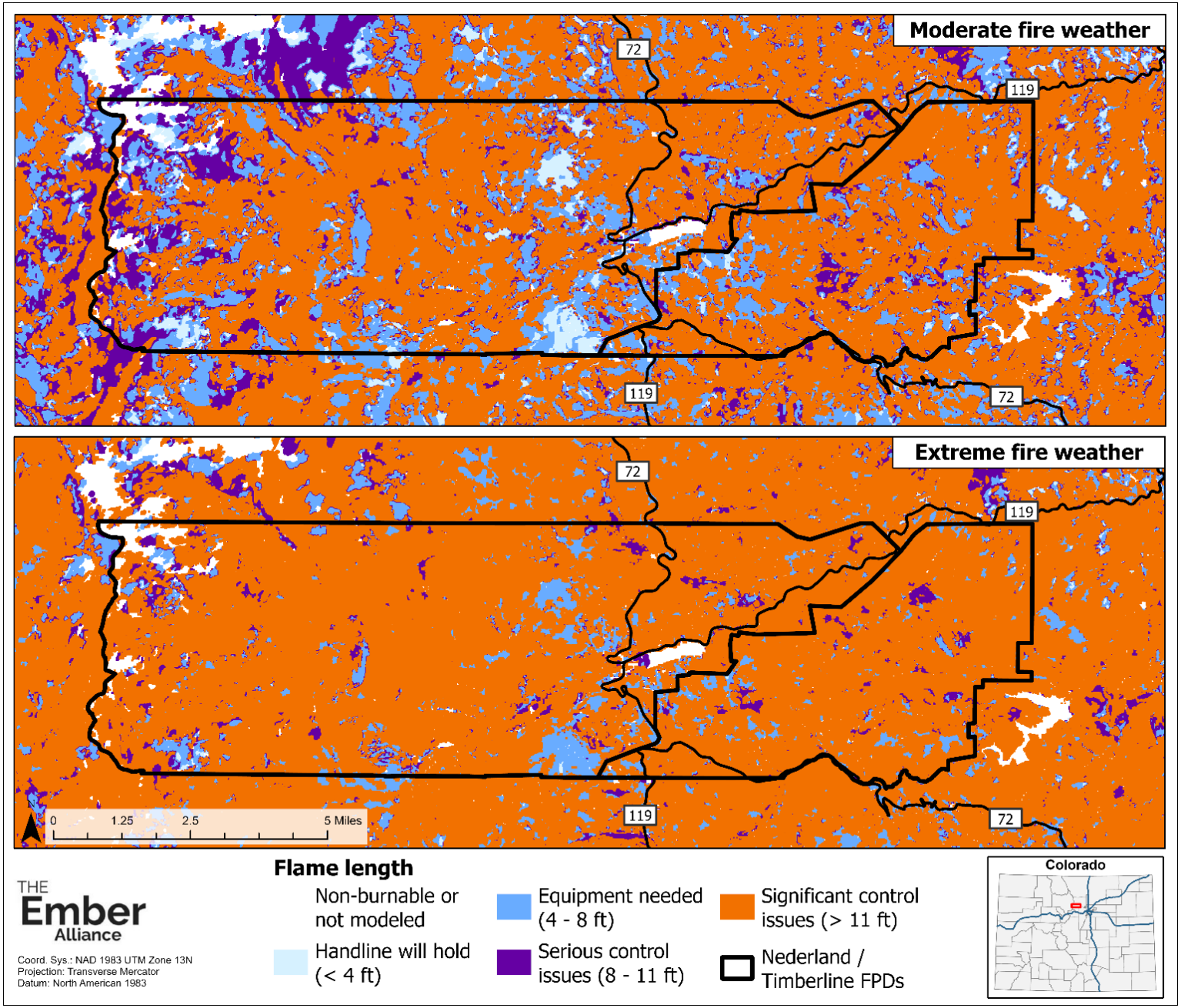


Figure B.3. Flame lengths in Nederland/Timberline FPDs under moderate and extreme fire weather conditions, categorized by the Haul Chart.

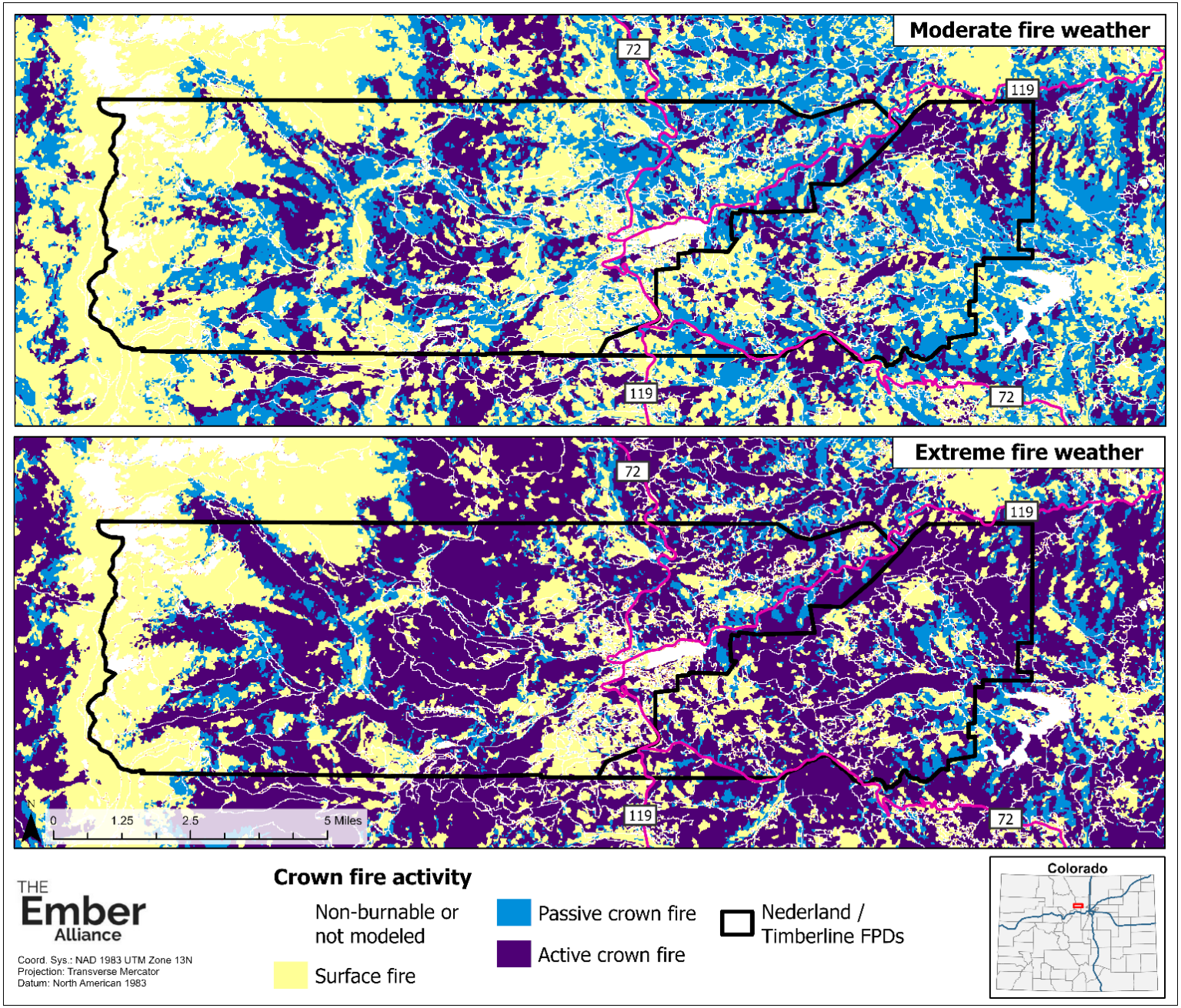


Figure B.4. Crown fire activity in Nederland/Timberline FPDs under moderate and extreme fire weather conditions.

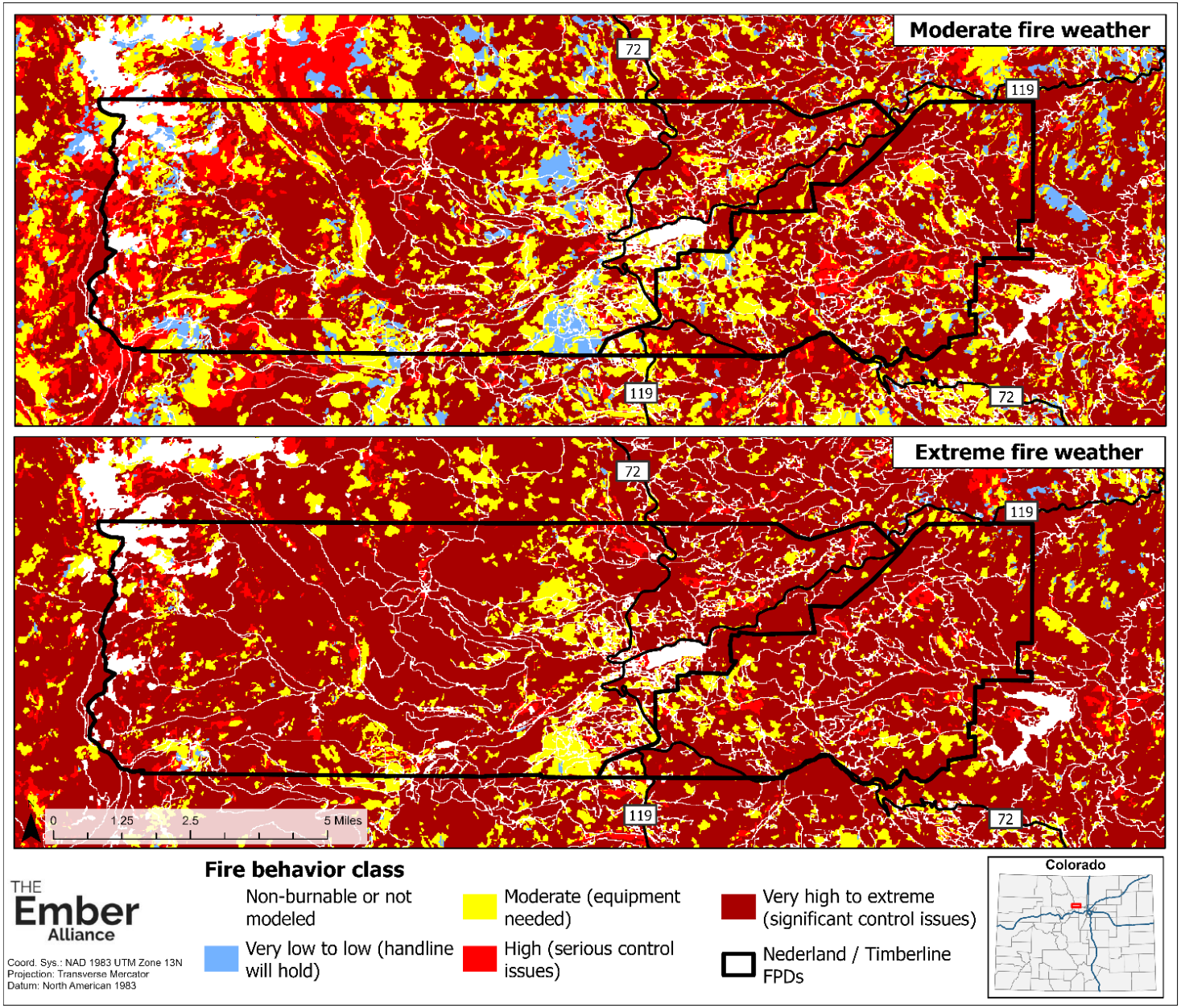


Figure B.5. Under moderate fire weather conditions—conditions typical of a summer day in Nederland/Timberline FPDs—64% percent of Nederland/Timberline FPDs could experience high to extreme fire behavior, and this percentage increases to 77% under less common but more extreme, hot, dry, and windy conditions.

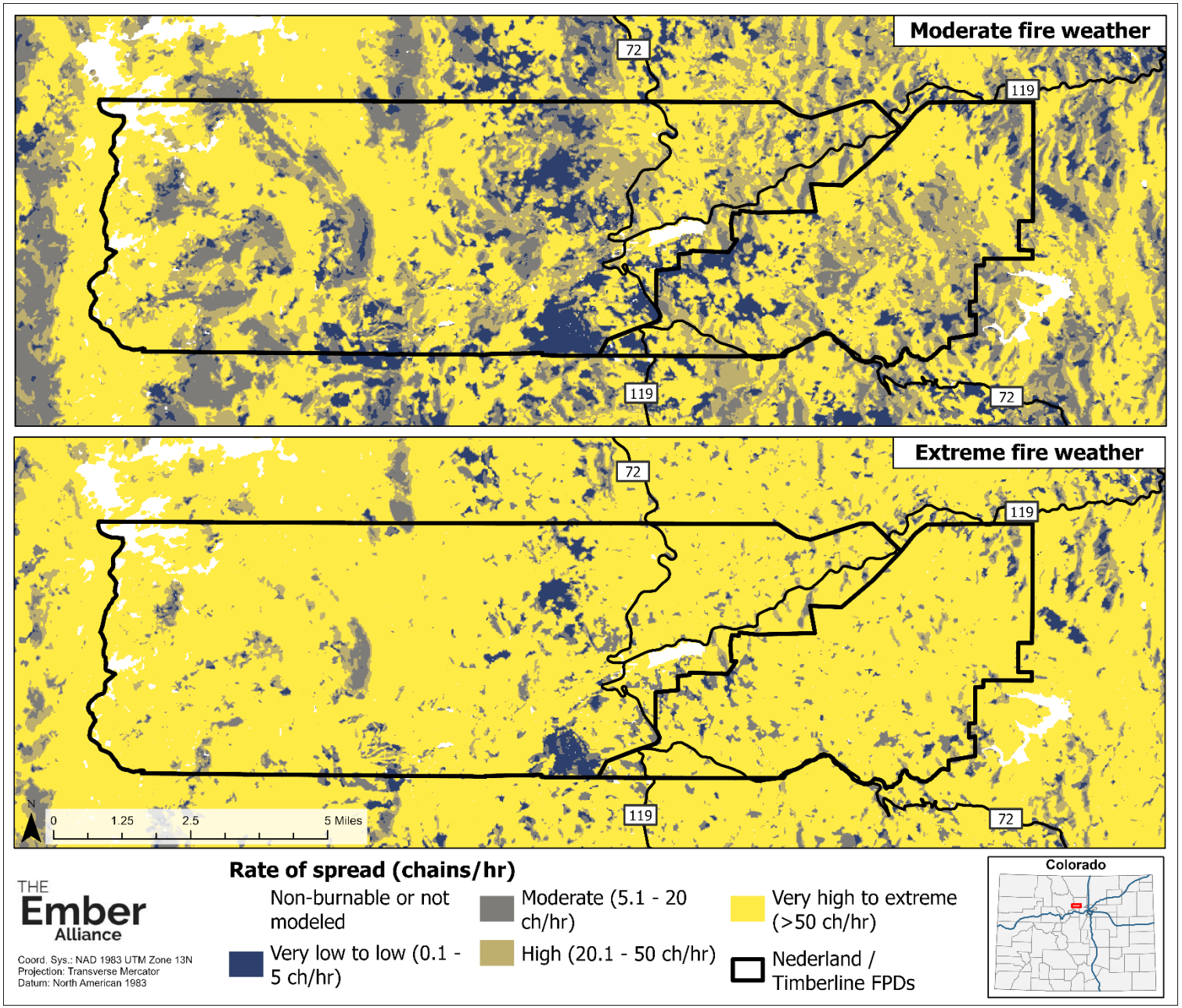


Figure B.6. Rate of spread (chains/hour) in Nederland/Timberline FPDs under moderate and extreme fire weather conditions, categorized by the Haul Chart.

Predicted Relative Burn Probability

Relative burn probability indicates how likely an area is to burn during a wildfire compared to other areas. 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 unburnable barriers such as Colorado State Highways 72 and 119. Rapid fire growth and spotting across roadways is more likely under higher windspeeds and with drier fuel conditions. **Unpredictable wind conditions along the Colorado Front Range make it difficult to predict potential fire spread, making it imperative for residents across Nederland/Timberline FPDs to take measures to mitigate their home ignition zone.**

The highest relative burn probabilities in Nederland/Timberline FPDs occurred along the exceptionally steep ridges south of Fourth of July Road, south of Jasper Creek, on the north side of Spencer Mountain, and along North Boulder Creek around Caribou Ranch (**Figure B.7**). The unique, glaciated topography in the western part of Nederland created steep, narrow canyons that can channel wildfires when strong winds blow downslope. Similarly, the complex canyon and valley topography in the eastern portion of Timberline FPD around Forsythe Canyon, Winger Ridge, and Twin Sister Peak resulted in elevated relative burn probabilities.

Relative burn probability modeled specifically for Nederland/Timberline FPDs (**Figure B.7**) should be interpreted differently from relative burn probability modeled for the entire state of Colorado for the 2022 CO-WRA (**Figure B.8**). Relative burn probability for Nederland/Timberline FPDs shows which parts of the district were more likely to burn relative to other parts of the district; therefore, the relative burn probability depicted in **Figure B.7** was useful for assessing relative risk among CWPP Plan Units and prioritizing fuel treatments. The CO-WRA relative burn probability shows which parts of the state are more likely to burn and is useful to assessing overall likelihood of fire in Nederland/Timberline FPDs relative to other parts of the state. Relative to the rest of the state, most of Timberline FPD falls into the high to highest burn probability categories. Higher elevation areas in the west of Nederland FPD have low to moderate burn probabilities relative to the rest of Colorado.

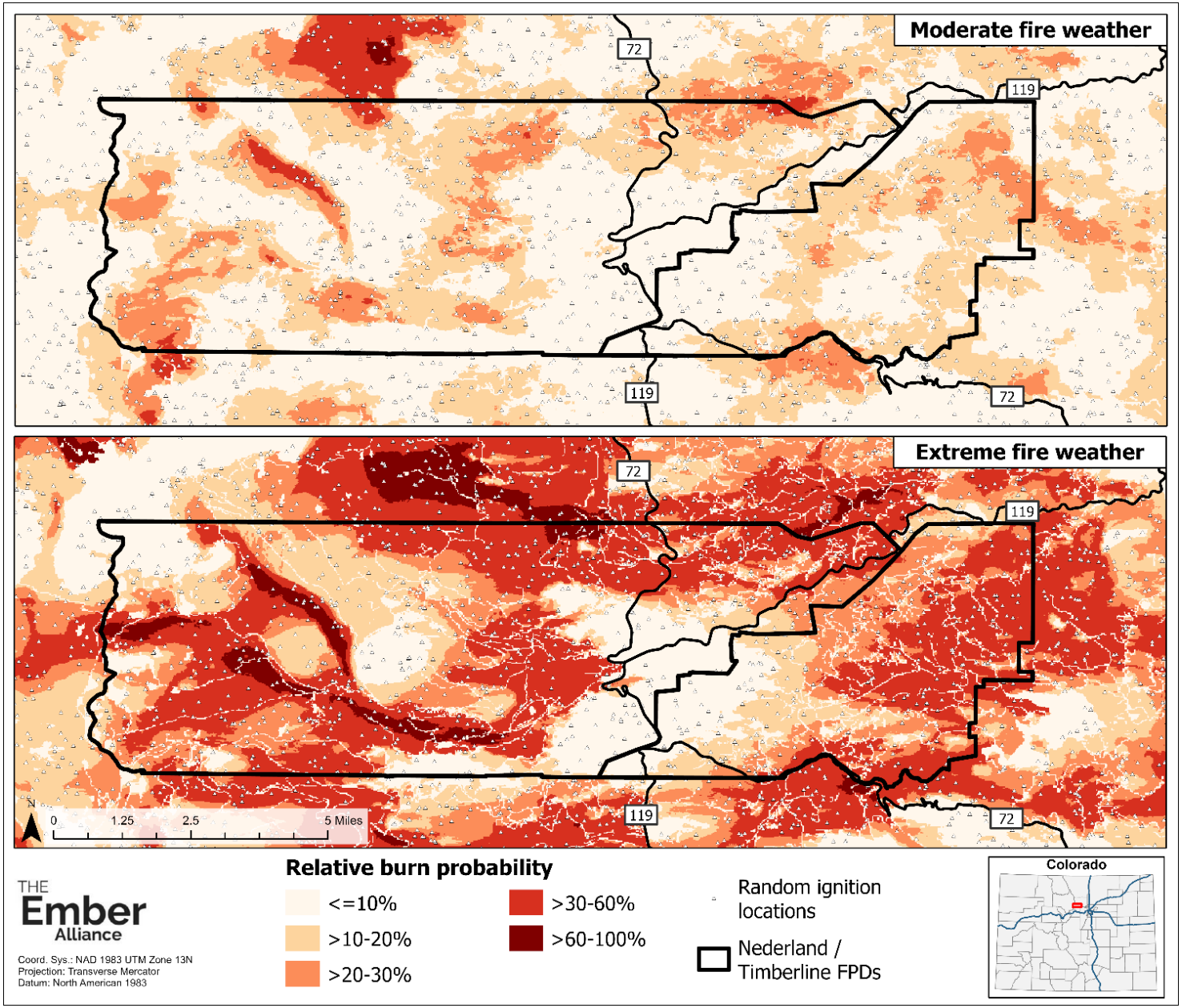


Figure B.7. Relative burn probability under moderate and extreme fire weather conditions with winds bellowing out of the west. Wildfire spread was simulated for 4-hours without suppression activities from 6,500 random ignition locations across an area several times larger than and centered on Nederland/Timberline FPDs.

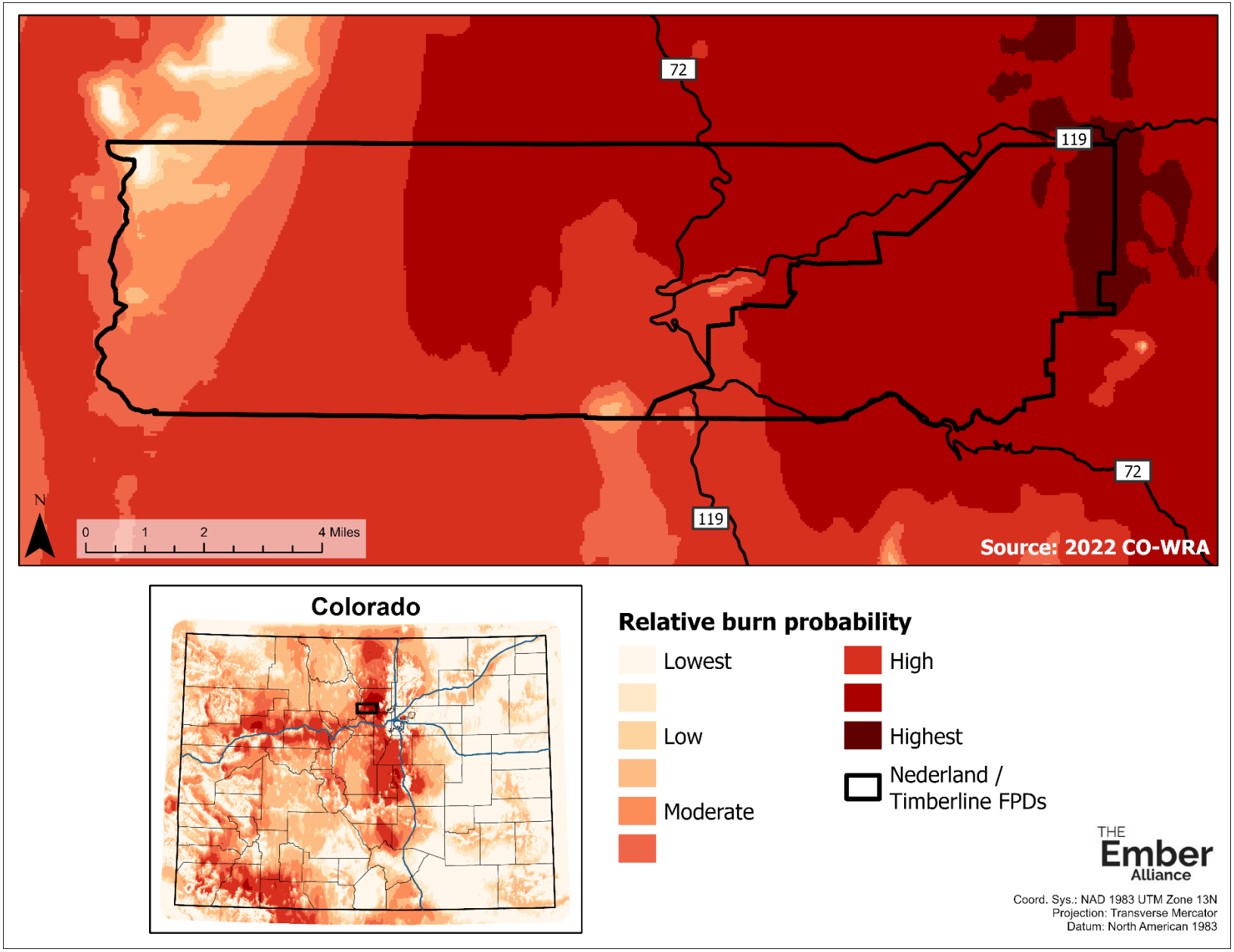


Figure B.8. Most of Timberline FPD falls into the high to highest burn probability categories relative to the state of Colorado. Higher elevation areas in the west of Nederland FPD have low to moderate burn probabilities. Predictions from the 2022 CO-WRA used high to extreme weather conditions. See (CSFS and Technosylva, 2023b) for detailed methodology. Source: 2022 CO-WRA.

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[4]. 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 > 12 feet[5]) 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 Section 3.a. 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. (Caggiano et al., 2020) also found that a vast majority (95%) of home losses during WUI fires occurred within 100 m of wildland vegetation. Although embers can travel miles ahead of a wildfire, 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.

Potential exposure to radiant heat and long- and short-range ember cast is widespread across Nederland/Timberline FPDs, and this awareness should encourage residents and business owners to complete home hardening practices to reduce the risk of ignition. Fuel treatments within HIZs and surrounding undeveloped areas could help reduce the exposure of homes to radiant heat and short-range ember cast. All homes should be built and upgraded with ignition-resistant materials to reduce the effects of short-range ember cast.

Under moderate fire weather, all homes in Nederland/Timberline FPDs could experience long-range ember cast, 70% could experience short-range ember cast, and about 25% could be exposed to damaging radiant heat **(Figure B.9)**. Under extreme fire weather, many more homes could be exposed to short-range embers (97% of homes) and damaging radiant heat (64% of homes).

[4] It is recommended to use this analysis to assess relative risk across Nederland/Timberline Fire Protection Districts 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.

[5] Cutoff for flame length comes from research summarized by (Abo El Ezz et al., 2022) showing that 80-100% of structures were destroyed when exposed to >12-foot flame lengths during actual wildfires.

Potential exposure to radiant heat under moderate fire weather conditions is notable for homes in Porter Ranch, Cold Springs, Eldora, and Lazy Z Plan Units (**Figure B.10**). Wildfires burning up steep slopes covered in dense forests can produce long flame lengths and abundant embers, resulting in elevated structure exposure. Exposure to radiant heat and embers from burning vegetation is lower in the town of Nederland due to lower cover of vegetation. However, the potential for short-range ember cast from neighboring homes if they ignite is great in densely developed parts of Nederland/Timberline FPDs.

Most structures in Nederland/Timberline FPDs (82%) could be exposed to short-range ember cast from at least one other home (**Figure B.11**). This creates the opportunity for home-to-home ignitions, especially if homes are not mitigated or hardened (Syphard et al., 2012). On average, homes could be exposed to short-range ember cast from 7 other homes, with some homes exposed to as many as 46 other homes. Nederland, South Nederland, Sundown, and Eldora Plan Units have the greatest potential for home-to-home spread due to higher housing densities.

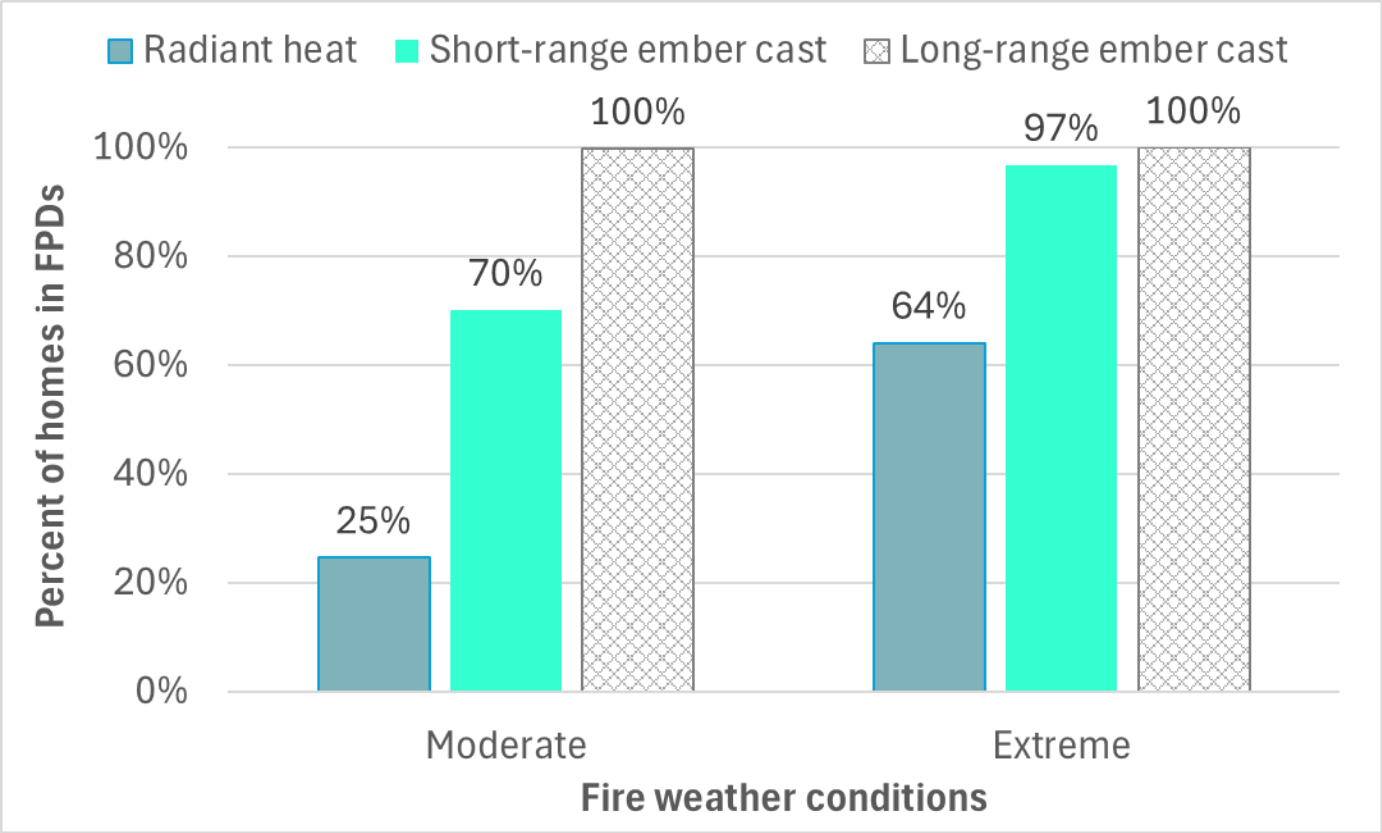


Figure B.9. Percentage of homes in Nederland/Timberline FPDs with different types of exposure to wildfire under moderate and extreme fire weather conditions. Radiant heat from burning vegetation can ignite nearby homes, and embers emitted from burning vegetation or other homes can travel long distances and ignite vegetation and homes away from the main fire.

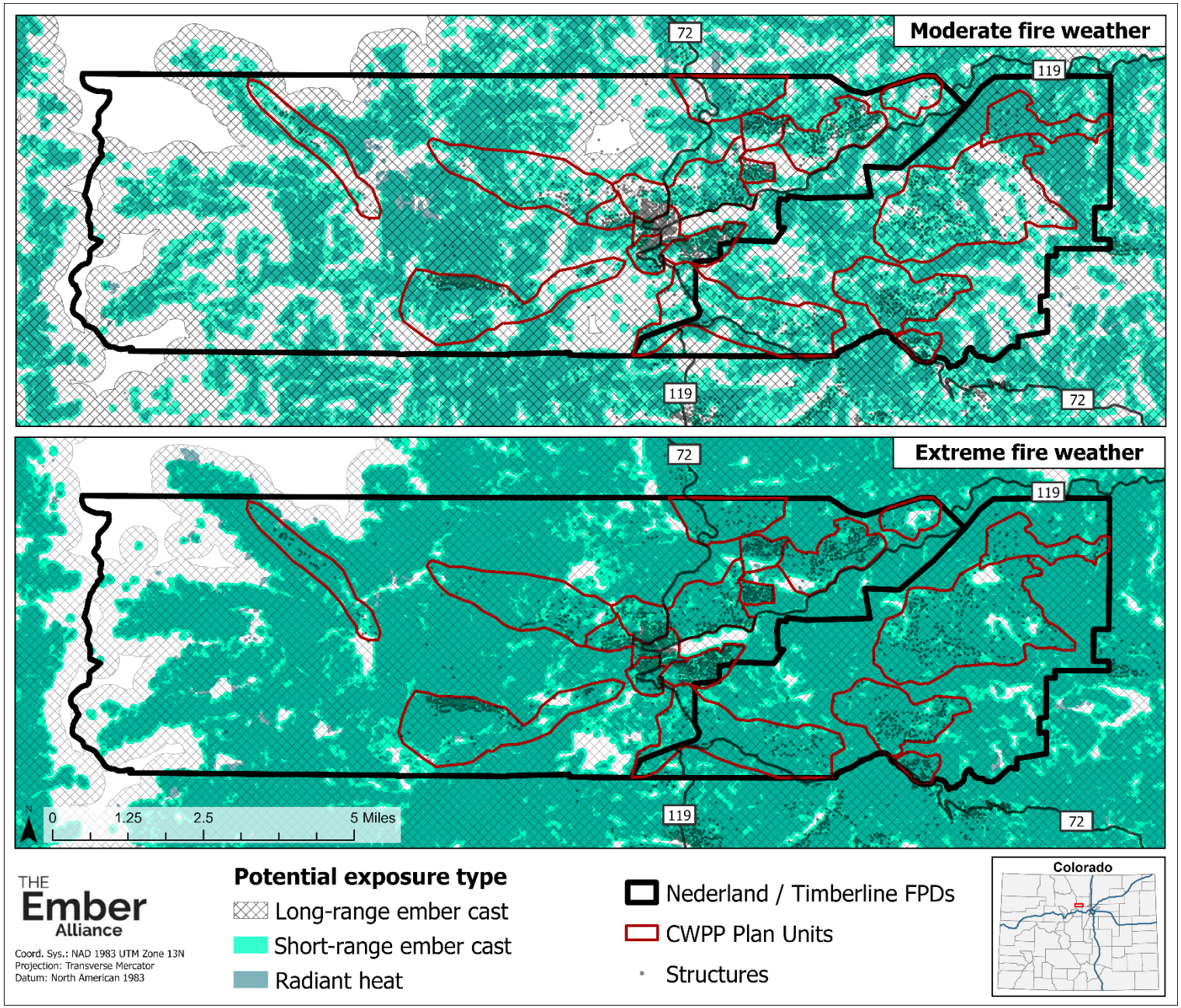


Figure B.10. Predicted exposure to short-and long-range ember cast and radiant heat under moderate and extreme fire weather conditions in Nederland/Timberline FPDs.

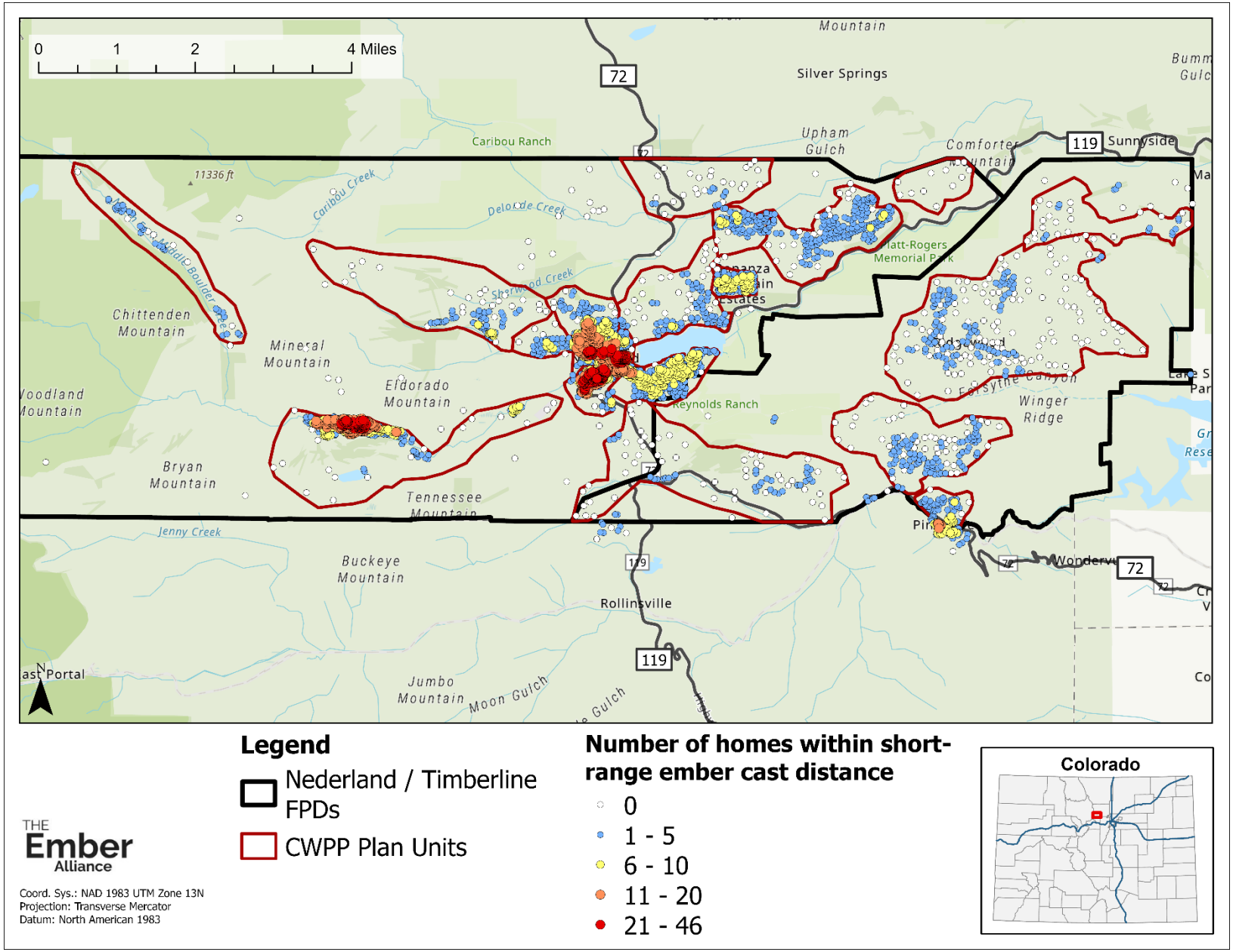


Figure B.11. 82% of structures in Nederland/Timberline FPDs could be exposed to short-range ember cast from at least one neighboring structure and are at greater risk of home-to-home ignitions. On average, structures could be exposed to short-range ember cast from 7 other structures, with some structures exposed to as many as 46 other structures.

Exposure of Highly Valued Resources

We identified highly valued resources in areas that could experience damaging radiant heat and/or short-range ember cast and were within 100 m of areas with a relative burn probability of ≥10 percent (**Figure B.12**; **Table B.4**). This analysis informed fuel treatment prioritization and plan unit recommendations. Keep in mind that our fire behavior analyses occurred at the scale of 0.1 acres (20 x 20 meters), and input fuel data is developed via extrapolation of aerial imagery and satellite data. **Site-level assessments are vital to verify exposure of highly valued resources and develop specific plans for mitigation.**

Data for the location of values at risk came from Boulder County Parks and Open Space, CO Department of Public Health & Environment, CO Division of Oil and Public Safety, CO Parks & Wildlife, Federal Emergency Management Agency, Google Maps, Homeland Infrastructure Foundation-Level Data, National Park Service, Nederland and Timberline FPDs, Town of Nederland, U.S. Department of Transportation, U.S. Environmental Protection Agency, U.S. Forest Service, U.S. Geological Survey, University of Redmon, and Western Regional Climate Center.

Table B.4. Highly valued resources with potential exposed to radiant heat and/or short-range ember cast in areas with ≥10% relative burn probability. Areas that could experience exposure under moderate weather conditions are at greater risk than those that only experience exposure under extremely hot, dry, and windy conditions.

Type	Name/location	Fire weather	
		Moderate	Extreme
Community and cultural resources	Wolf Tongue Mill (historic site)	x	x
Community and cultural resources	Pandora Mine Campground	x	x
Community and cultural resources	Caribou dispersed camping areas	x	x
Community and cultural resources	Front Range Trailhead	x	x
Community and cultural resources	Winiger Ridge camping areas	x	x
Critical infrastructure	Communication towers on Dakota Mountain	x	x
Critical infrastructure	Silver Lake Hydroelectric Power Plant	x	x
Critical infrastructure	Nederland Coop Weather Station	x	x
Safety and government services	Nederland Fire Protection District Station 2	x	x
Safety and government services	Timberline FPD Station 2	x	x
Safety and government services	Timberline FPD Station 1	x	x
Safety and government services	Pinecliffe Post Office	x	x
Community and cultural resources	New Explorers Learning Center		x
Community and cultural resources	Caribou Mountain Preschool		x
Community and cultural resources	Nederland Middle-Senior High School		x
Community and cultural resources	Nederland Elementary School		x
Community and cultural resources	Gold Miner Hotel (historic site)		x
Community and cultural resources	Town of Caribou (historic site)		x
Community and cultural resources	Town of Tungsten (historic site)		x

Type	Name/location	Fire weather	
		Moderate	Extreme
Community and cultural resources	Castle Rock climbing area		x
Community and cultural resources	Fourth of July Trailhead		x
Community and cultural resources	Hessie Trailhead		x
Community and cultural resources	Eldora Mountain Resort Ski Area		x
Community and cultural resources	Caribou Ranch Trailhead		x
Community and cultural resources	Kelly Dahl Campground		x
Community and cultural resources	Forsythe Canyon Trailhead		x
Community and cultural resources	Platt/Rogers Memorial Park		x
Critical infrastructure	Xcel Energy communication tower		x
Critical infrastructure	Eldora Mountain communication center		x
Critical infrastructure	Verizon Wireless		x
Critical infrastructure	Nederland FPD station 1		x
Critical infrastructure	Nederland FPD station 2		x
Critical infrastructure	Nederland Park-n-Ride		x
Critical infrastructure	Electric substations		x
Critical infrastructure	Lake Eldora Wastewater Treatment Plant		x
Critical infrastructure	Lake Eldora SNOTEL site		x
Critical infrastructure	Caribou Ranch Coop Weather Station		x
Safety and government services	Nederland Fire Protection District Station 3		x
Safety and government services	Nederland Fire Protection District Station 1		x
Safety and government services	Nederland Town Hall		x

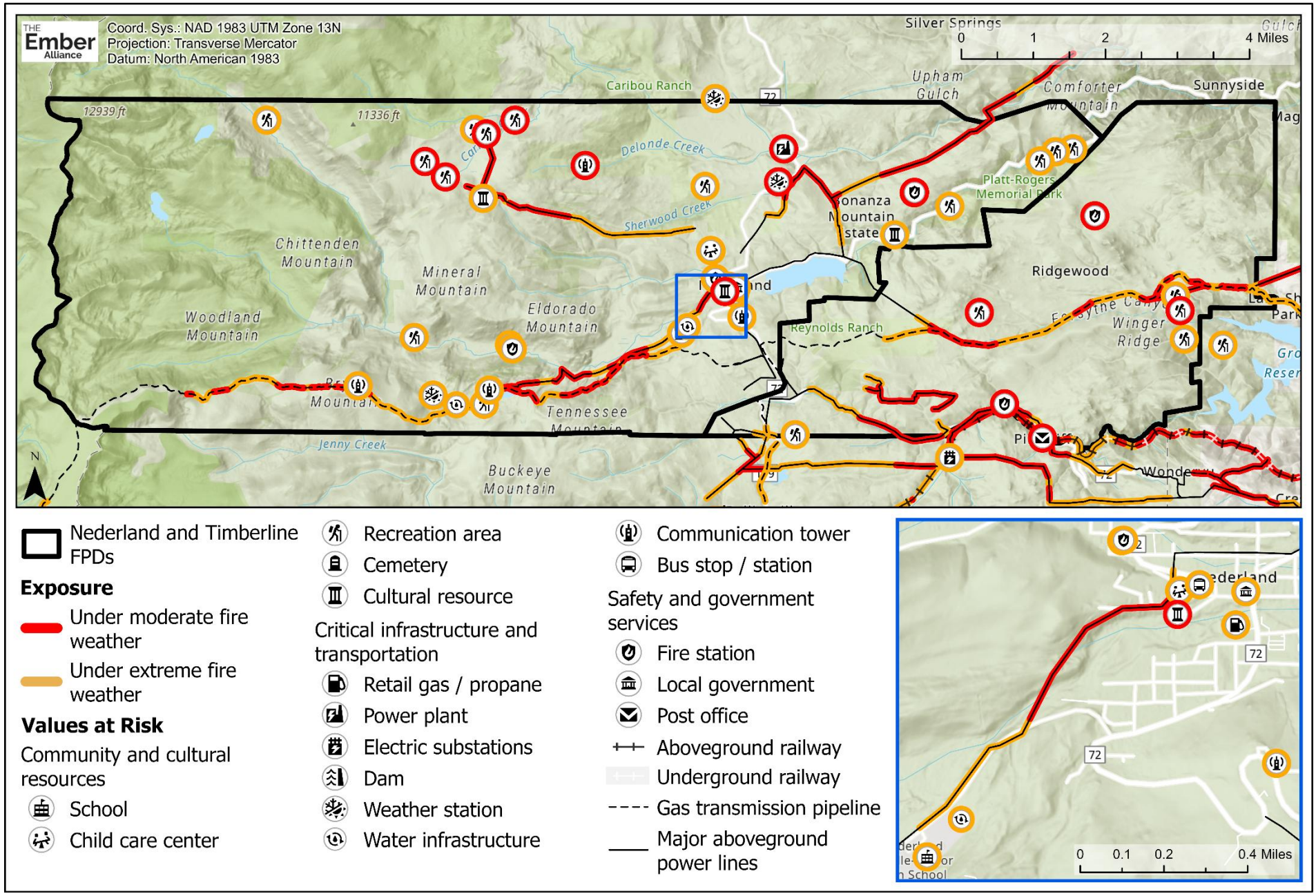


Figure B.12. Predicted exposure of values at risk within 1 mile of Nederland/Timberline FPDs. Areas that could experience exposure under moderate weather conditions are at greater risk than those that only experience exposure under extremely hot, dry, and windy conditions.

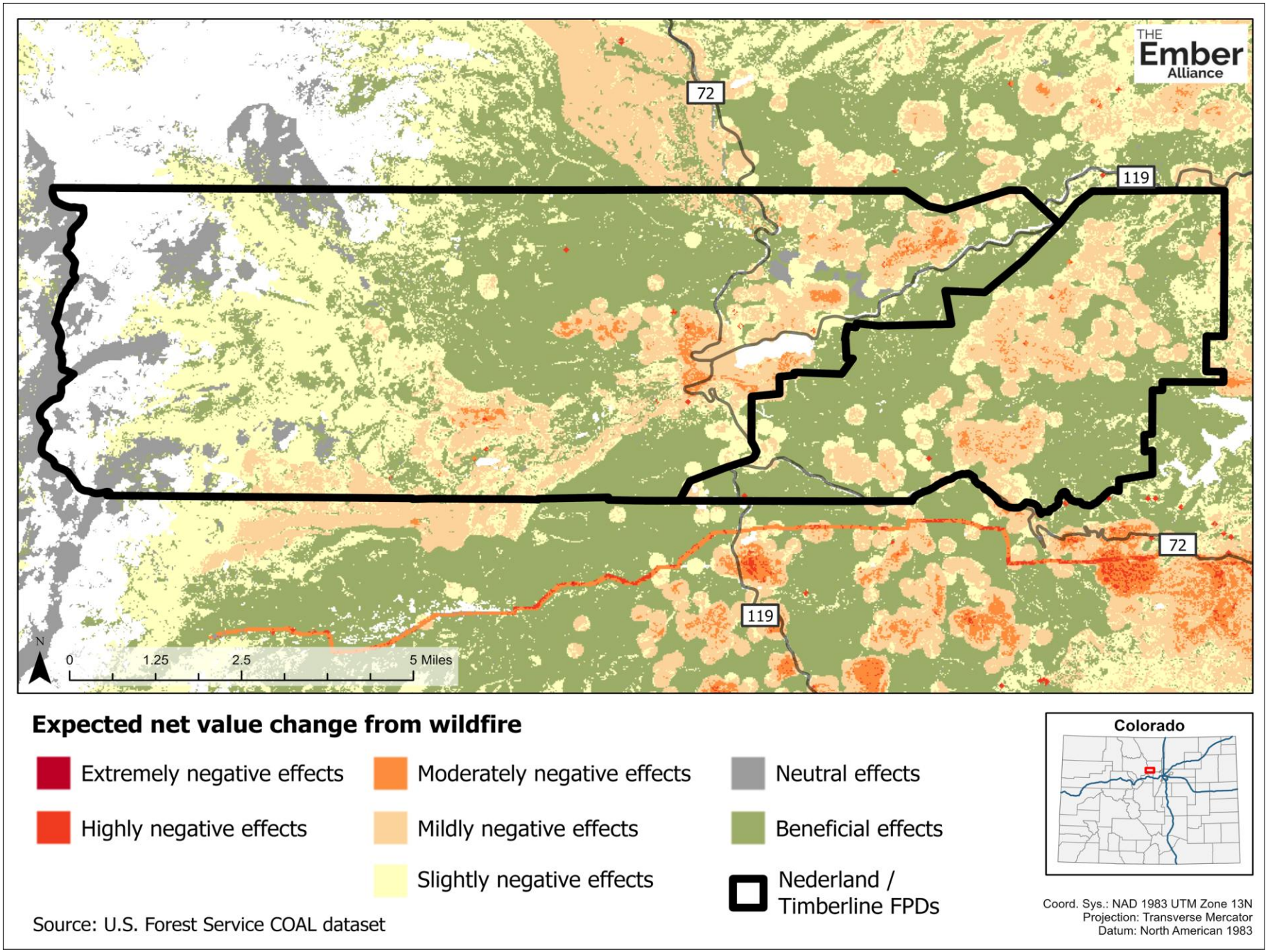


Figure B.13. Predicted net value change from wildfire. According to an analysis by the U.S. Forest Service for the state of Colorado, wildfire and/or broadcast prescribed burning could benefit portions of Nederland/Timberline FPDs by restoring ecological conditions and reducing fuel loads. Beneficial fire is more likely in areas without homes and where expected fire behavior is moderate. The analysis considered potential fire behavior, likelihood of wildfire, exposure of values at risk, relative importance of values, and sensitivity of values to different types of fire behavior. Source: U.S. Forest Service COAL dataset.

Evacuation Analysis

Evacuation concerns can weigh heavily on the minds of many residents in Nederland/Timberline FPDs. 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). Estimates from ArcCASPER are useful for determining relative evacuation capacity and congestion across Nederland/Timberline FPDs 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 residents.**

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.

Estimates from ArcCASPER are useful for determining relative evacuation capacity and congestion across the IHFPD 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 residents.

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 purpose of the model is to minimize evacuation time for the entire district, not to minimize the evacuation time for each individual resident.

ArcCASPER assumes simultaneous departure of vehicles, but the model's algorithm starts with the evacuee farthest from predefined scenario endpoint(s) and finds that evacuee's quickest path to an endpoint. 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 predefined scenario endpoints).

ArcCASPER does not account for unpredictable events, such as roadway blockage from accidents, non-survivable conditions along roadways burned-over by flames, or reduced visibility from smoke. It also does not consider emergency vehicles traveling the opposite direction of evacuation traffic.

Law enforcement personnel will direct traffic during a wildfire event. This evacuation analysis is not meant to suggest alternate routes for individual residents. Residents 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).

For our analysis, we used an exponential traffic model with a critical density of 10 and saturation density of 120. 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. 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 worked with Nederland/Timberline FPDs to conduct an extensive QAQC on road data from Open Street Map; an accurate road network is vital for evacuation modeling. We also work with Nederland/Timberline FPDs to define evacuation scenarios, each assuming a wildfire moving out of a different direction and affecting the availability of evacuation routes. The scenarios were for a fire spreading out of the center of Nederland FPD, out of the southwest, out of the southeast, and out of the northeast.

Evacuees were routed to two to four different endpoints depending on the scenario. Endpoints carried different weights so that the model was more likely to route evacuees along typical travel routes, even if sending more evacuees down that route increased the global evacuation time (**Table B.5**; **Figure B.16**). **Endpoints were locations along major roads at which point the evacuation simulation ended; endpoints were NOT evacuation destinations that would be used during an actual incident.**

Evacuees included in each scenario were based on feedback from the FPDs (**Figure B.16**). This included several addresses from outside the FPD boundaries if they were likely to be included in the same evacuation order. We modeled various number of vehicles departing from each address or recreation area depending on the address type and parking lot capacity (

Table B.6). We assumed two vehicles per residential address. We used aerial imagery to estimate the number of parking spots at each recreational area, and we assumed maximum capacity at trailheads and camping areas. We assumed one vehicle per camping site.

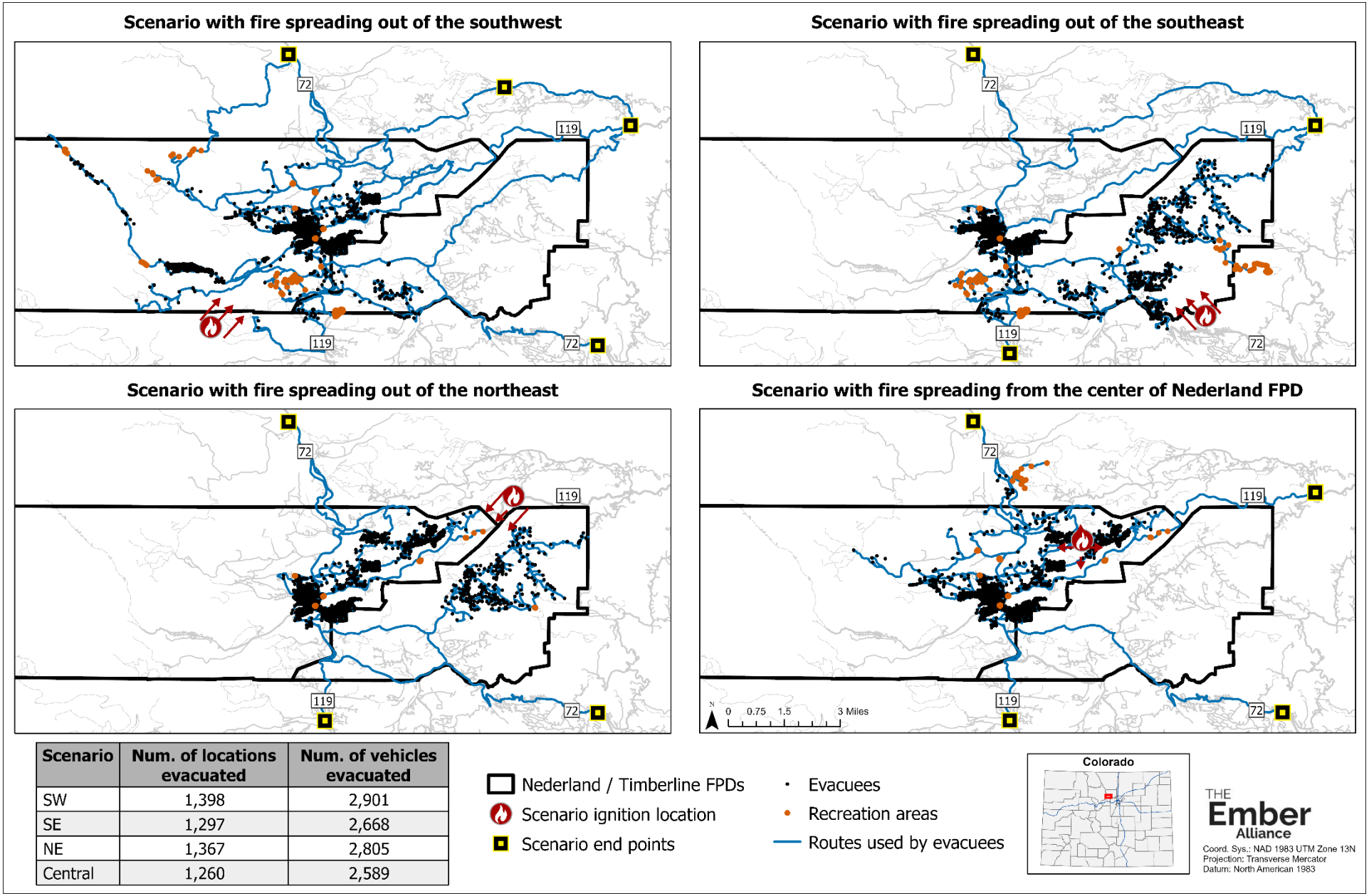
Table B.5. Locations of scenario endpoints and weighting to prioritize more common routes for the four evacuation scenarios. Scenarios are for a fire moving out of the center of Nederland FPD ("Central"), out of the southwest ("SW"), out of the southeast ("SE"), and out of the northeast ("NE").

Scenario endpoints	Scenario(s)	Priority
North on Hwy 72 (Peak-to-Peak Highway)	All	Moderate for central and SW scenarios Low for SE scenario High for NE scenario
Southeast on Hwy 72 (Coal Creek Canyon Road)	Central, SW, NE	High
North on Hwy 119 (Boulder Canyon Drive)	Central, SE, SW	High
South on Hwy 119 (Boulder Canyon Drive)	Central, SE, NE	High
North on CR 122 (Sugarloaf Road)	SW	Low

Table B.6. Number of vehicles simulated from each address type or location.

Address type / location	# vehicles	Address type / location	# vehicles
Residential addresses	2	Fourth of July Trailhead	55
Gas stations, schools, library	5	Chipeta Park	25
Caribou Room, Backdoor Theater, & Carousel of Happiness	10	Front Range Trailhead	8
Nederland Park-n-Ride	15	Hessie Trailhead	30
Winiger Ridge Camping Area	26	West Magnolia Trailhead (west lot)	8
Caribou Dispersed Camping Area	11	West Magnolia Trailhead (east lot)	7
Gordon Gulch Dispersed Camping	15	Mud Lake Trailhead	35
Kelly Dahl Campground	47	Nederland Ice & Racquet Park	14
West Magnolia Camping Area	22	Pandora Mine Campground	3
Forsythe Canyon Trailhead	20	Platt/Rogers Memorial Park (west lot)	12
Barker Reservoir Recreation Area	40	Platt/Rogers Memorial Park (center lot)	5
Caribou Ranch Trailhead	26	Platt/Rogers Memorial Park (east lot)	5
Castle Rock climbing area	15		

Table B.6 indicates how many vehicles were simulated for each location or address type.



Scenario	Num. of locations evacuated	Num. of vehicles evacuated
SW	1,398	2,901
SE	1,297	2,668
NE	1,367	2,805
Central	1,260	2,589

Figure B.14. Scenario endpoints and evacuees included in the four evacuation scenarios for Nederland/Timberline FPDs. Evacuees from recreational areas are indicated in orange.

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 Nederland/Timberline FPDs. 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. We also combined predicted roadway congestion with potential roadway survivability to prioritize roads for fuel treatments.

Significant congestion could occur along primary roads during wildfire evacuations in Nederland and Timberline FPDs—areas with elevated risk of wildfire compared to much of Colorado. The time to traverse a segment of road can be as much as 8 times longer under evacuation congestion than without traffic (**Figure B.15**). Roads with the potential for high to extreme evacuation congestion include:

- Highway 72 (Peak-to-Peak Highway, West 2nd Street, and Coal Creek Canyon Road)
- Highway 119 (Boulder Canyon Drive and North Bridge Street)
- County Road 122 (Sugarloaf Road)
- Eldora Road
- Magnolia Drive

The specific roads experiencing congestion and the degree of congestion depended on which parts of the FDPs were included in the evacuation scenario and which routes were available given the direction of fire spread. A wildfire moving out of the southwest and triggering an evacuation of most of the FPDs could result in the greatest potential for congestion (**Figure B.16**).

Evacuation Time

Evacuation time indicates how long it might take for a vehicle to receive an evacuation order, depart from an address, and reach a scenario endpoint. site Estimates of evacuation time can serve as a benchmark for emergency pre-planning and strategic decision making.

Evacuating residents during a wildfire in Nederland and Timberline FPDs could take between 2 hours and 15 minutes to 3 hours and 45 minutes depending on the evacuation scenario (**Figure B.17**). Evacuation times included a 30-minute estimate for people to gather their belongings and depart after receiving an evacuation order. A wildfire moving out of the southwest could result in the greatest evacuation times, particularly for residents and recreators near the end of Fourth of July Road. Low to moderate congestion was predicted for Fourth of July Road, but residents and recreators coming from this road could face substantial congestion once they merge onto Eldora Road and Highway 119.

Predictions for evacuees from each Plan Unit by scenario are presented in **Figure B.18**. The longest evacuation times were predicted for the Fourth of July and Eldora Plan Units under the scenario of a fire spreading out of the southwest. Potentially long evacuation times were notable for residents in the Porter Ranch Plan Unit if a fire were to spread out the northeast and prevent residents from traveling east on Magnolia Drive. Residents in the Lazy Z Plan Unit could experience elevated evacuation times if a fire were to spread out the southeast and high congestion were to build up merging onto Magnolia Drive from Lazy Z Drive, which is their only egress route.

These model results should be interpreted as relative ratings showing which neighborhoods may take longer than others to evacuate. It is important to note that these times are given under the best-case scenario in which residents are safely and efficiently evacuating, there are no accidents blocking the roads, there is no smoke hindering visibility, and evacuation groups are departing individually. **It is important for residents to be prepared so they can leave promptly in the case of an evacuation order.**

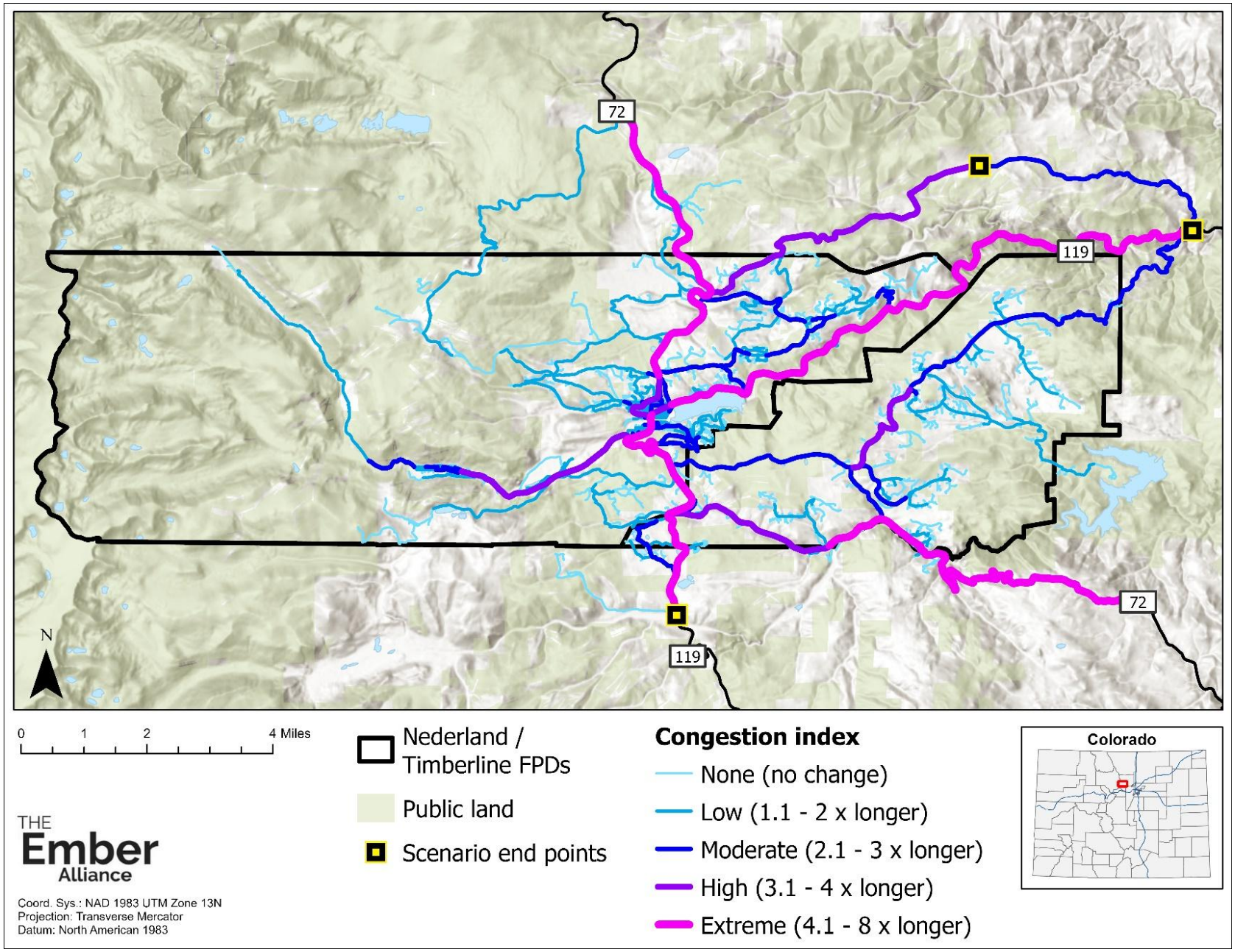


Figure B.15. Maximum predicted congestion across all four evacuation scenarios. categories (none, low, moderate, high, extreme) are based on the ratio between the time required to traverse a segment of road with congestion vs. without congestion.

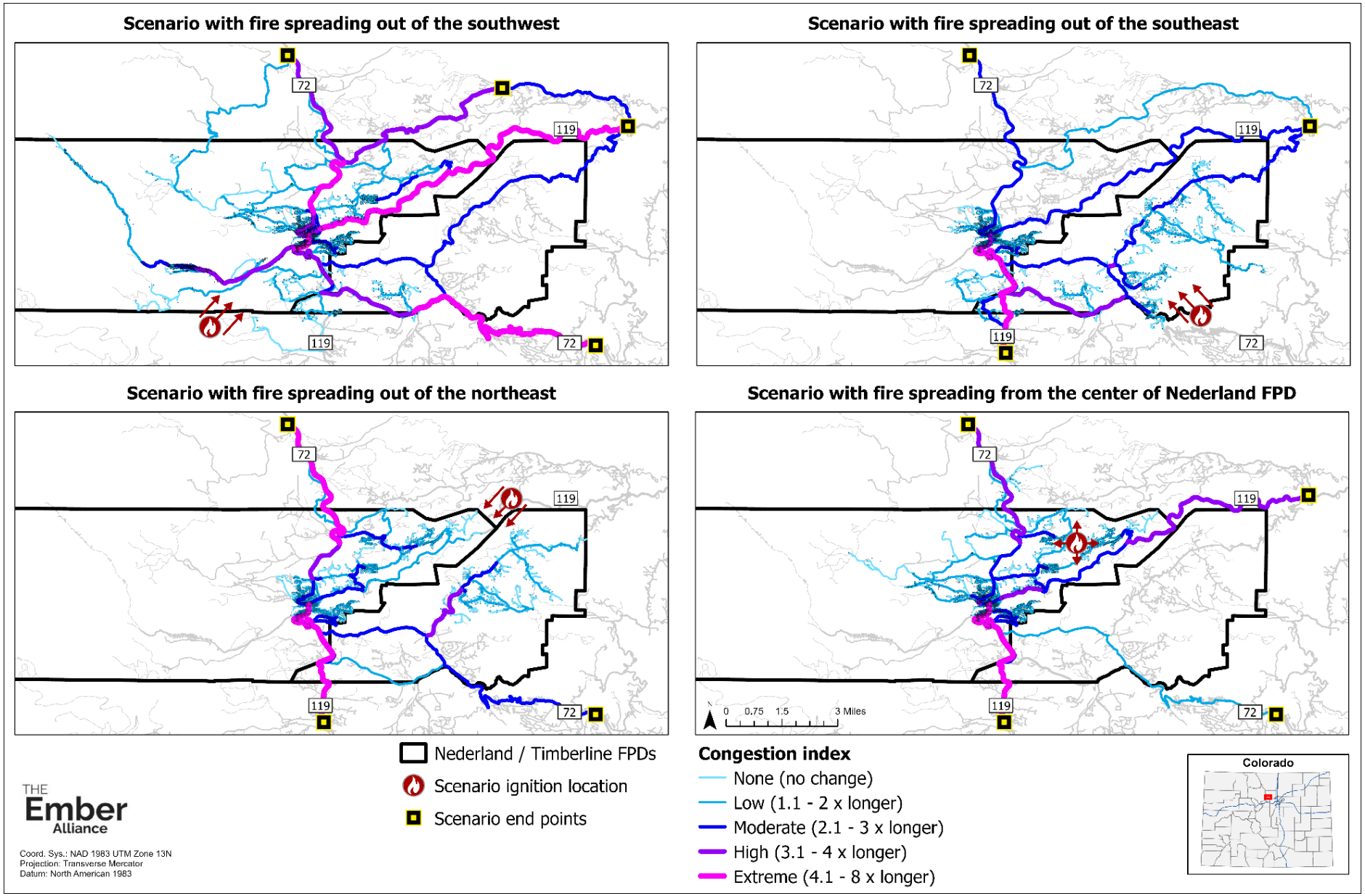


Figure B.16. Predicted congestion across Nederland/Timberline FPDs for each of four evacuation scenarios. Congestion categories (none, low, moderate, high, extreme) are based on the ratio between the time required to traverse a segment of road with congestion vs. without congestion.

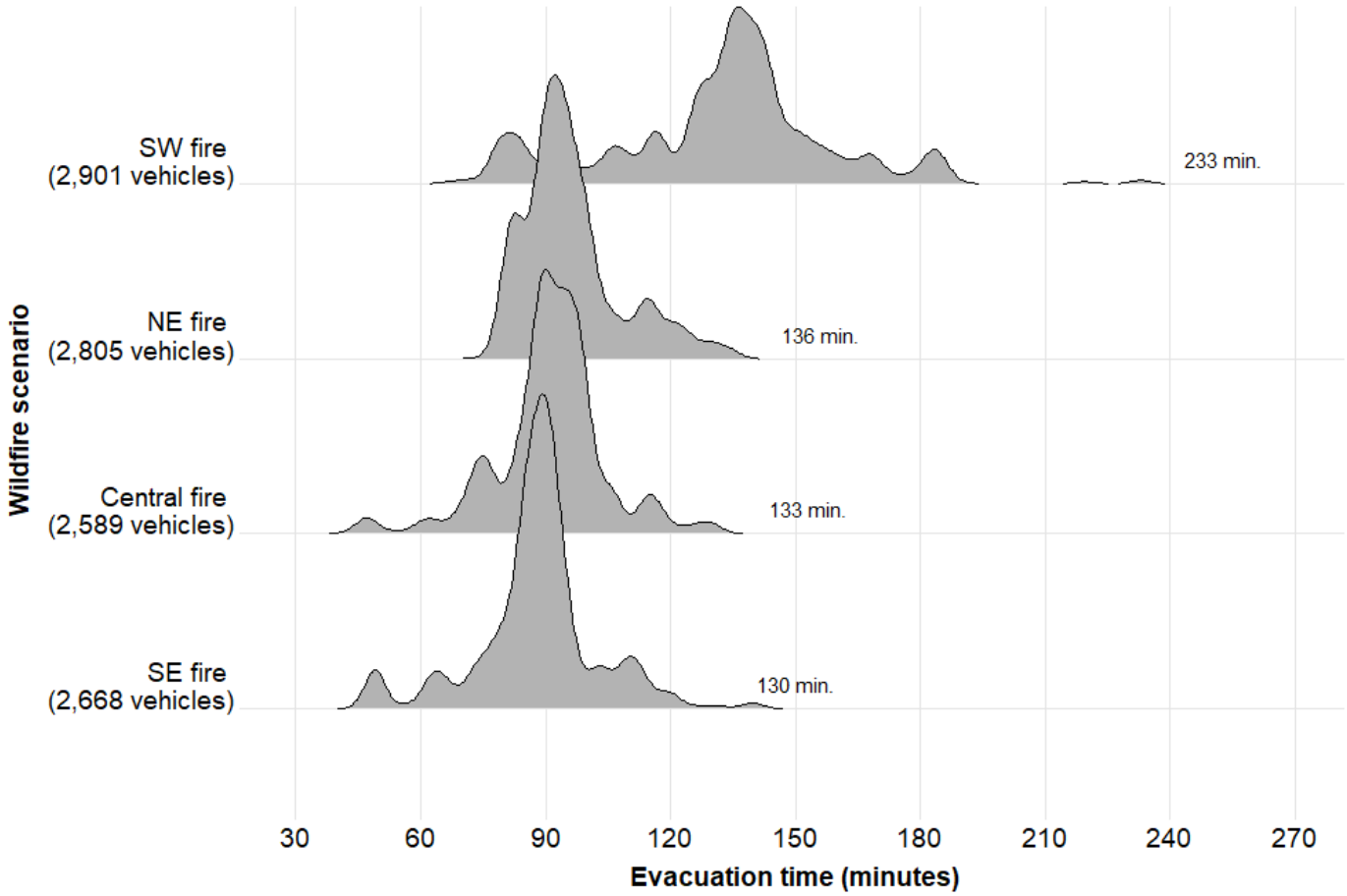


Figure B.17. Predicted evacuation times for Nederland/Timbeline FPDs for each of the four evacuation scenarios: out of the southwest ("SW"), out of the northeast ("NE"), center of Nederland FPD ("Central"), and out of the southeast ("SE"). Scenarios are ordered from the highest overall evacuation time to the lowest. 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. **Figure B.14** shows the location of evacuees and scenario endpoints.

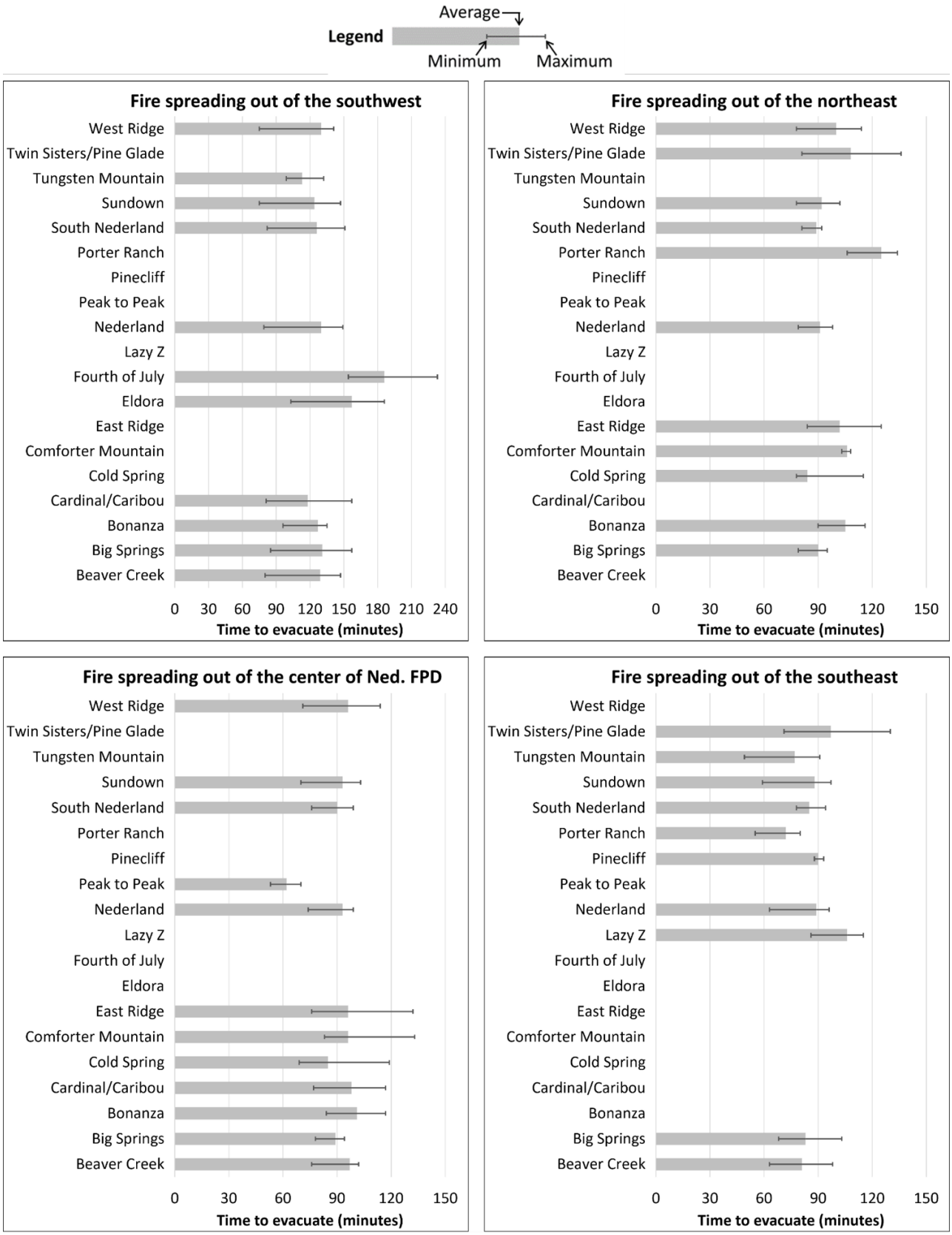


Figure B.18. Average, minimum, and maximum evacuation times predicted for evacuees in each plan unit in Nederland/Timberline FPDs under different evacuation scenarios. Not all plan units were included in each scenario. Predictions include 30 minutes for evacuees to mobilize and depart after receiving an evacuation order. Note the different scale on the x-axis for the southwest scenario. See **Figure B.22** for a map of plan units.

Roadway Survivability

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 residents 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, 14% of the roads in Nederland/Timberline FPDs could experience non-survivable conditions, and this percentage rises to 58% under extreme fire weather conditions (**Figure B.19**). Roadside hazards are particularly prevalent in the Porter Ranch Plan Unit (62% of roads under moderate conditions and 91% under extreme conditions), Peak-to-Peak Plan Unit (23% of roads under moderate conditions and 87% under extreme conditions), and Lazy Z Plan Unit (18% of roads under moderate conditions and 83% under extreme conditions).

Some non-survivable road segments across Nederland/Timberline FPDs are part of key evacuation routes, including portions of CO Highways 72 and 119, Ridge Road, and Boulder Canyon Drive. These areas are a high priority for roadside fuel mitigation to create safer conditions for residents, visitors, fire fighters, and other first responders.

Mitigation actions along sections of road with high risk for non-survivable conditions during a wildfire can increase the chances of survival for residents stranded in their vehicles during a wildfire and decrease the chance that roadways become impassable due to flames.

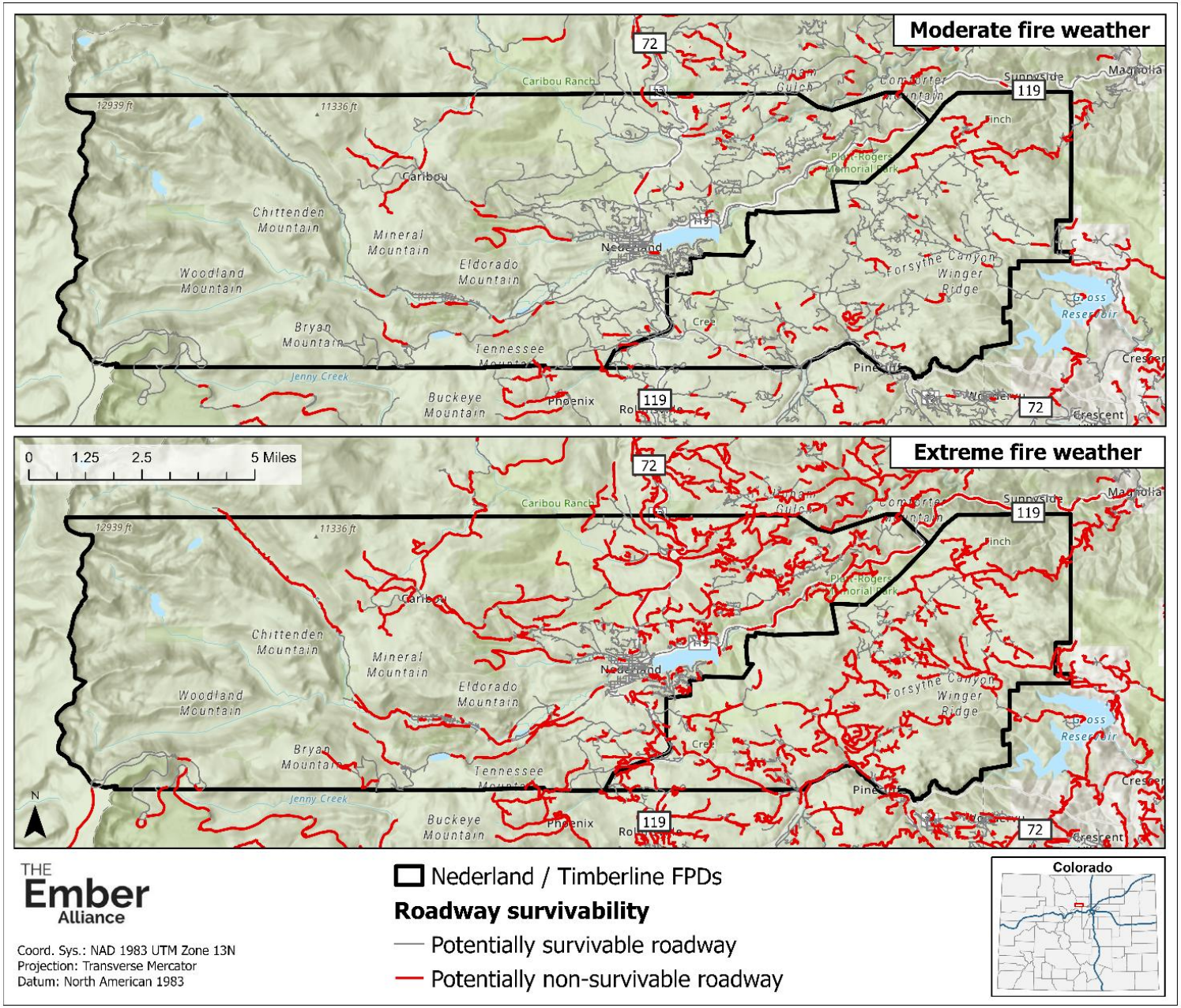


Figure B.19. Under moderate fire weather conditions, 14% of roads in Nederland/Timberline FPDs could experience potentially non-survivable conditions while a fire is actively burning over them (flame lengths >8 feet). This percentage rises to 58% under extreme fire weather conditions.

Climate Change Assessment

Climate change has a measurable impact on fire intensity, frequency, and size, and these impacts are likely to continue over the coming decades (Parks et al., 2016). Fire behavior modeling for this CWPP utilizes weather data from 2014-2022 and does not include future weather predictions. To explore the potential for exacerbated fire weather conditions in the future, we used the Climate Toolbox's future boxplots and future time series tools (Hegewisch et al., 2021). These tools model climate scenarios for the next 50-100 years using two representative concentration pathways (RCP) that assume different levels of global greenhouse gas emissions The RCP 4.5 scenario assumes that greenhouse gas emissions stabilize before the year 2100, peaking around 2040, and the RCP 8.5 scenario assumes that greenhouse gas emissions are not curtailed by 2100 (IPCC, 2014).

We selected three variables for this assessment: maximum temperatures in the summer (June, July, and August), the number of days with very high fire danger, and vapor pressure deficit (VPD) in the summer. The Climate Toolbox defines very high fire danger as days with 100-hour fuel moisture below the 10th percentile fuel moisture from 1971-2000. VPD is a meaningful measurement of moisture stress experienced by plants, more so than relative humidity because VPD is independent of temperature. High values of VPD indicate that the air can draw more moisture out of leaves while they photosynthesize, resulting in drier fuels. Higher values of VPD are strongly related to summers with a greater number of acres burned in the western U.S. (Seager et al., 2015).

The models predict that maximum summer temperatures in Nederland/Timberline FPDs could increase by 3-4.3° Fahrenheit by 2050, going from 74.0°F in 2005 to 77.0-78.3°F in 2050 (**Figure B.20**). Nederland/Timberline FPDs could experience 11-14 more days per year with very high fire danger**,** and average summer VPD could increase from 1.1 to 1.5 kilopascal (kPa) in 2050 compared to 2000 (**Figure B.21**). Drier fuels in the summer have a greater potential to carry large wildfires; an increase in summer VPD from 1.1 to 1.5 kPa is related to a 48 fold increase in annual area burned in forested parts of the western U.S. (Seager et al., 2015).

Fire behavior may be even more extreme, frequent, and extensive in the coming decades in Nederland/Timberline FPDs. Mitigating actions in the coming years, including fuel treatments, defensible space around homes, and structure hardening, are critical to protect the life safety of residents and enhance community resiliency now and into the future.

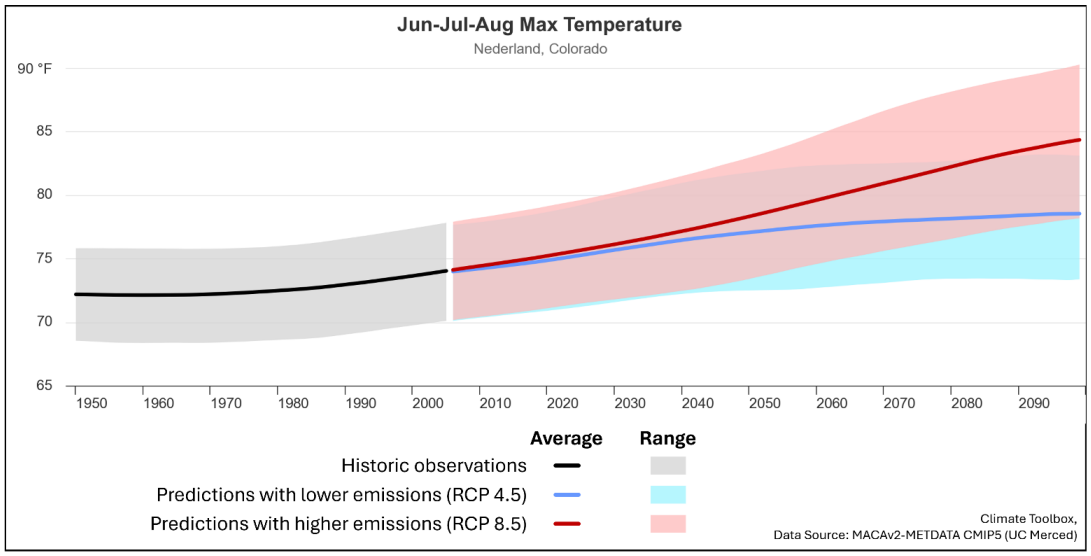
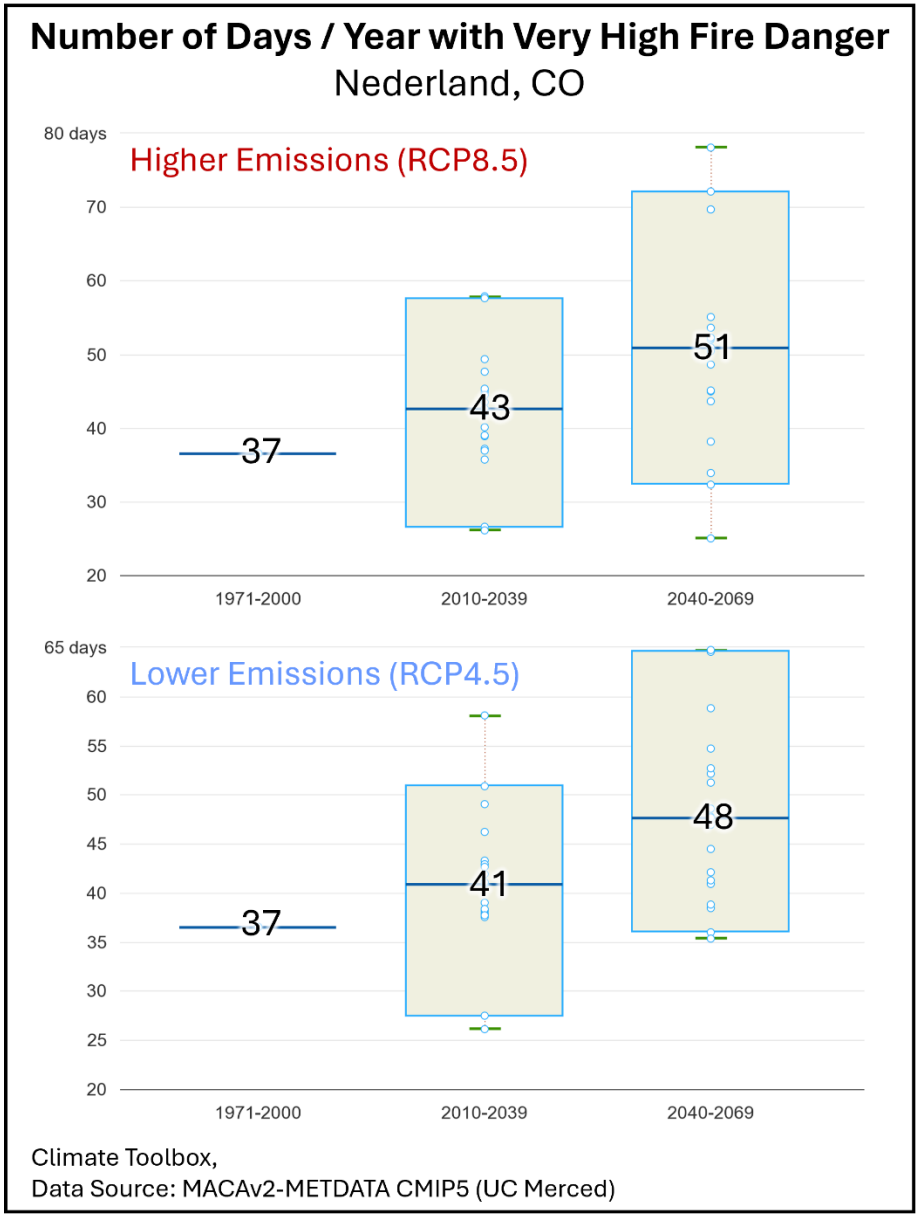


Figure B.20. Predicted maximum summer temperature in Nederland/Timberline FPDs under lower and higher greenhouse gas emission scenarios. Source: Climate Toolbox (Hegewisch et al., 2021).



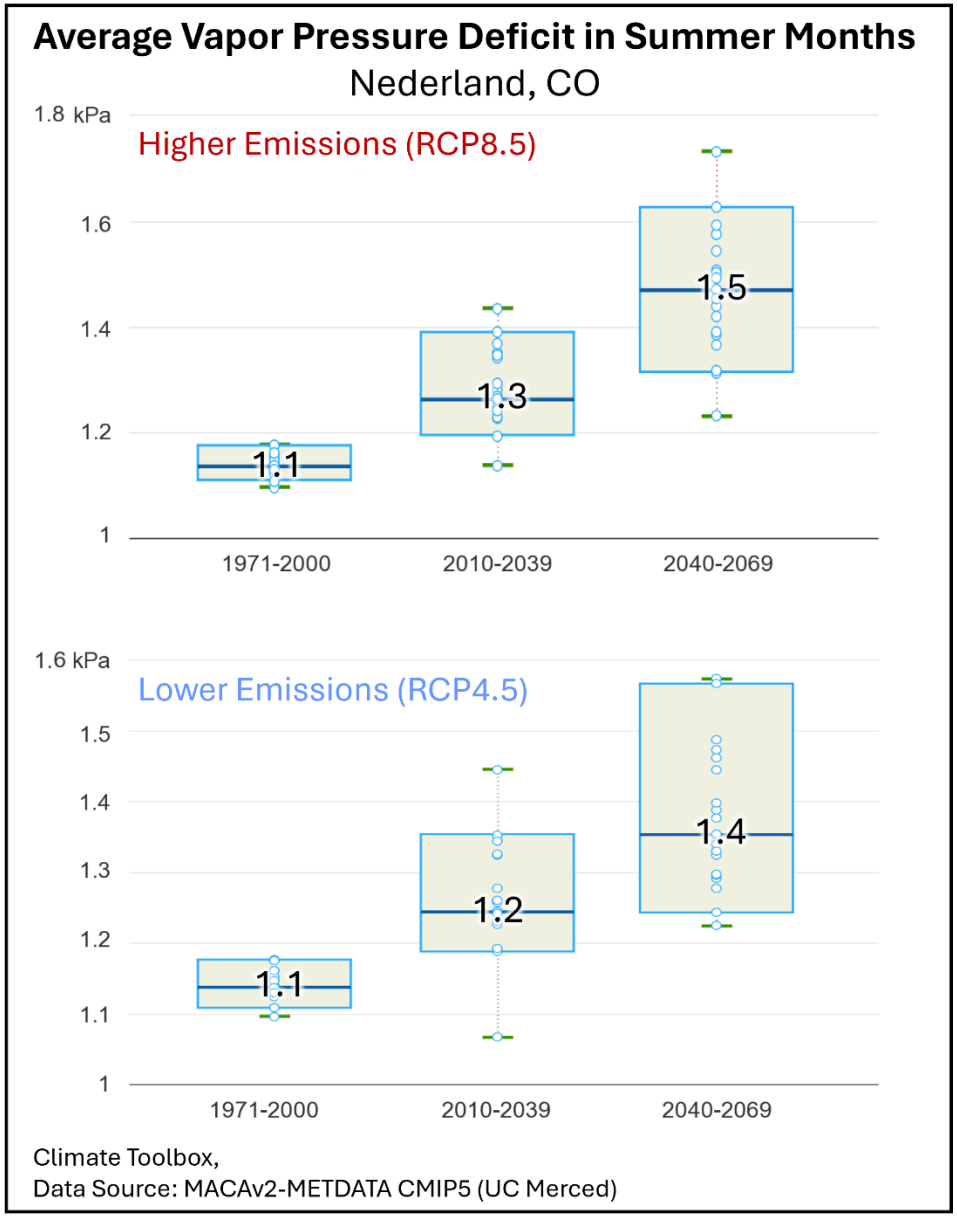


Figure B.21. Predicted number of days with very high fire danger (left) and average summer vapor pressure deficit (right) in Nederland/Timberline FPDs under lower and higher greenhouse gas emission scenarios. Source: Climate Toolbox (Hegewisch et al., 2021). Boxplots show 5th percentile, median, and 97th percentile predictions. Numbers indicate median values. Whiskers show minimum and maximum predictions. Dots represent individual predictions from different climate models.

Plan Unit Relative Risk Assessment

CWPP Plan Units

We compared the ***relative*** risk that wildfires pose to life and property in 15 plan units across Nederland/Timberline FPDs (**Figure B.22**). Plan units are areas with shared fire risk where residents can organize and support each other to effectively mitigate hazardous fuels across the plan unit. Plan Unit boundaries were developed by considering clusters of addresses, connectivity of roads, topographic features, land parcels, land ownership, and local knowledge of community organization. Topographic features were considered by utilizing sub-watershed boundaries to guide plan unit boundaries. We included topographic features into the delineation process to ensure that different units encompass areas with similar fire behavior. Amendments were made to boundaries based on local knowledge of the CWPP Core Team.

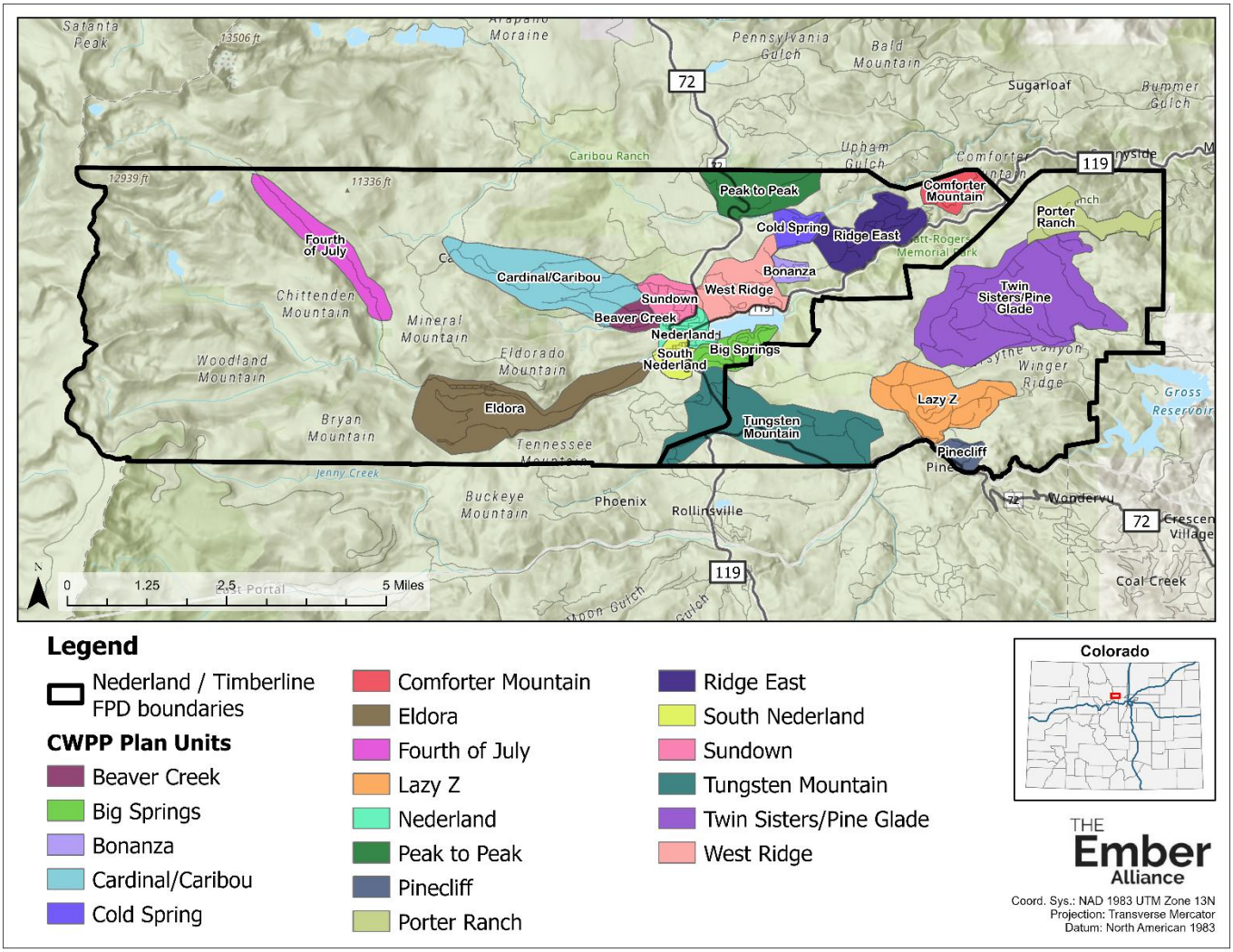


Figure B.22. CWPP plan units in Nederland/Timberline FPDs.

Risk Rating Approach

Some plan units Nederland/Timberline FPDs have extreme risk from wildfire damage, and to help prioritize hazard mitigation, we developed a rating of relative risk. A plan unit receiving a relative rating of "moderate risk" has risk factors that are lower than risk factors in other plan units, 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 home ignition zone hazards. We developed the ratings of relative risk specifically for Nederland/Timberline FPDs, so the assessment is not suitable for comparing this fire protection district to other communities in Colorado or the United States.

Our assessment was based on predictions of fire behavior, radiant heat and ember cast exposure, roadway survivability, and evacuation time, as well as an on-the-ground assessment of each plan unit. In summer 2023, employees of The Ember Alliance drove around Nederland/Timberline FPDs and used a modified version of the NFPA Wildfire Hazard Severity Form Checklist (NFPA 299 / 1144) to rate home ignition zone hazards within each plan unit.

A rating scale was developed specifically for Nederland/Timberline FPDs based on the range of values observed across the community (**Table B.7**). Home ignition zone hazards received the highest weighting based on conversations with the Core Team. The purpose of the assessment is to compare relative hazards within the community and is not suitable for comparing Nederland/Timberline FPDs to other communities.

Table B.7. Relative risk rating values for Nederland/Timberline FPDs. The "low" category was created for home ignition zone hazards to recognize the high-quality home hardening and defensible space across the Comforter Mountain Plan Unit that made it a significant outlier compared to other Plan Units.

Hazard category	Max. points possible	Percent of total	Range of values in Plan Units	Low	Moderate	High	Extreme
A. Fire risk	79	27%	46-78		45-60	61-70	>70
B. Fire suppression challenges	40	13%	10-27		10-14	15-20	>20
C. Evacuation hazards	55	18%	14-45		10-20	21-30	>31
D. Home ignition zone hazards	124	42%	4-116	4	60-75	76-99	>99
Overall risk	298		97-164		130-189	190-209	>210

Relative Risk Rating Form

A. Fire Risk	Points
1. Average flame length[1]	
<4 feet	4
4-8 feet	8
>8 feet	12
2. Percent area predicted for active crown fire[2]	
<10%	0
10-50%	6
>50%	12
3. Percent of homes exposed to extreme radiant heat[2]	
<30%	0
30-50%	6
>50%	12
4. Average relative burn probability[1]	
<5%	4
5-15%	8
>15%	12
5. Average relative burn probability[2]	
<10%	2
10-25%	4
>25%	6
6. 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	**79**

[1]Predictions from FlamMap under 75th percentile fire weather conditions for plan unit and adjacent watersheds.
[2]Predictions from FlamMap under 97th percentile fire weather conditions for plan unit 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 plan units.

B. Fire Suppression Challenges	Points
1. Percentage of homes near hydrants	
>75%	0
25-75%	5
<25%	10
2. Presence of dip / draft sites	
At least one dip / draft site OR not necessary due to hydrants	0
No dip / draft site	5
3. Road/driveway accessibility for Type 3 engines (percent of roads/driveways)	
>90%	0
75-90%	5
50-75%	10
<50%	15
4. Presence of legible and reflective signs (percent of roads and homes)	
>90%	0
75-90%	3
<75%	5
5. Presence / absence of HazMat	
Absent	0
Present	5
B. Total points possible	**40**

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[3]	
<=90 minutes	0
>90-120 minutes	4
>120 minutes	10
3. Number of main egress routes	
2 or more	0
Only 1	5
4. Percentage of road with non-survivable conditions under 97th percentile fire weather	
<25%	0
25-50%	10
>50%	20
5. Presence of livestock that could take multiple trips to evacuate	
Few property (0-1)	0
Some properties (2-5)	3
Many properties (>5)	5
C. Total points possible	**55**

[3]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	10
Class B or C on >25% of homes	20
Class C on >50% of homes	30
2. Percent of homes with combustible or non-ignition resistant siding	
<10%	0
10-50%	6
>50%	10
3. Percent of homes with combustible or non-ignition resistant decking	
<10%	0
10-25%	6
>25%	10
4. Percent of homes with wooden fences	
<10%	0
10-25%	2
>25%	4
5. Percent of homes with adequate mitigation in home ignition zone 1	
>90%	0
75-90%	6
50-75%	12
<50%	20
6. Percent of homes with adequate mitigation in home ignition zone 2	
>90%	0
75-90%	6
50-75%	12
<50%	20
7. Percent of homes with additional hazards in zones 1 and 2 (e.g., wood piles, propane tanks, wooden sheds)	
<10%	0
10-25%	2
25-50%	6
>50%	10
8. Average number of homes potentially exposed to short-range ember cast from other homes	
0 or 1 homes	4
2-5 homes	10
>5 homes	20
D. Total points possible	**124**

Prioritization of Fuel Treatments

Roadside Fuel Treatments

We assessed the potential need for roadside fuel treatments based on the potential for non-survivable conditions (predicted flame lengths >8 feet) to arise under moderate (75th percentile) and extreme (97th percentile) fire weather conditions, and potential congestion under a district-wide evacuation order. Segments of road with non-survivable conditions under moderate fire weather are at greater risk than those with conditions that only become non-survivable under extreme percentile weather. **Table B.8** 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 0.1 acres (20 x 20 meters), so locations of potential treatment areas are approximate.

Roads in need of fuel treatments are abundant and scattered across the western portion of Nederland/Timberline FPDs. Areas with potential need for roadside treatments overlapped closely with locations that residents expressed concerns about evacuation safety (**Figure B.23**). 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. Partners used this assessment of treatment need to inform the identification of priority projects for the CWPP.

Table B.8. Methodology for ranking potential need for roadside treatments to mitigate fire hazards along roadways in Nederland/Timberline FPDs. Potentially non-survivable conditions are those where >8-foot flame lengths could occur along segments of roadways.

Need for roadside fuel treatment	Conditions
Highest	Potentially non-survivable conditions under extreme fire weather conditions, and Extreme evacuation congestion (congestion index >4.0). **OR** Potentially non-survivable conditions under moderate fire weather conditions, and Moderate to extreme evacuation congestion (congestion index >2.0).
High	Potentially non-survivable conditions under extreme fire weather conditions, and Moderate to high evacuation congestion (congestion index >2.0 to ≤4.0).
Moderate	Potentially non-survivable conditions under extreme fire weather conditions, and Low evacuation congestion (congestion index >1.0 to ≤2.0).

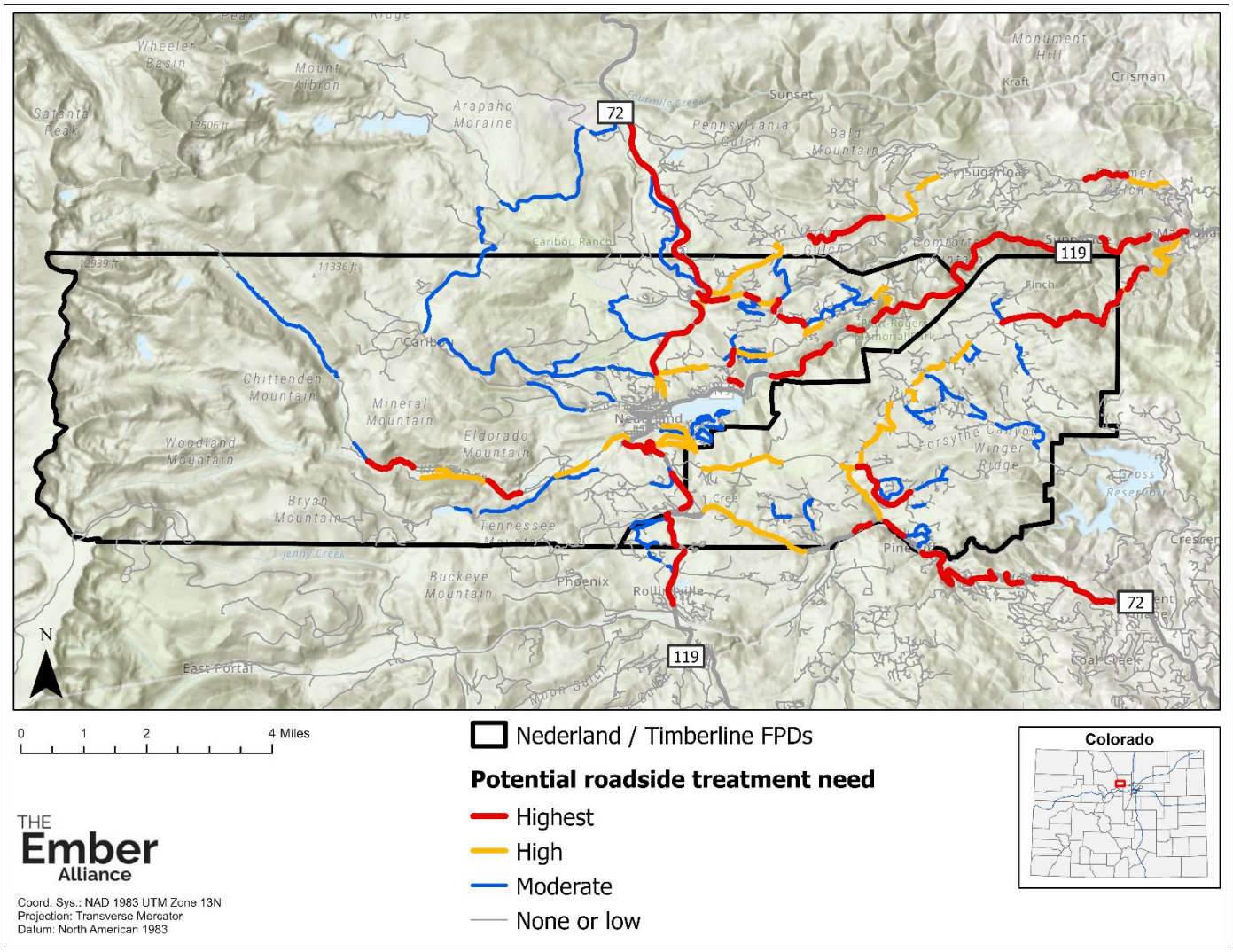


Figure B.23. Potential need for roadside fuel treatments based on potential fire behavior and evacuation congestion in and around Nederland/Timberline FPDs. Our fire behavior analyses occurred at the scale of 0.1 acres (20 x 20 meters), so locations of potential treatment areas are approximate.

Stand-Scale Fuel Treatments

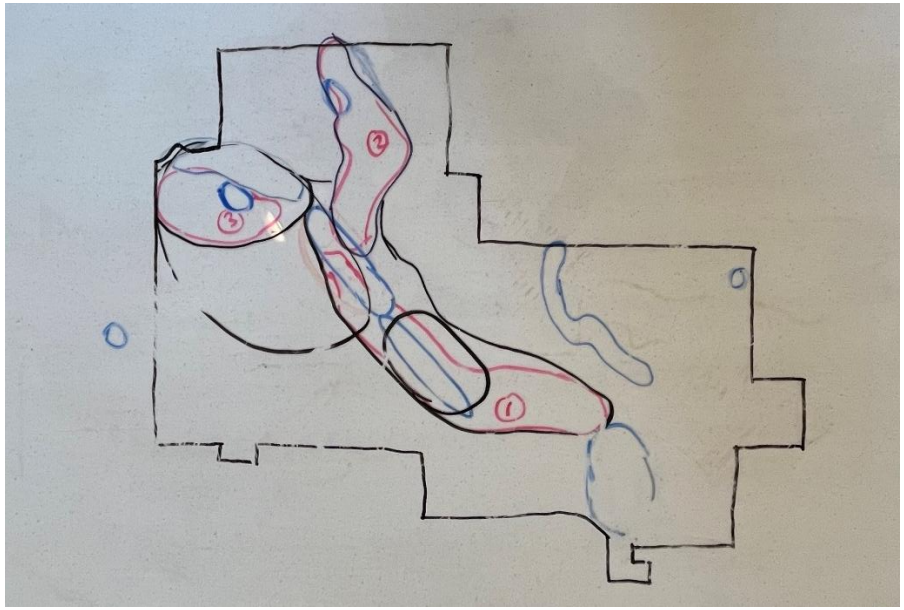
Stand scale fuel treatments resulted in projects recommended in Section 4.b. After completing fire modelling, post-fire erosion modelling, roadway analysis and value at risk analysis, residential hazard analysis, and compiling data of prior fires and fuels treatments, the Core Team and partners met in person to prioritize locations and projects. These decisions were made by representatives from Nederland/Timberline FPDs, Boulder Watershed Collective, Blue Mountain Forest Stewards Initiative, Crescent Park Fire Association, Arvada Water, Timberline Fire protection District, Mountain View Fire protection District, Colorado State Forest Service, US Forest Service, United Power, Jefferson County Open Space, CSU Extension Offices, Colorado Department of Transportation, and the Coal Creek Canyon Collaborative (C4).

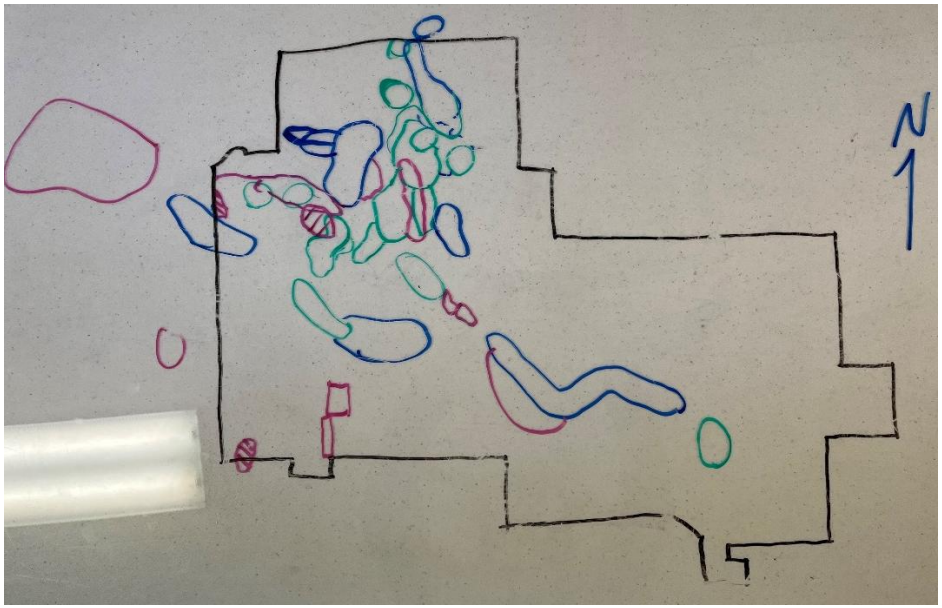
Eight maps were used in this process: modelled wildfire behavior, burn probability, post-fire sediment delivery, roadway congestion and safety, infrastructure and values at risk of wildfire, land ownership, ember cast, and past fires and fuel treatments. In groups, the partners drew treatment boundaries on clear sheets that they could move around between each of the maps. The groups gradually refined their potential projects into those that were the most impactful and feasible.

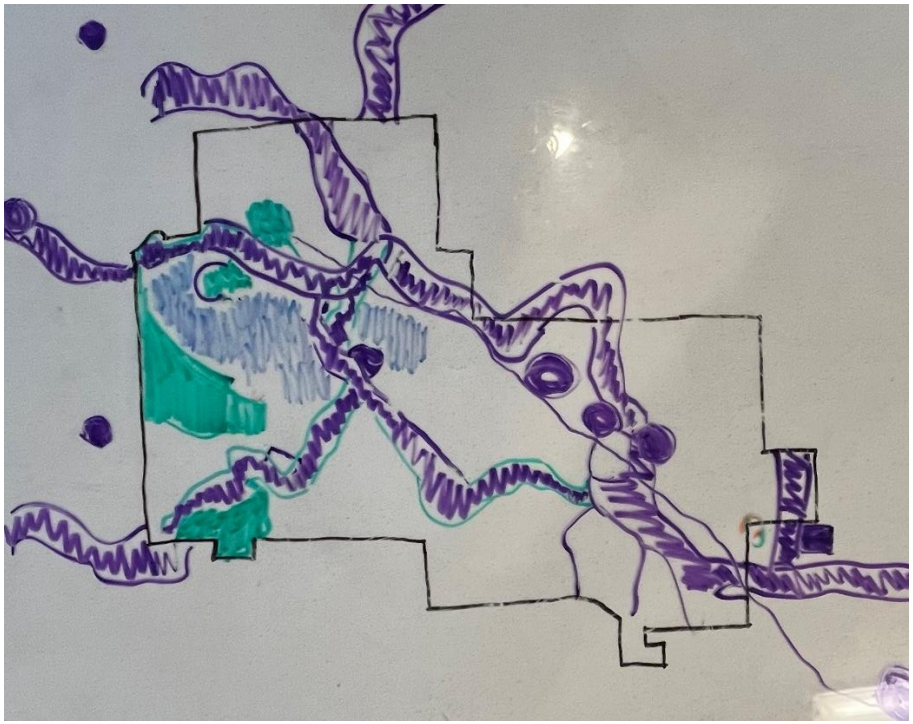
The three groups shared and compared their maps, which showed significant overlaps in top priority locations and goals. The process showed a clear shared goal to begin this work by protecting life safety within the community before anything else. Evacuation routes, resident homes, and communication infrastructure were prioritized by most of the groups.

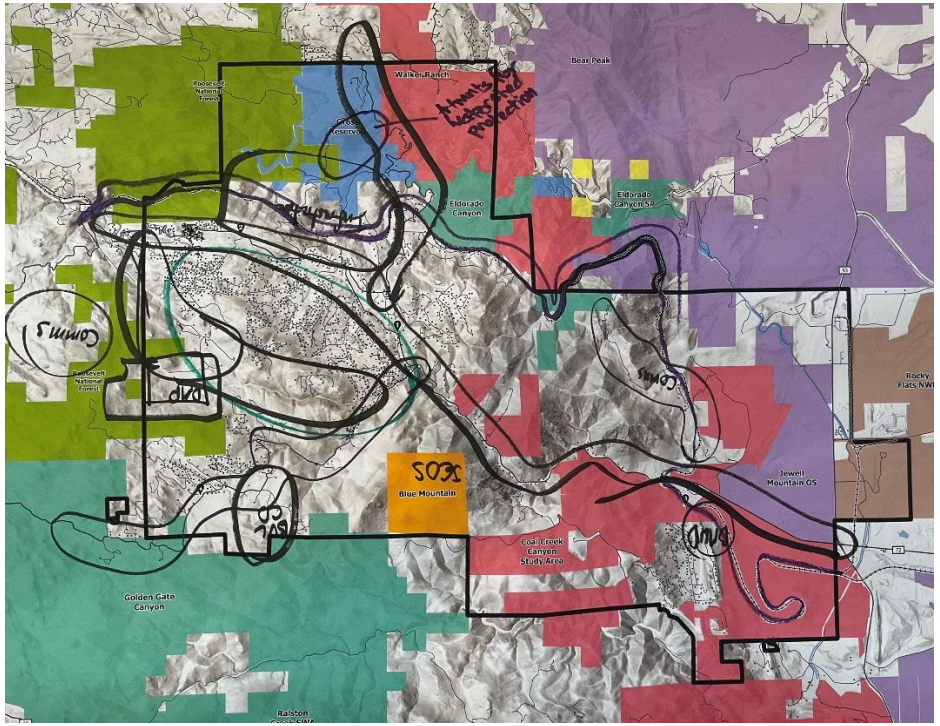
In December 2023 and January 2024, the CWPP Core Team refined priority project areas, created goals, and decided on leaders and timelines (**Figure B.24**; **Section 4**). There are many areas of Nederland/Timberline FPDs that need fuels treatment and forest health work; however, local land managers and partners are unable to accomplish all this work in the next 5-10 years, so only the top priority projects were chosen and detailed in this CWPP. Future CWPP updates can consider second and third priority projects (**Figure B.25**).

At the time of the initial prioritization meeting, there were no PODs (potential operational delineations) that covered Nederland/Timberline FPDs, however they were created collaboratively shortly after and have been incorporated into the priority project areas. The POD boundaries align with the Core Team priority areas.









Priority project areas as defined by the three groups, and the map that shows the shared project priorities between each of the three groups. This map was further refined in future meetings. All groups highlighted the primary communication towers, Highway 72, the landscape directly west of Camp Eden and Wondervu, Gross Dam Road, and the Blue Mountain Water District Infrastructure.

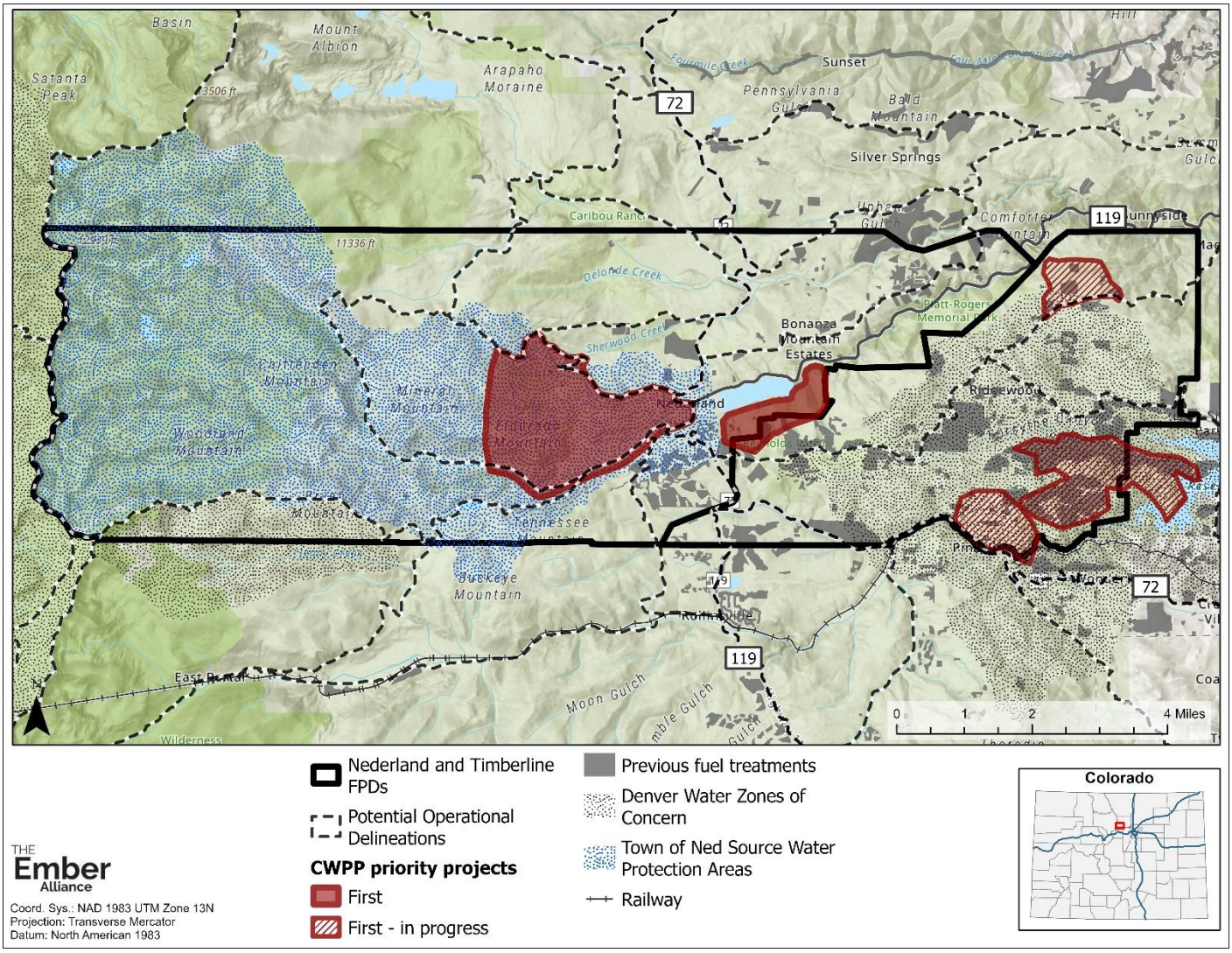


Figure B.24. First priority projects identified by the Core Team and partners. The black hatched areas are the community priorities, with the most community members identifying the roadways as their priority for fuels treatment.

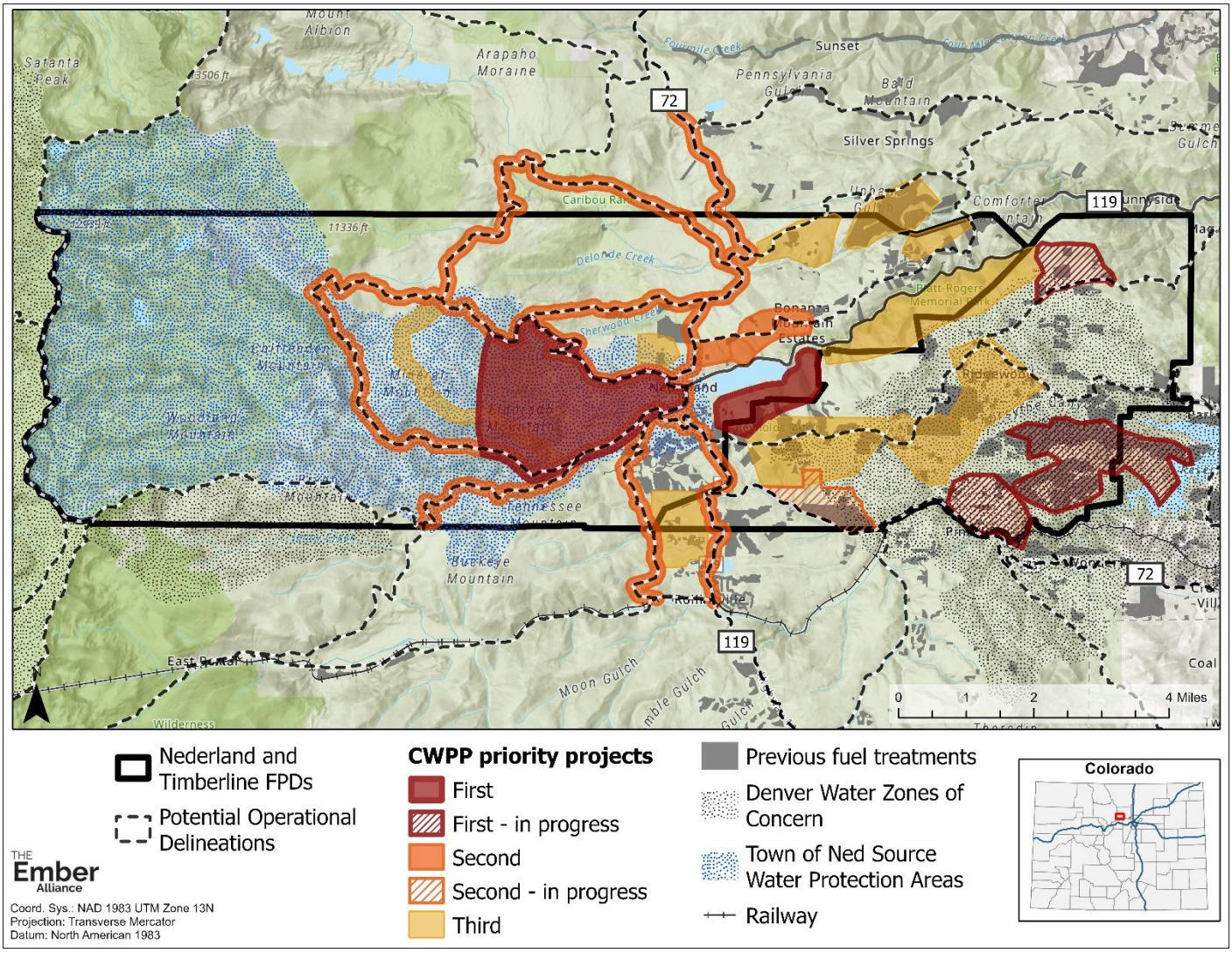


Figure B.25. First, second, and third priority projects identified by the Core Team and partners. Feedback from community members was an important consideration when identifying priority project areas. There are many areas of Nederland/Timberline FPDs that need fuels treatment and forest health work; however, local land managers and partners are unable to accomplish all this work in the next 5-10 years, so only the top priority projects were chosen and detailed in this CWPP. Future CWPP updates can consider second and third priority projects.

Prioritization of Non-Spatial Recommendations

The Core Team, partners, and residents had many ideas and suggestions on actions that would help create a more fire-adapted community that were not directly tied to on-the-ground fuels treatment. TEA collected all the ideas that came up during Core Team meetings, the public survey and focus groups, a Core Team brainstorming session, and during partner meetings. In all, there were over 150 listed ideas.

TEA and members of the Core Team combined similar ideas and grouped them based on categories from the Fire Adapted Communities Wheel: Public Health; Prevention; Infrastructure and Business; Regulation, Policy, and Planning; Recovery; Wildfire Response; Partnerships and Community Engagement; Evacuation; Other.

The Core Team met and ranked each recommendation by its impact and value to the community and its feasibility. They discussed each recommendation and shared thoughts on its impact and value. The Core Team was not told which ideas came from their group, their partners, or the public, and ranked each one on merit alone. Those that were deemed not feasible, not relevant, or already completed were removed from the list. Some statements were vague or confusing and the Core Team ranked them based on their interpretation of the action stated.

Impact/Value was ranked from a 1 – 10, with 10 having the highest impact or value to the community. Effort was ranked from 1 – 10, with 10 requiring the most effort. Each recommendation was given an average ranking for both Impact and Effort. Because High Impact was desirable and Low Effort was desirable, we took each recommendation's Effort score and subtracted it from 10. This left us with an Effort score that meant 10 was low effort and 1 was high effort. These two numbers were multiplied together to get a final score that would range from 0 – 100, with 100 representing the highest impact actions that would require the least effort.

After combining the similar ideas and removing the impractical ones, 77 action items remained. These were divided into four categories: Priority 1, 2, 3, and Other Projects. To correlate with the place-based priority action rankings, these are called "Immediate Action, Short-term Action, Mid-Term Action, and Other Projects" respectively. Each of the final recommendations was given a name, goals, and partners who should be involved.

Members of the Core Team reviewed amended, combined, and edited the recommendations again, and these final recommendations were included in **Section 4**

References

Abo El Ezz, A., Boucher, J., Cotton-Gagnon, A., Godbout, A., 2022. Framework for spatial incident-level wildfire risk modelling to residential structures at the wildland urban interface. Fire Safety Journal 131, 103625. https://doi.org/10.1016/j.firesaf.2022.103625

Beloglazov, A., Almashor, M., Abebe, E., Richter, J., Steer, K.C.B., 2016. Simulation of wildfire evacuation with dynamic factors and model composition. Simulation Modelling Practice and Theory 60, 144–159. https://doi.org/10.1016/j.simpat.2015.10.002

Beverly, J.L., Bothwell, P., Conner, J., Herd, E., 2010. Assessing the exposure of the built environment to potential ignition sources generated from vegetative fuel. International journal of wildland fire 19, 299–313.

Caggiano, M.D., Hawbaker, T.J., Gannon, B.M., Hoffman, C.M., 2020. Building loss in WUI disasters: Evaluating the core components of the wildland-urban interface definition. Fire 3, 3040073.

Caton, S.E., Hakes, R.S.P., Gorham, D.J., Zhou, A., Gollner, M.J., 2016. Review of pathways for building fire spread in the wildland urban interface part I: Exposure conditions. Fire Technology 54, 429–473.

CSFS, Technosylva, 2023a. Surface & canopy fuels methodology report. Colorado State University, Colorado State Forest Service, Fort Collins, CO.

CSFS, Technosylva, 2023b. 2022 Colorado Wildfire Risk Assessment update: Final report. Colorado State University, Colorado State Forest Service, Fort Collins, CO.

Finney, M.A., 2006. An overview of FlamMap fire modeling capabilities, in: In: Andrews, Patricia L.; Butler, Bret W., Comps. 2006. Fuels Management-How to Measure Success: Conference Proceedings. 28-30 March 2006; Portland, OR. Proceedings RMRS-P-41. Fort Collins, CO: US Department of Agriculture, Forest Service, Rocky Mountain Research Station. p. 213-220.

Hegewisch, K.C., Abatzoglou, J.T., Gross, J., 2021. Future Climate Analogs Web Tool. Climate Toolbox.

IPCC, 2014. Climate change 2014: Synthesis report. Contribution of working groups I, II and III to the 5th assessment report of the Intergovernmental Panel on Climate Change. IPCC, Geneva, Switzerland.

Maranghides, A., Link, E.D., Hawks, S., McDougald, J., Quarles, S.L., Gorham, D.J., Nazare, S., 2022. WUI structure/parcel/community fire hazard mitigation methodology (NIST Technical Note No. 2205). Department of Commerce, National Institute of Standards and Technology, Washington, DC.

NWCG, 2021. Midflame windspeed. Section 8.2 [WWW Document]. Firefighter Math, National Wildfire Coordinating Group. URL https://www.nwcg.gov/course/ffm/fire-behavior/82-midflame-windspeed

NWCG, 2019. Fire behavior field reference guide. PMS 437. National Wildfire Coordinating Group, Boise, ID. https://www.nwcg.gov/publications/pms437

Parks, S.A., Miller, C., Abatzoglou, J.T., Holsinger, L.M., Parisien, M.A., Dobrowski, S.Z., 2016. How will climate change affect wildland fire severity in the western US? Environmental Research Letters 11, 035002. https://doi.org/10.1088/1748-9326/11/3/03500

Scott, J.H., 2006. Comparison of crown fire modeling systems used in three fire management applications (Research Paper No. RMRS-RP-58). U.S. Department of Agriculture, U.S. Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

Scott, J.H., Burgan, R.E., 2005. Standard fire behavior fuel models: a comprehensive set for use with Rothermel's surface fire spread model. US Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Seager, R., Hooks, A., Williams, P., Cook, B., Nakamura, J., Henderson, N., 2015. Climatology, variability, and trends in the U.S. vapor pressure deficit, an important fire-related meteorological quantity. Journal of Applied Meteorology and Climatology 54, 1121–1141.

Shahabi, K., Wilson, J.P., 2014. CASPER: Intelligent capacity-aware evacuation routing. Computers, Environment and Urban Systems 46, 12–24. https://doi.org/10.1016/j.compenvurbsys.2014.03.004

Sullivan, A.L., 2009. Wildland surface fire spread modelling, 1990–2007. 1: Physical and quasi-physical models. International Journal of Wildland Fire 18, 349–368.

Syphard, A.D., Keeley, J.E., Massada, A.B., Brennan, T.J., J., T., Radeloff, V.C., 2012. Housing arrangement and location determine the likelihood of housing loss due to wildfire. PLoS ONE 7, e33954. https://doi.org/10.1371/journal.pone.0033954

Williams, J., 2013. Exploring the onset of high-impact mega-fires through a forest land management prism. Forest Ecology and Management 294, 4–10.

Appendix C: Objectives and Benefits of Fuel Treatments and Ecological Restoration

"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).

Fuel Treatments

Fuel treatments are a land management tool for reducing wildfire hazards 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 distance 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.

Hotter, drier conditions not only drive fire intensity, but also impact the ability of conifer forests to regenerate after severe wildfire. Management interventions such as fuels treatments that reduce wildfire severity can partially offset declines in regeneration of conifer forests resulting from climate pressures, and lead to more resilient forests for the future (Davis et al., 2023). Strategically located, high-quality fuel treatments can also 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.

Ecological Restoration

Ecological restoration is the process of assisting the recovery of an ecosystem that has been damaged, degraded, or destroyed (SER). 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. In the project area, mountain meadows that traditionally intermixed with ponderosa forests have declined as those forests have grown denser as a result of fire suppression. Aspen, generally the first trees to return in areas after a wildfire, have fewer opportunities for stand growth and replacement in the shadow of dense conifer forests, and traditionally dense lodgepole forests have become more prevalent across the landscape, reducing the variety of vegetation types across a given stretch of wildland. Ecological restoration objectives on the Colorado Front Range often aim to restore mountain meadows and native grasslands, regenerate aspens, or improve the variety of vegetation across a landscape due to these imbalances in the ecological systems.

In some cases, fuel treatments can be included or added to other ecological restoration techniques to create multi-objective landscape treatments that simultaneously reduce fire intensity while

providing other ecological benefits. The Boulder Watershed Collective coordinates with local agencies and private landowners to create multi-objective landscape treatments that aim to regenerate mountain meadows, wetlands, promote aspen regeneration, and protect watersheds, all while reducing wildfire hazards for residents. Wildfire resilience and ecological restoration are not necessarily mutually exclusive; it is possible to accomplish multiple goals and objectives at once with the proper planning and execution. For example, 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 wide, evenly spaced trees could serve as an effective fuel treatment but would not achieve ecological objectives in forest types such as lodgepole pines.

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 to improve their chance of surviving 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. Address shared wildfire risk when HIZ 3 overlaps neighboring properties. 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.
Roadside 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.

Defensible Space Recommendations for HIZ 3 Based on Forest Type

Lodgepole pine

Species: Lodgepole pine dominated; occasional Douglas-fir, ponderosa pine, aspen, white fir, Engelmann spruce, blue spruce, limber pine, gamble oak

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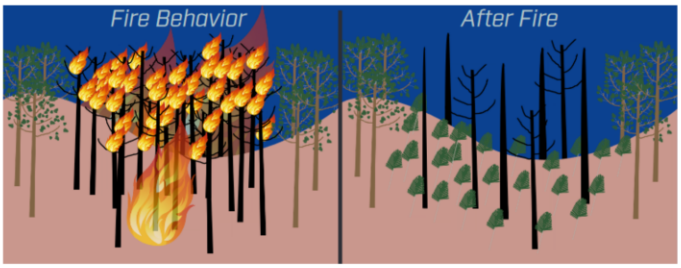
Typical elevation: 8,000-10,000 ft

Fire return interval: 75 to 300 years (infrequent)

Fire severity: Stand-replacing fire where most or all trees die

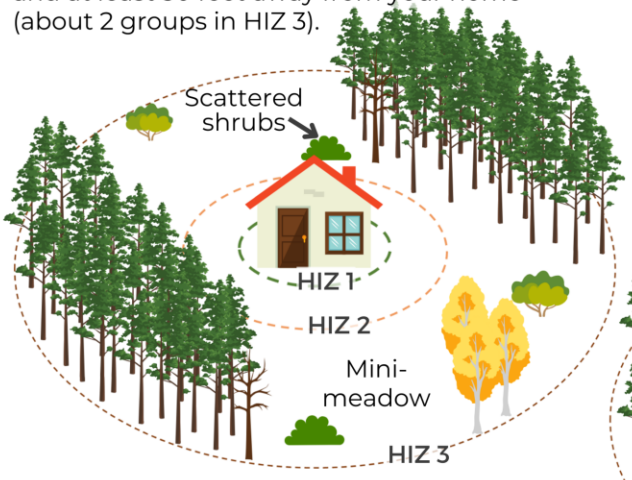


Lodgepole pine forests naturally grow densely, so fire spreads easily from tree crown to tree crown, resulting in patches where most trees are killed. Lodgepole pine also can have serotinous cones, which open and release seeds when heated by fire. These seeds then readily regenerate the new forest. More research is needed to understand forest recovery following the combination of drought, climate change, mountain pine beetle mortality, and recent wildfires.

Management in Home Ignition Zone 3

Lodgepole pine trees can blow over if too many neighboring trees are removed before they can adapt to the wind. There are two options for managing lodgepole pine in HIZ 3 to increase your home's chance of standing strong during a wildfire and to reduce windthrow:

Option 1: Leave groups of 30-50 trees at least 30-50 feet apart from other groups and at least 30 feet away from your home (about 2 groups in HIZ 3).



Option 2: Slowly thin the stand, no more than 30% of trees each time. Repeat to achieve at least 10-feet between tree crowns (no more than 80 trees/acre or 50 trees within HIZ 3, fewer for larger trees or on steep slopes). This can take about 10 years to achieve, during which time, your home is still at risk.

For both options 1 and 2:

- No limbs <6-10 feet above the ground
- No small trees or shrubs under remaining trees
- Very few to no trees in HIZ 2 and none in HIZ 1
- Favor aspen for biodiversity and fire resilience
- Retain several large snags (dead trees) for wildlife habitat at least 1.5 x tree height away from your home
- **Remove slash (logs and branches)**

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Sources: CSFS Home Ignition Zone; CSFS Lodgepole Management Guidelines.

Douglas-fir mixed conifer

Species: Douglas-fir, ponderosa pine, lodgepole, aspen, white fir, occasional spruce, limber pine, gamble oak

Typical elevation: 6,000-9,500 ft

Fire return interval: 20 to >100 years (semi-frequent)

Fire severity: Moderate-severity with patches of stand-replacing fire where most or all trees die

Douglas-fir mixed conifer forests contain a diversity of tree species, many of which are not as fire tolerant as ponderosa pine. These forests also tend to be cooler and wetter, and as a result do not burn as frequently. When fire burns in these areas, patches of stand-replacing fire can be common. These forests are naturally denser than lower elevation forests, but human management activities (grazing, logging, fire suppression) have resulted in unnaturally dense forests that can fuel larger, more extreme wildfires.

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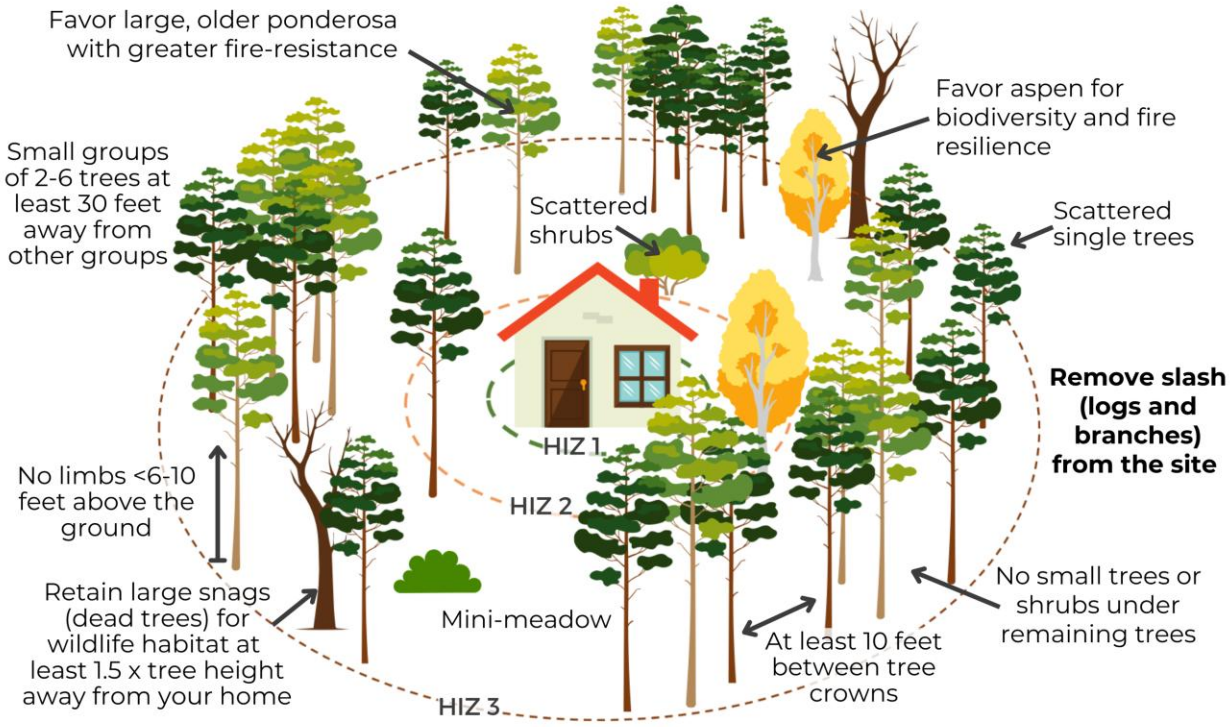
Management in Home Ignition Zone 3

To restore ecological conditions, increase fire resilience, and increase your home's ability to stand against wildfire, leave only 25-60 trees/acre in HIZ 3 (15-40 trees within 30 to 100 feet of your home) and create mini-meadows for grasses, wildflowers, and scattered shrubs.



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Sources: CSFS Home Ignition Zone; Battaglia et al. 2018. Forest Ecology & Management 422:147-160; Rocky Mountain Research Station GTR-310.

Ponderosa pine mixed conifer

Species: Ponderosa pine, Douglas-fir, aspen, juniper, white fir, gamble oak

Typical elevation: 6,300-9,500 ft

Fire return interval: 7-50 years (frequent)

Fire severity: Low- to moderate-severity, with some smaller patches of stand-replacing fire where most or all trees die

Ponderosa pine mixed conifer forests are fire dependent. Historically, fire burned across the forest floor, controlling tree regeneration, removing lower limbs on mature trees, and creating large, open spaces between trees.

Human management activities (grazing, logging, fire suppression) have resulted in unnaturally dense forests. During extreme weather, high winds can easily spread fire between tree crowns, resulting in very large high-severity wildfires where most trees are killed. This is not always the case but is a trend that has occurred more frequently in this forest type in the last few decades.

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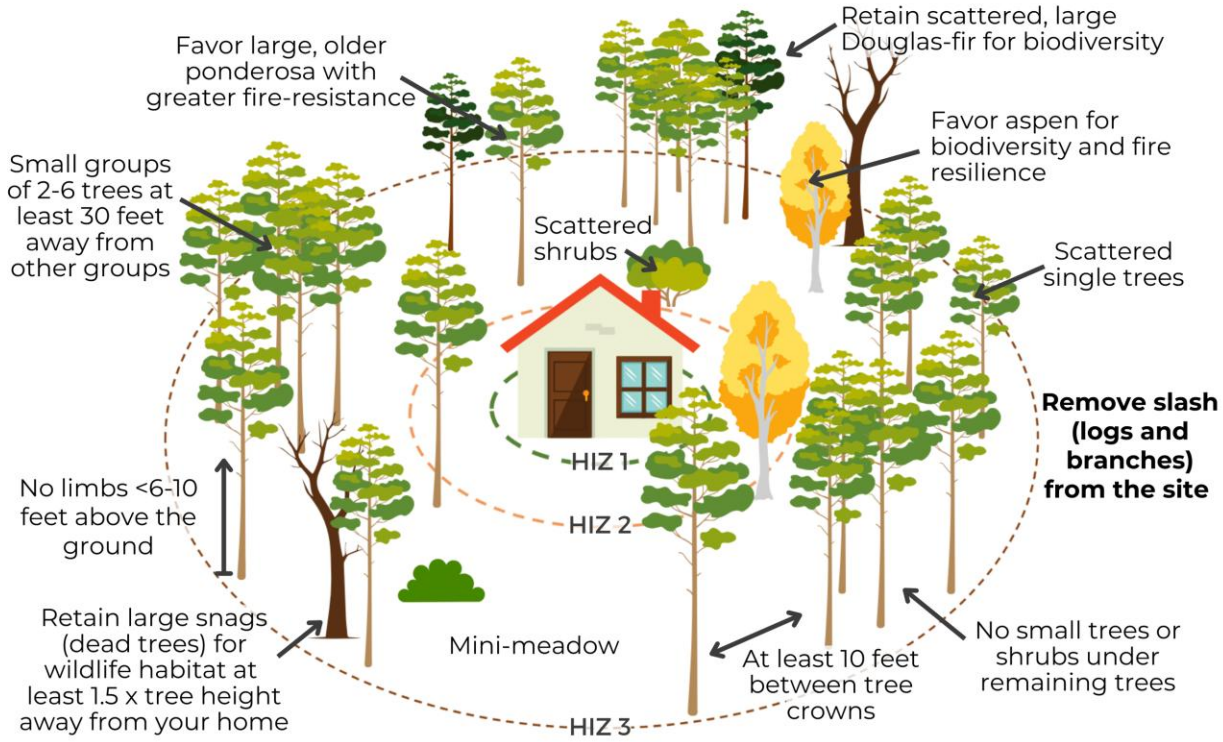
Management in Home Ignition Zone 3

To restore ecological conditions, increase fire resilience, and increase your home's ability to stand against wildfire, leave only 25-60 trees/acre in HIZ 3 (15-40 trees within 30 to 100 feet of your home) and create mini-meadows for grasses, wildflowers, and scattered shrubs.



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Sources: CSFS Home Ignition Zone; Battaglia et al. 2018. Forest Ecology & Management 422:147-160; Rocky Mountain Research Station GTR-310.

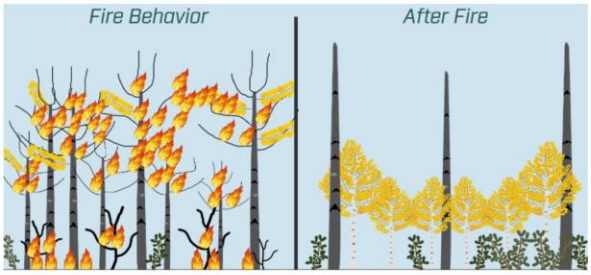
Aspen forests

Species: Aspen, occasional ponderosa pine, lodgepole pine, blue spruce, or other conifers

Typical elevation: Highly variable

Fire return interval: Highly variable

Fire severity: Slow and creeping or, during drought, stand-replacing fire where most or all trees die



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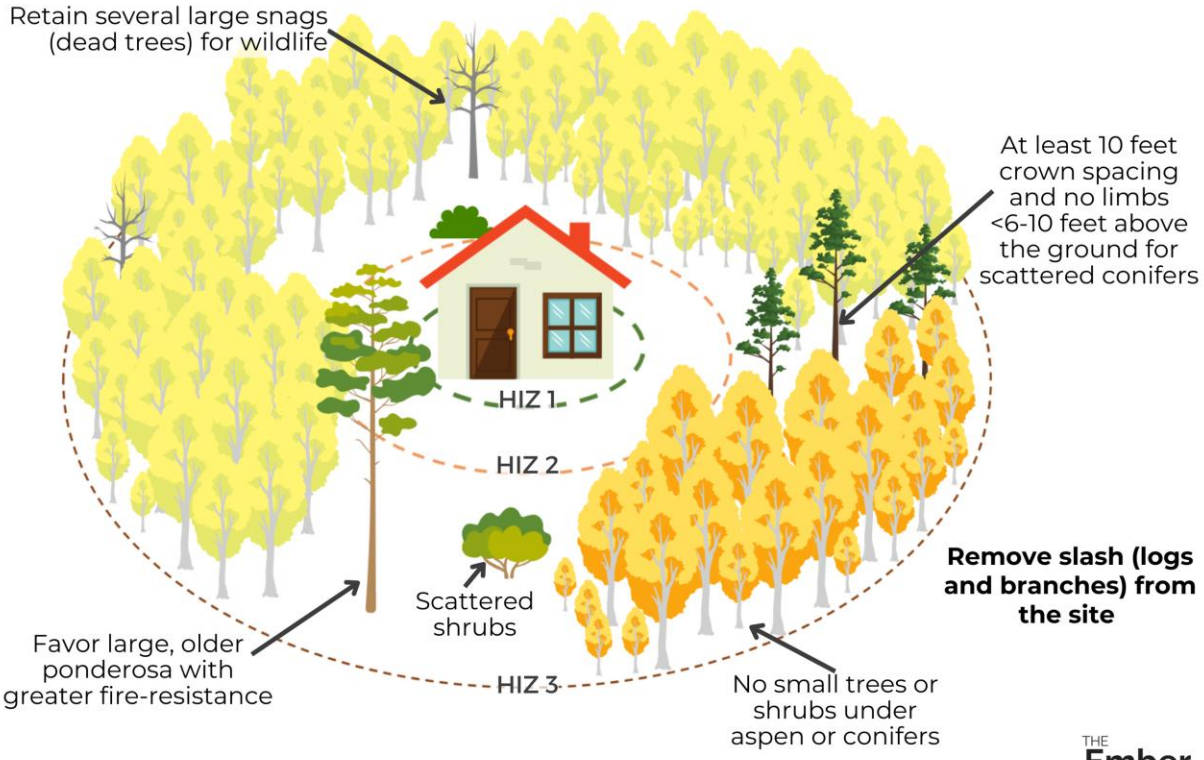
Aspen trees are fairly fire resistant and fire resilient. These deciduous trees have high fuel moisture, no low branches, and smooth bark, making them less likely to ignite than conifer trees. Aspens are readily killed by fire, but they recover quickly via sprouting. Fires can create conditions where aspen stands expand because of the species' ability to sprout rather than needing to germinate from seed, and because this sun-loving species experiences reduced competition from conifer trees killed by fire.

Management in Home Ignition Zone 3

Aspen trees do not need to be removed from HIZ 3 due to their fire-resistant and fire-resilient nature. Instead, focus on removing limbs from conifer trees, shrubs growing under aspen and conifers, and slash (logs, branches, and other woody material).



Source: CSFS Home Ignition Zone.

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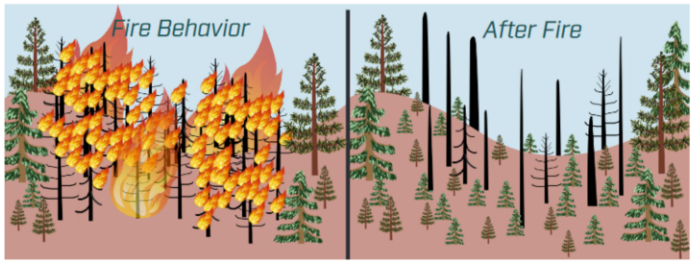
Subalpine forests

Species: Subalpine fir and Engelmann spruce; occasional blue spruce, aspen, and lodgepole, limber, and bristlecone pine

Typical elevation: 9,000-11,000 ft

Fire return interval: 100 to 600 years (infrequent)

Fire severity: Stand-replacing fire where most or all trees die



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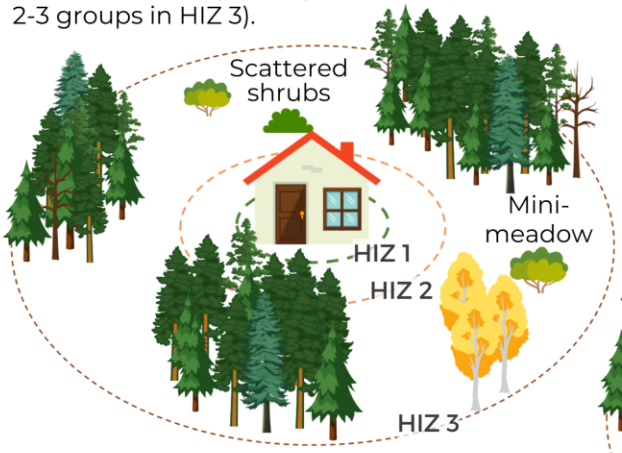
Subalpine forests are the wettest and densest forests in Colorado. When extended dry conditions occur in these forests, dead trees and other fuels that have accumulated over long periods of time dry out, creating conditions ripe for fire. Fires are infrequent, stand-replacing, and often synchronous across the region tied to widespread drought. More research is needed to understand forest recovery following the combination of drought, climate change, spruce beetle mortality, and recent wildfires.

Management in Home Ignition Zone 3

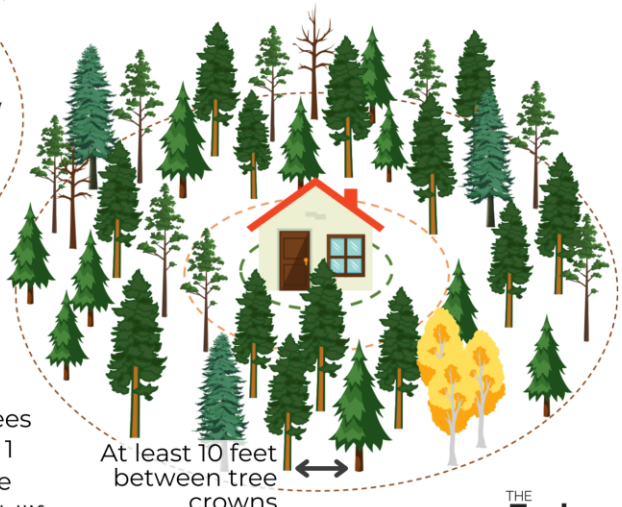
Spruce and fir trees can blow over if too many neighboring trees are removed before they can adapt to the wind. There are two options for managing spruce-fir in HIZ 3 to increase your home's chance of standing strong during a wildfire and to reduce windthrow:

Option 1: Leave groups of 15-30 trees at least 30-50 feet apart from other groups and at least 30 feet away from your home (about 2-3 groups in HIZ 3).



Option 2: Slowly thin the stand, no more than 30% of trees each time. Repeat to achieve at least 10-feet between tree crowns (no more than 80 trees/acre or 50 trees within HIZ 3, fewer for larger trees or on steep slopes).

This can take about 10 years to achieve, during which time, your home is still at risk.



For both options 1 and 2:

- No limbs <6-10 feet above the ground
- No small trees or shrubs under remaining trees
- Very few to no trees in HIZ 2 and none in HIZ 1
- Favor aspen for biodiversity and fire resilience
- Retain several large snags (dead trees) for wildlife habitat at least 1.5 x tree height away from your home
- **Remove slash (logs and branches)**

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Sources: CSFS Home Ignition Zone; CSFS Spruce Beetle Quick Guide FM 2014-1.

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. Treatments along roadways are often described as shaded fuelbreaks (Dennis, 2005). See **Table 0.1** for some example recommendations for roadside fuel treatments in NFPD/TFPD.

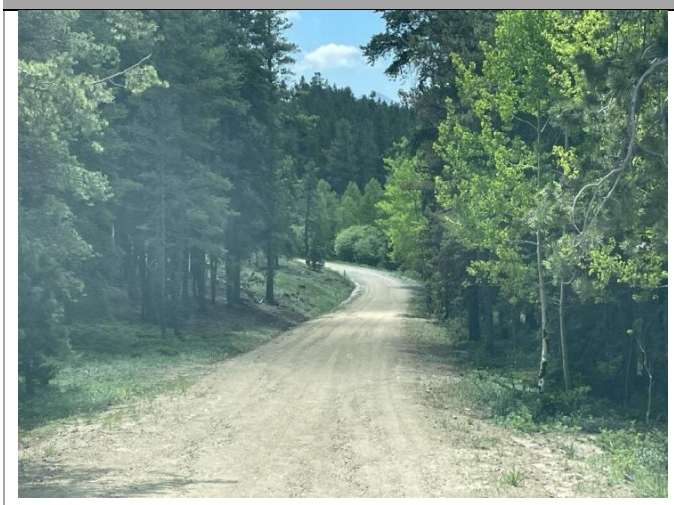
The width of an effective roadside fuel treatment (distance to the left and right of a road) is dependent on slope. It is recommended that treatments extend 150 to 240 feet off the downhill side of the road and 100 to 150 feet off the uphill side. Wider treatments are necessary on the downhill side on steeper slopes due to the exacerbating effect of slope on fire intensity when fires travel uphill (Dennis, 2005). Important aspects of all roadside fuel treatments include:

- Removing limbs overhanging the road to create ***at least*** 13.5-feet of vertical clearance.
- Removing trees alongside the road to create ***at least*** 20-feet of horizontal clearance.
- Removing trees to create ***at least*** 10-feet crown spacing between remaining trees within the roadside treatment zone.
- Removing shrubs and regeneration that can serve as ladder fuels.
- Mowing grasses adjacent to the road.
- Remove slash following fuel treatments.

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

Table 0.1. Examples of conditions occurring along roadways in NFPD/TFPD and suggestions for treatment and improvement.

Roadway example	Suggestions for improvement
	• Remove trees overhanging roadways • Clear trees and tall shrubs away from the roadways • Thin remaining trees to create at least 10ft crown spacing between them • Create regular pullouts and turnaround locations for engines • install mirrors on switchbacks to improve visibility
	• Mowing along the side of the road is recommended for the tall grasses. • The trees along this roadway are back from the road and upslope of the road. Trees should be removed to further away, but this would be lower priority than other roadways.
	• Remove trees that are leaning over the roadway because they could fall and trap residents during an evacuation • Clear all trees on the sides of the roadways

Logistics of Fuel Treatments

Roles and Responsibilities

Landowners are responsible for fuel mitigation on their own lands, including along their private driveways. Residents 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 Boulder County Wildfire Partners, the Boulder Watershed Collective, Colorado State Forest Service 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, and they provide a list of local contractors.

The responsibility for conducting roadside fuel treatments depends on the location of the road. Landowners are responsible for treatments along their private driveways. Treatments along county roads need to be coordinated with Boulder County. **Cooperation from private property owners is necessary for effective roadside fuel treatments; roadside easements are rarely wide enough to satisfy the minimum of 150 ft treatment depth on either side of a road.**

Treatment Costs

The cost of fuel treatments 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 10-20 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). Gamble oak shrublands can require retreatment every 3-5 years due to vigorous sprouting after treatment (CSFS, 2021).

Approaches to Slash Management

Forest management operations often increase surface fuel loads and can fail to achieve fire mitigation objectives if slash materials 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 residents and fire suppression personnel (Dennis, 2005), and they divert limited funds away from more effective, strategic projects.

Leaving untreated slash within roadside 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 residents 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.

Methods for managing slash come with different benefits and challenges. 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.

NFPD, TFPD, Boulder County, CSFS, and USFS should work together to develop a slash management strategy for the area. This can and should include a combination of the following slash management techniques.

Prescribed Broadcast Burning

Broadcast burning is generally the most effective method to reduce 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 population 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 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 different from broadcast burning; the overall complexity of pile burn operations is lower because fire activity 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).

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 wildfire, 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 burn permits from the Boulder County Sheriff Department. 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.

Air Curtain Burners

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 smoke from escaping out at 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 no 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

Community slash piles allow residents to immediately reduce fuel loads on their property, and it eliminates the need for residents to burn or chip their own material. However, it can be challenging for residents 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 residents and therefore lower than if individual residents were to create and burn their own slash piles.

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 the untreated slash, therefore increasing the distance between surface and canopy fuels (but not as effectively as broadcast prescribed burning of pule 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, or3 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 and 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). For detailed information on chipping and mastication, refer to CFRI's Mulching Knowledge Summary.

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. NFPD, TFPD, or Town of Nederland could host a chipping program for residents 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 that 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 6-18months. Homeowners can often manage preparing firewood themselves, so it can be an inexpesive 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.e.1. Many methods are available to remove slash created by forest thinning, each with their own benefits and challenges. Source: The Ember Alliance

Method	Removes surface fuel from site	Restores ecosystem functions	Retains nutrients on site	Expertise required to conduct	Effort to conduct	Relative cost/acre	Total time to plan and conduct
Broadcast burning	✓	✓	✓	Very high	Very high	$$$	Months to years
Pile burning on site	✓		✓	Moderate	Moderate to high	$$	Weeks to months
Air curtain burner	✓			High	Moderate	$$$$	Weeks to months
Community slash pile	✓			Low to moderate	Moderate	$$	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 they increase fuel loads near a home until burned

References

Abo El Ezz, A., Boucher, J., Cotton-Gagnon, A., Godbout, A., 2022. Framework for spatial incident-level wildfire risk modelling to residential structures at the wildland urban interface. Fire Safety Journal 131, 103625. https://doi.org/10.1016/j.firesaf.2022.103625

Beloglazov, A., Almashor, M., Abebe, E., Richter, J., Steer, K.C.B., 2016. Simulation of wildfire evacuation with dynamic factors and model composition. Simulation Modelling Practice and Theory 60, 144–159. https://doi.org/10.1016/j.simpat.2015.10.002

Beverly, J.L., Bothwell, P., Conner, J., Herd, E., 2010. Assessing the exposure of the built environment to potential ignition sources generated from vegetative fuel. International journal of wildland fire 19, 299–313.

Caggiano, M.D., Hawbaker, T.J., Gannon, B.M., Hoffman, C.M., 2020. Building loss in WUI disasters: Evaluating the core components of the wildland-urban interface definition. Fire 3, 3040073.

Caton, S.E., Hakes, R.S.P., Gorham, D.J., Zhou, A., Gollner, M.J., 2016. Review of pathways for building fire spread in the wildland urban interface part I: Exposure conditions. Fire Technology 54, 429–473.

CSFS, Technosylva, 2023a. Surface & canopy fuels methodology report. Colorado State University, Colorado State Forest Service, Fort Collins, CO.

CSFS, Technosylva, 2023b. 2022 Colorado Wildfire Risk Assessment update: Final report. Colorado State University, Colorado State Forest Service, Fort Collins, CO.

Finney, M.A., 2006. An overview of FlamMap fire modeling capabilities, in: In: Andrews, Patricia L.; Butler, Bret W., Comps. 2006. Fuels Management-How to Measure Success: Conference Proceedings. 28-30 March 2006; Portland, OR. Proceedings RMRS-P-41. Fort Collins, CO: US Department of Agriculture, Forest Service, Rocky Mountain Research Station. p. 213-220.

Hegewisch, K.C., Abatzoglou, J.T., Gross, J., 2021. Future Climate Analogs Web Tool. Climate Toolbox.

IPCC, 2014. Climate change 2014: Synthesis report. Contribution of working groups I, II and III to the 5th assessment report of the Intergovernmental Panel on Climate Change. IPCC, Geneva, Switzerland.

Maranghides, A., Link, E.D., Hawks, S., McDougald, J., Quarles, S.L., Gorham, D.J., Nazare, S., 2022. WUI structure/parcel/community fire hazard mitigation methodology (NIST Technical Note No. 2205). Department of Commerce, National Institute of Standards and Technology, Washington, DC.

NWCG, 2021. Midflame windspeed. Section 8.2 [WWW Document]. Firefighter Math, National Wildfire Coordinating Group. URL https://www.nwcg.gov/course/ffm/fire-behavior/82-midflame-windspeed

NWCG, 2019. Fire behavior field reference guide. PMS 437. National Wildfire Coordinating Group, Boise, ID. https://www.nwcg.gov/publications/pms437

Parks, S.A., Miller, C., Abatzoglou, J.T., Holsinger, L.M., Parisien, M.A., Dobrowski, S.Z., 2016. How will climate change affect wildland fire severity in the western US? Environmental Research Letters 11, 035002. https://doi.org/10.1088/1748-9326/11/3/03500

Schulte, L.A., Rickenbach, M. & Merrick, L.C. Ecological and economic benefits of cross-boundary coordination among private forest landowners. *Landscape Ecol* **23**, 481–496 (2008). https://doi.org/10.1007/s10980-008-9207-x

Scott, J.H., 2006. Comparison of crown fire modeling systems used in three fire management applications (Research Paper No. RMRS-RP-58). U.S. Department of Agriculture, U.S. Forest Service, Rocky Mountain Research Station, Fort Collins, CO.

Scott, J.H., Burgan, R.E., 2005. Standard fire behavior fuel models: a comprehensive set for use with Rothermel's surface fire spread model. US Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Seager, R., Hooks, A., Williams, P., Cook, B., Nakamura, J., Henderson, N., 2015. Climatology, variability, and trends in the U.S. vapor pressure deficit, an important fire-related meteorological quantity. Journal of Applied Meteorology and Climatology 54, 1121–1141.

Shahabi, K., Wilson, J.P., 2014. CASPER: Intelligent capacity-aware evacuation routing. Computers, Environment and Urban Systems 46, 12–24. https://doi.org/10.1016/j.compenvurbsys.2014.03.004

Sullivan, A.L., 2009. Wildland surface fire spread modelling, 1990–2007. 1: Physical and quasi-physical models. International Journal of Wildland Fire 18, 349–368.

Syphard, A.D., Keeley, J.E., Massada, A.B., Brennan, T.J., J., T., Radeloff, V.C., 2012. Housing arrangement and location determine the likelihood of housing loss due to wildfire. PLoS ONE 7, e33954. https://doi.org/10.1371/journal.pone.0033954

Williams, J., 2013. Exploring the onset of high-impact mega-fires through a forest land management prism. Forest Ecology and Management 294, 4–10.

Appendix D: Community Engagement

Prepared for the Nederland and Timberline Fire Protection District's CWPP
Kirin Riddell, Kathryn Sullivan & Erin Fried

The project description below provides comprehensive details on how the results of each phase of engagement were incorporated into the development of action items in the CWPP process. This was an intentional, evidence-based, and meticulous process. Overall, in the final incorporation of community input, any non-place-based input (priorities that were not attached to any specific location within the CWPP area), where 6 or more people commented/voted for a specific action item, was *automatically included* as a priority in the final CWPP. There were 10 priorities fitting these criteria. Priorities mentioned by 6 or fewer people were included in a further prioritization process, and as a result, many of these were included in the final CWPP if they also aligned with CWPP core team priorities. For place-based priorities (those that referenced a specific location within the CWPP area), the CWPP core team underwent a facilitated workshop in which community engagement findings were presented and the core team was given opportunities to adjust their priority projects in response. This resulted in adapting some projects to include community objectives and adjusting project boundaries to include the community's recommended spatial scales.

Community engagement was undertaken in two parts. In the lead up to the CWPP process, a team of CU students in the Masters of the Environment (MENV) track partnered with the Boulder Watershed Collective (BWC) to conduct interviews and community visioning workshops. The results of this process helped inform the CWPP planning process and further community engagement. The second community engagement effort began once the CWPP planning process was in motion. For this engagement, BWC, in collaboration with a CU PhD student, hosted a series of Public Participatory GIS (PPGIS) workshops. The results of this process helped inform the recommendations in this CWPP.

2022 Community Engagement

In 2022, an engagement effort focused in Nederland and the Timberline Fire Protection District area was led by four MENV students in collaboration with BWC. It provided an initial qualitative insight into community values and concerns regarding wildfire resilience within the community. This was achieved through a combination of 38 interviews and three community visioning workshops, two adult and one youth focused workshop. The purpose of this project was to create opportunities for the residents in both fire protection districts to reflect on the current state of wildfire resilience in the community, and envision what a wildfire resilient future might look like.

Interviews - Interviews were conducted from June to September, with 38 participants. These hour-long discussions focused on how interviewees defined wildfire resilience and what actions they recommended for their community to become more wildfire resilient. The engagement team made an effort to incorporate voices in this process that have not typically been heard in wildfire-planning efforts, such as community members that are elderly, unhoused, and Indigenous.

Workshops - All three workshops were rooted in the idea of reimagining a wildfire adapted future, with the goal of learning what community members believe to be an ideal future state, as well as discovering actionable pathways toward that vision. This allowed people to explore important concepts like wildfire resilience, while focusing on positive outcomes. Community members were able to work backwards through a process called backcasting, eventually working from their reimagined future toward action items that can be taken in the near or immediate future that will help the community on its path toward this reimagined state.

Backcasting is the process of identifying the means to achieving a goal, by working backwards from the preferred state/accomplishment and identifying important milestones and actions that lead to the completion of that goal.

Input from these workshops and interviews was analyzed through qualitative analysis, and produced the following community-facing story map.

Outcomes from this research effort were incorporated into the development of action items in the 2023-24 CWPP process. Actions recommended by community members through interviews and workshops were compiled into a list of place-based and non-place-based recommendations, and prioritized based on how frequently each theme emerged in the interviews and workshops.

1. PPGIS Goals

Overview
Throughout September 2023, The Boulder Watershed Collective, in collaboration with a PhD student at CU, Kathryn Sullivan, hosted a series of four in-person PPGIS workshops and one digital mapping alternative. Participants were provided with maps to:

a. **draw areas** (polygons) across the CWPP landscape with values associated with (1) fire resilient landscapes, (2) fire adapted communities, (3) safe and effective fire response, and (4) personal values.
b. **describe those values/priorities** as it relates to their chosen polygons.
c. **describe what specific action/initiatives** (if any) they recommend to support this value/item.
d. **choose and rank** the most prioritized areas and recommended actions across all participant polygons.

In addition to the activity, a facilitated conversation with community members was held to provide an opportunity for participants to discuss their recommendations for localizing wildfire ready actions to support the CWPP, and inform the creation of a community-led wildfire group.

Objectives
Through this engagement process, we hoped to:

(1) create a **frequency map** demonstrating the most frequently chosen actions items associated with polygons or overlapping areas across all participants.
(2) generate a **full list of *commonly* described project priorities** and locations across all planning unit areas.
(3) **compare community local knowledge and the core team's expertise** across metrics associated with wildfire risk perceptions (e.g. ignition source, burn probability etc.), project priorities & location, and evacuation routes. Through this comparison, we identified areas where there are agreement/hot spots (e.g. projects that are potential low hanging fruit) and areas of differences/cold spots (e.g. opportunities to educate and support community initiatives, opportunities to understand where strong project resistance from community perspectives might occur and what people's tolerance to change in the landscape are, organized by place).
(4) **identify the role(s) and visions** that local residents and other members of the community wish to play in translating the CWPP document into action.

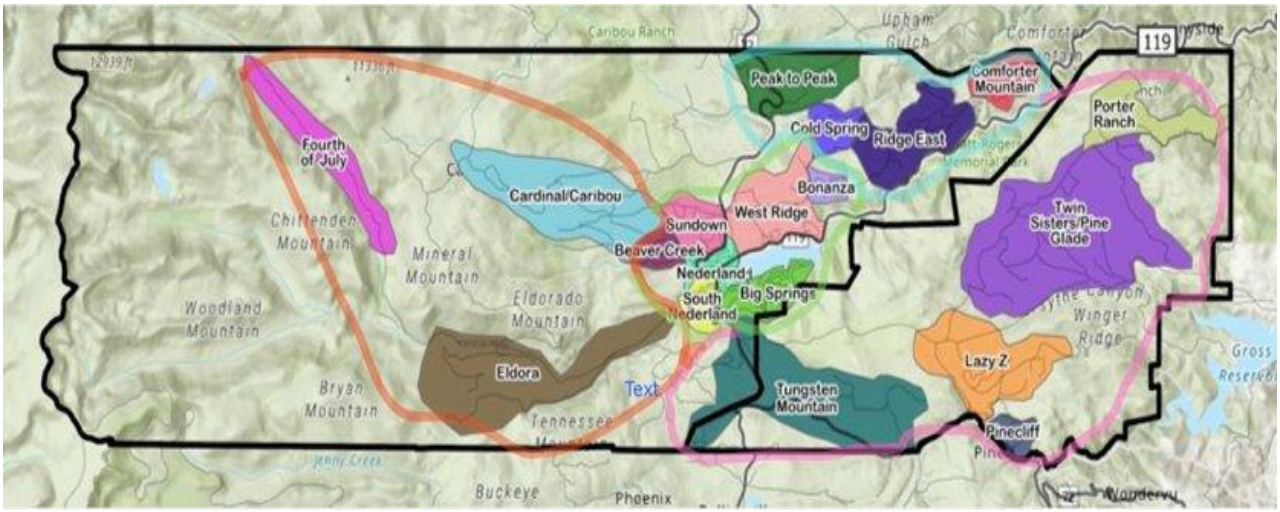
Integration into the CWPP
The GIS layers of *common* community wildfire concerns, values, and priority projects were integrated into the final CWPP project priority map and table of recommendations through a comprehensive project priority selection process occurring in December 2023/January 2024. Through the hot spot visualization, the team identified hot spots where core team projects matched community priorities, and cold spots in the overlapping community and core team maps where more specific educational opportunities are needed. Hot spots were incorporated into the recommendations list in Section 4.

2. PPGIS In-Person Workshop Methods

The following strategy was implemented for gathering geospatial community input for the final CWPP document. This process is based on a literature review of peer-reviewed papers and discussions with PPGIS experts, and conversations with community members on best practices for community engagement.

Workshop Locations
The team hosted one workshop in each of the following four community engagement units. The engagement team reached out to neighborhood listservs, passionate community wildfire leaders, and used localized outreach strategies (e.g. posts on NedHeads Facebook group, flyers posted at local spots) to determine the location and timing of each event in September/October. These engagement units were created from The Ember Alliance's planning units for this CWPP.

West: Cardinal/Caribou, Fourth of July, Eldora
Town of Nederland: Beaver Creek, Big Springs, Bonanza, Nederland, South Nederland, Sundown, West Ridge
Northeast: Cold Springs, Comforter Mountain, Peak to Peak, Ridge East
Southeast: Lazy Z, Pinecliffe, Porter Ranch, Tungsten Mountain, Twin Sisters/Pine Glade



Workshop Methods

Throughout these workshops, the PPGIS project team gathered both specific and generalizable community input. Specific polygons, values/priorities, and descriptions of projects supporting those values/priorities allowed the team to capture personalized and non-prescriptive values across the landscape, their wildfire preparedness priorities, and project ideas that provide recommendations for turning plans into action. Generalizable values/priorities allowed the team to understand the most common trends and how they ranked among other participants, and provided anonymous, higher-level input.

The workshops were structured as follows:

1) **(Registration before & at workshop) Gathered simple demographic information** through a quick questionnaire during registration and at two computers at the workshop if participants did not fill out the questionnaire beforehand. A sign in sheet assigned a number next to each participant**'s** name as an anonymous identifier for the remainder of the mapping input, placing this number on their polygons and any polygons they "starred" for the rest of the workshop. During analysis, these numeric identifiers were matched to a participant's input to anonymize sensitive personal and demographic information.
2) **(5 min "trickle in" + 10 min introduction) The introduction** outlined the workshop and quick description of the CWPP process, provided instructions for the mapping exercise, and emphasized that feedback documented and heard at the workshop is ONE perspective among many comprehensive perspectives considered in the full CWPP process - "what is gathered in the workshop informs the final CWPP document, but may or may not be explicitly included".
3) **(10 min instructions, 30 minute exercise) Transition to the mapping input.** We provided four printed maps of the entire Nederland and Timberline Fire Protection Districts included in this CWPP, with one of the following prompts at the top of each map:
   - **a)** When it comes to **fire adapted communities**, please:
     - **i)** Draw a circle or polygon of an area that you think could support more actions for a 'fire adapted community'.
     - **ii)** Choose a pre-made label from the side that best represents a title for the area you outlined. Feel free to write on a blank label if needed. ***put your identifier on the label.**
     - **iii)** Open the label and describe why you choose this item/value for this area.
     - **iv)** Describe what you would like to see happen in this area to support this item/value (if any action at all). Please be as specific as possible.
     - **v)** Stick this label on your polygon.
   - **b)** When it comes to **fire resilient landscapes,** please:
     - **i)** See items i. - iv. under 2.a. above
   - **c)** When it comes to **safe and effective fire response,** please:
     - **i)** See items i. - iv. under 2.a. above
   - **d)** When it comes to your **personal values surrounding the Nederland and Timberline community, ecosystems, and landscapes,** please:
     - **i)** See items i. - iv. under 2.a. above

Participants were given 30 minutes to visit any and all of these maps and draw polygons, choosing from pre-made 'labels' associated with each map. Labels were provided as folded pieces of paper with pre-labeled values/priorities to choose from. Participants had the option to write-in their own value/priority and choose as few or as many pre-labeled or blank labels as they saw fit. The label paper provided space to write (1) why they chose that value/priority for that area, and (2) what action/initiative best supports that value/priority. Once folded again, participants placed the label on their polygon with tape, magnets, and/or Velcro. Each label had multiple copies. Participants **were not** required to 1) visit all the maps, 2) place all their ideas on a map if ideas were not geospatially specific (those were placed to the side of the maps if they chose), 3) choose all labels for each map, and 4) only choose one label for each polygon they drew.

Fire adapted Community Labels
Collective Community Action & Trainings
Home Hardening & Defensible Space
Postfire Planning for Communities
Insurance
Blank Labels

Fire Resilient Landscape Labels
Land Management - Forest Thinning & Patch Cuts
Land Management - Prescribed Broadcast Burns
Land Management - Prescribed Pile Burns
Land Management - Meadow Restoration
Land Management - Beaver Reintroduction
Ecosystem Health
Water Quality
Wildlife Habitat
Postfire Planning for Landscapes
Local Climate Change Impacts
Large Wildfire Hazards
Blank Labels

Safe & Effective Fire Response Labels
Ignition Source/Fire Bans
Water Resources/Cisterns
Reducing Impacts of Smoke
Evacuation/Egress Route
Emergency Communication Systems
Vulnerable Populations to Wildfire Safety & Impacts
Blank Labels

Personal Values Labels
Recreational Value

Aesthetic Value
Spiritual Value
Biological Diversity Value
Ecological Value
Learning Value
Intrinsic Value
Future Value
Heritage Value
Economic Value
Social Value
Essential Human Services Value
Blank Labels

4) **(5 minute instructions, 20 minute exercise) Time was provided for people to read each other's ideas and place a dot with their identifier on any ACTIONS they agreed with. Next to the dot, participants were told to put a value $0-100 on that dot for how intensely they prioritized that polygon.** This provided frequency data and intensity data for the team to analyze. Each participant was provided with five dots to place on separate polygons, and told to allocate money (out of $100 of fake money) based on how much they supported that idea. Totals had to add up to $100.
5) **Personal time & discussion** allowed participants to talk to others about their recommendations for wildfire ready actions, and ways to improve the PPGIS process. Ten minutes of quiet reflection were provided for participants to write ideas and comments, and ten minutes were provided for the whole room discussion. The following questions were used to guide the reflection and discussion period.
   a) What ideas do you have to make your wildfire priorities a reality?
   b) Relating specifically to a Wildfire Council:
      i) Where would/could it be housed?
      ii) What would it need to be successful (e.g. funding, capacity?)
      iii) How large or small? How would it be organized across the landscape?
6) Workshop Feedback:
   a) General feedback
   b) If we were to provide it, would it be useful to have a digital version of this mapping workshop for those who were unable to attend tonight? Yes/No/Maybe: _____
7) **(10 min) Brief conclusion of the workshop.** The final few minutes summarized key trends heard throughout the workshop, and discussed next steps.

3. PPGIS Digital Map Methods

Participant Recruitment

The Digital Mapping Workshop sought to reach a wider network of Nederland and Timberline area residents and stakeholders unable to attend the in-person workshops. The team contacted all in-person workshop attendees and asked them to send a digital "survey" to their neighbors and local friends (CC'ed in an email). Links to the digital survey also went out through neighborhood listservs, passed along by passionate community wildfire leaders who did not attend the workshops, and as posts on other communication platforms (e.g. posts on NedHeads Facebook group). Participants were given 2 weeks to complete the survey, and were provided with clear instructions not to take the survey if they attended an in-person workshop.

Digital Map Methods

Through the digital survey, the team aimed to capture similar wildfire resilient and personal value priorities as the in-person workshop but with a slightly adjusted, more simplified methodology based on feedback from the workshops. Namely, the digital mapping option provided participants with the option to add polygons and their associated actions to a blank map *not* limited by pre-made labels or fitted to a certain themed map. Additionally, participants ranked the importance of each polygon they added on a 1-10 scale rather than providing a relative value in dollars. In this way, the key function of the in-person workshop was to understand general trends representing common desired wildfire resilient actions based on a participant's own ideas and in relation to others', whereas the digital mapping survey asked participants to create and rank their own ideas. Identification of the most frequent and intense polygons occurred during the analysis phase rather than the data collection phase of this process.

The digital survey was made using Esri's Survey 123 platform, and used the following format:

1. **A brief introductory paragraph** described the CWPP, how the information from the digital survey would be integrated into the CWPP process, and participant consent to be included in research. Exclusion of participation in the research did not exclude participants from providing input through the digital workshop. The intro also briefly described the in-person workshops and more ways to be involved in the engagement process.
2. **5 blank maps,** each centered in Nederland with the CWPP boundary as the baseline, were provided, with participants asked to answer the 4 corresponding survey questions after each map. A description above all of the maps provided clear instructions on how to interact with the maps and provided a few examples of labels and action items participants might create, taken from the in-person workshops. Participants were asked to draw one area/polygon that they would like to prioritize in each map for a total of 5 priority areas. In the survey questions after each map, participants were asked to 1) label each chosen area with a title, 2) describe why they chose this area, 3) describe what they would like to see happen to support this item/value, and 4) rank the importance of this prioritization area on a scale from 1-10 (1 = least important, 10 = most important). These ranking values were converted to dollar amounts (intensity) as: 1 = $10, 2 = $20, 3 = $30, 4 = $40, 5 = $50, 6 = $60, 7 = $70, 8 = $80, 9 = $90, 10 = $100.

3. **A series of demographic questions** were also asked at the workshops. These questions were placed at the end of this digital survey as a combination of forced single response and open response questions. See the registration questionnaire for the exact questions asked.

4. Community Input Integration into CWPP Prioritization Process

Research Questions

Based on this PPGIS research (and action items from 2022 data collection), we outlined the following research questions to guide this work and to meet the original objectives of this project:

Non-place-based Questions

Question # 1: What are the most frequent non-geospatial project priorities that participants mentioned from 2022 MENV work, and at the PPGIS workshops?

Question # 2: What are the most frequent reasons why community members choose their selected areas?

Question #3: What are the most common ways that participants:
1) List which agency/entity they would like to oversee a wildfire council?
2) Describe what is needed to make a wildfire council successful?
3) Describe landscape scale coordination of a wildfire council?

Place-Based Questions

Question #4: Which areas and their priority actions of the full CWPP landscape did community members most frequently choose across 1) No-Yes Forest Management - Thinning/Patch cuts/Preserve Together, 2) No-Yes Forest Management - Prescribed Burns, 3) Ecological Solutions, 4) Egress Routes, and 5) Home Hardening & Defensible Space

Question #5: Which areas and their associated priority actions of the full CWPP have the largest similarities and differences when comparing the most frequently chosen community members and the CWPP Core Team priority actions, organized by 1) Forest Management - Cutting, 2) Forest Management - Prescribed Burns, and 3) Egress Routes.

Data Organization & Quality Control

We first input all the tags/qualitative information written at the workshops and digital survey into a spreadsheet, matching each participant's characteristics to every statement/row but de-identifying their name, address, phone number, email address or any other personal information in this spreadsheet. We coded all statements based on an inductive coding and codebook development process. For quality control, we read through and re-assigned any place-based comments as non-place-based if the statement referenced the entire area or was clearly not place specific. For ambiguous statements, we left them as place-based. We converted coded values to binary values (e.g. intrinsic value statement mentioned two times in a statement became a 1 value), and aggregated or averaged values when necessary to answer research questions (e.g. created new higher-level codes of "yes-forest management/fuels reduction" to be any statements that mentioned patch cuts, thinning, and/or fuels reduction). For community place-based comments, we input

polygons into Arc GIS Pro and matched these to each row (aka one statement) from the spreadsheet through their Object ID. We gave weight to these polygons based on 1) how many votes that polygon and statement received within one workshop, *and* 2) how many times that area was drawn/captured in a polygon with a similar recommended action (e.g. ecological solution, yes forest management) across all the workshops and the digital survey. This was based on the frequency column values from 1/0 (if code was mentioned) x number of people who wanted that action (person who wrote statement + all people who voted for that statement). This frequency value included the person voting for their own statement. For non-place-based comments, we copied all non-geo specific comments from these 2023 workshops and all 2022 action items from the 2022 interview data (each of these action items received a frequency of 1 since we were unsure how many people actually mentioned each of these action items) and placed this all into a CWPP priority table spreadsheet. Using a similar coding process, we grouped comments into themes first, and then broke these out by more specific, common recommendations. Each of these were tied to and referenced the actual statement from the original data spreadsheet.

Data Analysis & CWPP Prioritization

To answer RQ 1, we calculated the priority value (1, 2 or 3) of non-place-based community statements based on the number of people who wrote + voted for that specific action recommended, adding up all repeating or similar ideas together and the number of people voting for those statements. This resulted in 1-5 people = 3 priority, 6 - 10 = 2 priority, > 10 = 1 priority. This same process was conducted on the core team's non-place-based action items, grouping similar/same action items but assigning priority values based on what that core team member had assigned to that action. We combined these items into one spreadsheet to compare and see where the community had 0 (not mentioned that action item but the core team had) through 3 priority levels and vice-versa for the core team. This action list was condensed and simplified by The Ember Alliance to eliminate redundancy, package items together or delete any non-feasible recommendations from either group (e.g. provide a map of privately-owned cisterns to residents). This reduced the list from 75 items to 46 items. To answer RQ3, we used a similar categorization and codebook development process and visualized these results for presentation at the January core team meeting.

To answer RQ4, we created heat maps of each of the following constructs: 1) No-Yes Forest Management - Thinning/Patch cuts/Preserve Together, 2) No-Yes Forest Management - Prescribed Burns, 3) Ecological Solutions, 4) Egress Routes, 5) Home Hardening & Defensible Space. These resulted in maps with "hot spots" identifying the "hottest" or most frequently chosen areas that those constructs associated with based on the frequency value associated with those polygons or points. We then created our own polygons based on the "hottest" of these hot spots to identify which statements associated with the hottest spots from the original data spreadsheet. From these statements, we teased out common themes/action recommendations among the statements and calculated the frequency value (summing all people who wrote the statement + those voting for it) and converted this to priority values using the same process as the place-based process, listed in a priority table. For those constructs with pro- and anti-supportive statements, we identified the "hottest spots" that overlapped for and against a construct (e.g. forest cutting of any kind) and subtracted those who did not support that action in that location from those who did - this included subtracting or including all those who also voted for or against those statements.

To answer RQ5, we used the heat maps from RQ4 and transposed this against the core team's priority placed based projects. This included first coding all place-based core team project plans into similar codes we used for the community for easy cross comparison, and comparing all 1-1 values across both groups (high values) all the way to no priority for either group - forming a matrix to visually compare across the landscape of high project weight to low project weight against the two groups. Since in RQ4 we already created priority values for place-based statements by subtracting those anti-statements, this already included those opposing statements.

CWPP Action Item Finalization

For non-place-based action items (out of 46 items), The Ember Alliance (TEA) and BWC presented key non-place-based findings and trends and methods of data collection at the final core team prioritization meeting in January 2024. We let the core team know that any priority 1 or 2 non-place-based action would be included in the final CWPP. Using the final 0-3 core team priority list and 0-3 community priority lists, we then used mentimeter to have core team members rank the 'Impact' (0-3 value on a likert scale) and 'Feasibility' (0-3 value on a likert scale) of each action item when compared across the same thematic categories (e.g. Home Hardening and Defensible Space). We included even the 1 or 2 priority values from the community in this facilitation to understand their relative importance to core team members, even though they would be included in the final CWPP document regardless of core team perspectives. TEA leads looked through the rankings of Impact and Feasibility from action items within each category and distinguished which items were the most impactful and feasible (again, community 1 and 2 priorities were automatically included).

For place-based action items, TEA and BWC again presented key findings for RQ 4 and 5. After key findings were presented, TEA facilitated a conversation around re-prioritizing and/or redrawing core team place-based project priorities given the communities' preferences. This included the core team recognizing the options to: 1) not adjust anything, 2) adjust boundaries or scale of the core team project, 3) adjust priority weighting value, 4) Consider phasing the project/adjusting timing/communicating/monitoring the project, 5) adjust the objectives of the recommendation, and 6) get rid of the core team's priority project. This resulted in adapting current core team projects to include community objectives for two projects and simplifying project boundaries to include the communities' recommended spatial scales. This also resulted in more emphasis being placed on how to communicate key objectives for projects where community values do not easily align with core team recommendations.