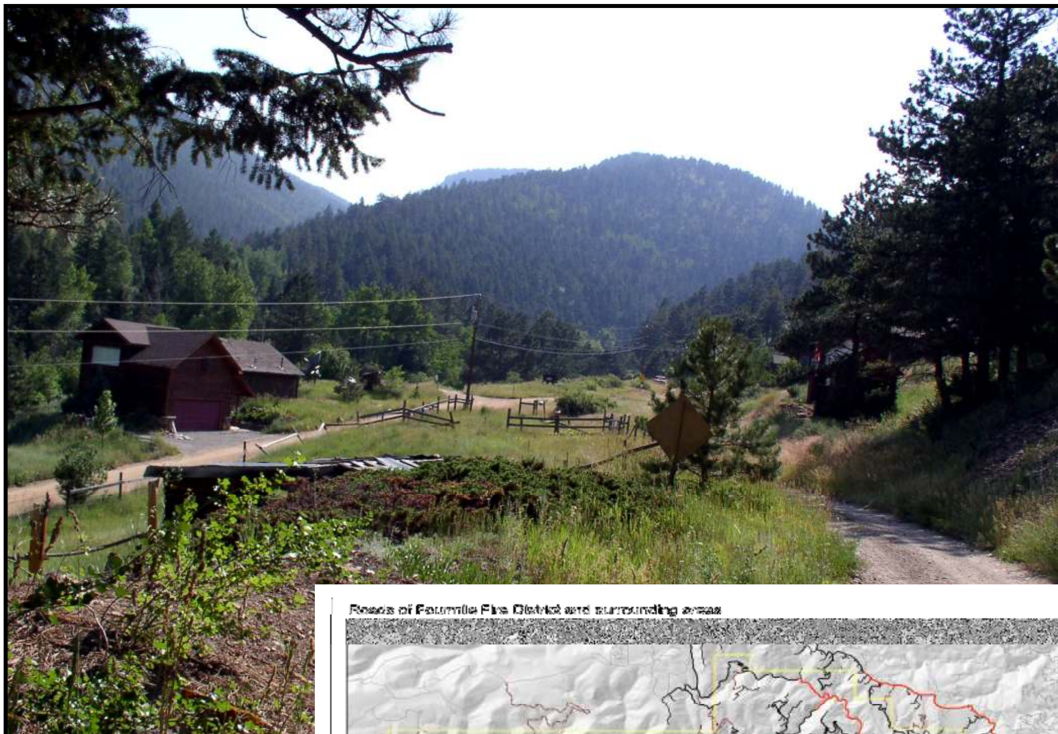
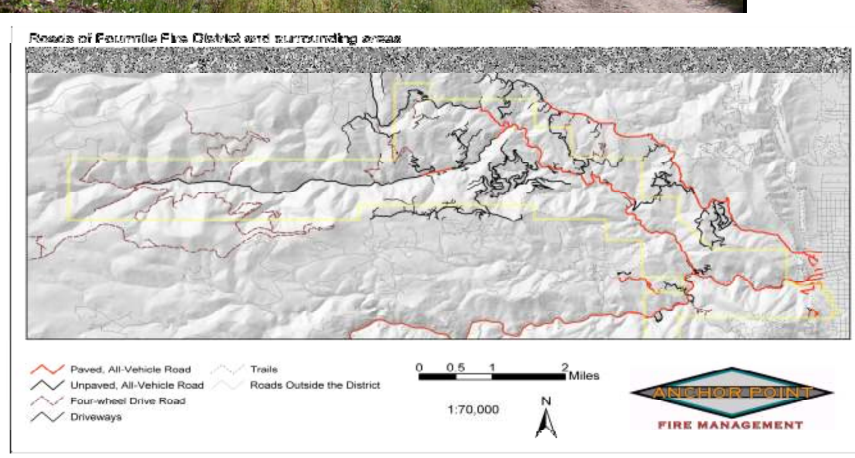
Four Mile Fire Protection District

Wildland Urban Interface

Community Wildfire Protection Plan





Prepared for:

Four Mile Fire Protection District

Boulder, Colorado

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SUMMARY OF THIS DOCUMENT

This document incorporates new and existing information relating to wildfire for citizens, policy makers, and public agencies in the Four Mile Fire Protection District (FMFPD), Boulder, CO. Wildfire hazard data is derived from the community wildfire hazard rating analysis (WHR) and the analysis of fire behavior potential, which are extensive and/or technical in nature. As a result, detailed findings and methodologies are included in their entirety in appendices rather than the main report text. This approach is designed to make the actual plan more readable while establishing a reference source for those interested in the technical elements of the FMFPD wildfire hazard and risk assessment.

The FMFPD Community Wildfire Protection Plan (CWPP) is the result of a community-wide fire protection planning effort including extensive field data gathering, compilation of existing fire suppression documents, a scientific analysis of the fire behavior potential of the study area, and collaboration with various participants including homeowners, FMFPD officials, the Four Mile Fire Department (FMFD), and the Colorado State Forest Service (CSFS). This plan was initially compiled in 2003 and revised in 2006 in response to a contract from the FMFPD to quantify, clarify and manage their wildland urban interface (WUI) responsibility. This project meets the requirements of the federal Healthy Forests Restoration Act (HFRA) of 2003 for community fire planning.

The CWPP meets the requirements of HFRA by:

1. **Identifying and prioritizing fuels reduction opportunities across the landscape;**
   See section Fuels Modification Projects beginning on page 37 of this document.

2. **Addressing structural ignitability;**
   See pages 33-36 and **Appendix B.**

3. **Collaborating with stakeholders.**
   See **Appendix E.**

The National Fire Plan

In 2000, more than eight million acres burned across the United States, marking one of the most devastating wildfire seasons in American history. One high-profile incident, the Cerro Grande fire at Los Alamos, NM, destroyed more than 235 structures and threatened the Department of Energy's nuclear research facility.

Two reports addressing federal wildland fire management were initiated after the 2000 fire season. The first was a document prepared by a federal interagency group entitled "Review and Update of the 1995 Federal Wildland Fire Management Policy" (2001), which concluded among other points that the condition of America's forests had continued to deteriorate.

The second report issued by the Bureau of Land Management (BLM) and the United States Department of Agriculture Forest Service (USFS) - "Managing the Impacts of Wildfire on Communities and the Environment: A Report to the President in Response to the Wildfires of 2000" - would become known as the National Fire Plan (NFP). That report, and the ensuing congressional appropriations, ultimately required actions to:

1. Respond to severe fires
2. Reduce the impact of fire on rural communities and the environment
3. Ensure sufficient firefighting resources

Congress increased its specific appropriations to accomplish these goals. Yet another severe season was seen in 2002, with more than 1,200 homes destroyed and seven million acres burned. In response to public pressure, congress and the Bush administration continued to obligate funds for specific actionable items, such as preparedness and suppression. That same year, the Bush administration announced the HFRA initiative, which enhanced measures to restore forest and rangeland health and reduce the risk of catastrophic wildfires. In 2003, that act was signed into law.

Through these watershed pieces of legislation, Congress continues to appropriate specific funding to address five main sub-categories: preparedness, suppression, and reduction of hazardous fuels, burned-area rehabilitation, and state and local assistance to firefighters. The general concepts of the NFP blended well with the established need for community wildfire protection in the study area. The spirit of the NFP is reflected in the FMFPD CWPP.

PURPOSE

The purpose of the fire behavior analysis, WHR and the resulting CWPP is to provide a comprehensive, scientifically-based assessment of the wildfire hazards and risks within the FMFPD.

The assessment estimates the risks and hazards associated with wildland fire in proximity to communities. This information in conjunction with values-at-risk defines “areas of concern” for the community and allows for prioritization of mitigation efforts. From this analysis, solutions and mitigation recommendations are offered that will aid homeowners, land managers and other interested parties in developing short-term and long-term fuels and fire management plans.

For the purposes of this report the following definitions apply:

Risk is considered to be the likelihood of an ignition occurrence. This is primarily determined by the fire history of the area.

Hazard is the combination of the WHR ratings of the WUI communities and the analysis of fire behavior potential, as modeled from the fuels, weather and topography of the study area. Hazard attempts to quantify the severity of undesirable fire outcomes to the values at risk.

Values at Risk are the human and intrinsic values identified as important to the way of life of the study area by its inhabitants, such as life safety, property conservation, access to recreation and wildlife habitat. (See pages 11-13 for a comprehensive overview.)

GOALS AND OBJECTIVES

Goals for this project include the following:

1. Enhance Life Safety for Residents and Responders
2. Mitigate Undesirable Fire Outcomes to Property and Infrastructure
3. Mitigate Undesirable Fire Outcomes to the Environment and Quality of Life

In order to accomplish these goals the following objectives have been identified:

1. Establish an approximate level of risk (the likelihood of a significant wildfire event for the study area)
2. Provide a scientific analysis of the fire behavior potential of the study area
3. Group values-at-risk into "communities" that represent relatively similar hazard factors
4. Identify and quantify factors that limit (mitigate) undesirable fire effects to the values at risk (hazard levels)
5. Recommend specific actions that will reduce hazards to the values at risk

Other Desired Outcomes

1. Promote community awareness:

   Quantification of the community's hazards and risk from wildfire will facilitate public awareness and assist in creating public action to mitigate the defined hazards.

2. Improve wildfire prevention through education:

   Awareness, combined with education, will help to reduce the risk of unplanned human ignitions.

3. Facilitate and prioritize appropriate hazardous fuel reduction:

   Organizing and prioritizing hazard mitigation actions into Fire Management Units (FMU) can assist stakeholders in focusing future efforts from both a social and fire management perspective.

4. Promote improved levels of response:

   The identification of areas of concern will improve the accuracy of pre-planning, and facilitate the implementation of cross-boundary, multi-jurisdictional projects.

COLLABORATION:

COMMUNITY/AGENCIES/STAKEHOLDERS

Representatives involved in the development of the FMFPD CWPP are included in the following table. Their names, organization, and roles and responsibilities are indicated in **Table 1**. For more information on the collaborative process that led to the development of this CWPP see **Appendix E** FMFPD CWPP Collaborative Effort.

Table 1. CWPP Development Team

Name	Organization	Roles / Responsibilities
Bret Gibson Chief	Four Mile Fire Department	Local information and expertise, including community risk and value assessment, development of community protection priorities, and establishment of fuels treatment project areas and methods.
Alan Owen District Forester	Colorado State Forest Service (CSFS)	Facilitation of planning process and approval of CWPP process and minimum standards; input and expertise on forestry, fire and fuels, and FireWise concepts.
Chris White Project Manager	Anchor Point Group LLC Consultants	Development of CWPP and decision-making, community risk and value assessment, development of community protection priorities, and establishment of fuels treatment project areas and methods.

STUDY AREA OVERVIEW

The Four Mile Fire Protection District is located in Boulder County, immediately west of Boulder, Colorado. The district is bordered to the east by the City of Boulder, to the south by the Cherryvale and Sugarloaf Fire Districts, to the west by the Arapahoe/Roosevelt National Forest and to the north by Sunshine Canyon Fire Protection District and the town of Gold Hill. Four Mile Canyon covers an area of 20 square miles, and has approximately 2,200 residents. The primary access to the district is via Colorado Highway 119.

Figure 1: Typical Area

For the purpose of this report, communities have been assessed for the hazards and risks that occur inside the district boundaries. Some of these communities continue into other fire districts, and GIS work for this project has been extended to a project boundary beyond the district boundaries. Unless noted otherwise, rankings and descriptions of communities, as well as hazard and risk recommendations, pertain only to the portions of those areas that lie within the boundaries of the Four Mile Fire Protection District.

The area is considered to be in the Montane zone (6,000'-10,000') of the eastern slope of the Northern Colorado Front Range. The predominant vegetation is ponderosa pine (*Pinus ponderosa*) and Douglas fir (*Pseudotsuga menziesii*). The area also contains dense stands of mixed conifers primarily on north facing slopes. Dense riparian shrub corridors and open canopy woodlands broken by large grass meadows also exist in the district.

Figure 2 and **Table 2** show the communities that define the WUI study area. As a part of this project the most populated areas were divided into 16 communities. Each community represents certain dominant hazards from a wildfire perspective. Fuels, topography, structural flammability, availability of water for fire suppression, egress and navigational difficulties as well as other hazards both natural and manmade are considered in the overall hazard ranking of these communities. The methodology for this assessment uses the WHR community hazard rating system that was developed specifically to evaluate communities within the WUI for their relative wildfire hazard.[1] The WHR model combines physical infrastructure such as structure density and roads and fire behavior components like fuels and topography, with the field experience and knowledge of wildland fire experts. For more information on the WHR methodology please see **Appendix B**.

For reference to the rest of this document, **Figure 3** and **Figure 4** show the general topography of the area. These graphic representations of the landforms of the study area (elevation and slope) will be helpful in interpreting other map products in this report.

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[1] C. White, "Community Wildfire Hazard Rating Form" *Wildfire Hazard Mitigation and Response Plan*, Colorado State Forest Service, Ft. Collins, CO, 1986.

Figure 2: Study Area Communities

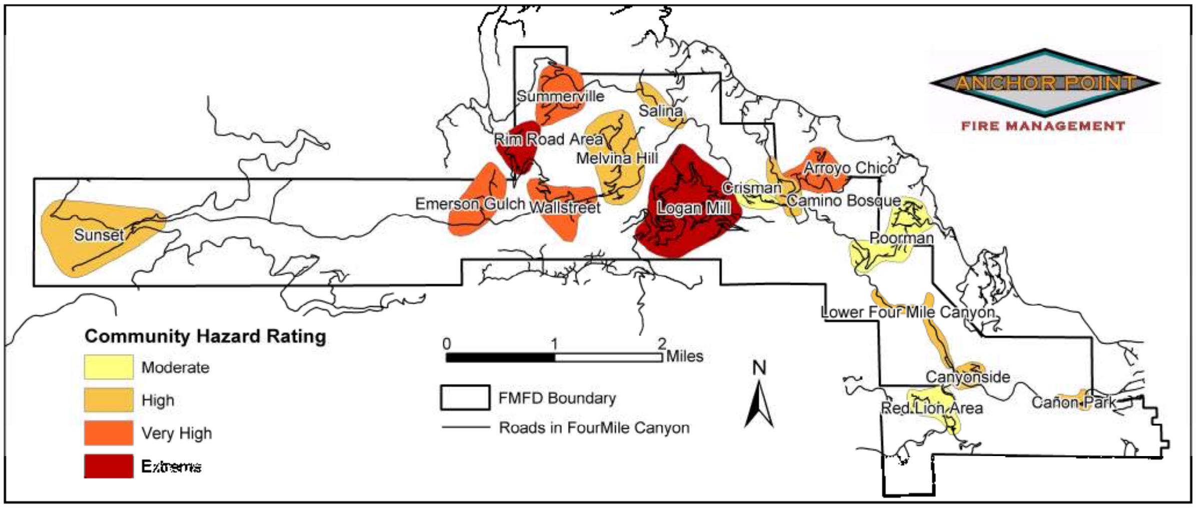


Table 2: Hazard Ranking of Communities in the Study Area

Extreme Very High High Moderate Low

1. Rim Road Area	**9. Lower Four Mile Canyon**
2. Logan Mill	**10. Melvina Hill**
3. Wallstreet	**11. Canon Park**
4. Summerville	**12. Salina**
5. Emerson Gulch	**13. Canyonside**
6. Arroyo Chico	**14. Red Lion Area**
7. Sunset	**15. Crisman**
8. Camino Bosque	**16. Poorman**

Figure 3: Percent Slope

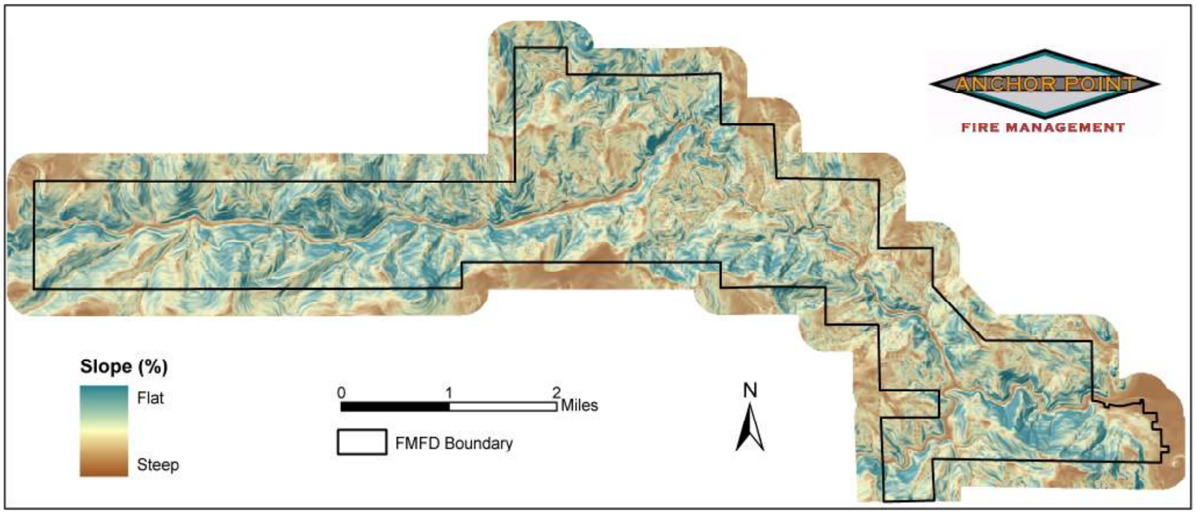
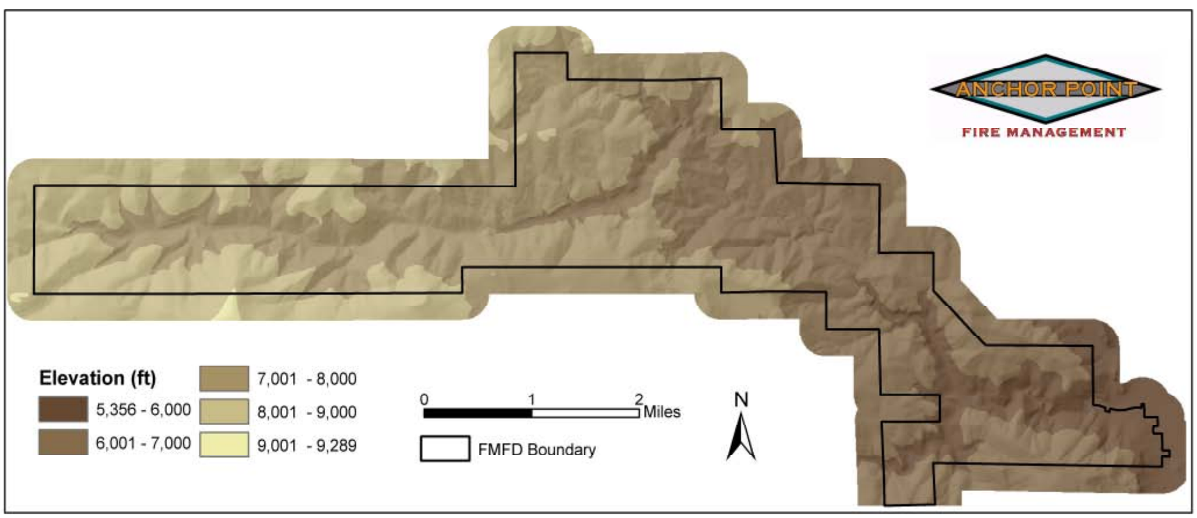


Figure 4: Elevation



VALUES

Life Safety and Homes

There are approximately 495 homes in FMFPD. The most populated areas were divided into 16 communities. The areas within each community represent certain dominant hazards from a wildfire perspective. Fuels, topography, structural flammability, availability of water for fire suppression, egress and access difficulties, as well as other hazards both natural and manmade, are considered in the overall hazard ranking of these communities. The hazard assessment identified 6 of the 16 communities in the study area to be extreme or very high hazard areas. Under extreme burning conditions, there is a likelihood of rapid increases in fire intensity and spread in this area due to steep topography, fast burning or flashy fuel components and other topographic features that contribute to channeling winds and promotion of extreme fire behavior. This area may also represent a high threat to life safety due to poor egress, the likelihood of heavy smoke, heat, and /or long response times.

With tens of thousands of people moving to Colorado each year, building in the once inaccessible mountain areas has become a growing concern. Most of Boulder County is vulnerable to some form of natural disturbance. Recent national disaster events have focused increased attention at both local and state government levels on the need to mitigate such events where possible and to prepare to cope with them when unavoidable.[2]

Boulder County recognizes the wildland urban interface as an area particularly at risk to wildland fires. Fire should be recognized as a natural and/or human-caused occurrence with certain benefits to the ecosystem. The county should strive towards balancing the natural processes of the ecosystem with development concerns so that residents may co-exist in a fire-dependent ecosystem.[3]

The population of Boulder County is growing at an average rate of 3% per year, and has increased 29% between 1990 and 2000, with increased mountain development and recreational pressures following this increase in population. Over 154,000 people in the county live in wildfire hazard areas, and the county experiences an average of 100 fire starts per year. Over the past 15 years the county has seen a number of major wildland fires, and until 2001, held the Colorado record for structural losses from wildland fires. This was due largely to the 1989 Black Tiger fire, which claimed 44 homes and the 1990 Old Stage fire, which took 10 homes. The culture of Boulder County emphasizes environmental values and outdoor recreation. Boulder County has intermixed land ownership. Approximately 60% of the land is owned publicly with 40% owned privately.

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[2] Boulder County Comprehensive Plan - Boulder County Land Use Department (http://www.co.boulder.co.us/lu/bccp/introduction.htm)

[3] Ibid.

Public land is divided among a variety of local, state and federal managers including the United States Forest Service, Boulder County Open Space, the City of Boulder and Colorado State Parks.[4]

Commerce and Infrastructure

Another significant component in both the county *Comprehensive Plan* and a majority of the municipal plans and programs is recognition of the importance of environmental factors, natural and cultural amenities, or "quality of life" issues to the health of the economy. The Boulder County economy has benefited from its legacy of careful land use decisions and its open space lands including national and state parks, national and state forests as well as city and county open space and parks.[5]

There are some commercial properties (lodging, restaurant and office buildings) but these are primarily concentrated along Highway 119 and the east end of the district. Although commercial property and retail business are limited within FMFPD, residents maintain a variety of home-based businesses. The economy of the area is based largely on the quality of life that attracts professionals to establish residences. Wildfire, therefore, has the potential to cause significant damage to the local economy.

Recreation and Lifestyle

The idea of a county open space program was initiated in the mid-1960s by Boulder County citizens who were interested in parks and recreation needs of the unincorporated area and in "preserving open space land in the face of rapid county development". This was at a time when Boulder County's 750 square miles were home to a population of fewer than 130,000 people. The 1995 population was almost 260,000.[6]

In 1978 the *Boulder County Comprehensive Plan* was adopted. The plan included goals and policies for preserving open space, protecting environmental resources (including both natural and cultural resources) and developing a county-wide trail system. The implementation of the open space plan has been based both on private cooperation and on the county's financial ability to acquire an interest in these lands.

By early1998, the county open space program comprised more than 52,000 acres of preserved land scattered throughout the county, along with 70 miles of trails. The majority of this land is open for public use. The remainder is under agricultural lease or conservation easements, which do not include public access. Most of the properties are well-suited to passive recreation (recreation development is limited to trails, parking areas/trailheads, picnic areas/shelters, outhouses, and simple boat docks or fishing piers where necessary).

Residents who currently live in the study area have a keen appreciation for their natural environment. They like to be in the mountains—it's the context of their quality of life. Recreation

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4 "Community Responses to Wildland Fire Threats in Colorado" – T. Steelman, D. Bell, Dept. of Forestry, NCSU (http://www.ncsu.edu/project/wildfire/Colorado/boulder/b_reduce.html)

5 Boulder County Comprehensive Plan – Boulder County Land Use Department (http://www.co.boulder.co.us/lu/bccp/introduction.htm)

6 Ibid.

and the natural beauty of the area are frequently quoted as reasons local residents have chosen to live in the study area.

Habitat Effectiveness & Environmental Resources

Residents are clear that the preservation of wildlife and the environment is important to the quality of life of the area. Habitat effectiveness is defined as the degree to which habitat is free of human disturbance and available for wildlife to use. Effective habitat is mostly undisturbed land area, which is buffered (at least 300 feet in essentially all situations) from regular motorized and non-motorized use of roads and trails (11 or more people or vehicle trips per week). It is felt that habitat effectiveness should not fall below 50%, and the best wildlife habitats have a much higher percentage.[7] Wildfire, specifically severe wildfire, can have significant adverse effects on habitat effectiveness.

The environmental character of Boulder County is due in large measure to the abrupt altitudinal variation within a 20-mile east-west gradient. The dramatic landform changes sharply define the native ecosystems and their associations of plant and animal species.

The county's environmental heritage includes non-renewable resources such as natural areas, historic/archaeological sites and natural landmarks. As irreplaceable resources, they warrant preservation from destruction or harmful alteration. Wetlands are critical environmental resources that function variously as wildlife habitat, aquifer recharge areas, and linkages in the overall county wildlife system, and aids for smog control.

The goal of the Boulder County Comprehensive Plan is to maintain and monitor the forests on open space in accordance with ways that benefits the ecosystem and the public by:

- Assessing overall forest conditions through forest inventories and surveys
- Implementing prescriptions based on the results of these inventories and surveys
- Taking action to change or increase the individual tree's health and vigor
- Reducing fire danger
- Improving or maintaining wildlife habitat
- Maintaining and preserving the aesthetic and ecological value of the forest

The FMFPD CWPP process is in concert with these guiding comprehensive plan principles. Through public involvement, local support and a regional perspective, the fuels reduction elements described in this document can and should enhance and protect the values of the study area.

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[7] Peak to Peak Community Indicators Project 2003 Presented by Peak to Peak Healthy Communities Project ©Copyright 2003 Peak to Peak Healthy Communities Project

CURRENT RISK SITUATION

For the purposes of this report the following definitions apply:

Risk is considered to be the likelihood of an ignition occurrence. This is primarily determined by the fire history of the area.

Hazard is the combination of the wildfire hazard ratings of the Wildland Urban Interface (WUI) communities and fire behavior potential, as modeled from the fuels, weather and topography of the study area.

The majority of the district is at a moderate risk for WUI fires. This assessment is based on the analysis of the following factors.

1. The city of Boulder is listed in the Federal Register as a community at high risk from wildfire (http://www.fireplan.gov/reports/351-358-en.pdf).
2. The area is shown in the Colorado State Forest Service WUI Hazard Assessment map to be an area of high Hazard Value (an aggregate of Hazard, Risk and Values Layers).
3. Until recently, FMFPD did not have a significant fire history, but in the last few years wildland fires have increased in frequency. The Four Mile Fire Department responded to only 5 wildland fires from 1998 to 2002, but responded to 18 confirmed wildland fires from 2003 to 2005 (2003- eight wildland fires and eight smoke reports, 2004- three wildland fires and ten smoke reports, 2005- seven wildland fires and five smoke reports). It is important to note that none of these fires exceeded two acres in size. Major fires occurred near the district in 2000 (the Walker Ranch Fire) and again in 2003 (the Overland Fire).
4. No major fires (fires greater than 100 acres) have burned in the district since 1989 (the Black Tiger Fire). However, it is important to note that there are over 20 fire departments in Boulder County, and many mutual aid agreements are in place. The Boulder area has a large number of well-trained resources. Ignitions in this area attract a rapid, professional response and are generally extinguished quickly.
5. The USDA Forest Service fire regime and condition class evaluation of forest stands in the study area shows that historic fire regimes have been moderately to substantially altered. Please see the *Fire Regime and Condition Class* section of this report for details.
6. The surrounding federal lands report an active, but far from extreme, fire history. Fire occurrences for the Boulder and Clear Creek Ranger Districts of the Arapahoe-Roosevelt National Forest (see Figure) were calculated from the USDA Forest Service Personal Computer Historical Archive for the ten-year period from 1994-2004. These areas represent federal lands adjacent to the study area, but do not include any data from state, county or private lands. The data have been processed and graphed using the Fire Family Plus software program and are summarized below.

Figure 5a shows the number of fires (red bars) and the total acres burned (blue hatched bars) in the two ranger districts each year. While the number of annual fires ranges from approximately 9 to over 30 fires per year, there is little year-to-year pattern to the variation. Acres burned are by far the greatest in 2003 primarily, due to the Overland fire in the Boulder Ranger District. Of the 4,571 acres reported burned in these two ranger districts between 1994 and 2004, 3,869 were burned by the Overland fire. Between 1994 and 2004 the only other fire to burn more than 100 acres in the two ranger districts was the Bear Tracks fire in 1998.

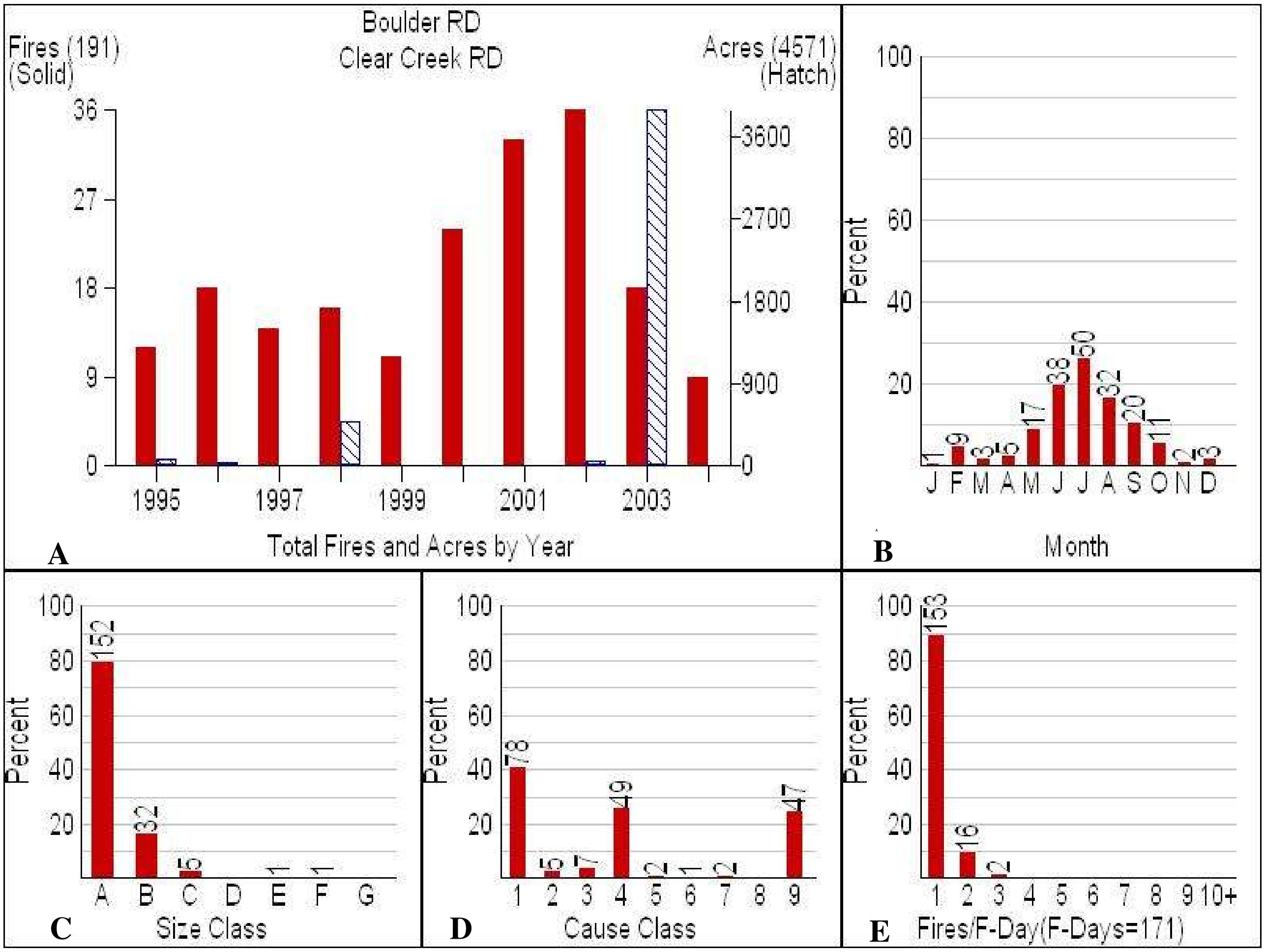
Figure 5b shows the percentage and number of fires between 1994 and 2004 occurring in each month of the year. July had the greatest number of fires followed by June and August. The fewest fires occurred between the months of November and April, which reflects the climate conditions for the area.

Figure 5c shows the size class distribution of fires. Approximately 96% of the reported fires (184 of 191) were less than 10 acres in size. These statistics reflect the widely held opinion that throughout the western US the vast majority of fires are controlled during initial attack.

Figure 5d shows the number of fires caused by each factor. As shown in this graph, the most common cause of ignitions is lightning (41%); however, the next most common cause is campfires (26%). If we remove the miscellaneous cause category, natural causes still represent the majority of ignitions (54% natural and 46% human caused), but it should be noted that these numbers are for national forest areas which lack the concentrated development and many other risk factors present in the portions of the study area where private land is dominant.

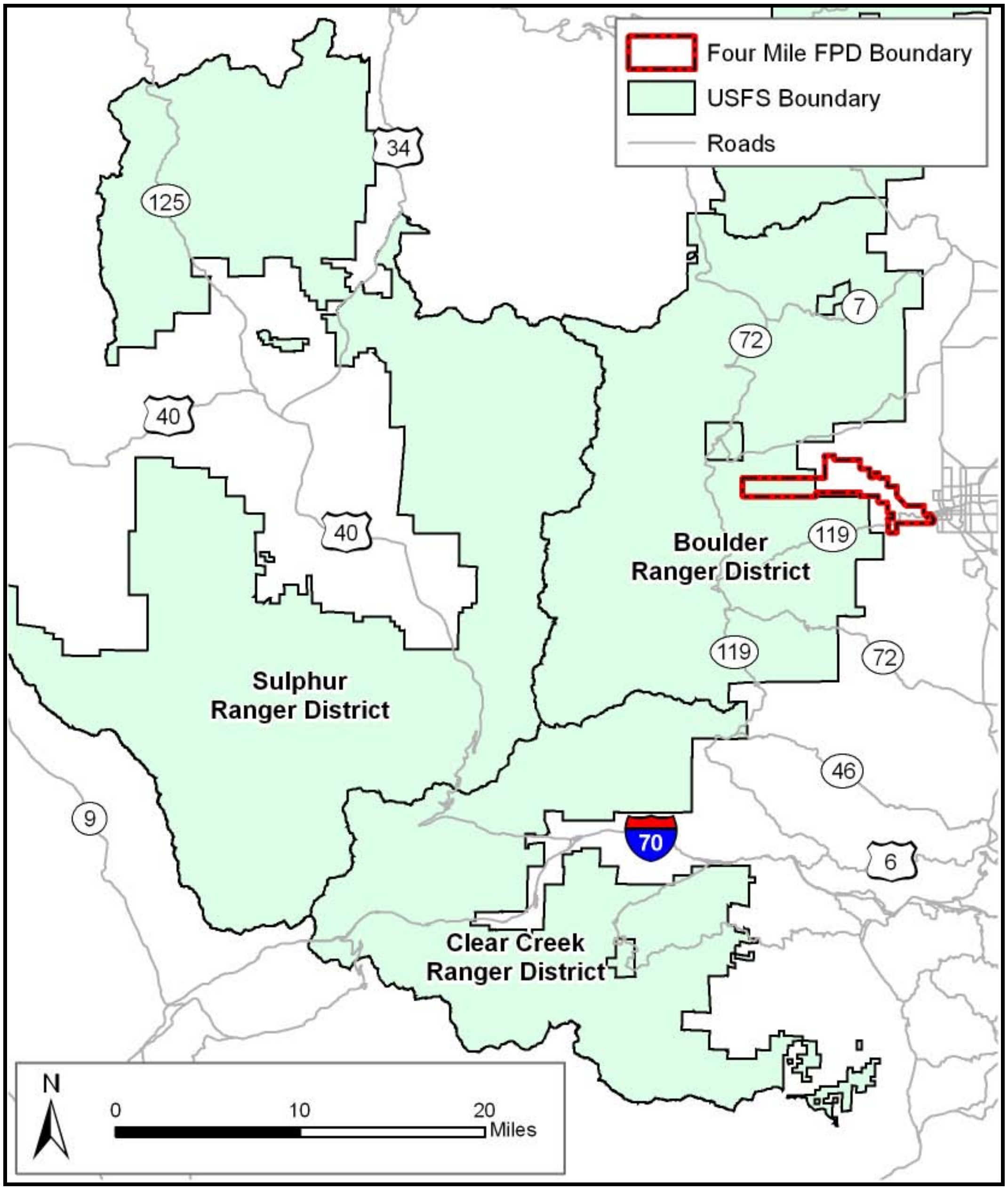
Figure 5e shows the number of fire starts for each day that a fire start was recorded. Most fires (153) occurred on days that only had one fire start. Approximately 8% (16) of fire days had two fire starts recorded and days with three or more fire starts represent approximately 1% of all fire start days. The statistics suggest that multiple start days are a rare occurrence compared to fire days with a single ignition.

Figure 5. Local Fire Statistics



Size Class (in acres)	A < ¼	B ¼ - 9	C 10 – 99	D 100-299	E 300-999	F 1000 - 4999	G 5000 +		
Causes	1 Lightning	2 Equipment	3 Smoking	4 Campfire	5 Debris Burning	6 Railroad	7 Arson	8 Children	9 Misc.

Figure 6: ARNF Ranger Districts



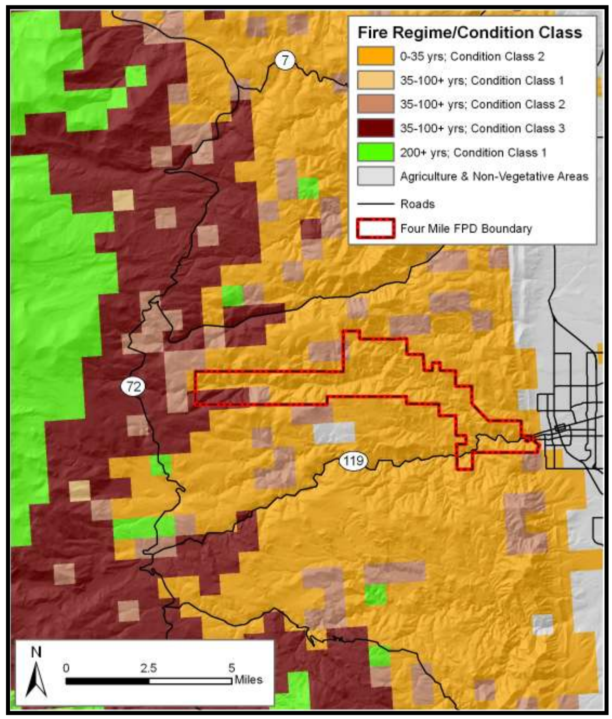
Development is increasing in the study area. As the density of structures and the number of residents in the interface increases, possible ignition sources will multiply. Unless efforts are made to mitigate the potential for human ignition sources spreading to the surrounding forest, the probability of a large wildfire occurrence will undoubtedly increase.

FIRE REGIME CONDITION CLASS

The Fire Regime Condition Class (FRCC) is a landscape evaluation of expected fire behavior as it relates to the departure from historic norms. The data used for this study is from a national level map. The minimum mapping unit for this data is 1 square kilometer. FRCC is not to be confused with BEHAVE and FlamMap fire behavior models, detailed in the fire behavior section, which provide the fire behavior potential analysis for expected flame length, rate of spread and crown fire development.

The FRCC is an expression of the departure of the current condition from the historical fire regime. It is used as a proxy for the probability of severe fire effects (e.g., the loss of key ecosystem components - soil, vegetation structure, species, or alteration of key ecosystem processes - nutrient cycles, hydrologic regimes). Consequently, FRCC is an index of hazards to the status of many components (e.g., water quality, fish status, wildlife habitats, etc.). **Figure 7** displays graphically the return interval and condition class of the study area.

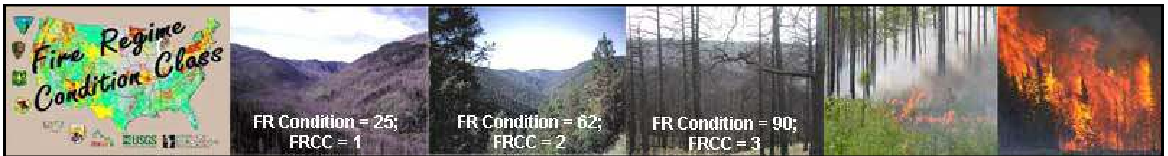
Figure 7. Condition Class Map



Deriving fire-regime condition class entails comparing current conditions to some estimate of the historical range that existed prior to substantial settlement by Euro-Americans. The departure of the current condition from the historical baseline serves as a proxy to likely ecosystem effects. In applying the condition class concept, it is assumed that historical fire regimes represent the conditions under which the ecosystem components within fire-adapted ecosystems evolved and have been maintained over time. Thus, if it is projected that fire intervals and/or fire severity has changed from the historical conditions, then it would be expected that fire size, intensity, and burn patterns would also be subsequently altered if a fire occurred. Furthermore, it is assumed that if these basic fire characteristics have changed, then it is likely that there would be subsequent effects to those ecosystem components that had adapted to the historical fire regimes. As used here, the potential of ecosystem effects reflect the probability that key ecosystem components may be lost should a fire occur within the FMFPD. Furthermore, a key ecosystem component can represent virtually any attribute of an ecosystem (for example, soil productivity, water quality, floral and faunal species, large-diameter trees, snags, etc.).

The following categories of condition class are used to qualitatively rank the potential of effects to key ecosystem components:

Table 3. Condition Class Descriptions[8]



Condition Class	***Condition Class Description***
1	Fire regimes are within their historical range and the risk of losing key ecosystem components as a result of wildfire is low. Vegetation attributes (species composition and structure) are intact and functioning within an historical range. Fire effects would be similar to those expected under historic fire regimes.
2	Fire regimes have been moderately altered from their historical range. The risk of losing key ecosystem components as a result of wildfire is moderate. Fire frequencies have changed by one or more fire-return intervals (either increased or decreased). Vegetation attributes have been moderately altered from their historical range. Consequently, wildfires would likely be larger, more intense, more severe, and have altered burn patterns than that expected under historic fire regimes.
3	Fire regimes have changed substantially from their historical range. The risk of losing key ecosystem components is high. Fire frequencies have changed by two or more fire-return intervals. Vegetation attributes have been significantly altered from their historical range. Consequently, wildfires would likely be larger, more intense, and have altered burn patterns from those expected under historic fire regimes.

The study area is dominantly classified under Condition Class 2 and 3. By definition, historic fire regimes have been moderately to substantially changed. Consequently, **Wildfires are likely to be larger, more severe, and have altered burn patterns from those expected under historic fire regimes**.

8 Fire Regime Condition Class, website, http://www.frcc.gov/, July 2005.

FIRE BEHAVIOR POTENTIAL

From the Wildfire Hazard-Risk analysis carried out as a part of this study (see Appendix A and B), the fire behavior potential of the study area was modeled. This model can be combined with structure density and values at risk information to generate current and future “areas of concern”. Figure 5 shows the fire behavior potential map for the analysis area given the average weather conditions existing between May 1 and October 31. Weather observations from the Boulder Remote Automated Weather Station (RAWS) were averaged for a ten-year period (1992-2002) to calculate these conditions. Figure 6 shows the fire behavior potential map for the analysis area given ninetieth percentile weather data. That is to say the weather conditions existing on the eighteen most severe fire weather days in each season for the ten-year period were averaged together to provide the weather data for this calculation. It is a reasonable assumption that similar conditions may exist for at least eighteen days of the fire season during an average year. In fact, during extreme years such as 2000 and 2002, such conditions may exist for significantly longer periods.

Weather conditions are extremely variable and not all combinations are accounted for. These outputs are best used for pre-planning and not as a stand-alone product for tactical operations. This model can be combined with the WHR and values-at-risk information to generate current and future “areas of concern”, which are useful in the prioritizing of mitigation actions. It is recommended, that when this information is used for tactical operations, fire behavior calculations be done with actual weather observations during the fire event. For greatest accuracy, the most current Energy Release Component (ERC) values should be calculated and distributed during the fire season to be used as a guideline for fire behavior potential. For a more complete discussion of the fire behavior potential methodology, please see **Appendix A**.

Figure 8: Fire Behavior Potential (Average Weather Conditions)

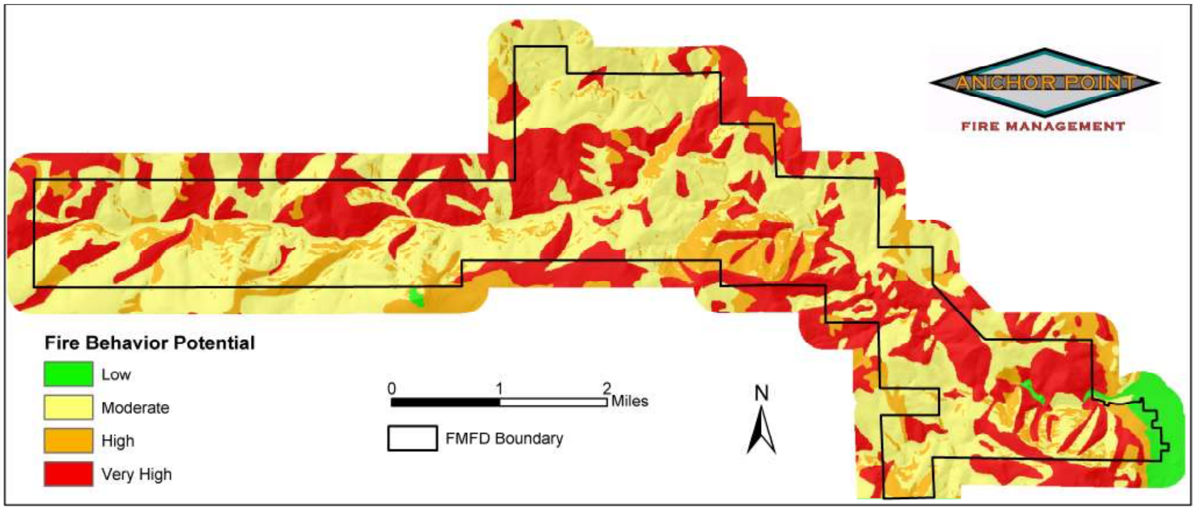
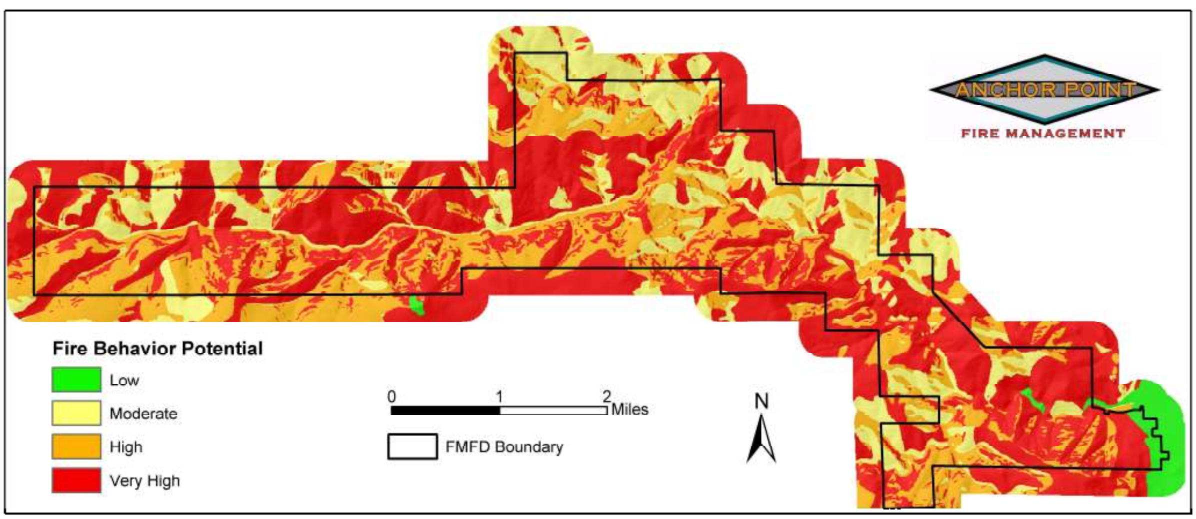


Figure 9: Fire Behavior Potential (Extreme Weather Conditions)



SOLUTIONS AND MITIGATION

Establishing and Prioritizing Fire Management Units (FMUs)

An efficient method for prioritizing work efforts is to create FMUs. These units reflect a particular function, like developing an effective public outreach program, or a geographic treatment area, such as an area with related fuel reduction projects. FMUs are created prior to initiating management projects and mitigation activities. Unique activities and objectives are recommended for each unit. These solutions are designed to serve as proposed outlines for projects. They are presented as a starting point for communities to determine the priority and scope of the final project implementation. Local land and fire management agencies, with the input of the citizen's advisory council or fire safe council, must determine the final solutions.

The following FMUs have been identified for the FMFPD; recommendations are provided for each. FMUs are **not** ranked by priority, however priority recommendations have been provided for specific tactical mitigation actions where appropriate within FMUs.

- Evacuation Routes, Safety Zones, and Addressing FMU
- Public Education FMU
- Local Preparedness and Firefighting Capabilities FMU
- Home Mitigation FMU
- Fuels Modification Projects FMU
- Water Supply FMU

Addressing, Evacuation Routes and Shelter-in-Place FMU

Addressing

One difficulty with rapid response in this area is inconsistent street signage and addressing of properties. In an area like Four Mile with its labyrinthine mountain roads and driveways, proper reflective signage is critical to effective response. The time saved, especially at night and in difficult conditions, is not to be underestimated. Knowing at a glance the difference between a road and a driveway (and which houses are on the driveway) cuts down on errors and time wasted interpreting maps. This is especially true for volunteer operators who do not have the opportunity to train on access issues as often as career departments.

In the Logan Mill neighborhood symbols referenced to fire department maps have been used to indicate major junctions. While this is a great backup system, it should not be considered a replacement for proper street signage and addressing. The symbols require the operator to either memorize their meanings or constantly refer back to the map. This system is not as intuitive as street names and address numbers. It is also unlikely that citizens calling in directions to an ignition will be familiar with the symbols. Recommendations for address markers can be found in **Appendix D**.

In the Four Mile Emergency Response Guide there is a set of maps covering some of the more challenging areas of the district. On these maps some turnarounds for trucks are indicated. Along with the GIS package for this project a new set of maps is being generated. It is our recommendation that these maps be used to locate areas where turnarounds are not possible or other access safety issues are present. These hazards should be indicated on the map set used in all apparatus and incorporated into future updates of the map set printing.

In some areas of the district, such as lower Four Mile Canyon and Wallstreet, there are many untested bridges apparatus must cross to access structures. FMFD has a partial database of bridges that have been deemed safe for access based on their use by propane trucks. Where bridges are known to be safe for apparatus, and where they are known not to be, markings should be provided. This should be done both on the bridge itself and in the map set. Considering the serious consequences of a bridge failure, it would be advisable to investigate the possibility of obtaining a grant to test, mark, and record all of the bridges in the district.

Evacuation Routes

Four Mile Canyon Drive and Gold Run Road are the major transportation corridors in the study area. Highway 119, Sugarloaf Road and Sunshine Canyon Drive are major arteries that could also be useful for access and evacuation. Five roads have been identified that would be good evacuation routes connecting communities with these major roads. In dry conditions these routes are passable by two-wheel drive vehicles with reasonable clearance. They may become impassable or require four-wheel drive when wet or snowy. The routes are represented graphically by **Figures 10-15**.

1. **Poorman Road**: Poorman Road connects with Sunshine Canyon Drive about two miles north of the district boundary.
2. **Camino Bosque**: Camino Bosque connects with Sunshine Canyon Drive by continuing on private land past the gate.
3. **North Switzerland Trail**: This portion of the Switzerland Trail connects Sunset with Gold Hill Road (an extension of Sunshine Canyon Drive) three miles west of the town of Gold Hill.
4. **South Switzerland Trail**: This portion of the Switzerland Trail connects Sunset to Highway 119.
5. **Logan Mill**: This escape route runs south out of Logan Mill and connects with Sugarloaf Road via the Arkansas Mountain Road.

Figure 10: Evacuation Routes Overview

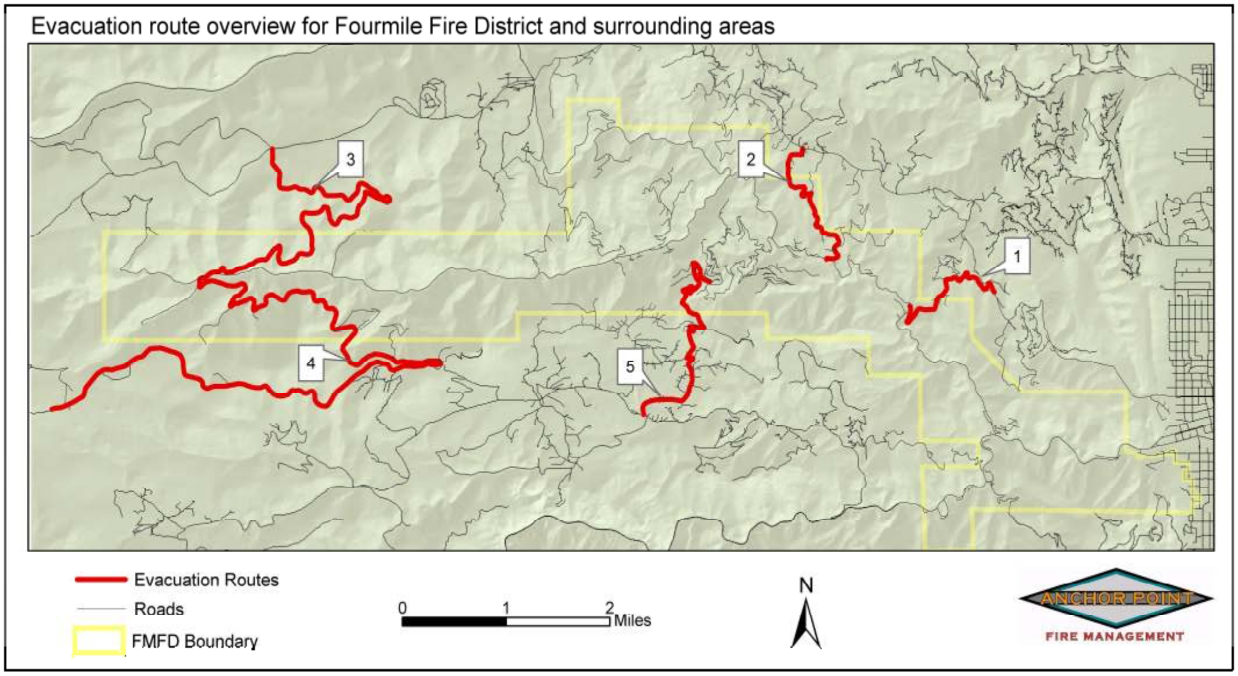


Figure 11

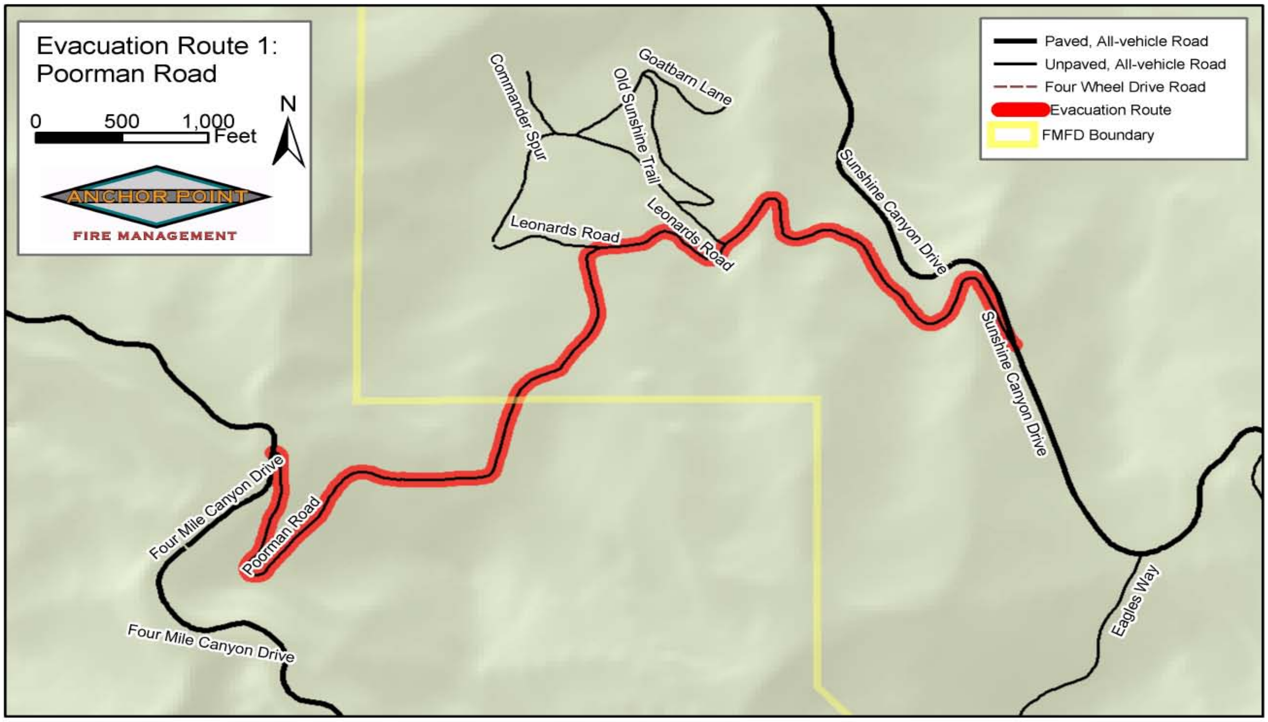


Figure 12

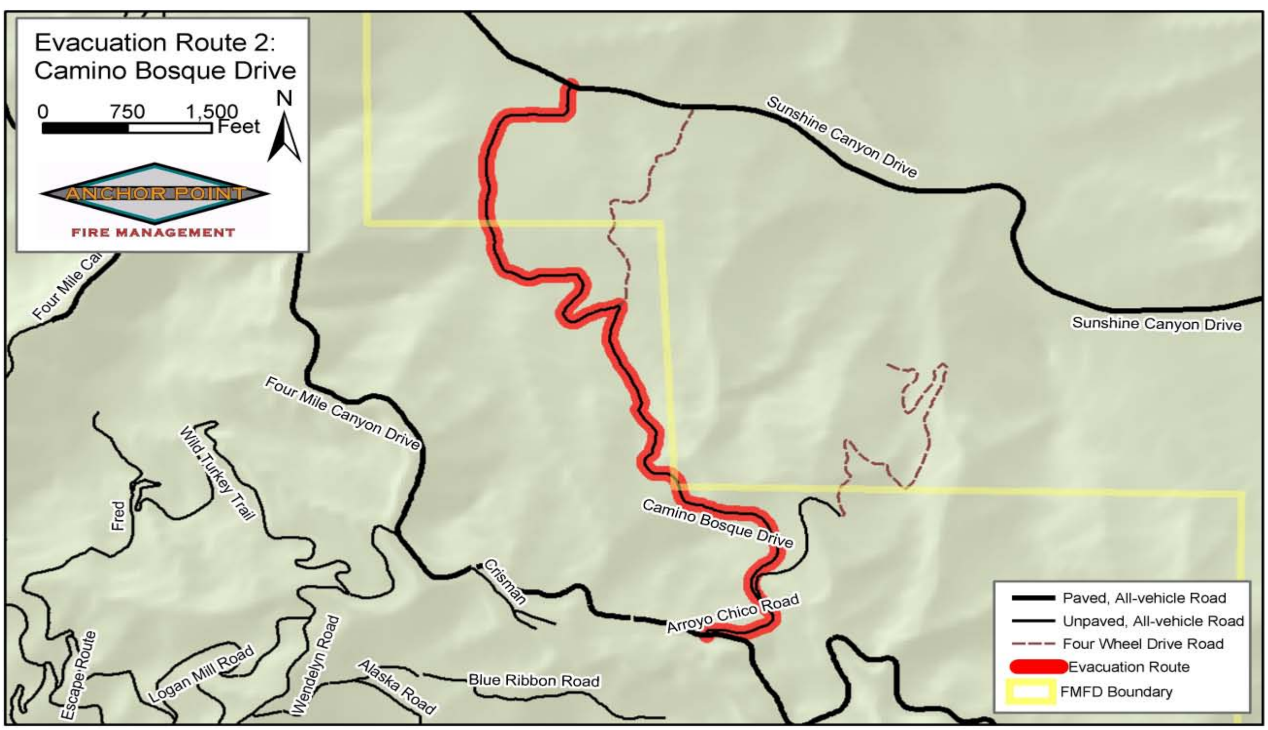


Figure 13

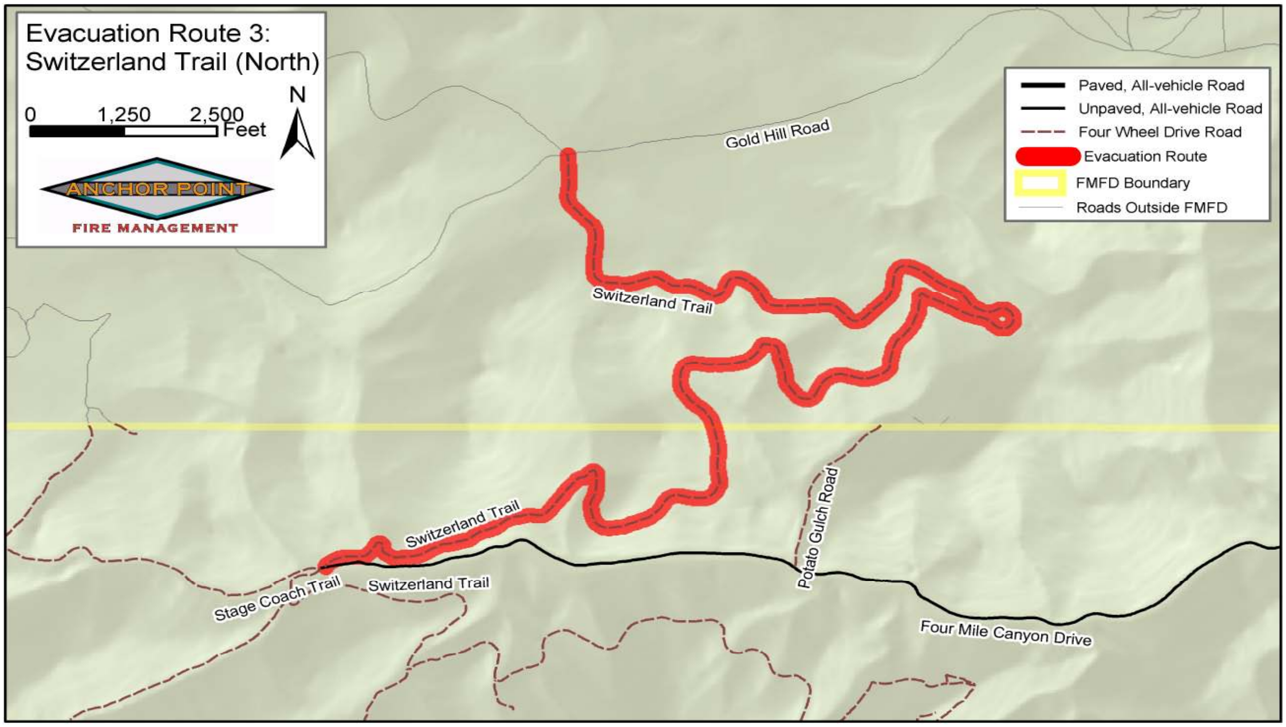


Figure 14

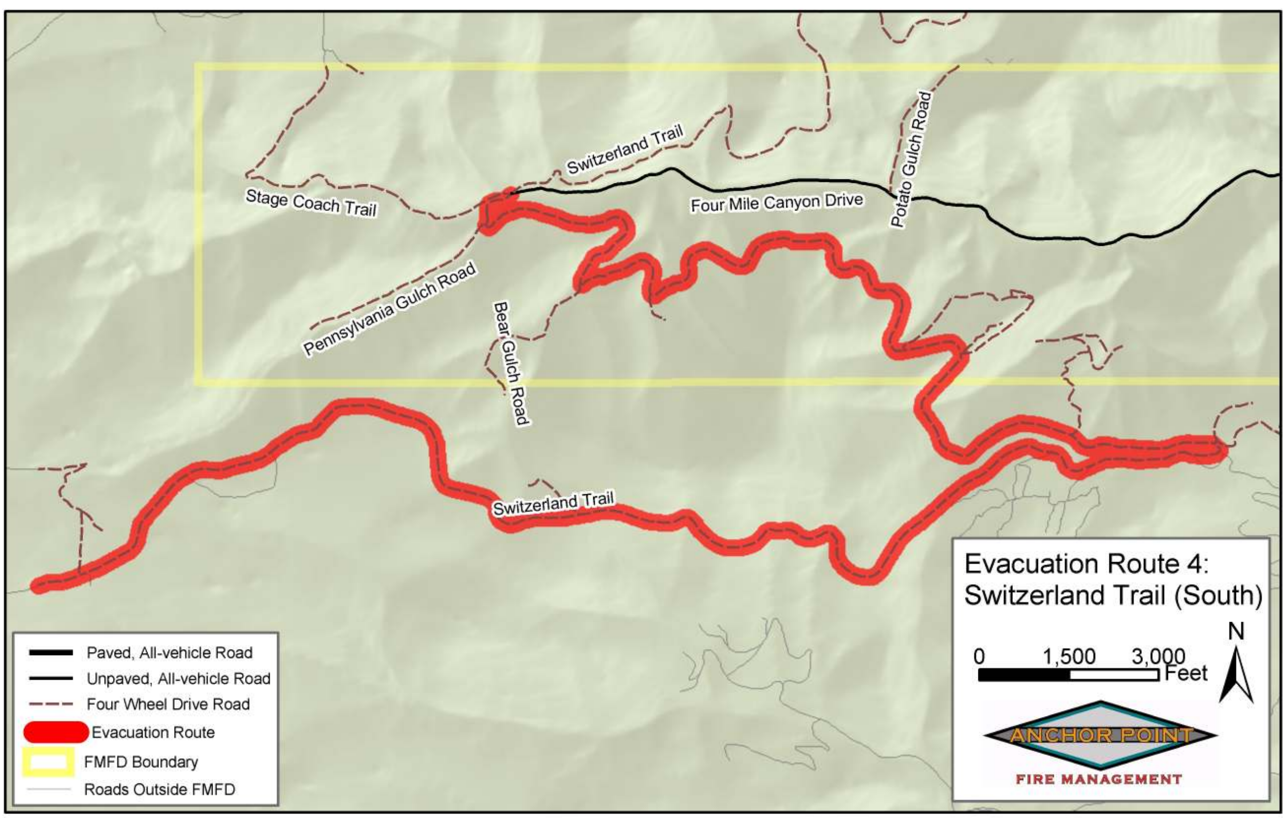
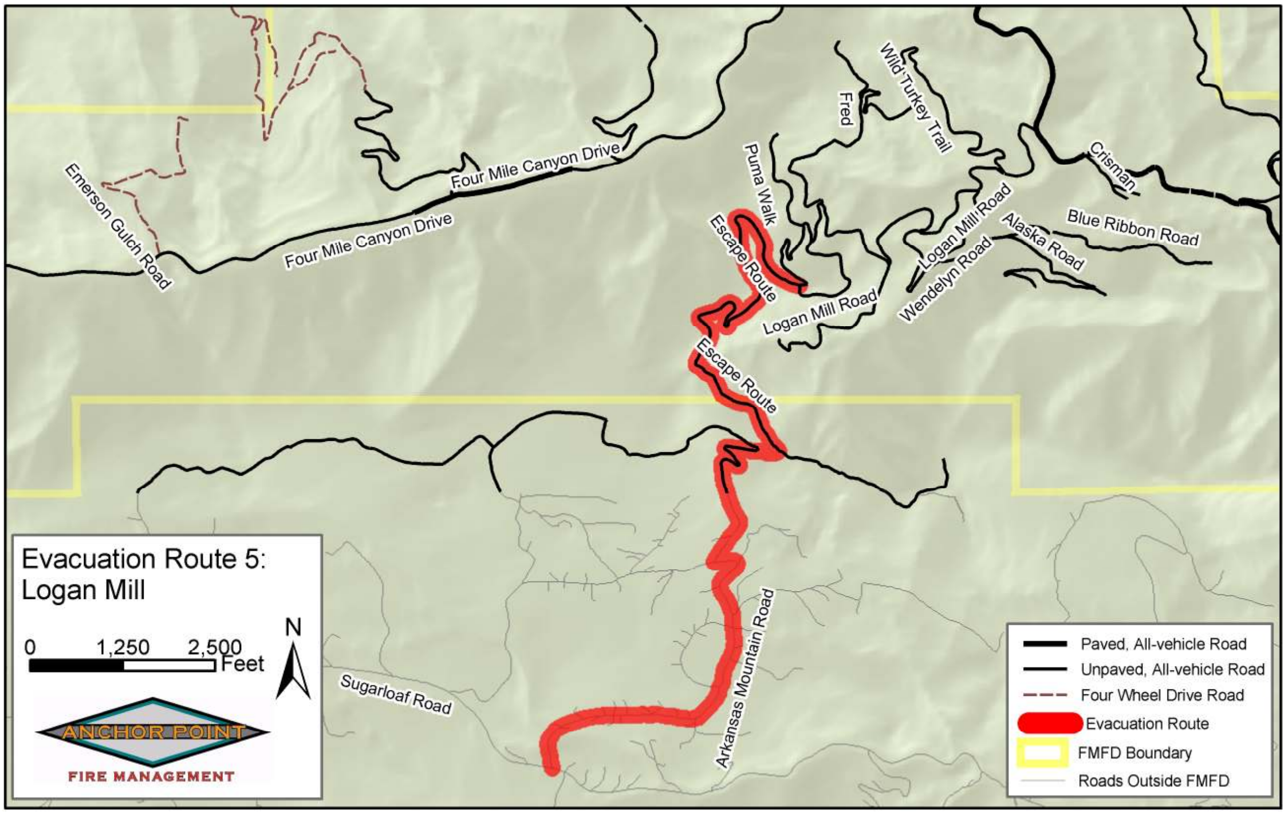


Figure 15



Evacuation Route 5:
Logan Mill
0
1,250
2,500
Feet
N
ANCHOR POINT
FIRE MANAGEMENT
Paved, All-vehicle Road
Unpaved, All-vehicle Road
Four Wheel Drive Road
Evacuation Route
FMFD Boundary
Roads Outside FMFD
Four Mile Canyon Drive
Four Mile Canyon Drive
Emerson Gulch Road
Puma Walk
Fred
Wild Turkey Trail
Crisman
Blue Ribbon Road
Alaska Road
Logan Mill Road
Wendelyn Road
Logan Mill Road
Escape Route
Escape Route
Arkansas Mountain Road
Sugarloaf Road

ACCESS ROUTE FUELS MODIFICATION RECOMMENDATIONS

In addition to developing these additional escape routes, a fuel modification project for primary access corridors should be implemented. Four Mile Canyon Drive and Gold Run Road constitute the primary transportation corridors through the district. In general, these roads have adequate openings. However, many of the communities in the study area would benefit from fuels reduction along their principal access routes.

Thinning along primary access roads into communities should include an area of at least 100' on either side of the centerline of the access routes, where practical. This distance should be modified to account for increased slope and other topographic features that increase fire intensity (see **Table 4**). This is especially important in communities with steep, narrow roads and few turnouts. In these areas, safer access for firefighters would make an impact on the number of structures that could be defended in a wildfire. Existing and natural barriers to fire should be incorporated into the project dimensions.

Table 4: Recommended Treatment Distances For Mid-Slope Roads

% Slope	Distance Above Road	Distance Below Road
30	70 feet	145 feet
35	65 feet	153 feet
40	60 feet	160 feet
45	55 feet	168 feet
50	50 feet	175 feet

The communities that should be considered highest priority for fuels reduction along access corridors include:

- Rim Road
- Logan Mill
- Melvina Hill
- Emerson Gulch
- Some of the multi-home driveways in Camino Bosque

In addition to the escape routes suggested on page 21, other possibilities should be defined and similar fuels reduction projects employed. If other routes exist, consider preplanning the use of one primary access for mutual aid agencies and one primary escape route for citizens.

The cooperation of adjacent, contiguous landowners should be secured. If this is not possible, more intensive thinning may need to occur within the road easement. Landowner participation allows the project to be more flexible in selecting trees for removal. It allows greater consideration for the elements of visual screening and aesthetics. Enlarging the project dimensions allows more options for tree selection while still protecting the access/egress corridor.

- Elements of the fuels modification space for access and egress routes should include:
    - Tree crown separation of at least 10' with groups of trees and shrubs interspersed as desired.
    - Tree crown separation greater than 10' may be required to isolate adjacent groups or clumps of trees.
    - Limb all remaining trees to a height of 8' or 1/3 of the tree height (whichever is greater).
    - Clean up ground fuel within the project area.
    - Post placards clearly marking "fire escape route". This will provide functional assistance during an evacuation and communicate a constant reminder of wildfire to the community. Be sure to mount signage on non-combustible poles.

OTHER ACCESS ROUTE RECOMMENDATIONS

- In order to reduce conflicts between evacuating citizens and incoming responders, it is desirable to have nearby evacuation centers for citizens and staging areas for fire resources. Evacuation centers should include heated buildings with facilities large enough to handle the population. Schools and churches are usually ideal for this purpose. Fire staging areas should contain large safety zones, a good view in the direction of the fire, easy access and turnarounds for large apparatus, a significant fuel break between the fire and the escape route, topography conducive to radio communications, and access to water. Local responders are encouraged to preplan the use of potential staging areas with property owners.

- Identify and pre-plan alternate escape routes and staging areas.

- Perform response drills to determine the timing and effectiveness of fire resource staging areas.

- Educate citizens on the proper escape routes, and evacuation centers to use in the event of an evacuation.

- Utilize a reverse 911 system or call lists to warn residents when an evacuation may be necessary. Notification should also be carried out by local television and radio stations. Any existing disaster notification systems, such as tornado warnings, should be expanded to include wildfire notifications.

- Emergency management personnel should be included in the development of preplans for citizen evacuation.

Shelter-in-Place

The communities of Emerson Gulch, Rim Road, Melvina Hill, Logan Mill, Camino Bosque, Arroyo Chico, and the portion of the Red Lion Area north of Highway 119 could be easily cut off by ignitions in drainages below homes. In addition to improved access/egress, consideration should be given to developing “shelter-in-place” areas designed as alternatives to evacuation through hazardous areas.

There are several ways of protecting the public from an advancing wildfire. One of these methods, evacuation, involves relocation of the threatened population to a safer area. Another method is to instruct people to remain inside their homes or public buildings until the danger passes. This concept is new to wildfire in the United States, but not to hazardous materials incident response where time, hazards, and sheer logistics often make evacuation impossible. This concept is the dominant modality for public protection from wildfires in Australia where fast moving, non-persistent fires in light fuels make evacuation impractical. The success of this tactic depends on a detailed preplan that takes into account the construction type and materials of the building used, topography, depth and type of the fuel profile, as well as current and expected weather and fire behavior.

Shelter–in-place should only be considered when the structure is determined to be "stand alone" in structural triage terms. In order to be considered as suitable as a stand alone structure, homes need to be of ignition resistant construction and have defensible space. Depending on the fuel type and fuel bed depth, it may be necessary to continue treatment beyond the minimum recommended defensible space boundaries in order to make the home stand alone. For a list of defensible space recommendations please see the "General Recommendations" section of Appendix B.

Ignition resistant construction is also necessary for shelter-in-place tactics. Wooden roofs and old structures with untreated wooden sidings are particularly hazardous and should not be considered. It is preferable to have metal or asphalt roofs and ignition resistant materials such as stucco or concrete, especially close to the ground. Heavy timber constructions, such as log homes, are also resistant to surface fires. When combined with a metal, or some other ignition resistant type roof, heavy timber may be acceptable. Eaves should be enclosed. Any holes in the foundation, siding, or eves should be covered to prevent embers from entering.

Threats to residents remaining in structures include heat, smoke, and ignition of the structure itself. Several steps can be taken by residents to mitigate the effects of heat exposure. The following list highlights some of the important concepts:

- If there is adequate time and water, consider plugging downspouts and filling any gutters with water. The sand bags mountain residents commonly have are good for this purpose.
- If a sprinkler that will reach the roof is available, it should be set up so it covers as much of the roof as possible, paying particular attention to the direction from which the fire is approaching.
- Fill all of the tubs and sinks, and any buckets that are easily handled, with water.
- Remove any lightweight or highly flammable window coverings. Heavy drapes or blinds should be closed in case the windows break.
- Move furniture away from windows, and be sure to remove flammables, such as gasoline and propane, to a safe distance away from the structure. Tanks containing propane or other volatile compressed gas may rocket as high as ½ mile, so they are best removed to an area cleared of fuels, such as a concrete driveway or pad.
- Wear clothes of fire resistant natural fibers such as wool or cotton. Be sure to cover as much exposed skin as possible, and keep water with you for personal protection.

- o When the fire arrives, retreat to the room in the house farthest away from the flaming front.
- o Take drinking water with you and drink often to avoid dehydration.
- o Even if it becomes uncomfortably hot and smoky do not run outside while the fire is passing.

Fires consume oxygen and produce toxic gasses and smoke. Many studies have been performed in the hazardous materials field on the infiltration of toxic gasses into structures. Average homes under average weather conditions may experience indoor concentrations of smoke and contaminants of 45 to 65 percent of the outdoor concentrations in 30 minutes. In two hours the concentrations may reach 60 to 65 percent of the outdoor levels.[1] These numbers are for homes with all doors and windows closed and ventilation systems turned off. Buildings with open windows, doors, or operating ventilation systems will experience contamination levels close to the outdoor levels in minutes. Residents can further slow contamination by blocking gaps around doors and windows with wet towels.

After the fire has passed, the main danger to residents is the home igniting from embers and sparks that entered during the flame front passage. Systematically patrol inside and outside looking for embers and spot fires. Be sure to include attics and other roof spaces. Houses may catch fire several hours after the fire has passed if embers are not found and extinguished. For more information on structural triage and preparation please see **Appendix C**. For more information on shelter-in-place tactics please see the following articles and websites:

- Wildland Fire Management NFPA Journal Jan/Feb 2005
  http://findarticles.com/p/articles/mi_qa3737/is_200501/ai_n9482983
- NFPA Wildland Section News (Wildfire News and Notes-December 2004
  http://216.70.126.67/library/?p=165
- Red Cross Shelter-in-Place Fact Sheet
  http://www.redcross.org/services/disaster/beprepared/shelterinplace.pdf

[1] FEMA, *Handbook of Chemical Hazard Analysis Procedures, Washington D.C. 1990*

Public Education Efforts FMU

The area around Boulder is experiencing continuing development. Spiraling property values and a limited number of building sites have resulted in recently constructed high-value residences mixed in with older seasonal cabins, rental properties and historic buildings in various states of decay. There is likely to be a varied understanding among property owners of the intrinsic hazards associated with building in these areas. An approach to wildfire education that emphasizes safety and hazard mitigation on an individual property level should be undertaken, in addition to community and emergency services efforts at risk reduction. Combining community values such as quality of life, property values, ecosystem protection and wildlife habitat preservation with the hazard reduction message will increase the receptiveness of the public.

RECOMMENDATIONS

- Visit these web sites for a list of public education materials, and for general homeowner education:
  - http://www.nwcg.gov/pms/pubs/pubs.htm
  - http://www.firewise.org
  - http://www.colostate.edu/Depts/CSFS/fire/interface.html
  - http://www.fourmilefire.org

- Provide citizens with the findings of this study including:
  - Levels of risk and hazard
  - Values of fuels reduction programs
  - Consequences and results of inaction for ignitions within the community

- Create a Wildland Urban Interface (WUI) citizen advisory council to provide peer level communications for the community. Too often, government agency advice can be construed as self-serving. Consequently, there is poor internalization of information by the citizens. The council should be used to:
  - Bring the concerns of the residents to the prioritization of mitigation actions
  - Select demonstration sites
  - Assist with grant applications and awards

Local Preparedness and Firefighting Capabilities

The Four Mile Fire Department (FMFD) provides suppression services for the study area. The district has four fire stations: Lodge, Logan, Salina, and Wall Street. Mutual aid is available from the Gold Hill, Sunshine, Boulder Rural, Sugar Loaf, Cherryvale, and Boulder fire districts. FMFD maintains two type-two CAFS engines, one type-two engine, three water tenders (2,200, 1,500, and 1,000 gallons) and one type-six engine.

FMFD adheres to the National Wildfire Coordinating Group (NWCG) curriculum for training. Of FMFD's 33 members, 20 are firefighters with NWCG S-130/190 training (basic Wildland fire fighting and weather). Approximately 8 firefighters are qualified at the Crew Boss/Engine Boss level or higher.

RECOMMENDATIONS

- Provide continuing education for all firefighters including:
    - NWCG S-130/190 for all department members
    - Annual wildland fire refresher and "pack testing" (physical standards test)
    - S-215 Fire Operations in the Urban Interface
    - S-290 Intermediate Fire Behavior
    - I-200 and I-300 – Basic and Intermediate ICS
- Equipment:
    - Provide minimum wildland Personal Protective Equipment (PPE) for all firefighters.
        - (See NFPA Standard 1977 for requirements).
    - Provide gear bags for both wildland and bunker gear to be placed on engines responding to fire calls. This will help ensure that firefighters have both bunker gear and wildland PPE available when the fire situation changes.
    - Provide and maintain a ten-person wildland fire cache in addition to the tools on the apparatus. The contents of the cache should be sufficient to outfit two squads for hand line construction and direct fire attack. Recommended equipment would include:
        - Four cutting tools such as pulaskis or super pulaskis
        - Six scraping tools such as shovels or combis
        - Four smothering tools such as flappers
        - Four backpack pumps with spare parts
        - Two complete sawyer's kits including chainsaw, gas, oil, sigs, chaps, sawyer's hard hat, ear protection, files, file guides, spare chains and a spare parts kit
        - MREs and water cubies sufficient for 48 hours
- Communications:
    - Surveys of FMFD officers revealed three areas where radio communications are poor or nonexistent:
        - Near the tunnels in Boulder Canyon

- Four Mile Canyon Road between Poorman Road and the Lodge Station (approximately 1000-1900 Four Mile Canyon Road)
- Four Mile Canyon Road west of the Wallstreet Station

Due to the restrictions of terrain, it is unlikely that more powerful base stations or portable radios would make any impact on this problem. Some areas might see slight improvements in base station reception by increasing the height of the base station antenna above average terrain. However, the best solution is to increase the number of repeaters in the district. If landowners are a barrier to fixed repeater sites, another solution is to construct one or more mobile repeaters in engines or command vehicles. Mobile repeaters allow the vehicle to be positioned for optimum communication for each incident. Repeaters are expensive, but considering the fact that cell phone communications are non-existent in most of the study area, grants and other sources of funding should be pursued in order to solve this critical operational problem. If it is not possible to obtain a repeater frequency, which is likely, satellite phones may be a reasonable solution for emergency-only communications.

Home Mitigation FMU

Community responsibility for self-protection from wildfire is essential. Educating homeowners is the first step in promoting shared responsibility. Part of the educational process is defining the hazard and risks both at the mid-level and parcel level.

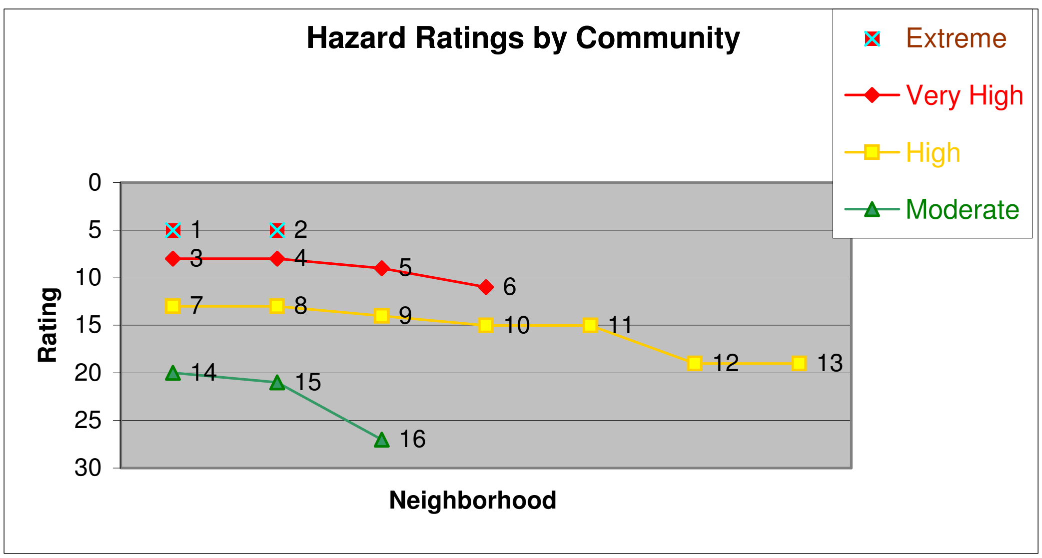
The mid-level assessment has identified six of the sixteen communities in the study area to be at extreme or very high risk. There is a likelihood of rapid fire growth and spread in these areas due to steep topography, fast burning or flashy fuel components and other topographic features that contribute to channeling winds and promotion of extreme fire behavior.

Table 5 illustrates the relative hazard rankings for communities in the study area.

- A rating of 5 or less indicates an area of extreme hazard.
- A rating of 6 to 10 indicates a very high hazard.
- A rating of 11 to 19 indicates high hazard.
- A rating of 20 or greater indicates moderate hazard.

The communities with extreme and very high hazard ratings should be considered an FMU where a parcel level analysis should be implemented as soon as possible. Please see Appendix B for more detailed information.

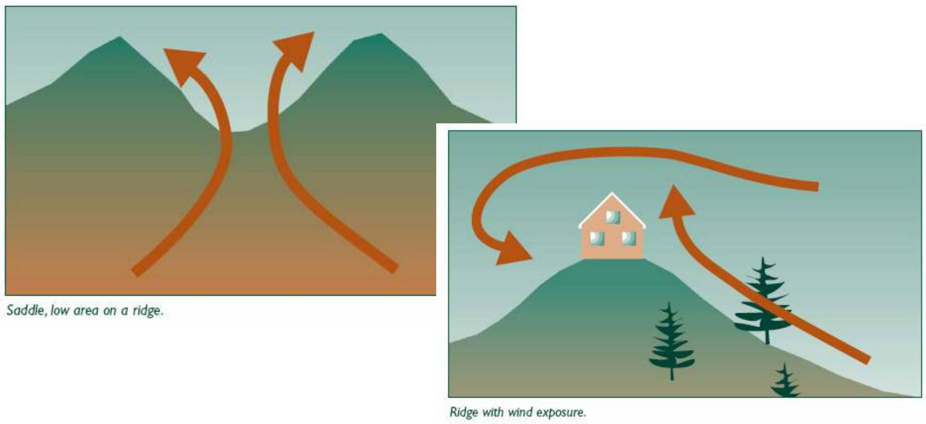
Table 5



1. Rim Road Area	**9. Lower Four Mile Canyon**
2. Logan Mill	**10. Melvina Hill**
3. Wallstreet	**11. Canon Park**
4. Summerville	**12. Salina**
5. Emerson Gulch	**13. Canyonside**
6. Arroyo Chico	**14. Red Lion Area**
7. Sunset	**15. Crisman**
8. Camino Bosque	**16. Poorman**

The most important element for the improvement of life safety and property preservation is for every home in the study area to have compliant, effective defensible space. This is especially important for homes with wood roofs and homes located on steep slopes, in chimneys, saddles, or near any other topographic feature that contributes to fire intensity.

Figure 16. Saddle & Ridge Top Development [9]

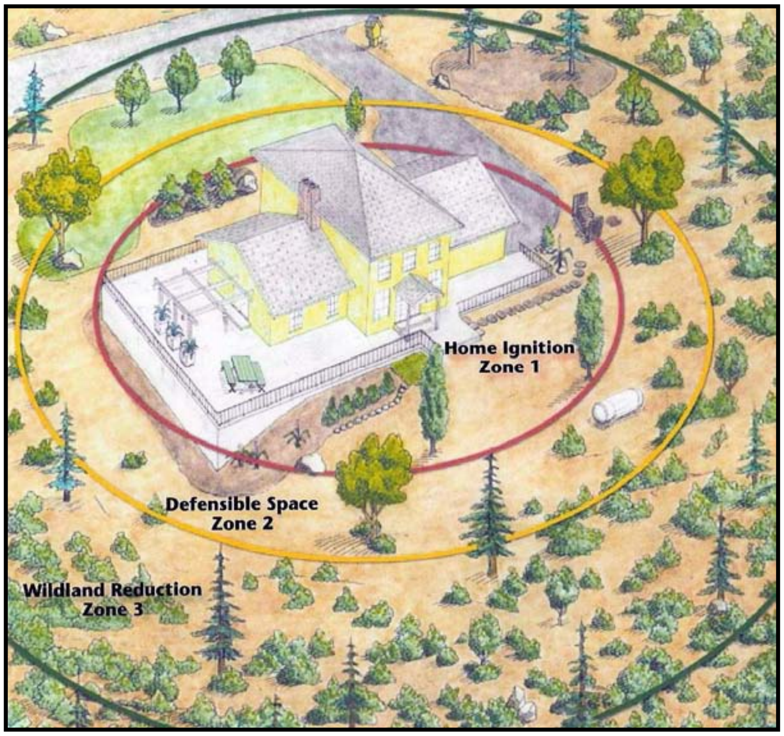


An aggressive program of evaluating and implementing defensible space for homes will do more to limit fire-related property damage than any other single recommendation in this report.

There is no question that any type of dense/flammable vegetation should be removed from around a home in order to reduce the risk of structural ignition during a wildfire. The better question is: how much to remove? The basic rule is to eliminate all flammable materials (fire-prone vegetation, wood stacks, wood decking, patio furniture, umbrellas, etc.) from within 30 feet of the home. For structures near wildland open space, an additional 70 feet should be modified in such a way as to remove all dead wood from shrubbery, thin and trim trees and shrubs into "umbrella" like forms (lower limbs removed), and prevent the growth of weedy grasses. Steep slopes and/or the presence of dangerous topographic features as described above may require the defensible space distances to be increased.

[9] *FireWise Construction*, Peter Slack, Boulder Colorado

Figure 17: Defensible Space Zones [10]



The term "clearance" leads some people to believe all vegetation must be removed down to bare soil. This is not the case. Removing all vegetation unnecessarily compromises large amounts of forested terrain, increases erosion, and will encourage the growth of weeds in the now disturbed soil. These weeds are considered "flashy fuels," which actually increase fire risk because they ignite so easily.

Defensible space must be ecologically sound, aesthetically pleasing and relatively easy to maintain. Only then will the non-prescriptive use of fuels reduction around homes become commonplace.

RECOMMENDATIONS

- Conduct a parcel level wildfire hazard analysis for the homes in the study area. Starting with homes in communities rated as extreme, very high and high will ensure that the most critical homes are evaluated first. Completing this process will facilitate the following important fire management practices.
  - Establish a baseline hazard assessment for homes in these communities
  - Educate the community through the presentation of the parcel-level hazard-risk analysis at neighborhood public meetings
  - Identify defensible space needs and other effective mitigation techniques
  - Home inspection for likely areas of ember intrusion and collection

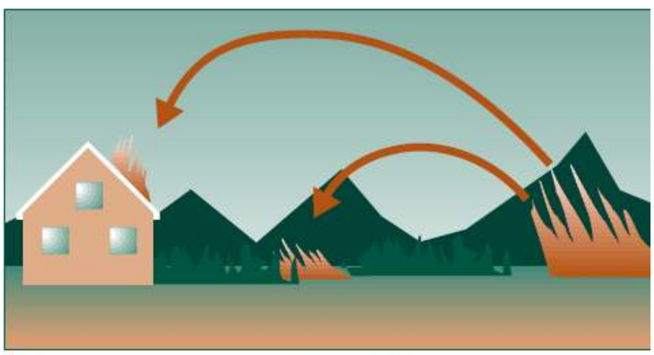
[10] *A Homeowner's Guide to Fire Safe Landscaping*(2005) www.FireSafeCouncil.org

- Identification and facilitation of "cross-boundary" and “cross-lot” projects
- Home inspection for likely areas of ember intrusion and collection

- Improve access roads and turnarounds on driveways to create safer access for firefighting resources. (See *Four Mile FPD Emergency Access and Water Supply* **Appendix D**.)
- Eliminate the use of cedar shakes or other flammable materials for roofs and sidings.
- Add reflective address signs at each driveway entrance to all homes (**See Appendix D** for recommendations.)
- Encourage and or mandate the use of ignition resistant construction for all re-modeled and new construction.

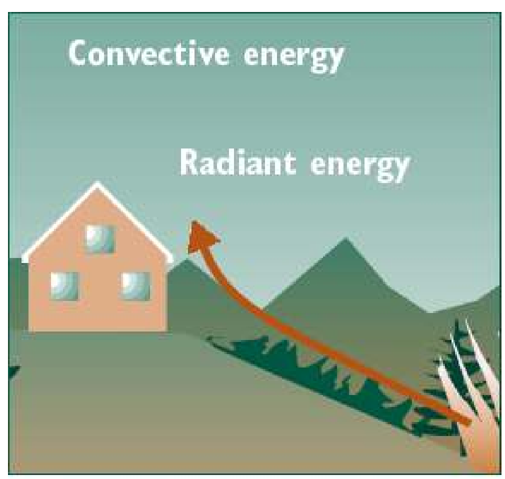
As stated above, the most effective wildfire mitigation technique for property conservation will be the widespread utilization of defensible space in combination with ignition resistant construction. Until appropriate construction can be retrofitted on existing homes, defensible space will at least reduce radiant heat energy (see **Figure 19**) and therefore structure ignition from direct flame contact or radiant heat. Firebrand generation (see **Figure 18**) will need to be mitigated by a very refined inspection of each structure for any openings or areas of likely ember collection. These areas should be identified and mitigated as part of every defensible space inspection.[11]

Figure 18. Firebrands



Firebrands, transported by convective lifting, create spot fires.

Figure 19. Convective & Radiant Energy



Convective and radiant energy from a fire.

[11] *FireWise Construction*, Peter Slack, Boulder, Colorado

Fuels Modification Projects FMU

Introduction

One of the most effective forms of landscape scale fuels modification is the fuelbreak (sometimes referred to as "shaded fuelbreak"). A fuelbreak is an easily accessible strip of land of varying width, depending on fuel and terrain, in which fuel density is reduced, thus improving fire control opportunities. Vegetation is thinned, removing diseased, fire-weakened, and most standing dead trees. Thinning should select for the more fire resistant species. Ladder fuels, such as low limbs and heavy regeneration, are removed from the remaining stand. Brush, dead and down materials, logging slash, and other heavy ground fuels, are removed and disposed of to create an open park-like appearance. The use of fuelbreaks under normal burning conditions can limit the uncontrolled spread of fires and aid firefighters in slowing the spread rate. Under extreme burning conditions, where spotting occurs for miles ahead of the main fire, and probability of ignition is high, even the best fuelbreaks are not effective. That said, fuelbreaks have proven to be effective in limiting the spread of crown fires in Colorado.[12] Factors to be considered when determining the need for fuelbreaks in mountain subdivisions include:

- The presence and density of hazardous fuels
- Slope
- Other hazardous topographic features
- Crowning potential
- Ignition sources

With the exception of Aspen, all of Colorado's major timber types represent a significant risk of wildfire. Increasing slope causes fires to move from the surface fuels to crowns more easily, due to preheating. A slope of 30% causes the fire-spread rate to double when compared to the fire-spread rate (with the same fuels and conditions) on flat ground. Chimneys, saddles, and deep ravines are all known to accelerate fire spread and influence intensity. Communities with homes located on or above such features as well as homes located on summits and ridge tops would be good candidates for fuel breaks. Crown fire activity values for Four Mile were generated by the FlamMap model and classified into four standard ranges. In areas where independent and dependent crown fire activity is likely to exist, fuelbreaks should be considered. If there are known likely ignition sources (such as railroads and recreation areas that allow campfires) present in areas where there is a threat of fire being channeled into communities, fuelbreaks should be considered.

Fuelbreaks should always be connected to a good anchor point like a rock outcropping, river, lake, or road. The classic location for fuelbreaks is along the tops of ridges, in order to stop fires from backing down the other side or spotting into the next drainage. This is not always practical from a WUI standpoint, because the structures firefighters are trying to protect are usually located at the tops of ridges or mid-slope. Mid-slope positioning is considered the least desirable for fuelbreaks, but it may be easiest to achieve as an extension of defensible space work or of existing roads and escape routes. One tactic would be to create fuelbreaks on slopes below homes located mid-slope and on ridge tops, so that the area of continuous fuels between the defensible space of homes and the fuelbreak is less than ten acres. Another commonly employed tactic is to position fuelbreaks

[12] Frank C. Dennis, "Fuelbreak Guidelines for Forested Subdivisions" (Colorado State Forest Service, Colorado State University, 1983), p. 3.

along the bottom of slopes. Due to the topographic nature of Four Mile Canyon, this already exists in the form of clearings around the major access roads. It would make sense to locate fuelbreaks mid-slope below homes to break the continuity of fuels into the smaller units mentioned above. Even though this position is considered the least desirable from a fire suppression point of view, it would be the most effective approach in much of the study area.

Fuelbreaks are often easiest to locate along existing roadbeds (see the description of the fuels modification project for primary access corridors on page 26 of this report). The minimum recommended fuelbreak width is usually 200 feet. As spread rate and intensity increases with slope angle, the size of the fuelbreak should also be increased, with an emphasis on the downhill side of the roadbed or centerline employed. The formulas for slope angles of 30% and greater are as follows: below road distance = 100' + (1.5 x slope %), above road distance = 100' – slope % (see Table 3). Fuelbreaks that pass through hazardous topographic features should have these distances increased by 50%.[13] Since fuelbreaks can have an undesirable effect on the esthetics of the area, crown separation should be emphasized over stand density levels. In other words, isolating groupings rather than cutting for precise stem spacing will help to mitigate the visual impact of the fuelbreak.

In *Appendix B* we noted that some communities have done mitigation work and not removed the resulting debris. It is important to note that in Colorado's dry climate slash decomposes very slowly. One consequence of failing to remove slash is to add to the surface fuel loading, perhaps making the area more hazardous than before treatment. It is imperative that all materials be disposed of by piling and burning, chipping, physical removal from the area, or lopping and scattering. Of all of these methods lopping and scattering is the cheapest. However, it is also the least effective, since it adds to the surface fuel load.

It is also important to note that fuelbreaks must be maintained to be effective. Thinning usually accelerates the process of regenerative growth. The effectiveness of the fuelbreak may be lost in as little as three to four years if ladder fuels and regeneration are not controlled.

One of the most difficult issues in establishing and maintaining fuelbreaks is securing the cooperation and participation of landowners. Ownership maps of the area indicate that implementation of fuels reduction projects recommended here and in the *Escape Routes, Safety Zones, and Addressing FMU* section would require the approval of several public land management agencies as well as private landowners. These entities include the City of Boulder Open Space and Mountain Parks Department, the United States Forest Service, the Bureau of Land Management, and possibly others.

Existing and proposed cross-boundary projects

The Logan Mill Ranch Tree Farm completed an agricultural plan for 150 acres in the Logan Mill and Salina communities in 2005. This plan calls for two small fuelbreaks (3 acres each) and other treatments which could be useful when developing and implementing the final fuels reduction projects in these communities. Other agricultural plans exist in the Poorman and Arroyo Chico communities which should be consulted before fuels reduction projects are finalized for those communities.

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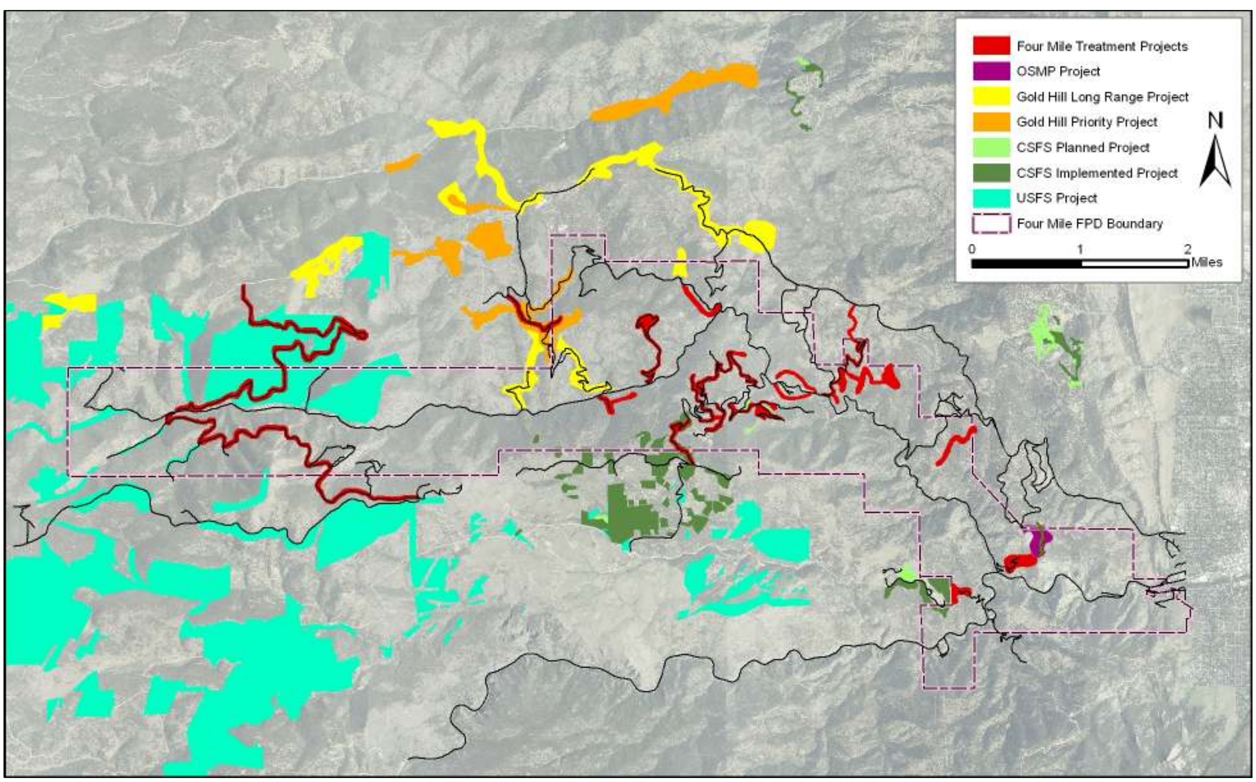
[13] Frank C. Dennis, "Fuelbreak Guidelines for Forested Subdivisions" (Colorado State Forest Service, Colorado State University, 1983), p. 11.

The Gold Hill Fire Department is in the final stages of completing a CWPP for their response area. Many of the treatments recommended in the Gold Hill plan extend into FMFPD or connect with treatments proposed in this document. Public land managers including CSFS, USFS, BLM and the City of Boulder Open Space and Mountain Parks Department (OSMP) also have existing and proposed treatments that extend into or have an impact on treatments recommended for FMFPD. A summary map of these projects is shown in **Figure 20**. The summary map shows the following treatment areas.

- Gold Hill priority and long-range treatments as described in the Gold Hill Fire Department CWPP
- USFS prescribed burns planned as part of their Environmental Assessment (EA)
- USFS mechanical fuels reduction treatments planned as part of their EA
- CSFS completed grant treatments from 2004-2006 (not all inclusive)
- CSFS currently planned treatments (not all inclusive)

Some, but not all of these projects are also shown in the detail maps of FMFPD recommended projects. Some of these other-agency projects have been omitted from the detail maps for the sake of intelligibility. For a complete discussion of the projects recommended in the Gold Hill CWPP please refer to the draft CWPP on the Gold Hill Fire Department website at http://goldhillfire.org/cwpp/.

Figure 20: Other agency projects in and adjacent to the study area



Proposed fuels reduction projects for FMFPD

The following recommendations are in addition to, not in place of, the fuels reductions mentioned in the *Escape Routes, Safety Zones and Addressing FMU*. It is important to note that the boundaries shown on the maps in this document are only approximate. Exact boundaries will be determined when treatment agreements are negotiated with the involved land owners and/or land managers.

RECOMMENDATIONS

A. **Wild Turkey Trail/Evening Star Road Treatment (Approximately 38 Acres). Priority level – High. (See Figure 23.)** This project focuses on limbing and thinning along Wild Turkey Trail and Evening Star Road from the intersection of Wild Turkey Trail and Logan Mill Road to the intersection of Evening Star Road and Logan Mill Road. Limbing and thinning should be continued from the intersection of Evening Star and Logan Mill south along Logan Mill to the dead end at 1310 Logan Mill and along Fred Road from the intersection with Wild Turkey Trail to the dead end at the driveway for 822 Fred Road. Thinning should be conducted to conform to the shaded fuelbreak guidelines described in the **Access Route Fuels Modification Recommendations** section. If combined with defensible spaces for all homes, this project will help protect a critical access route, as well as breaking the continuity of fuels in the hazardous Logan Mill Community.

B. **Alaska Road Treatment (Approximately 29 Acres). Priority level – High. (See Figure 23.)** This project focuses on limbing and thinning along Blue Ribbon Road and Alaska Road. Limbing and thinning should be continued along the unpaved 4WD road connecting the end of Alaska and Wendelyn Road with Logan Mill Road. Thinning should be conducted to conform to the shaded fuelbreak guidelines described in the **Access Route Fuels Modification Recommendations** section. If combined with defensible spaces for all homes, this project will help protect a critical access route, as well as breaking the continuity of fuels in Sunshine Gulch.

C. **Southwest Chrisman Fuelbreak (Approximately 9 Acres). Priority level - High. (See Figure 23.)** This project area is southwest of the Chrisman community and is anchored to Four Mile Canyon Road. Thinning to reduce ladder fuels and to interrupt the crown continuity of fuels is recommended for a distance of at least three times the flame lengths predicted by the extreme weather scenario fire behavior model. This project is designed to reduce fire intensity and improve defensible space for homes in the Chrisman community. This fuelbreak also serves to slow the spread of ignitions from Sunshine Gulch into Camino Bosque.

D. **Puma Walk/Escape Route Road Treatment (Approximately 17 Acres). Priority level – High. (See Figure 23.)**This project focuses on limbing and thinning along Puma Walk and the southern escape route from the dead end of Puma Walk in the north to the intersection of the escape route and Boulder Canyon (Hwy 119). Thinning should be conducted to conform to the shaded fuelbreak guidelines described in the **Access Route Fuels Modification Recommendations** section. If combined with defensible spaces for all homes, this project will help protect an important escape route, as well as providing a critical fuelbreak between the heavy fuels in the Arkansas Mountain area and the Logan Mill community.

E. **Alpine Gulch Fuelbreak (Approximately 15 Acres). Priority level – High. (See Figure 24.)** This project area is south of the Wallstreet community and is anchored to Four Mile Canyon Drive on both ends. Thinning to reduce ladder fuels and interrupt the crown continuity of fuels is recommended for a distance of at least three times the flame lengths predicted by the extreme weather scenario fire behavior model. This project is designed to reduce fire intensity and slow the spread of ignitions from Logan Mill and Alpine Gulch. This project is rated as high priority because the additive effect of slope and prevailing winds is likely to make defensible space alone inadequate to protect homes in Wallstreet.

F. **Melvina Hill Road Treatment (Approximately 35 Acres). Priority level – High. (See Figure 24.)** This project focuses on limbing and thinning along Melvina Hill Road. Limbing and thinning should be continued along the unpaved 4WD road east of Melvina Hill Road to provide a buffer to homes in Salina. Thinning should be conducted to conform to the shaded fuelbreak guidelines described in the **Access Route Fuels Modification Recommendations** section. If combined with defensible spaces for all homes, this project will help protect a critical access route, as well as breaking the continuity of fuels between Melvina Hill and Salina. This project is rated as high priority because it protects the only access into (or out of) the Melvina Hill community.

G. **Rim Road Treatment (Approximately 25 Acres). Priority level – High. (See Figure 24.)** This project focuses on limbing and thinning along Rim Road from the intersection with Dixon Road to the dead end at 508B Rim Road. Thinning should be conducted to conform to the shaded fuelbreak guidelines described in the **Access Route Fuels Modification Recommendations** section. If combined with defensible spaces for all homes this project will help protect the only access route into (and out of) the most hazardous community in the study area.

H. **Nancy Mine Road (Approximately 45 Acres). Priority level – High. (See Figure 24.)** This project connects the Rim Road treatment with the Alpine Gulch Treatment by limbing and thinning along the Nancy Mine Road. The Nancy Mine Road is a rough four-wheel-drive road that is not recommended for citizen evacuation, but could be used operationally by firefighters and could complete an east-west fuelbreak between Rim Road and Alpine Gulch. This project has also been identified in the Gold Hill CWPP.

I. **Canyonside Drive Road Treatment (Approximately 24 Acres). Priority level – High. (See Figure 21.)** This project focuses on limbing and thinning along Canyonside Drive and using the access thinning to link existing defensible spaces. Thinning should be conducted to conform to the shaded fuelbreak guidelines described in the **Access Route Fuels Modification Recommendations** section. If combined with defensible spaces for all homes this project will help protect the primary access route into (and out of) the Canyonside community. This project ties in with the Anemone Hill project proposed by OSMP.

J. **Salina Fuelbreak (Approximately 17 Acres). Priority level – Moderate. (See Figure 23.)** This project area is southwest of Salina and is anchored to Four Mile Canyon Road on the south and Gold Run Road to the north. Thinning to reduce ladder fuels and interrupt the crown continuity of fuels is recommended for a distance of at least three times the flame lengths predicted by the extreme weather scenario fire behavior model. This project is designed to reduce fire intensity and slow the spread of ignitions from Melvina Hill. This project is rated as moderate priority because it provides a secondary buffer between Melvina Hill and Salina.

K. **Northeast Crisman Fuelbreak (Approximately 11 Acres). Priority level – Moderate. (See Figure 23.)** Thinning to reduce ladder fuels and interrupt the crown continuity of fuels is recommended for a distance of at least three times the flame lengths predicted by the extreme weather scenario fire behavior model. The project area is northeast of the Chrisman community and is anchored to Four Mile Canyon Road. This project is designed to reduce fire intensity and slow the spread of ignitions from Sunshine Gulch into Camino Bosque.

L. **Switzerland Trail Road Treatment (Approximately 261 Acres). Priority level – Moderate. (See Figure 25.)** This project focuses on limbing and thinning along the Switzerland Trail from Sunshine Canyon to Sugarloaf. Thinning should be conducted to conform to the shaded fuelbreak guidelines described in the **Access Route Fuels Modification Recommendations** section and is currently planned for 200 feet below and 100 feet above the road. This project will be a joint effort with the USFS and is useful both for firefighter access and for escape from the western portion of the district.

M. **Arroyo Chico Fuelbreak (Approximately 52 Acres). Priority level – Moderate. (See Figure 22.)** Thinning should be conducted to conform to the shaded fuelbreak guidelines described in the **Access Route Fuels Modification Recommendations** section from the intersection of Arroyo Chico and Four Mile Canyon Drive extending along the private driveway leading to 500 Arroyo Chico. Thinning will also continue into the heavily loaded drainages to the south of the road. This would help protect both Arroyo Chico and Camino Bosque from fires moving up steep, heavily loaded drainages from Short Cut Gulch.

N. **Bald Mountain Fuelbreak (Approximately 23 Acres). Priority level – Moderate. (See Figure 22.)** Thinning should be conducted to conform to the shaded fuelbreak guidelines described in the **Access Route Fuels Modification Recommendations** section along a trail starting from the hairpin turn due east of 1243 Arroyo Chico to a four-wheel drive road that crosses Bald Mountain Open Space and connects with Sunshine Canyon Road. When combined with the Arroyo Chico Fuelbreak (project L) this project completes an east-west fuelbreak between Four Mile Canyon Drive and Sunshine Canyon Road.

O. **Betasso Fuelbreak (Approximately 13 Acres). Priority level – Low. (See Figure 21.)** Thinning to reduce ladder fuels and interrupt the crown continuity of fuels is recommended for a distance of at least three times the flame lengths predicted by the extreme weather scenario fire behavior model. The project area links defensible spaces along the private road in the northern end of the Red Lion community and extends into the heavy fuels between the Red Lion Community and the Betasso Water Treatment Plant. This project is rated as moderate priority because all of the existing homes have defensible space and the water treatment plant also has a significant existing clearing.

P. **Poorman Fuelbreak and Safety Zones (Approximately 18 Acres). Priority level – Low. (See Figure 21.)** Although the portion of Poorman that lies within the Four Mile Fire Protection District received a moderate hazard rating for this study, the portion north of the district has much greater fuel loadings and more hazardous terrain. A fuelbreak east of the homes on Poorman Road would help reduce the intensity and slow the spread of slope driven fires originating on the slopes below. This project is given a low priority rating because the area in need of treatment is not within FMFPD and is currently under consideration for fuels reduction by Boulder Rural Fire Department. However, a cooperative effort should be considered between FMFD, Boulder Rural Fire Department, and the landowners, to best utilize large grassy openings in this area for the creation of a fuelbreak, and potential safety zones for firefighters.

There are many areas mentioned in **Appendix B** have a large amount of standing dead and diseased trees. In particular, the portions of the district west of Emerson Gulch and Arroyo Chico have very high tree mortality. Cooperating with the landowners—especially the USFS— to reduce this material is recommended.

Figure 21: East Side Fuels Modification Projects

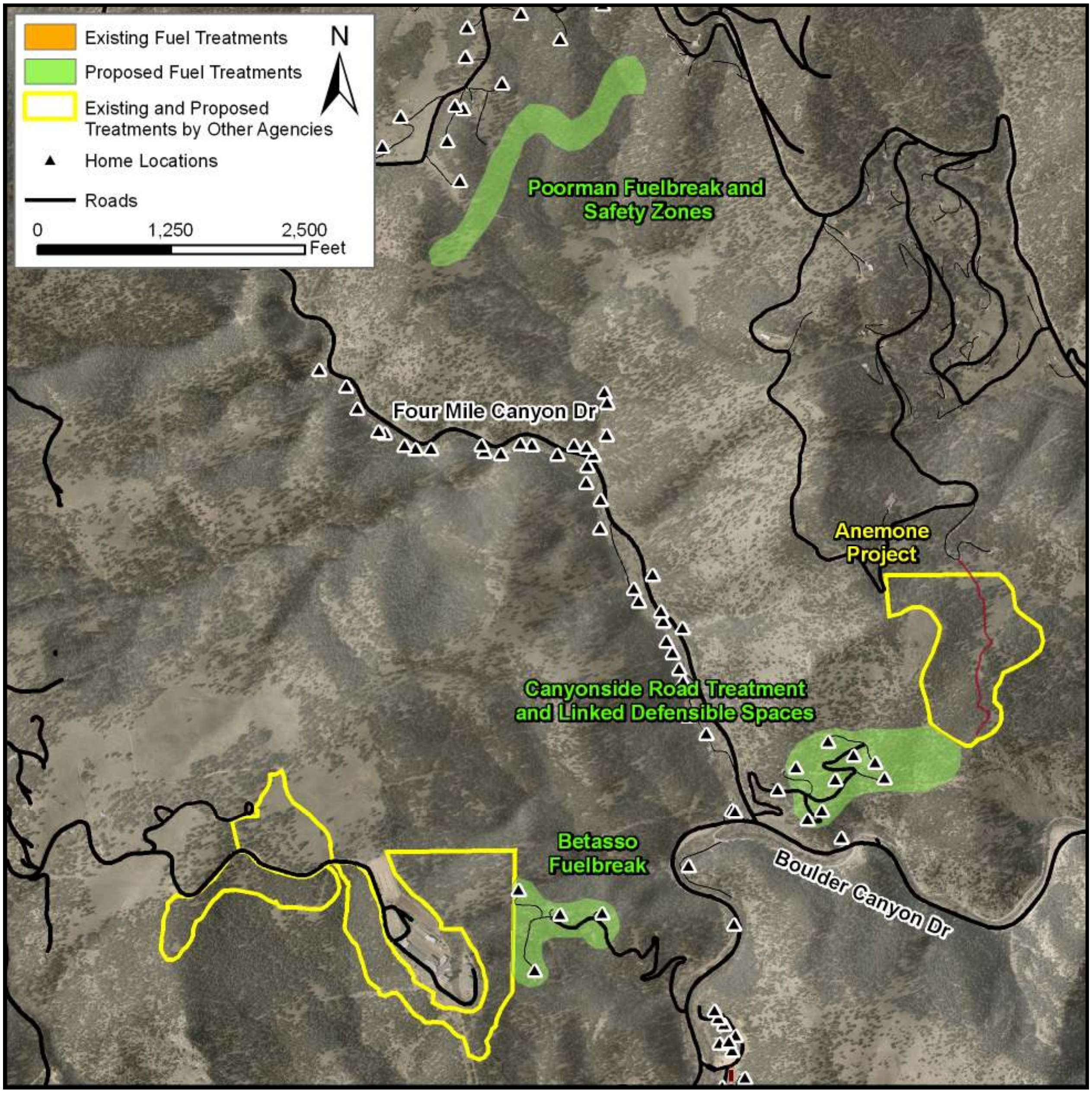


Figure 22: Arroyo Chico Area Fuels Modification Projects

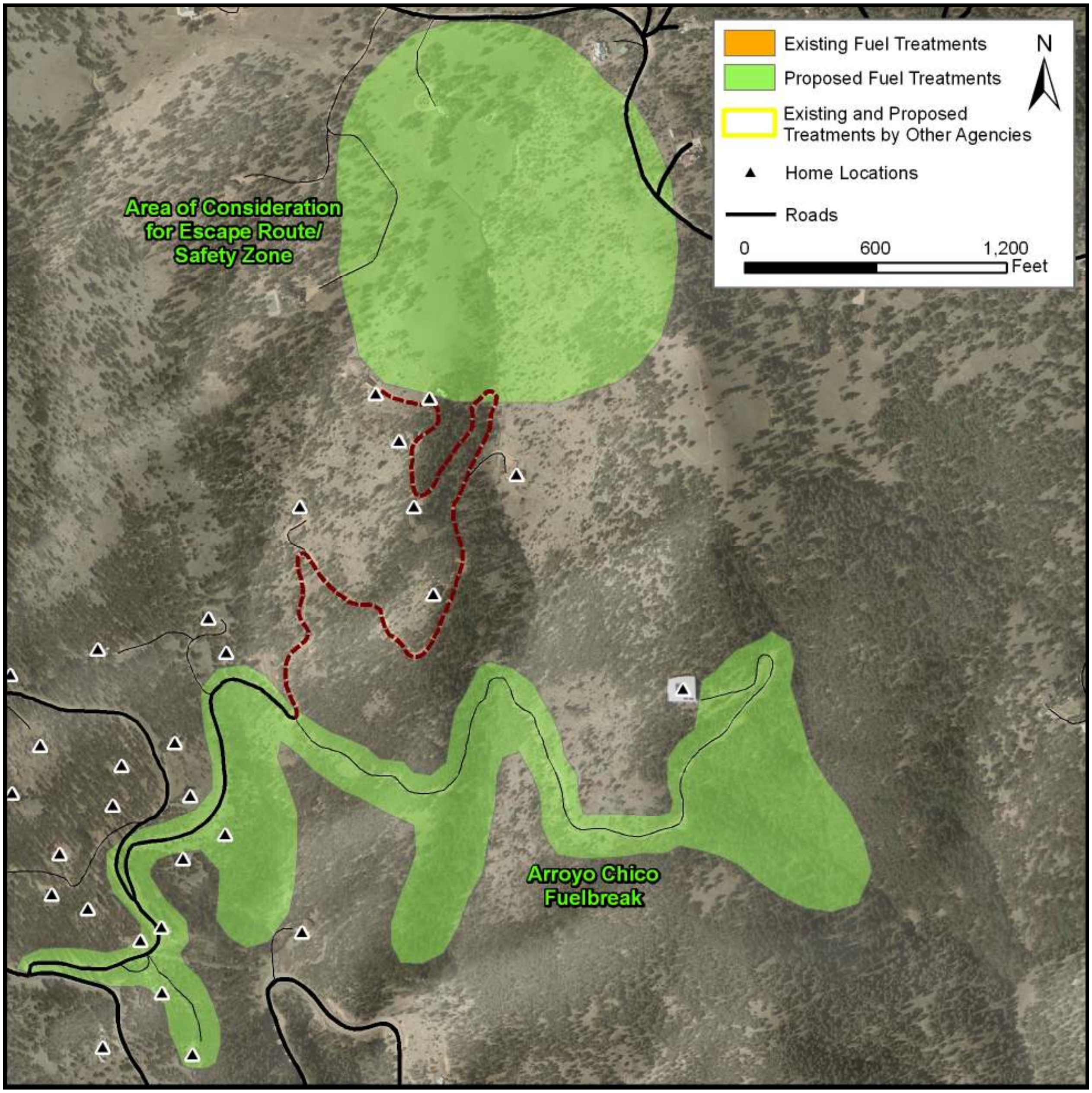


Figure 23: Logan Mill Area Fuels Modification Projects

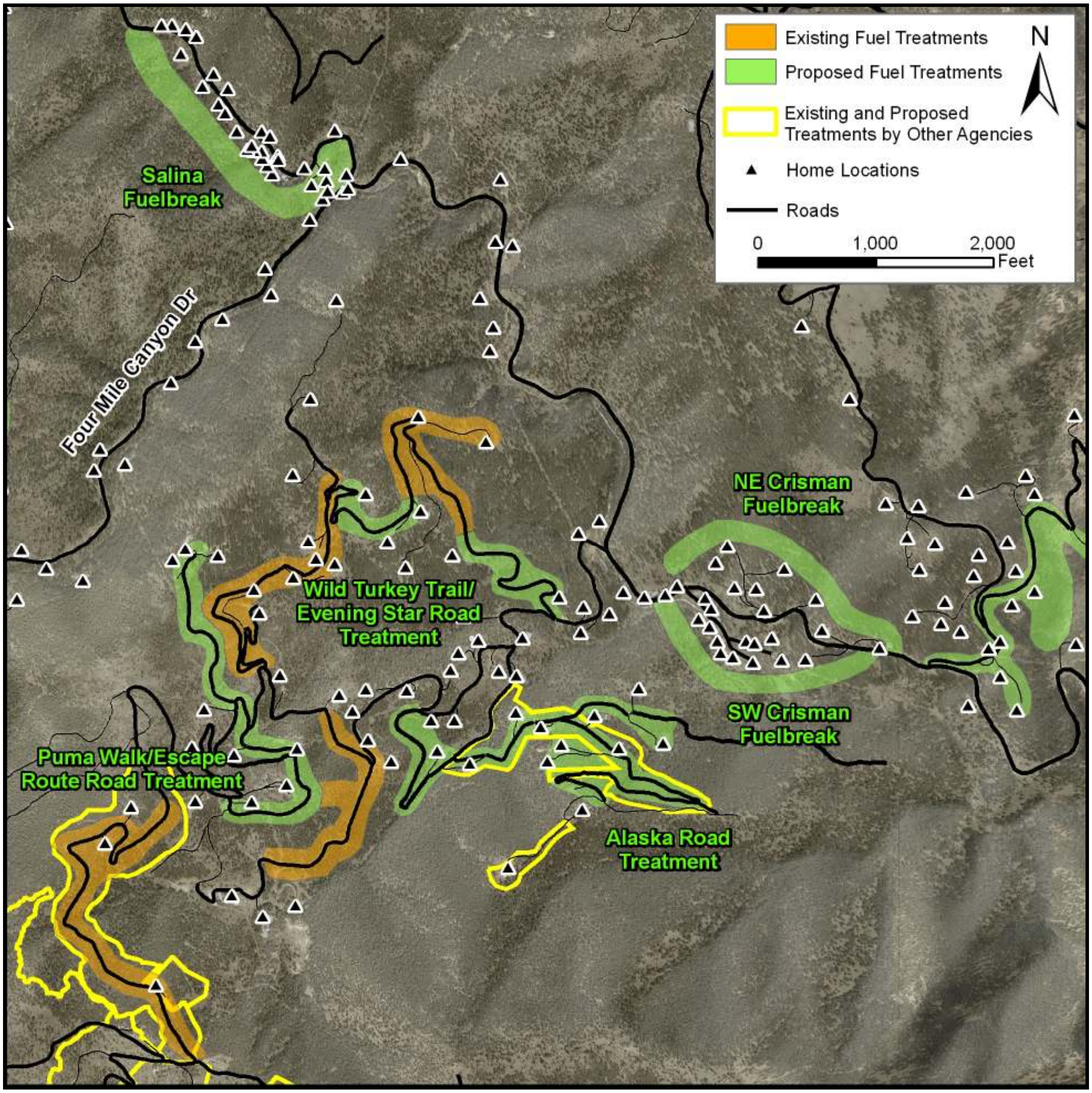


Figure 24: Melvina Hill Area Fuels Modification Projects

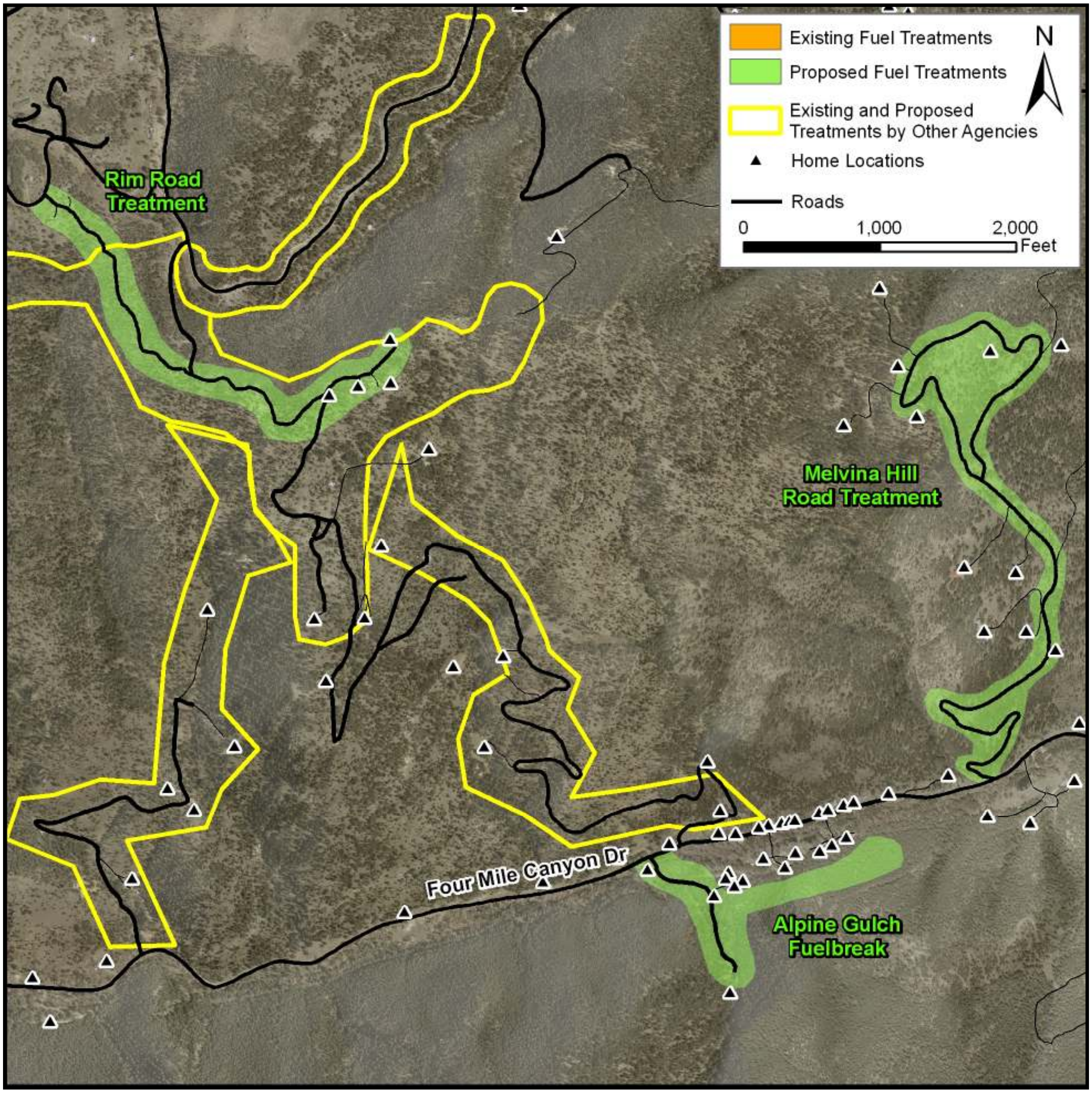
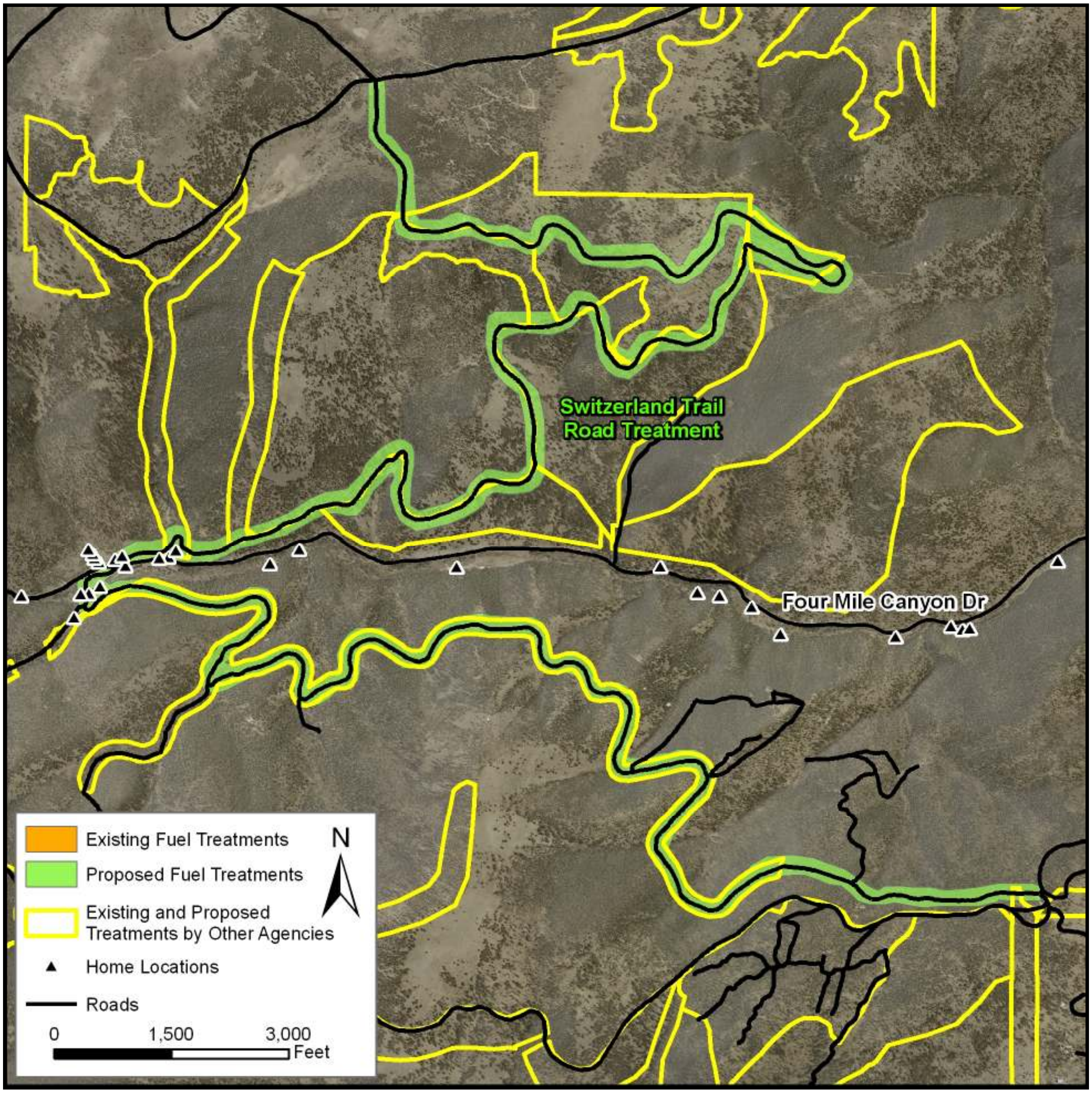


Figure 25: West Side Fuels Modification Projects



Water Supply FMU

In the study area, like many of the mountainous areas of Colorado's Front Range, water is a critical fire suppression issue. The water supplies currently used by FMFD are shown in **Figure 26**. **Table 6** gives a brief description of these water sources.

Figure 26: Water Sources

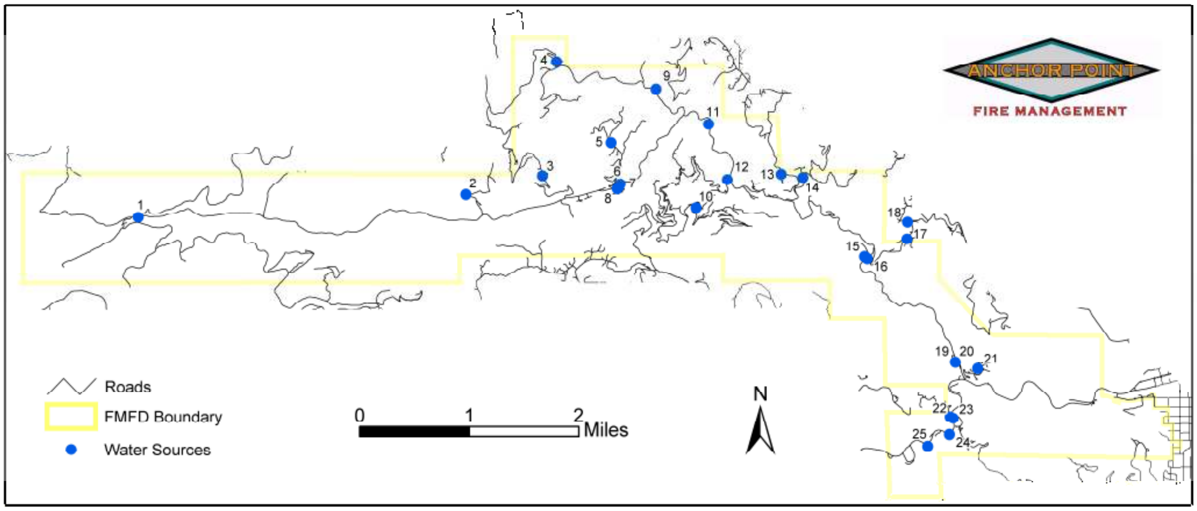


Table 6

Water Source Name	Address / Location	Capacity (Gallons)	Type	Delivery
1. Sunset Pond	10571 Four Mile Canyon Dr.	50,000	Pond	Draft
2. Emerson Gulch	First Switchback	5,000	Mine Shaft	2 1/2' Draft
3. Nancy Mine Cistern	Brian Mygatt's house	8,000	Cistern	4" Draft
4. Summerville Cistern	East of 1693 Gold Run Rd.	10,000	Cistern	4" Draft
5. Melvina Cistern	Right side of junction, 1385 Melvina Hill	10,000	Cistern	4" Draft
6. Wallstreet Station (Ponds)	Below 5931 Four Mile Canyon Dr.	20,000	Pond	Draft
7. Wallstreet Station (Creek Weir)	Behind Wallstreet Fire Station	6,000	Dry hydrant	4" Draft
8. Wallstreet Station (NCAR Tank)	Just east of Wallstreet Fire Station	5,000	Seasonal cistern	2 1/2' Male / Gravity
9. Salina Station	Just west of Salina Station	10,000	Cistern	4" Draft
10. Logan Mill Cistern	Upper Wendelyn Road junction	12,000	Cistern	4" Draft
11. Beebe's Pond	4451 Four Mile Canyon Dr. (just upstream)	5,000	Small Stream Pond	Portable Pump
12. Logan Station (Creek Weir)	9 Logan Mill Rd.	2,000	Small Stream Pond	Draft
13. Camino Bosque Cistern	304 Camino Bosque (Lock Code=3000)	10,000	Cistern	Draft
14. Arroyo Chico	301 Arroyo Chico Dr.	20,000	Cistern	Draft
15. Poorman & Four Mile (Pond)	1685 Four Mile Canyon Dr.	30,000	Pond	Draft

16. Poorman & Four Mile (Pump Station)	1690 Four Mile Canyon Dr.	10,000	Deep Well	100 GPM Pump
17. Poorman Cistern	823 Poorman Rd.	8,000	Cistern	4" Gravity
18. Poorman Boulder Rural Cistern	474 Leonards Rd. (Lock Code = 3000)	40,000	Cistern	4"/6" Gravity
19. Lodge Station (Creek Dry Hydrant)	91 Four Mile Canyon Dr.	5,000	Seasonal Pond	4" Draft
20. Lodge Station (Cistern)	91 Four Mile Canyon Dr.	5,000	Cistern	4" Draft
21. Canyonside Cistern	Above 357 Canyonside Dr.	20,000	Cistern	4" Draft
22. 38411 Hwy 119 (Mailboxes)	Lock Code = 3000	40 GPM	City Water Line	1 1/2" Male
23. Red Lion	Across lawn behind the road E side.	Unlimited	Stream	Draft
24. Pullout on Hwy 119	Picnic Pullout (200 yds. W of Red Lion)	Unlimited	Stream	Draft
25. Boulder Creek Draft Point 2		Unlimited	Stream	Draft

Nine of the twenty-five water sources listed could be dry or too low to be effective during at least part of the fire season. These include ponds, dry hydrants, seasonal cisterns, and drafting from Four Mile Creek. Four Mile Creek experiences large fluctuations in its flow. In the spring it may overflow its banks by as much as a few feet, whereas by late July or early August it may be completely dry, especially in the lower canyon. During drought years it may be unusable for drafting during the entire fire season. Even in normal years, dams are usually required. **Figure 27** shows Four Mile Creek between Sunset and Emerson Gulch taken in mid-August of an average moisture year. At this same time the creek was dry in most of the lower canyon (see **Figure 28**).

Figure 27

Figure 28

The mid-level assessment revealed several communities in the study area that are a considerable distance from reliable water sources for fire suppression. Improvement of the water supply in these communities constitutes an important FMU. These communities include:

- Rim Road Area
- Emerson Gulch
- Red Lion Area (north of Hwy 119)
- Crisman

FMFD is equipped with a good supply of water tenders and portable tanks (See *Fire Department Involvement*). However, firefighting efforts can be enhanced by improving water supplies in the FMU and eventually throughout the study area.

RECOMMENDATIONS

- A large (10,000-20,000 gal.) cistern is recommended for the Rim Road Area. This area is not only extremely hazardous, but is also a long way from reliable water. This is the most critical water supply need in the study area.
- The upper area of Summerville is in need of a water supply. The existing Summerville cistern is a long way from this area. There are only four residences here currently, and they are spread out. The best tactic may be to install individual cisterns of 1,500-2,000 gallons on each property.
- The existing water supply for Emerson Gulch is a 45-foot deep mine shaft that may or may not be useful, depending on conditions. There is a good water supply on Wallstreet, but this area could easily be cut off. Our recommendation is for a large (10,000-20,000 gal.) community cistern to be constructed in the upper area.
- The large ponds in Sunset are big enough and have good enough access to be considered a reliable water source in all but the worst conditions. The addition of a dry hydrant to these ponds is highly recommended.
- A large (10,000-20,000 gal.) cistern for the Lower Four Mile Canyon area is also recommended. Although there are seasonal ponds in the area and a dry hydrant available at the Lodge Station, Four Mile Creek is not a reliable water supply in this part of the canyon.
- The portion of the Red Lion Area north of Hwy 119 has a 1.5" low volume fill site at the intersection of the highway. An additional midsized (2,000-5,000 gals.) cistern should be constructed in the upper part of this area to supplement the water supply.
- There are different fittings employed throughout the district. A standard for new construction and refitting of existing water supplies, where possible, is recommended. Standardization would result in a smoother, faster, and more reliable connection. In most areas the water district supplying service to the area specifies fitting sizes and types. Since there is no water district servicing this area (with the exception of the lower canyon), a standard should be adopted by the fire department. Our recommendation is to use the construction standards proposed in the Summit County Dry Hydrant Manual. This manual was developed specifically for rural fire protection in the mountains of Colorado. A copy of the manual has been included with this report.

GLOSSARY

The following definitions apply to terms used in the Four Mile Fire Protection District Community Wildfire Protection Plan.

1 hour Timelag fuels: Grasses, litter and duff; <1/4 inch in diameter.

10 hour Timelag fuels: Twigs and small stems; ¼ inch to 1 inch in diameter.

100 hour Timelag fuels: Branches; 1 to 3 inches in diameter.

1000 hour Timelag fuels: Large stems and branches; >3 inches in diameter.

Active Crown Fire: a crown fire in which the entire fuel complex – all fuel strata – become involved, but the crowning phase remains dependent on heat released from the surface fuel strata for continued spread (also called a Running Crown Fire or Continuous Crown Fire).

ArcGIS 9.x: Geographic Information System (GIS) software designed to handle mapping data in a way that can be analyzed, queried, and displayed. ArcGIS is in its ninth major revision and is published by the Environmental Systems Research Institute (ESRI).

Crown Fire (Crowning): The movement of fire through the crowns of trees or shrubs, which may or may not be independent of the surface fire.

Defensible Space: An area around a structure where fuels and vegetation are modified cleared or reduced to slow the spread of wildfire toward or from the structure. The design and distance of the defensible space is based on fuels, topography, and the design/materials used in the construction of the structure.

Energy Release Component: An index of how hot a fire could burn. ERC is directly related to the 24-hour, potential worst case, total available energy within the flaming front at the head of a fire.

Extended Defensible Space (also known as Zone 3): A defensible space area where treatment is continued beyond the minimum boundary. This zone focuses on forest management with fuels reduction being a secondary consideration.

Fine Fuels: Fuels that are less than ¼ inch in diameter such as grass, leaves, draped pine needles, fern, tree moss, and some kinds of slash which, when dry, ignite readily and are consumed rapidly.

Fire Behavior Potential: The expected severity of a wildland fire expressed as the rate of spread, the level of crown fire activity, and flame length. Derived from fire behavior modeling programs using the following inputs: fuels, canopy cover, historical weather averages, elevation, slope, and aspect.

Fire Danger: Not used as a technical term in this document due to various and nebulous meanings that have been historically applied.

Fire Hazard: Given an ignition, the likelihood and severity of Fire Outcomes (Fire Effects) that result in damage to people, property, and/or the environment. Derived from the Community Assessment and the Fire Behavior Potential.

Fire Mitigation: Any action designed to decrease the likelihood of an ignition, reduce Fire Behavior Potential, or to protect property from the impact of undesirable Fire Outcomes.

Fire Outcomes (aka Fire Effects): A description of the expected effects of a wildfire on people, property and/or the environment based on the Fire Behavior Potential and physical presence of Values-at-Risk. Outcomes can be desirable as well as undesirable.

Fire Risk: The probability that an ignition will occur in an area with potential for damaging effects to people, property, and/or the environment. Risk is based primarily on historical ignitions data.

Flagged Addressing: A term describing the placement of multiple addresses on a single sign, servicing multiple structures located on a common access.

FlamMap: A software package created by the Joint Fire Sciences Program, Rocky Mountain Research Station. The software uses mapped environmental data such as Elevation, Aspect, Slope, and Fuel Model, along with fuel moisture and wind information, to generate predicted fire behavior characteristics such as Flame Length, Crown Fire Activity, and Spread Rate.

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)—an indicator of fire intensity.

FMU (Fire Management Unit): A method of prioritizing fire mitigation work efforts. Units can be defined by function (e.g., public education efforts) or geography (e.g., fuel reduction projects in a given area).

Fuelbreak: A natural or constructed discontinuity in a fuel profile used to isolate, stop, or reduce the spread of fire. Fuelbreaks may also make retardant lines more effective and serve as control lines for fire suppression actions. Fuel breaks in the WUI are designed to limit the spread and intensity of crown fire activity.

ICP (Incident Command Post): The base camp and command center from which fire suppression operations are directed.

ISO (Insurance Standards Office): A leading source of risk information to insurance companies. ISO provides fire risk information in the form of ratings used by insurance companies to price fire insurance products to property owners.

Jackpot Fuels: a large concentration of discontinuous fuels in a given area such as a slash pile.

Passive Crown Fire: a crown fire in which individual or small groups of trees torch out (candle), but solid flaming in the canopy fuels cannot be maintained except for short periods.

Shelter-in-Place Areas: A method of protecting the public from an advancing wildfire involving instructing people to remain inside their homes or public buildings until the danger passes. This concept is new to wildfire in the United States, but not to hazardous materials incident response where time, hazards, and sheer logistics often make evacuation impossible. This concept is the dominant modality for public protection from wildfires in Australia where fast moving, short-duration fires in light fuels make evacuation impractical. The success of this tactic depends on a detailed preplan which takes into account the construction type and materials of the building used, topography, depth and type of the fuel profile, as well as current and expected weather and fire behavior. For a more complete discussion of the application and limitations of shelter-in-place concepts see the *Addressing, Evacuation, and Shelter-In-Place FMU* section of this report.

Slash: Debris left after logging, pruning, thinning, or brush cutting; includes logs, chips, bark, branches, stumps, and broken understory trees or brush.

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.

Structural Triage: the process of identifying, sorting, and committing resources to a specific structure.

Surface Fire: a fire that burns on the surface litter, debris, and small vegetation on the ground.

Timelag: Time needed under specified conditions for a fuel particle to lose 63 percent of the difference between its initial moisture content and its equilibrium moisture content.

Values at Risk: People, property, ecological elements, and other human and intrinsic values within the project area. Values at Risk are identified by inhabitants as important to the way of life of the study area and are susceptible specifically to damage from undesirable fire outcomes.

WHR (Community Wildfire Hazard Rating. AKA Community Assessment): A fifty-point scale analysis designed to identify factors which increase the potential for and/or severity of undesirable fire outcomes in WUI communities.

WUI (Wildland Urban Interface): The line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuels. Sometimes referred to as Urban Wildland Interface, or UWI.

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Standard for Protection of Life and Property from Wildfire, NFPA 1144, http://www.normas.com/NFPA/PAGES/NFPA-1144(02).html, January 2005.

Standard for Protection of Life and Property from Wildfire, NFPA 299, http://webstore.ansi.org/ansidocstore/product.asp?sku=29997PDF, January 2005.

Community Wildfire Protection Plan
Mutual Agreement Page

The Community Wildfire Protection Plan developed for/by the Four Mile Fire Protection District:

- Was collaboratively developed. Interested parties and federal land management agencies managing land in the vicinity of Four Mile FPD have been consulted.

- This plan identifies and prioritizes areas for hazardous fuel reduction treatments and recommends the types and methods of treatment that will protect Four Mile FPD.

- This plan recommends measures to reduce the ignitability of structures throughout the area addressed by the plan.

The following entities mutually agree with the contents of this Community Wildfire Protection Plan:

____

Bret Gibson, Chief Four Mile Fire Department

____

Four Mile Fire Protection District Board

____

Alan Owen, District Forester, Boulder District, Colorado State Forest Service

1/07

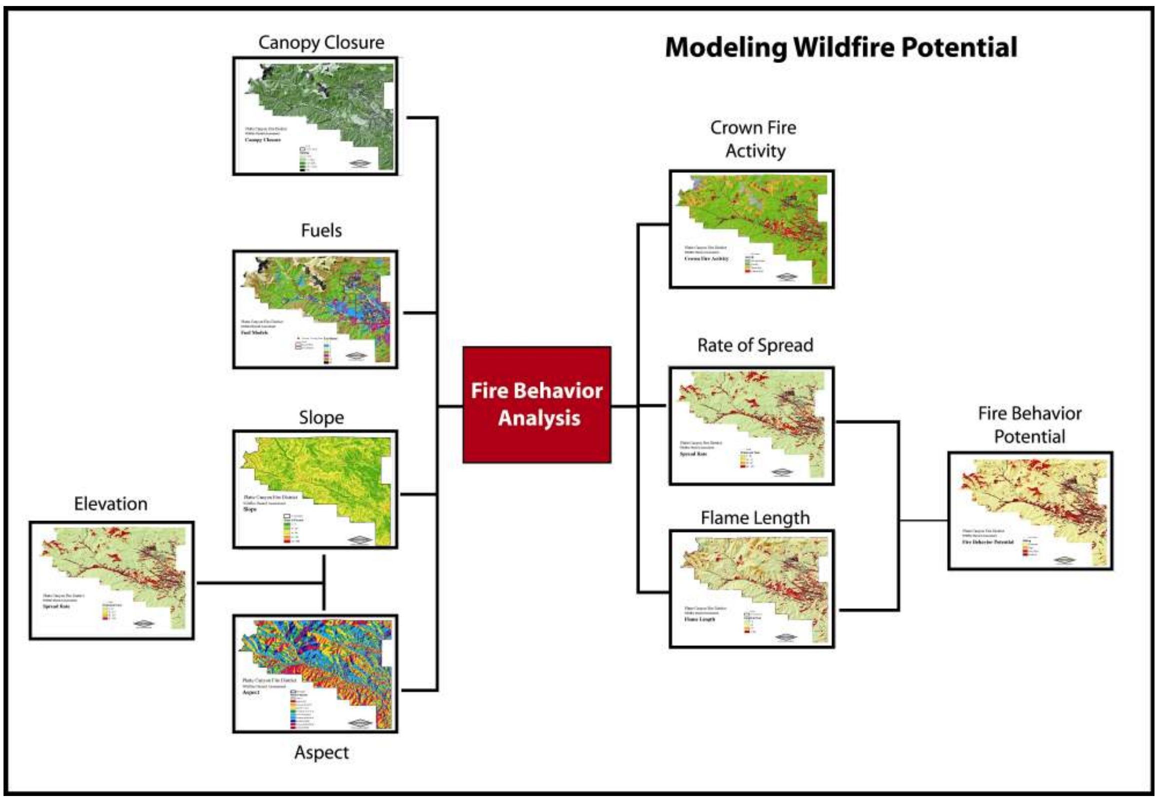
Appendix A

Fire Behavior Potential Analysis Methodology

PURPOSE

The purpose of this appendix is to describe the methodology used to estimate the physical hazard of fuels in proximity to structures and to combine those data with an evaluation of the values at risk.

Figure 1: Model Description



BEHAVE MODELING

The wildfire behavior potential analysis assigns a relative ranking to locations based upon expected surface fire intensity and rate of spread. The model inputs for surface fire behavior include aspect, slope, elevation, canopy cover, and fuel type. Calculations are based on the USDA Forest Service's fire behavior model **BEHAVE**. **BEHAVE** is a nationally recognized set of calculations to estimate a fire's intensity and rate of spread given certain conditions of topography, fuels and weather.

The **BEHAVE** modeling system has been used for a variety of applications including prediction of an ongoing fire, prescribed fire planning, fuel hazard assessment, initial attack dispatch, and fire prevention planning and training. Predictions of wildland fire behavior are made for a single point in time and space given simple user-defined fuel, weather and topography. Requested values depend on the modeling choices made by the user. For example, fuel model, fuel moisture, wind speed and direction, and terrain and slope are used to calculate rate of spread, flame length and intensity.

Assumptions of **BEHAVE:**

- Fire is predicted at the flaming front
- Fire is free burning
- Behavior is heavily weighted toward the fine fuels
- Continuous and uniform fuels
- Surface fires

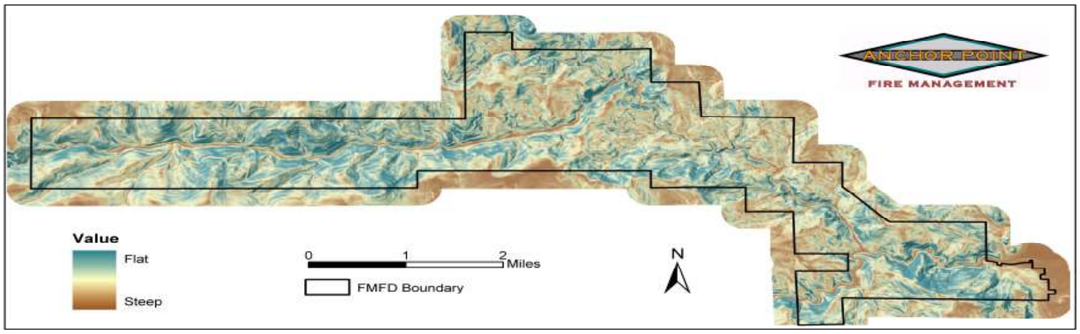
FLAMMAP

Anchor Point uses **FlamMap** developed by Systems for Environmental Management (Missoula, Montana) and the Fire Sciences Laboratory of the Rocky Mountain Research Station (USDA Forest Service, Missoula, Montana) to evaluate the potential fire conditions in the study area. The Four Mile Canyon study area encompasses approximately 12,800 acres, which are broken down into 10 meter (m) grids. Using **FlamMap**'s spatial analysis capabilities, each 10 meter square (sq) grid is queried for its elevation, slope, aspect and fuel type. These values are input into **FlamMap,** along with reference weather information. The outputs of **FlamMap** include the estimated Rate of Spread (ROS), Flame Length (FL) (from **BEHAVE**) and Crown Fire Activity for a fire in that 10m sq grid. The model computes these values for each grid cell in the study area. These values are then reclassified into Wildfire Hazard classes of None, Low, Moderate, High, Very High, and Extreme.

FIRE BEHAVIOR INPUTS

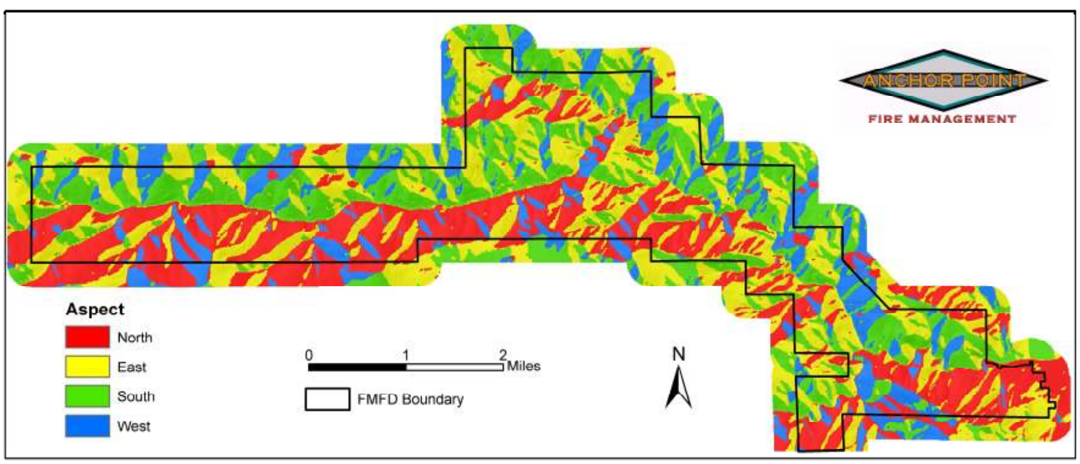
Fire behavior is dependant upon aspect, slope, elevation, canopy cover and fuel type. The following pages contain an explanation of each.

Figure 2: Slope



Slopes are shown here as percent (rise/run x100). Steeper slopes intensify fire behavior and thus will contribute to a high wildfire hazard rating.

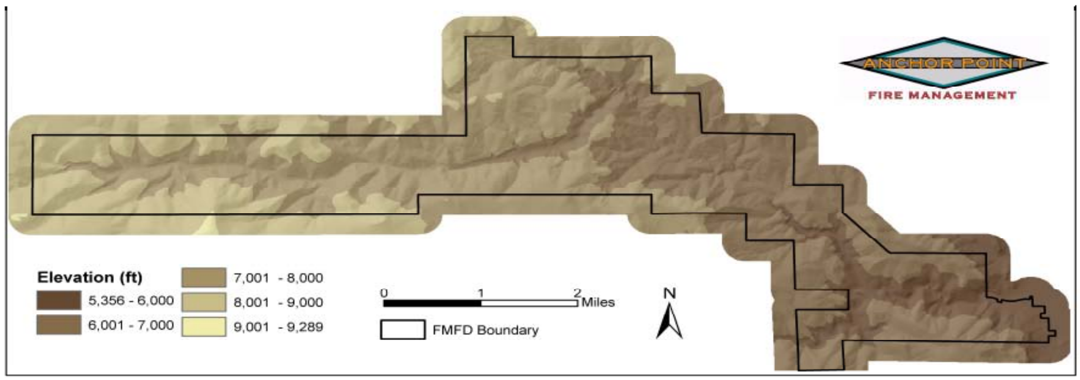
Figure 3: Aspect



Aspects are shown as degrees from North ranging from 0 to 360 according to their orientation.

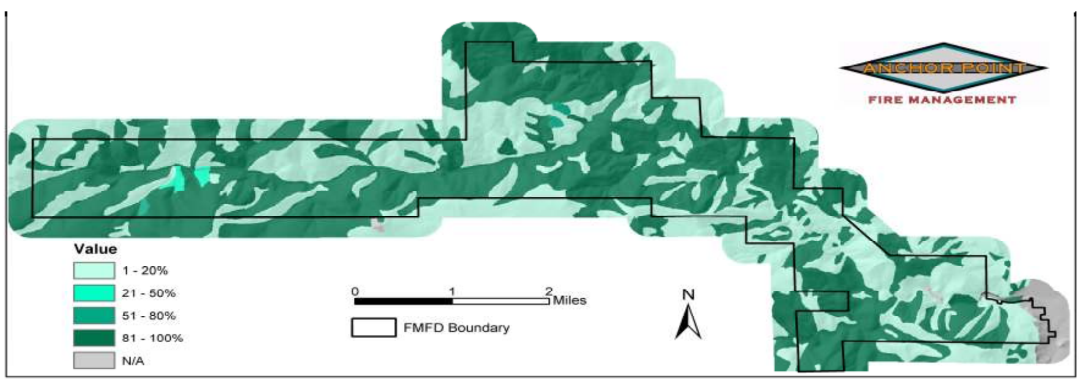
Classification	North	East	South	West
Range	315-45	45-135	135-225	225-315

Figure 4: Elevations



Elevations within Four Mile FPD vary from 5,300' to over 9,000'. As elevation increases, fuel loading and available oxygen for combustion change. Above tree line fuels become sparse and the natural burn interval is measured in centuries.

Figure 5: Canopy Cover



Canopy cover is the horizontal percentage of the ground surface that is covered by tree crowns. Canopy cover is measured as the horizontal fraction of the ground that is covered directly overhead by tree canopy. Coverage units are in four categories (1=1-20%, 2=21-50%, 3=50-80%, 4= 81-100%).

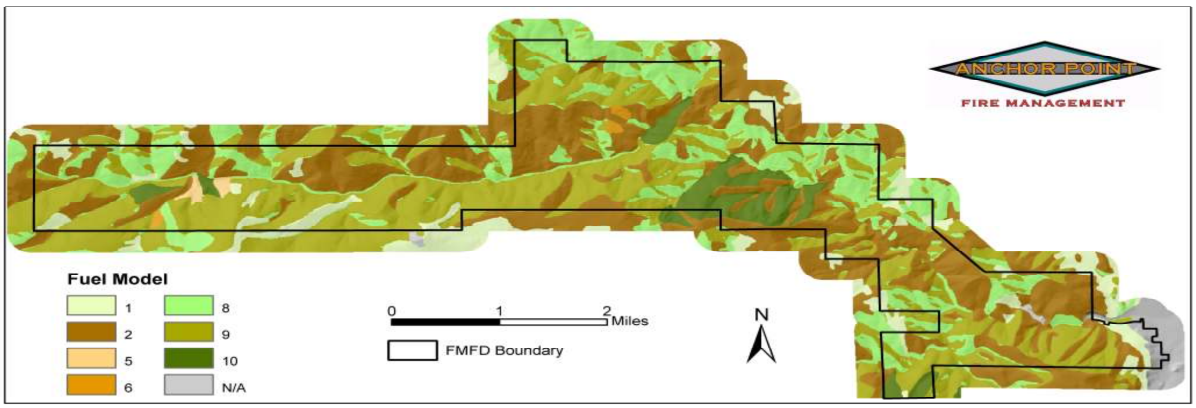
Fuel Models

Fuel models are a set of numbers that describe the fuel in terms that a fire spread model can use. There are seven characteristics used to categorize fuel models:

- Fuel Loading
- Size and Shape
- Compactness
- Horizontal Continuity
- Vertical Arrangement
- Moisture Content
- Chemical Content
- Description

The study area is represented primarily by five fuel models (FM): FM 1, 2, 8, 9 and 10 (Anderson, 1982). Fuel models 5 and 6 exist, but not in enough quantity to significantly influence fire behavior. Each of the major fuel types present are described below with a table showing a range of fire behavior based on the **BEHAVE** system. Figure 18 displays the fuel types graphically for Four Mile Canyon.

Figure 18: Four Mile Canyon Fuels Map



FUEL MODEL 1[1]

Figure 19: Annual Grasses

Characteristics
Grasslands and savanna are represented along with stubble, grass-tundra and grass-shrub combinations.

Common Types/Species
Annual and perennial grasses are included in this fuel model. Refer to **Figure 16** for illustrations.

Fire Behavior
Fire spread is governed by the fine, very porous and continuous herbaceous fuels that have cured or are nearly cured. Fires in this fuel model are surface fires that move rapidly through the cured grass and associated material. Very little shrub or timber is present, generally less than one-third of the area.

[1] Anderson, Hal. 1982. Aids to Determining Fuel Models for Estimating Fire Behavior. Gen. Tech. Rep. INT-122. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station 22 p. (NFES 1574).

Rate of spread in chains/hour (1 chain=66 ft)

Fine Dead Fuel moisture %	Mid-flame Wind Speed 2.0	4.0	6.0	8.0	10.0	12.0
2.0	28.8	92.9	203.6	362.4	570.1	665.6
4.0	22.0	71.1	155.7	277.0	345.1	345.1
6.0	19.4	62.4	136.8	243.4	270.1	270.1
8.0	16.7	53.9	118.1	198.7	198.7	198.7
10.0	11..0	35.6	64.8	64.8	64.8	64.8

10 hr fuel=5%, 100 hr fuel=6%, herbaceous fuel moisture=100%, slope=10%

Flame Length in Feet

Fine Dead Fuel moisture %	Mid-flame Wind Speed 2.0	4.0	6.0	8.0	10.0	12.0
2.0	3.0	5.1	7.3	9.6	11.8	12.7
4.0	2.4	4.1	5.9	7.8	8.6	8.6
6.0	2.2	3.8	5.5	7.1	7.5	7.5
8.0	2.0	3.4	4.9	6.3	6.3	6.3
10.0	1.4	2.4	3.2	3.2	3.2	3.2

FUEL MODEL 2[2]

Figure 20: Timber with Grass Understory

Characteristics

This fuel model consists of open grown pine stands. Trees are widely spaced with few understory shrubs or regeneration. Ground cover consists of mountain grasses and/or needles and small woody litter. This model occurs in open-grown and mature Ponderosa pine stands in the Foothill to Montane zone.

Common Types/Species

The predominate tree species is Ponderosa pine and may include some scattered Douglas fir. Other tree and shrub species include Common and Rocky Mountain Juniper, Buckbrush, Bitter brush and Mountain Mahogany. Mountain grasses are included in this model.

Fire Behavior

Surface fires in this fuel model spread easily. Clumps of fuel may generate higher fire intensities. Fire is carried by grasses and/or woody litter.

[2] Anderson, Hal. 1982. Aids to Determining Fuel Models for Estimating Fire Behavior. Gen. Tech. Rep. INT-122. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station 22 p. (NFES 1574).

Rate of spread in chains/hour (1 chain=66 ft)

Fine Dead Fuel moisture %	Mid-flame Wind Speed 2.0	4.0	6.0	8.0	10.0	12.0
2.0	12.4	34.2	67.5	111.6	166.0	230.2
4.0	10.2	28.0	55.3	91.4	135.9	188.5
6.0	9.0	24.9	49.1	81.2	120.8	167.6
8.0	8.3	22.9	45.3	74.9	111.3	154.4
10.0	7.4	20.5	40.5	67.0	99.7	138.3
12.0	5.9	16.3	32.3	53.3	79.3	110.0

10 hr fuel=5%, 100 hr fuel=6%, herbaceous fuel moisture=100%, slope=10%

Flame Length in Feet

Fine Dead Fuel moisture %	Mid-flame Wind Speed 2.0	4.0	6.0	8.0	10.0	12.0
2.0	4.3	6.9	9.4	11.8	14.2	16.5
4.0	3.7	5.8	8.0	10.1	12.1	14.0
6.0	3.4	5.4	7.3	9.2	11.1	12.9
8.0	3.2	5.1	6.9	8.7	10.5	12.2
10.0	2.9	4.7	6.4	8.1	9.7	11.2
12.0	2.4	3.9	5.3	6.7	8.0	9.3

FUEL MODEL 8[3]

Figure 21: Timber Litter, Light Fuel Load

Characteristics
This fuel model is represented by closed canopy stands of Lodgepole pine or Ponderosa pine with little under growth. Amounts of needle and woody litter are also low. This fuel model occurs at higher elevations in the Montane zone.

Common Types/Species
This fuel model is most often represented by Lodgepole pine but Ponderosa pine can be included. There are little or no understory plants.

Fire Behavior
Fires in this fuel model are slow burning, low intensity fires burning in surface fuels. Fuels are mainly needles and woody litter. Heavier fuel loadings can cause flare-ups. Heavier fuel loads have the potential to develop crown fires in extreme burning conditions.

[3] Anderson, Hal. 1982. Aids to Determining Fuel Models for Estimating Fire Behavior. Gen. Tech. Rep. INT-122. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station 22 p. (NFES 1574).

Rate of spread in chains/hour (1 chain=66 ft)

Fine Dead Fuel moisture %	Mid-flame Wind Speed					
	2.0	4.0	6.0	8.0	10.0	12.0
2.0	1.1	2.3	3.9	5.7	7.8	10.1
4.0	0.9	1.9	3.2	4.7	6.4	6.9
6.0	0.7	1.6	2.6	3.9	4.9	4.9
8.0	0.6	1.4	2.3	3.4	3.8	3.8
10.0	0.6	1.2	2.0	3.0	3.1	3.1
12.0	0.5	1.1	1.8	2.7	2.7	2.7

10 hr fuel=5%, 100 hr fuel=6%, herbaceous fuel moisture=100%, slope=10%

Flame Length in Feet

Fine Dead Fuel moisture %	Mid-flame Wind Speed					
	2.0	4.0	6.0	8.0	10.0	12.0
2.0	0.9	1.3	1.7	2.0	2.3	2.6
4.0	0.8	1.1	1.4	1.7	2.0	2.0
6.0	0.7	1.0	1.2	1.5	1.7	1.7
8.0	0.6	0.9	1.1	1.3	1.4	1.4
10.0	0.6	0.8	1.0	1.2	1.3	1.3
12.0	0.6	0.8	1.0	1.2	1.3	1.3

FUEL MODEL 9[4]

Figure 22: Timber Litter, (note heavier surface fuels).

Characteristics

Both long-needle conifer stands and hardwood stands, especially the oak-hickory types, are typical. Concentrations of dead-down woody material will contribute to possible torching out of trees, spotting and crowning.

Common Types/Species

Closed stands of long-needled pine like Ponderosa, Jeffrey, and Red pines, or southern pine plantations are grouped in this fuel model.

Fire Behavior

Fires in this fuel model run through the surface litter faster than model 8 and have longer flame height. Fall fires in hardwoods are predictable, but high winds will actually cause higher rates of spread than predicted because of spotting caused by rolling and blowing leaves.

[4] Anderson, Hal. 1982. Aids to Determining Fuel Models for Estimating Fire Behavior. Gen. Tech. Rep. INT-122. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station 22 p. (NFES 1574).

Rate of spread in chains/hour (1 chain=66 ft)

	Mid-flame Wind Speed					
Fine Dead Fuel moisture %	2.0	4.0	6.0	8.0	10.0	12.0
2.0	4.0	9.8	18.1	28.7	41.5	56.2
4.0	3.2	7.7	14.3	22.7	32.7	44.4
6.0	2.6	6.4	11.8	18.8	27.1	36.7
8.0	2.3	5.5	10.2	16.3	23.5	31.8
10.0	2.0	5.0	9.2	14.7	21.2	28.7
12.0	1.9	4.6	8.5	13.5	19.5	26.5

10 hr fuel=5%, 100 hr fuel=6%, herbaceous fuel moisture=100%, slope=10%

Flame Length in Feet

	Mid-flame Wind Speed					
Fine Dead Fuel moisture %	2.0	4.0	6.0	8.0	10.0	12.0
2.0	2.3	3.5	4.7	5.8	6.8	7.9
4.0	1.9	2.9	3.9	4.8	5.7	6.6
6.0	1.7	2.5	3.4	4.2	5.0	5.7
8.0	1.5	2.3	3.1	3.8	4.5	5.2
10.0	1.4	2.2	2.9	3.5	4.2	4.8
12.0	1.4	2.1	2.7	3.4	4.0	4.6

Fuel Model 10[5]

Figure 23: Timber Litter, (note heavier fuels and understory)

Characteristics
This fuel model is represented by dense stands of over-mature Ponderosa pine, Lodgepole pine, mixed conifer and continuous stands of Douglas fir. In all stand types heavy downed material is present. There is also a large amount of dead-down woody fuels. Reproduction of vegetation may be present, acting as ladder fuels. This fuel model includes stands of budworm killed Douglas fir, closed stands of Ponderosa pine with large amounts of ladder and surface fuels. Stands of Lodgepole pine with heavy loadings of downed trees are also present. This fuel model can occur from the foothills through the sub-alpine zone.

Common Types/Species
All types of vegetation can occur in this fuel model, but primary species are: Douglas fir, Ponderosa pine and Lodgepole pine.

Fire Behavior
Fire intensities in this fuel model can be moderate to extreme. Fire moves through dead, downed woody material. Torching of trees and spot fires are more frequent. Crown fires are quite possible.

[5] Anderson, Hal. 1982. Aids to Determining Fuel Models for Estimating Fire Behavior. Gen. Tech. Rep. INT-122. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Research Station 22 p. (NFES 1574).

Rate of spread in chains/hour (1 chain=66 ft)

Fine Dead Fuel moisture %	Mid-flame Wind Speed 2.0	4.0	6.0	8.0	10.0	12.0
2.0	3.8	8.2	13.7	20.1	27.3	35.1
4.0	3.3	7.2	12.1	17.8	24.1	31.0
6.0	3.0	6.6	11.0	16.1	21.8	28.0
8.0	2.8	6.1	10.2	14.9	20.2	26.0
10.0	2.6	5.7	9.6	14.1	19.1	24.5
12.0	2.5	5.5	9.2	13.4	18.2	23.4

10 hr fuel=5%, 100 hr fuel=6%, herbaceous fuel moisture=100%, slope=10%

Flame Length in Feet

Fine Dead Fuel moisture %	Mid-flame Wind Speed 2.0	4.0	6.0	8.0	10.0	12.0
2.0	3.8	5.5	7.0	8.3	9.5	10.7
4.0	3.5	5.0	6.3	7.5	8.6	9.7
6.0	3.2	4.6	5.8	6.9	7.9	8.9
8.0	3.0	4.3	5.5	6.5	7.5	8.4
10.0	2.9	4.1	5.2	6.2	7.2	8.0
12.0	2.8	4.0	5.1	6.0	6.9	7.8

REFERENCE WEATHER

Weather for **FlamMap** was created by using weather data collected in Boulder.

Latitude (dd mm ss)	**40 ° 01 ' 05 " N**
Longitude (dd mm ss)	**105 ° 21 ' 38 " W**
Elevation (ft.)	**6,775**

The mean for each variable (1 hr, 10 hr, and 100 hr fuel moisture, woody fuel moisture, herbaceous fuel moisture, and wind speed) was calculated for the months of May-October for the years 1992-2002. Then, the average of each mean/month was calculated to represent an average fire season day.

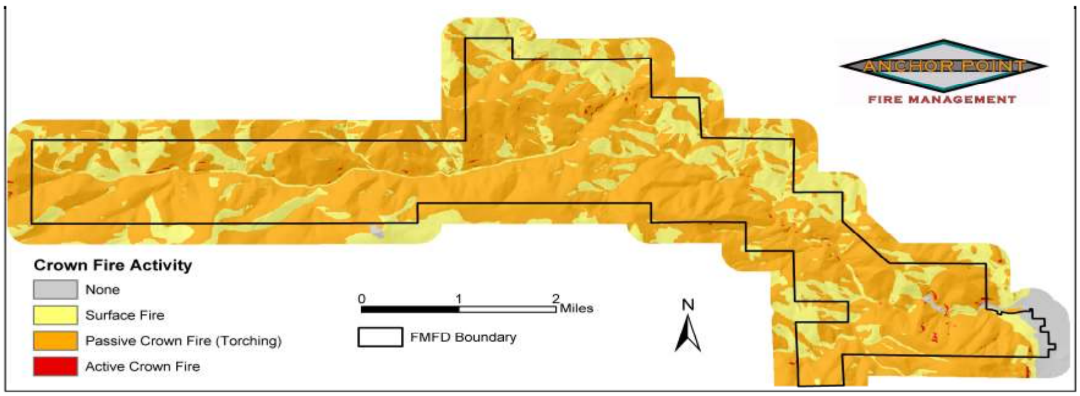
The "extreme conditions" maps were calculated using ninetieth percentile weather data. That is to say, the weather conditions existing on the eighteen most severe fire weather days in each season for the ten-year period were averaged together. It is reasonable to assume that similar conditions may exist for at least eighteen days of the fire season during an average year. In fact, during extreme years such as 2000 and 2002, such conditions may exist for significantly longer periods. Even these calculations may be conservative compared to observed fire behavior. Drought conditions the last few years have significantly changed the fire behavior in dense forest types such as mixed conifer. The current values underestimate fire behavior especially in the higher elevation fuels because the extremely low fuel moistures are not represented in the averages. The following values were used in **FlamMap**:

Average Weather Conditions	
Variable	**Value**
20 ft Wind speed up slope	25 mph
Herbaceous fuel moisture	57%
Woody fuel moisture	110%
100 hr fuel moisture	11%
10 hr fuel moisture	9%
1 hr fuel moisture	7%
Canopy height	15 m
Crown base height	1 m
Crown bulk density	0.1 kg/m3
Foliar moisture content	100%

FIRE BEHAVIOR ANALYSIS OUTPUTS

From the fire behavior analysis predictions of crown fire activity, rate of spread and flame length are derived. Rate of spread and flame length predictions are combined to produce the fire behavior potential map that shows the results of the analysis.

Figure 6: Predictions of Crown Fire Activity (Average Weather Conditions)



Crown fire activity values are generated by the FlamMap model and classified into 4 categories based on standard ranges: active, passive, surface, and not applicable.

Figure 7: Predictions of Crown Fire Activity (Extreme Weather Conditions)

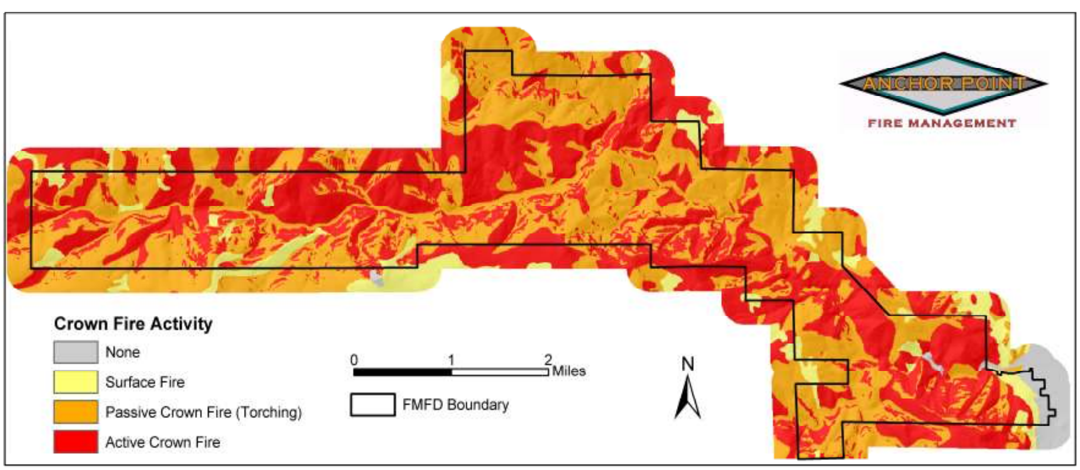
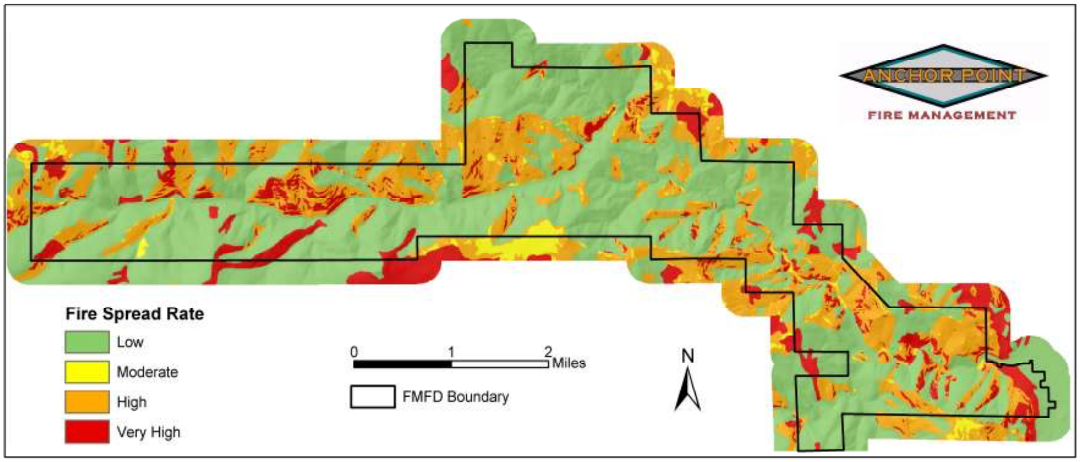


Figure 8: Spread Rate Predictions (Average Weather Conditions)



Spread rate values are generated by the FlamMap model and classified into four categories based on standard ranges: 0-20 chains/hour (CPH), 20.1-40 CPH, 40.1-60 CPH, and 60.1-450 CPH.

Figure 9: Spread Rate Predictions (Extreme Weather Conditions)

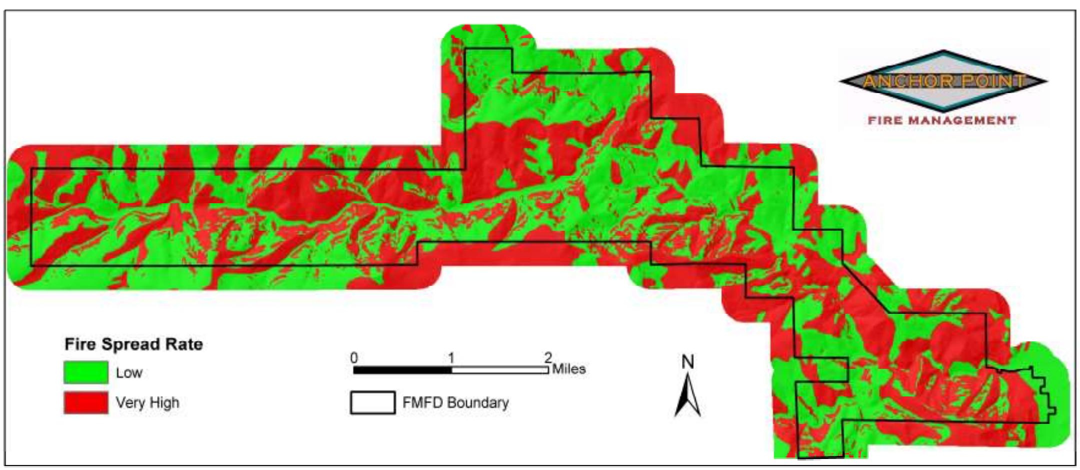
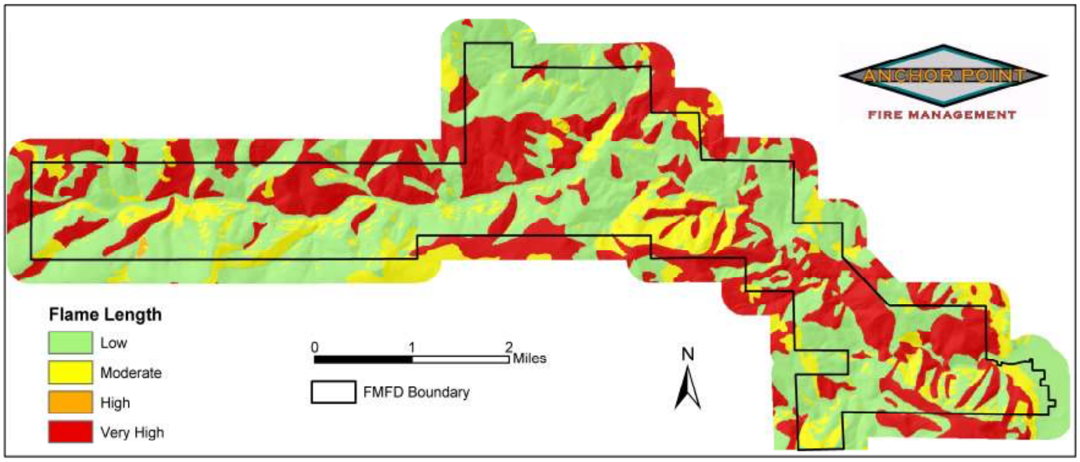


Figure 10: Flame Length Predictions (Average Weather Conditions)



Flame length values are generated by the FlamMap model and classified in the four categories based on standard ranges: 0-4 feet, 4.1-8 feet, 8.1-11 feet and 11.1-60 feet.

Figure 11: Flame Length Predictions (Extreme Weather Conditions)

Figure 12: District Wide Fire Behavior Potential (Average Weather Conditions)

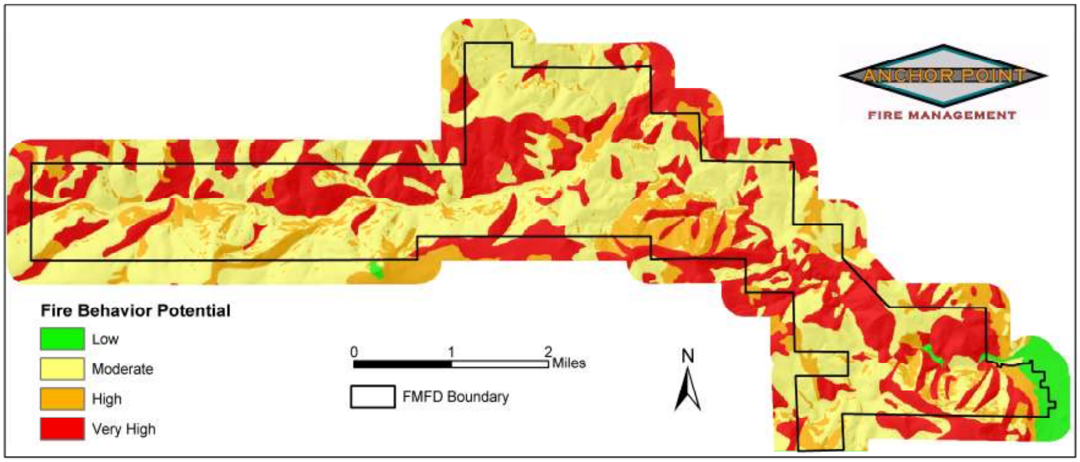
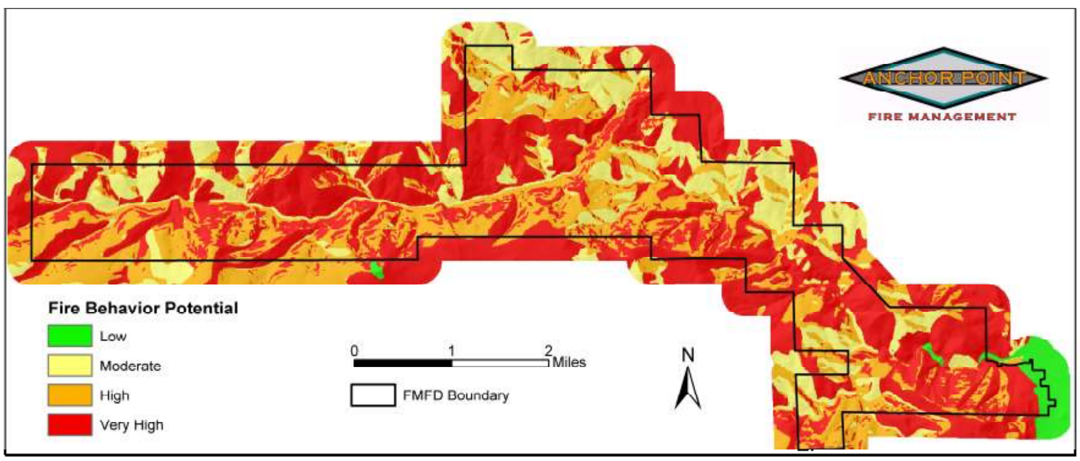


Figure 13: District Wide Fire Behavior Potential (Extreme Weather Conditions)



FIRE BEHAVIOR INTERPRETATION

The Fire Behavior Potential map shows the results of the Wildfire Hazard Evaluation. This evaluation is a prediction of likely fire behavior given a standardized set of conditions and a single point source ignition at every point. It does not consider cumulative impacts of increased fire intensity over time and space. The model does not calculate the probability that a wildfire will occur. It assumes an ignition occurrence for every cell (a 10 x 10 meter area).

Appendix B

Communities

Purpose

The purpose of this appendix is to examine, in greater detail, the communities in the study area. Of the sixteen communities in Four Mile Fire Protection District, two were found to represent an extreme hazard; four were rated as very high hazard, seven as high hazard and three as moderate hazard (see Figure1). For easy reference, the map of communities presented in the main text has been reproduced here as Figure 2. Figure 3 displays this grouping graphically. Table 1 has been included for quick identification.

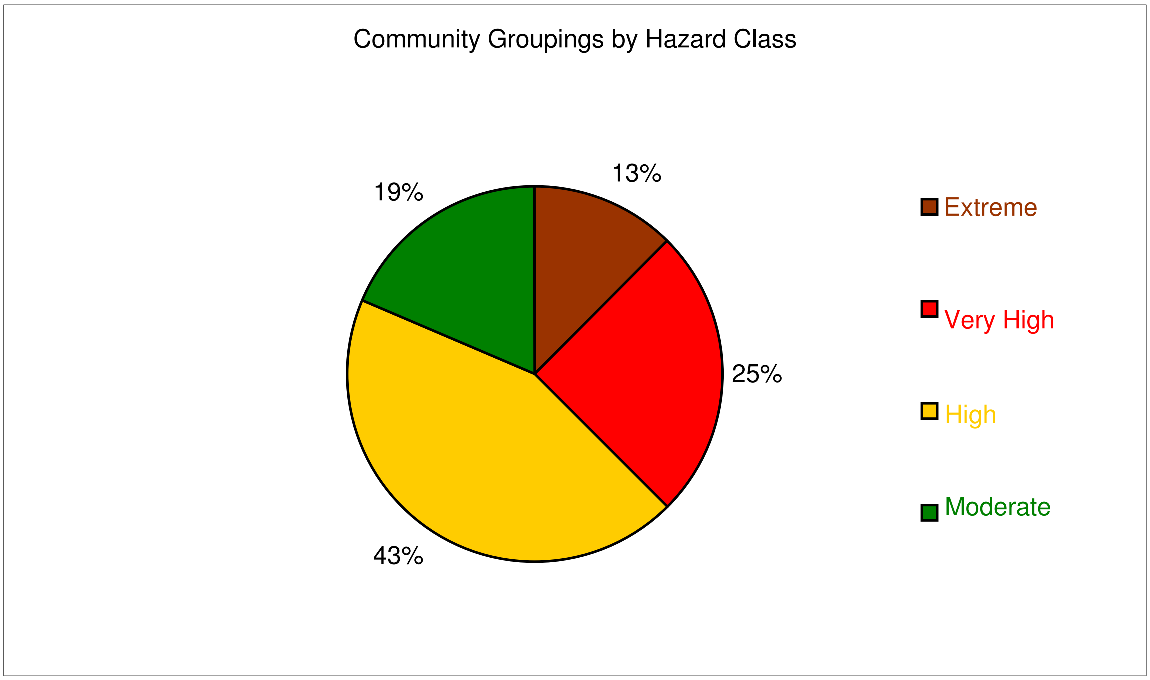


Figure 1

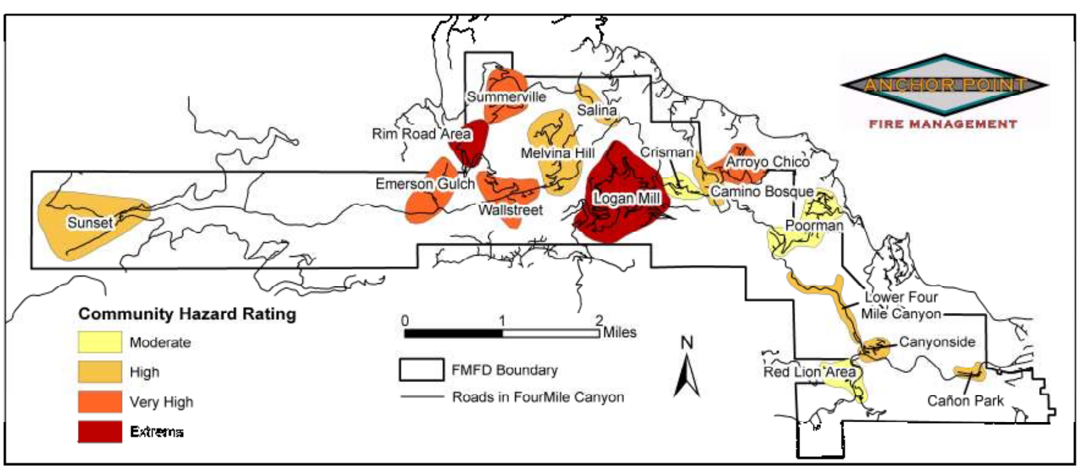


Figure 2

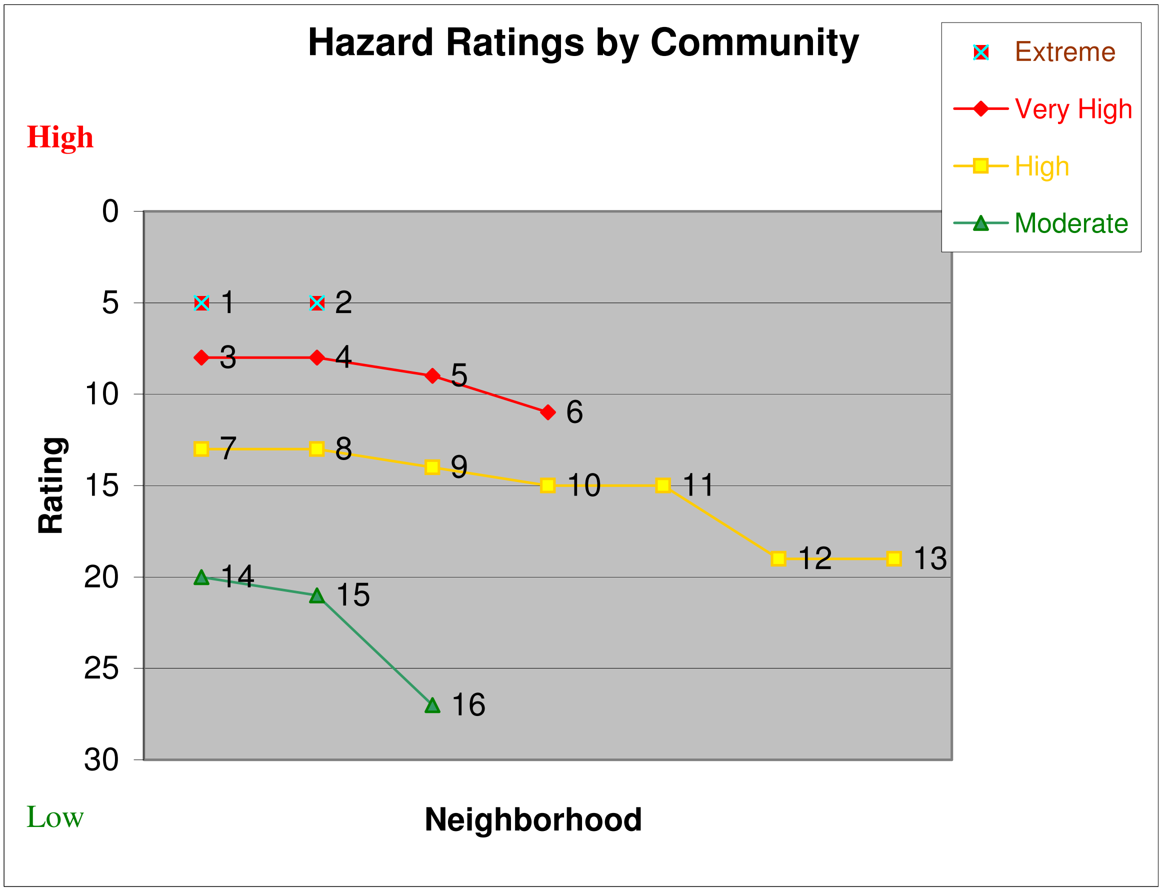


Figure 3

Table 1: Communities by Hazard Rating

1. Rim Road Area	**9. Lower Four Mile Canyon**
2. Logan Mill	**10. Melvina Hill**
3. Wallstreet	**11. Canon Park**
4. Summerville	**12. Salina**
5. Emerson Gulch	**13. Canyonside**
6. Arroyo Chico	**14. Red Lion Area**
7. Sunset	**15. Crisman**
8. Camino Bosque	**16. Poorman**

Extreme Very High High Moderate

General Recommendations

A combination of access, ignition resistant construction, and fuels reduction should create an environment safe for emergency service personnel and provide reasonable protection to structures from a wildfire. These techniques should also significantly reduce the chances of a structure fire becoming an ignition source to the surrounding wildlands.

In addition to the suggested mitigations listed for the individual communities, several general measures can be taken to improve fire safety. The following recommendations should be noted and practiced by all who live in the Wildland-Urban Interface:

1. Be aware of the current fire danger in the area.
2. Clean your roof and gutters at least 2 times a year, especially during fall clean up.
3. Stack firewood uphill or on a side contour, at least 30 feet away from structures.
4. Don't store combustibles or firewood under decks.
5. Maintain and clean spark arresters on chimneys.
6. When possible, maintain an irrigated greenbelt around the home.
7. Connect (and have available) a minimum of 50 feet of garden hose.
8. Post reflective lot and/or house numbers so that they are clearly visible from the main road. There should also be reflective numbers on the structure itself.
9. Trees along driveways should be limbed and thinned as necessary to maintain a minimum 13’6” vertical clearance for emergency vehicle access.
10. Continually maintain your defensible space:
    - Mow grass and weeds to a low height.
    - Remove any branches overhanging the roof or chimney.
    - Remove all trash, debris and cuttings from the defensible space.

Note

All communities that rated as extreme to high hazard level were recommended for a parcel level analysis. In the moderate level communities a parcel level analysis was recommended only if the evaluator found that a significant number of homes had no or ineffective defensible space or a significant number of hazards near homes was detected. In short the recommendation was made if the evaluator felt a parcel level analysis would generate a noticeable improvement in the community’s defensibility.

Technical Terms

The following definitions apply to terms used in the "description" and "comments and mitigation" sections of this appendix.

Defensible Space: An area around a structure where fuels and vegetation are modified, cleared, or reduced to slow the spread of wildfire toward or from the structure. The design and distance of the defensible space is based on fuels, topography, and the design of and materials used in the construction of the structure.

Extended Defensible Space (also known as Zone 3): This is a defensible space area where treatment is continued beyond the minimum boundary. This zone focuses on forest management with fuels reduction being a secondary function.

Shelter-in-Place Areas: There are several ways of protecting the public from an advancing wildfire. One of these methods is evacuation and involves relocation of the threatened population to a safer area. Another is to instruct people to remain inside their homes or public buildings until the danger passes. This concept is new to wildfire in the United States, but not to hazardous materials incident response where time, hazards, and sheer logistics often make evacuation impossible. This concept is the dominant modality for public protection from wildfires in Australia where fast moving, non-persistent fires in light fuels make evacuation impractical. The success of this tactic depends on a detailed preplan that takes into account the construction type and materials of the building used, topography, depth and type of the fuel profile, as well as current and expected weather and fire behavior. For a more complete discussion of the application and limitations of Shelter-in-Place concepts see the "Evacuation Routes and Safety Zones FMU" section in the main report.

Citizen Safety Zone: An area that can be used for protection by residents in the event that the main evacuation route is compromised. The area should be maintained, cleared of fuels and large enough for all residents of the area to survive an advancing wildfire without special equipment or training.

Fuelbreak: A natural or constructed discontinuity in a fuel profile utilized to segregate, stop, or reduce the spread of fire. As a practical matter fuelbreaks in the WUI are most effective against crown fires.

Community Assessment Methodology

The community level methodology for this assessment uses a Wildfire Hazard Rating (WHR) that was developed specifically to evaluate communities within the Wildland Urban Interface (WUI) for their relative wildfire hazard.[1] The WHR model combines physical infrastructure such as structure density and roads and fire behavior components like fuels and topography, with the field experience and knowledge of wildland fire experts. It has been proven and refined by use in rating over 1,400 neighborhoods throughout the United States.

Numerous fire management professionals were queried regarding their knowledge about, and experience with, specific environmental and infrastructure factors, and wildfire behavior and hazards. Weightings within the model were established through these queries. The model was designed to be applicable throughout the western US.

The model was developed from the perspective of performing a triage on a threatened community in the path of an advancing wildfire with moderate fire behavior. The WHR survey and fuel model ground truthing are accomplished by field surveyors with WUI fire experience. The rating system assigns up to a maximum of 50 points based on six categories: average lot size, slope, primary aspect, average fuel type, fuel continuity and surface fuel loading. The higher the community scores, the lower its wildfire hazard. For example, a community with an average lot size of less than 1 acre and slopes of greater than 30% would receive 0 points for those factors whereas a community with an average lot size of 5 acres and slopes of less than 15% would receive 16 points for the same factors. Additional hazards are then subtracted from the subtotal of points earned in the six categories to give a final numeric value. The final value is then used to group communities into one of five hazard ratings: Extreme, Very High, High, Moderate, or Low.

It is important to note that not all groupings occur in every geographic region. There are some areas with no low hazard communities, just as there are some areas with no extreme communities. The rankings are also related to what is customary for the area. That is to say a high hazard area on the plains of Kansas may not look like a high hazard area on the western slope of Colorado. The system creates a relative ranking of community hazard rating in relation to the other communities in the study area. It is designed to be used by experienced wildland firefighters who have a familiarity with structural triage operations and fire behavior in the interface.

[1] C. White, "Community Wildfire Hazard Rating Form" *Wildfire Hazard Mitigation and Response Plan*, Colorado State Forest Service, Ft. Collins, CO, 1986.

Communities

1. Rim Road

Figure 4

Hazard Rating:	**Extreme**
Does the neighborhood have dual access roads?	No
Are there road grades > 8%?	Yes
Are all access roads of adequate width?	No
Average lot size:	>5 Acres
Fuel models found in the neighborhood:	9
Water supply:	None
Hazards:	Steep slopes, inadequate access roads.

Description:

This neighborhood has steep, rocky, narrow roads with no turnarounds. Access and egress would be difficult in fire conditions. Address and street signage both need improvement. Homes are built on steep slopes and at the top of the ridge. Most of the access is along the ridge. There is a continuous heavy fuel load, with plentiful ladder fuels. Low power lines and construction equipment parked in the roadway are additional hazards. The closest water supply for suppression is a cistern on Dixon Gold Trail below this neighborhood. Some yards are in need of clean up.

Comments & Mitigation Notes:

Reduce ladder fuels. Clean up dead and down material in yards. Remove combustibles and trash from around homes. Improve roads, signage, and turnarounds. Improvement in the water supply is critical (see Water Supply FMZ). Most homes need defensible space. Extended defensible spaces and adequate shelter-in-place areas or safety zones are highly recommended. A parcel level analysis of this neighborhood is recommended.

2. Logan Mill

Figure 5

Hazard Rating:	**Extreme**
Does the neighborhood have dual access roads?	No
Are there road grades > 8%?	Yes
Are all access roads of adequate width?	No
Average lot size:	1-5 Acres
Fuel models found in the neighborhood:	2, 9
Water supply:	Draft water at Station 1 and a 12,000 gal. cistern at upper Wendelyn Road.
Hazards:	Ravines, inadequate access roads, steep draws and steep slopes.

Description:

This area has steep roads. Access to many homes is steep and narrow with difficult or absent turnarounds. There are missing or inadequate street signs and addressing. Many homes are built at the top or mid-slope on slopes of greater than 30%. There is a heavy fuel load and a continuous canopy with plentiful ladder fuels. There are many parcels with tree limbs touching the structures. There is a high structure density in this community.

Comments & Mitigation Notes:

Thin conifers, especially "dog hair" stands of Douglas fir, and reduce ladder fuels. Clean up dead and down material. Add reflective street and address signage. Thin trees along the roadways. Improve roads and turnarounds, especially on dead end roads. If it is not possible to create additional escape routes consider developing shelter-in-place areas or safety zones. Most homes in this area need defensible space. A parcel level analysis of this neighborhood is recommended.

3. Wall Street

Figure 6

Hazard Rating:	**Very High**
Does the neighborhood have dual access roads?	Yes
Are there road grades > 8%?	Yes
Are all access roads of adequate width?	No
Average lot size:	**<**1 Acres
Fuel models found in the neighborhood:	2, 9
Water supply:	Wall Street station and ponds.
Hazards:	Steep slopes, inadequate roads, yards full of flammable materials.

Description:

Wall Street is located at the bottom of Four Mile Canyon along both sides of the creek. Both sides of the canyon have a high fuel load. Most of the yards are cluttered with trash, woodpiles and other hazards. Many homes have fuels under and around propane tanks and trees right up to the buildings. Four Mile Canyon Road has adequate width and turnarounds, but some of the secondary roads and driveways are steep and have inadequate turnarounds. The area can be escaped to the west by using the Switzerland Trail, but egress would be slow.

Comments & Mitigation Notes:

Yards need to be cleaned up, fuels thinned and trees limbed. Many homes need defensible space. Exposed areas of the structure and propane tanks need to be cleared of flammable vegetation. Improved access for homes not located on Four Mile Canyon Road is strongly recommended. As with all structures located in the canyon bottoms, ignition resistant roofs are highly recommended to prevent ignitions from spotting and ember cast. Reflective addressing needs to be added on most homes and on private drives. A parcel level assessment is recommended for this community.

4. Summerville

Figure 7

Hazard Rating:	Very High
Does the neighborhood have dual access roads?	Yes
Are there road grades > 8%?	Yes
Are all access roads of adequate width?	No
Average lot size:	<1 Acre
Fuel models found in the neighborhood:	9
Water supply:	Summerville cistern
Hazards:	Poor access to the upper area, steep slopes.

Description:

The main portion of Summerville is a collection of very old houses located along the road. Access to these is good, however they are at the bottom of steep slopes with heavy fuel load. Vegetation and combustible materials exist right up to structures. There are propane tanks surrounded by flammable vegetation. There is a secondary area located up a steep narrow road with single access. There are three large homes here that are under construction, and located on steep slopes.

Comments & Mitigation Notes:

Many homes need defensible space. Extended defensible spaces should be considered to protect older structures from spotting and rolling materials. Combustibles and grasses should be cleared away from structures and propane tanks. Fuel breaks and thinning downhill of homes in upper Summerville should be considered. A parcel level analysis of this neighborhood is recommended.

5. Emerson Gulch

Figure 8

Hazard Rating:	**Very High**
Does the neighborhood have dual access roads?	No
Are there road grades > 8%?	Yes
Are all access roads of adequate width?	No
Average lot size:	1-5 Acres
Fuel models found in the neighborhood:	2, 9
Water supply:	5,000 gal. cistern in Emerson Gulch. Additional water at Wall Street station.
Hazards:	Steep draws. Inadequate roads and turnarounds.

Description:

This lower portion of Emerson Gulch has homes located on slopes as steep as 45%. Although the fuels are primarily fuel model two in the middle and upper areas, there is an appreciable amount of fuel model nine with moderate to heavy slash components lower down. There is only one way in and out, so the fuels hazard in the lower area is dangerous to the entire community. Most homes need defensible space and better addressing.

Comments & Mitigation Notes:

Fuels reduction and slash removal should be done downhill of homes and along the road, especially in the lower area. Most homes need defensible space and yard cleanup. Since there is no escape from the upper gulch, the development of shelter-in-place areas and/or safety zones is strongly recommended. A parcel level analysis is recommended.

6. Arroyo Chico

Figure 9

Hazard Rating:	**Very High**
Does the neighborhood have dual access roads?	No
Are there road grades > 8%?	Yes
Are all access roads of adequate width?	No
Average lot size:	>5 Acres
Fuel models found in the neighborhood:	2
Water supply:	Cistern near 411Camino Bosque
Hazards:	Steep slopes, inadequate roads

Description:

Fuel loads are mostly moderate, however high mortality makes these fuels more hazardous than normal. Although most roads are of adequate width, some driveways and private roads are inadequate. Some homes have combustible materials near structures and propane tanks. Many homes need defensible space.

Comments & Mitigation Notes:

Eliminate standing dead and thin dog hair stands. A shaded fuel break to the east of homes above the steeper drainages should be considered. Be sure to clear grasses and combustible materials away from structures and propane tanks. Extended defensible space, shelter-in-place areas or safety zones, and yard clean up are recommended for most homes. A parcel level analysis is recommended.

7. Sunset

Figure 10

Hazard Rating:	High
Does the neighborhood have dual access roads?	Yes
Are there road grades > 8%?	Yes
Are all access roads of adequate width?	Yes
Average lot size:	<1 Acre
Fuel models found in the neighborhood:	2,9,10
Water supply:	50,000-60,000 gal. pond at 10571 Four Mile Canyon Road.
Hazards:	Steep slopes, dilapidated mining shacks, heavy insect kill.

Description:

Sunset is primarily located in a wide section of Four Mile Canyon with good access and 4WD escape routes to both the south and north. Some homes are located up steep driveways and private roads. Homes located in Pennsylvania Gulch have steep, rocky single access. There are a lot of snags from insect activity. There is an area of heavy blow down on the north slope. Most homes need defensible space. Tree limbs touch most homes and tall grasses grow up to foundations.

Comments & Mitigation Notes:

The pond would be a good place to add a dry hydrant. Homes need defensible space and yard clean up. Remove dead and diseased vegetation. Investigate the possibility of combining private and public landowners to thin stands and remove snags on slopes above homes. Extended defensible space, especially for homes on north slopes, is recommended. A parcel level analysis is recommended.

8. Camino Bosque

Figure 11

Hazard Rating:	High
Does the neighborhood have dual access roads?	No
Are there road grades > 8%?	Yes
Are all access roads of adequate width?	No
Average lot size:	1-5 Acres
Fuel models found in the neighborhood:	2
Water supply:	10,000 gal. cistern near 411 Camino Bosque
Hazards:	Houses on ridge tops, steep slopes, narrow steep access to some homes and poor turnarounds in some areas.

Description:

This area has had some mitigation. Limbing and thinning near homes is apparent, however tall grasses need to be mowed away from houses and propane tanks. There are many homes located mid-slope on slopes of up to 34% and at the top of ridges. The entire area needs better address signage. Main access roads are steep but good, but some homes, particularly in the lower section, have steep, rocky, narrow access with poor turnarounds. Some homes need defensible space.

Comments & Mitigation Notes:

Improve poor roads in the lower section. Extended defensible space, shelter-in-place areas and/or safety zones are recommended. Improve address and road signage. A parcel level analysis is recommended.

9. Lower Four Mile Canyon

Figure 12

Hazard Rating:	High
Does the neighborhood have dual access roads?	Yes
Are there road grades > 8%?	Yes
Are all access roads of adequate width?	Yes
Average lot size:	1-5 Acres
Fuel models found in the neighborhood:	2
Water supply:	20,000 gal. Cistern above 357 Canyonside. Dry hydrant in the area may be usable. Possible draft water (see description).
Hazards:	Untested bridges. Steep slopes.

Description:

Homes closer to Boulder Canyon are generally built in the riparian corridor along the creek. Although the heavy vegetation near these homes is mostly riparian, there is a threat of spotting and rolling materials from the steep slopes, many over 50%, of primarily fuel model two above structures. Access to many structures requires crossing bridges that are neither tested nor marked. Some homes farther up canyon have been built mid-slope and although access is steep to some of these, it is generally adequate. There is a dry hydrant at Boulder Mountain Lodge and draft access is available, but the creek often has little or no water in the lower canyon in late summer and fall.

Comments & Mitigation Notes:

Most homes need defensible space. As with all structures located in the canyon bottoms ignition resistant roofs are highly recommended to prevent ignitions from spotting and ember cast. Address signage needs improvement. Bridges should be marked where their condition is known (see main report). A parcel level analysis is recommended.

10. Melvina Hill

Figure 13

Hazard Rating:	High
Does the neighborhood have dual access roads?	No
Are there road grades > 8%?	Yes
Are all access roads of adequate width?	Yes
Average lot size:	1-5 Acres
Fuel models found in the neighborhood:	2
Water supply:	10,000 gal. cistern at the fork in Melvina Hill Road. Additional water is available at Wall Street.
Hazards:	Steep draws and roads. Many snags.

Description:

This neighborhood has steep but good roads. A lot of mitigation has been done around homes and roads, but slash removal needs to be completed especially around roads. This is another area with many snags from insect kill. Although the dominant vegetation is ponderosa pine, there are more junipers here than in other areas. Presently there are only a few homes on the steeper, and more hazardous, east side, but it looks as though this area is being surveyed for development. If this is the case it may make this community of higher concern.

Comments & Mitigation Notes:

Continue to limb and thin near homes. Continue removal of dead and diseased trees. Mow grasses away from structures. Develop shelter-in-place areas and/or safety zones. A shaded fuel break between homes on the west side and the steep drainage to the west is recommended. Some homes need defensible spaces. A parcel level analysis is recommended.

11. Cañon Park Area

Figure 14

Hazard Rating:	High
Does the neighborhood have dual access roads?	No
Are there road grades > 8%?	Yes
Are all access roads of adequate width?	No
Average lot size:	<1 Acre
Fuel models found in the neighborhood:	2
Water supply:	City of Boulder hydrant at 101 Pearl and draft water available from Boulder Creek.
Hazards:	Steep slopes, narrow dead end roads, no turnarounds, shake roofs, power lines.

Description:

The area can be divided into three parts. Cañon Park Drive is composed of older homes located on the north side of Boulder Creek. Access is flat, but narrow and lacking adequate turnarounds. These homes are mainly threatened by spotting and rolling materials from the south-facing slope above them. The area on the south side of Boulder Canyon has three wood structures with shake roofs. Access is better here, but ember cast would easily involve structures. There are some homes on the north side of Boulder Canyon east of Cañon Park Drive. Three of these are cantilevered wood structures located mid-slope up a narrow, dead end driveway. These structures would be very hazardous to defend.

Comments & Mitigation Notes:

The structures on Cañon Park Drive need defensible spaces particularly on the north side where there is the most risk from spotting and rolling materials. The homes to the east need yard cleanup and wider access with a turnaround. Consider installing non-combustible materials under the cantilevered portions. Grasses and flammable vegetation should be cleared away from all structures. Reflective address signage should be added to all homes, and any improvements in road widths and turnarounds that are possible should be considered. A parcel level analysis is recommended.

12. Salina

Figure 15

Hazard Rating:	High
Does the neighborhood have dual access roads?	Yes
Are there road grades > 8%?	Yes
Are all access roads of adequate width?	Yes
Average lot size:	<1 Acre
Fuel models found in the neighborhood:	8, 9
Water supply:	10,000 gal. cistern at Salina station.
Hazards:	Homes with no vehicle access, combustibles stored near homes, low power lines, steep slopes.

Description:

This is another community surrounded by steep slopes (up to 60%). There are parcels with flammable debris near structures. There are low power lines in the community and some homes are only accessible by steep narrow staircases. Most homes need defensible spaces.

Comments & Mitigation Notes:

Clean up around structures. Remove or limb trees touching structures. Improve address signage. Most homes in this area need defensible space. A parcel level analysis of this neighborhood is recommended.

13. Canyonside

Figure 16

Hazard Rating:	High
Does the neighborhood have dual access roads?	No
Are there road grades > 8%?	Yes
Are all access roads of adequate width?	No
Average lot size:	1-5 Acres
Fuel models found in the neighborhood:	2
Water supply:	20,000 gal. cistern above 357 Canyonside.
Hazards:	Steep slopes and roads.

Description:

A lot of mitigation work has been done in this community. There is noticeably less insect kill in this area. Roads are generally adequate except for a few narrow driveways. The main problems here are that most homes are located mid-slope on steep (over 40%) slopes, and there is only one way in and out of the community.

Comments & Mitigation Notes:

Improve narrow driveways if possible. Consider extended defensible spaces, shelter-in-place areas and/or safety zones. Consider a shaded fuel break below homes or encourage homeowners to thin vegetation on slopes below homes. A parcel level analysis is recommended.

14. Red Lion Area

Figure 17

Hazard Rating:	**Moderate**
Does the neighborhood have dual access roads?	No
Are there road grades > 8%?	Yes
Are all access roads of adequate width?	Yes
Average lot size:	>5 Acres
Fuel models found in the neighborhood:	2, 9
Water supply:	Fill site at the pull out west of the Red Lion, and draft water from Boulder Creek.
Hazards:	Steep slopes, ravines

Description:

The area on the north side of Boulder Canyon has slopes up to 45% with moderate loads of primarily fuel model two. Roads are steep, but otherwise good. There are some parcels with tree limbs touching structures. Woodpiles and other combustibles are stored against structures. The area on the south side of Boulder Canyon includes the Red Lion Restaurant, which is on city water. There are several cabins clustered around the restaurant. These are all near the creek and have irrigated greenbelt. There are a few homes located up a steep drainage to the south. That area has a high loading of fuel model nine. There is a 4WD road that provides an escape to Flagstaff Mountain, but a landowner usually blocks the access. This route, Chapman Road, is also steep and poorly maintained.

Comments & Mitigation Notes:

Cut trees away from homes and thin downhill of homes. Some homes in this area need defensible space.

15. Crisman

Figure 18

Hazard Rating:	**Moderate**
Does the neighborhood have dual access roads?	No
Are there road grades > 8%?	No
Are all access roads of adequate width?	No
Average lot size:	<1 Acre
Fuel models found in the neighborhood:	2
Water supply:	Draft water from Four Mile Creek (low flow and not always reliable)
Hazards:	Low power lines.

Description:

This area has moderate loads of primarily fuel model two. The community is at the bottom of slopes up to 45%. Access roads are flat, but lack turnarounds, and there is an unrated bridge which must be crossed to access several homes. Some parcels have a lot of vegetation against structures.

Comments & Mitigation Notes:

This would be a good place to consider a dry hydrant or a cistern. Low power lines should be marked or relocated. Some houses need defensible spaces, and all need better address signage. Improve turnarounds.

16. Poorman

Figure 19

Hazard Rating:	**Moderate**
Does the neighborhood have dual access roads?	Yes
Are there road grades > 8%?	Yes
Are all access roads of adequate width?	Yes
Average lot size:	>5 Acres
Fuel models found in the neighborhood:	1, 2, 8
Water supply:	10,000 gal. cistern on Poorman Road. Draft pond and pump station at Four Mile Canyon Road and Poorman Road.
Hazards:	Steep slopes on the Sunshine Canyon side.

Description:

This neighborhood has light to moderate loads of fuel models one, two and eight. Slopes up top are generally less than 20%. The lower area is steeper (up to 30% slope) and has a higher fuel load. There are few homes here and the access is good. This community continues outside the Four Mile FPD, where its hazard level increases due to steep slopes, more fuels and greater structure density on the Sunshine Canyon side.

Comments & Mitigation Notes:

Some homes need defensible space. Consider a fuelbreak, if possible, to separate homes from the steep slopes on the Sunshine Canon side. This community would rate as high or very high if the analysis were continued into the Sunshine FPD.

Appendix C

Four Mile Canyon Hazard Assessment
Structural Triage and Preparation

Size Up Considerations

- What is the current and expected weather?
- Are fuels heavy, moderate, or light? What is the arrangement and continuity of fuels?
- Note any hazardous topography.
- What have fires in this area done before?
- What is the fire's current and expected behavior?
  - What is the rate and direction of spread?
  - What is the potential for spotting and firebrands?
  - Will topographical features or expected weather changes affect the rate of spread?
- What are the number and density of structures threatened?
- What are the available resources?
- Will you have to evacuate people or animals?
  - Are there residents who will not evacuate?
- How hazardous is the structure?
  - What is the roofing material?
  - Are the gutters full of litter?
  - Are there open eves and unscreened vents?
  - Does the structure have wooden decking?
  - Is there defensible space?
  - Are there large windows with flammable drapes or curtains?
  - What is the size and location of propane tanks and/or fuel storage tanks?

Fire Fighter Safety

- What are the routes of egress and ingress?
  - What is the largest engine that can access the structure safely?
  - Are the roads two way or one way?
  - Are there road grades steeper than 8%?
  - Are the road surfaces all weather?
  - Are there load-limited bridges?
- Are there anchor points for line construction?
- Are there adequate safety zones?
- What are the escape routes?
- Are there special hazards such as hazardous materials, explosives, high-voltage lines, or above ground fuel tanks?
- Are communications adequate?

Structural Triage Categories

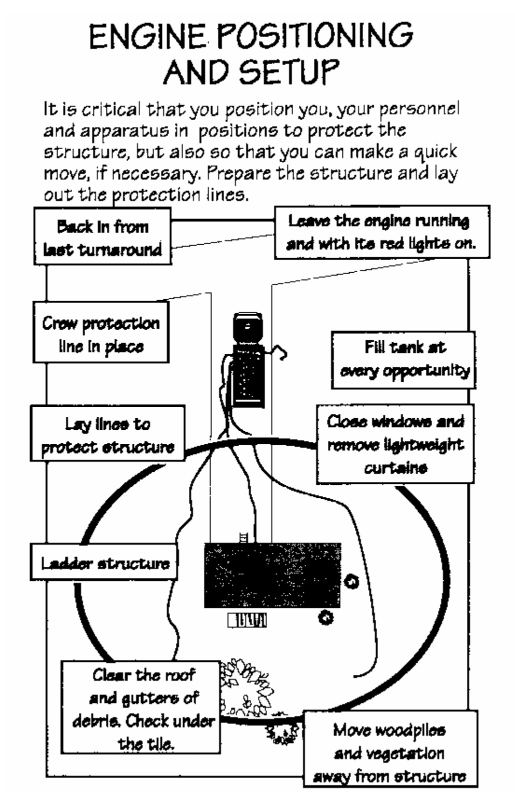
Sort structures into one of three categories:
1. Stand Alone or Not Threatened
2. Defendable
3. Not Defendable.

- Factors that may make an attempt to save a structure too dangerous or hopeless:
  - The fire is making sustained runs in live fuels and there is little or no defensible space
  - Spot fires are too numerous to control with existing resources
  - Water supply will be exhausted before the threat has passed
  - The roof is more than ¼ involved in flames
  - There is fire inside the structure
  - Rapid egress from the area is dangerous or may be delayed

Apparatus Placement Considerations

Common Ignition Points

- Flammable roof coverings and debris
- Unscreened vents, windows or holes
- Open doors, windows or crawl spaces
- Wooden decks, lawn furniture, stacked wood and trash piles
- In windy conditions, firebrands can enter almost any opening
- Openings under porches or patio covers



[1]

[1] Teie,William C.,1995, Firesighter's Guide, Urban/Wildland Situations. Deer Valley Press

Appendix D

Access and Water Supply Recommended Guidelines

Introduction

This appendix has been designed with public education in mind and is intended to be used to help familiarize homeowners, contractors, and developers with the general principles of the access and water supply needs of firefighters. The recommendations in this section are based on proven practices. However, they are not intended to be a substitute for locally adopted codes.

Emergency response personnel do their best to respond to calls in a timely manner, often while negotiating difficult terrain. Planning for access by emergency equipment allows for a more efficient response, improving safety for residents and their families, as well as that of the firefighters and emergency medical technicians that will arrive on scene. This is especially important in rural areas, where response times may be considerably longer than in cities.

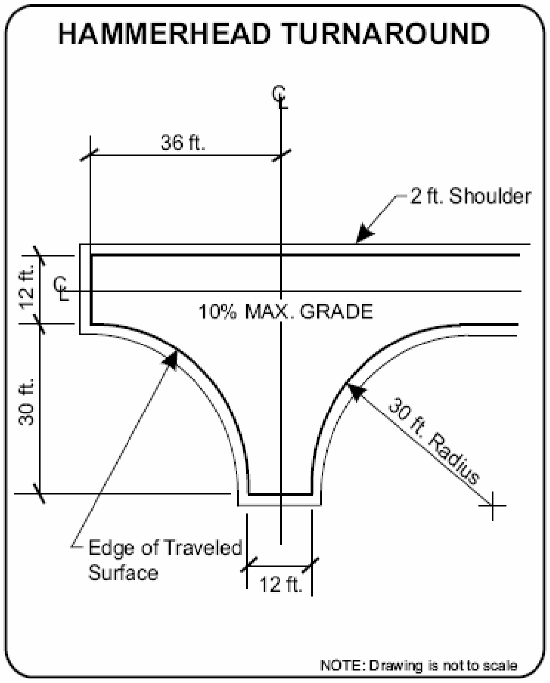
Access Guidelines

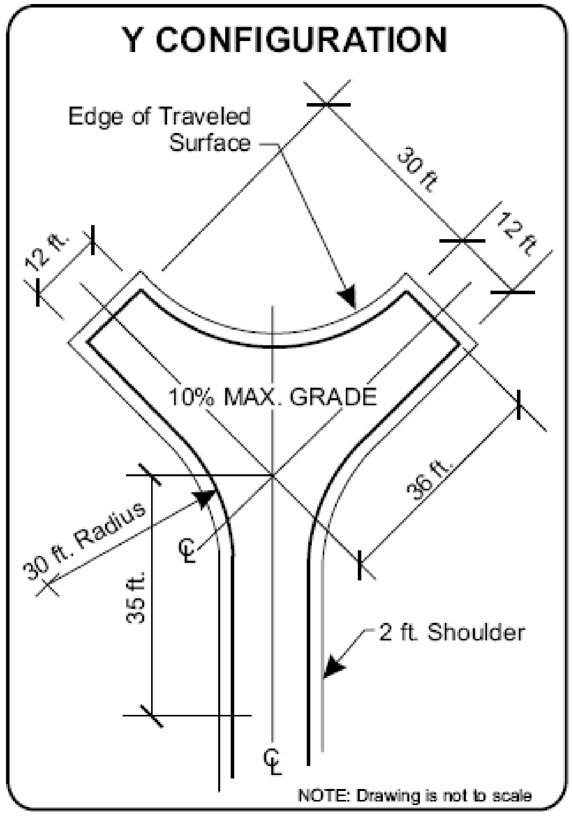
Driveway Turnarounds

Turnarounds that are unobstructed by parked vehicles are designed to allow for the safe reversal of direction by emergency equipment. The “Y” and “Hammerhead” turnarounds shown below are preferred because they provide the necessary access while minimizing disturbance to the site. Turnarounds should be located at the end of every driveway.

Driveway Width and Height

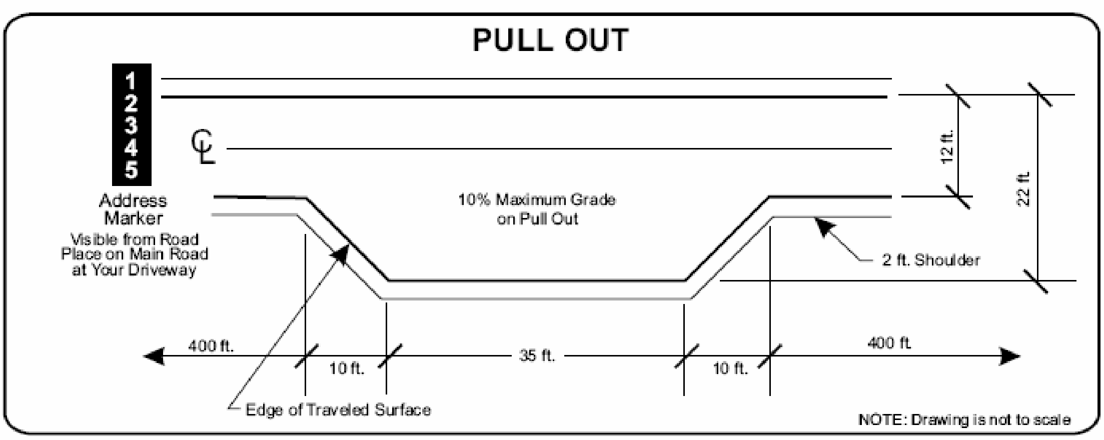
Driveways should have an unobstructed vertical clearance of 13 feet 6 inches. Trees may need to be limbed, and utility lines relocated to provide the necessary clearance. Driveways should have a 12-foot wide drivable surface and 14 feet of horizontal clearance.





Driveway Pullouts

Driveway pullouts are designed with sufficient length and width to allow emergency vehicles to pass one another during emergency operations. These features should be placed at 400-foot intervals along driveways and private access roads (community driveways). The location of pullouts may be modified slightly to accommodate physical barriers such as rock outcroppings, wetlands, and other natural or manmade features.



Address Markers

Every building should have a permanently posted, reflective address marker mounted on a non-combustible pole. The sign should be placed and maintained at each driveway entrance. Care should be taken to ensure that the location will not become obscured by vegetation, snow, or other features, whether natural or manmade. It is critical that the location and markings are adequate for easy night-time viewing. It is preferable to locate markers in a consistent manner within each community. A good guideline for this practice is to place the markers five feet above ground level on the right side of every driveway. Where multiple homes are accessed by a single driveway, all addresses that are accessed via that driveway should be clearly listed on the driveway marker. Where multi-access driveways split, each fork should indicate all residences accessed by that fork, and the proper direction of travel to arrive at a given address. It is not adequate to simply mark addresses on a common pole in the center of the fork. Residential homes should have an additional reflective address marker permanently attached to the home in clear view of the driveway or access road. Homes that are marked by lot number while under construction should have the lot number removed and a permanent address marker posted before granting a certificate of occupancy.

Bridge Load Limits

Bridge load limits should be posted with a permanently mounted, reflective marker at both entrances to the bridge. Care should be taken to ensure that these markers will not become obscured by vegetation, snow, or other features, whether natural or manmade. It is critical that the location of the markings and the markings themselves be adequate for easy night-time viewing.

Alternative Water Sources

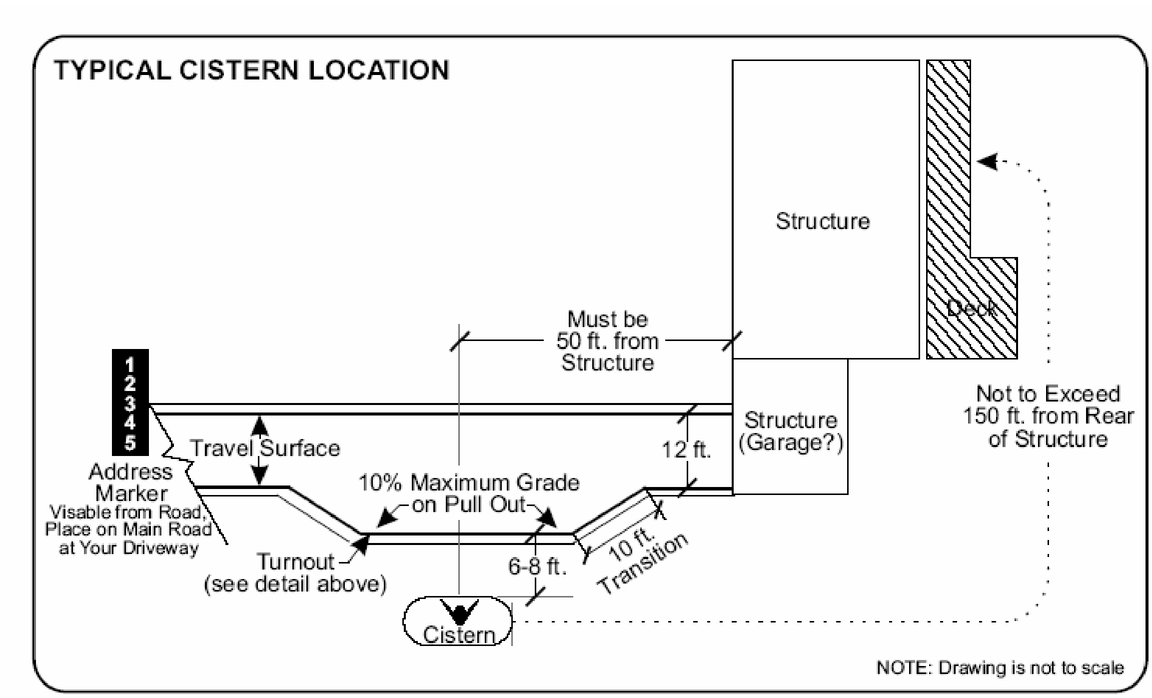
In the study area, like many of the mountainous areas of Colorado’s front range, water is a critical fire suppression issue. Nine of the twenty-five water sources commonly used by the FMFD for fire suppression could be dry or too low to be effective during at least part of the fire season. The hazard assessment revealed several communities in the study area which are a considerable distance from reliable water sources for fire suppression. The following information on the use of cisterns and dry hydrant installations has been included to provide guidelines for future water supply development in the district. For more detailed recommendations regarding enhancement of the existing water supply system, please see the *Water Supply FMU* section of the main report.

Cisterns

Once emergency vehicles have arrived on site, they will need a dependable supply of water to help control the fire. Although residential wells with outdoor taps can be used by fire crews to help fill engine tanks, they are not adequate for fire control. If the property is a significant distance from a reliable water supply or fire station, it may be advisable to employ one of the following water supply options:

- An on-site 1,800 to 2,500 gallon cistern for each residence.
- A monetary contribution to a large community cistern fund.

For more information about local standards and regulations, please contact the FMFD.



Dry Hydrants

Dry hydrant installations already are in use in the study area. Guidelines for the construction and maintenance of dry hydrants may be found in the *Dry Hydrant Manual* included as a supplement to this report.

It is always helpful to discuss any potential construction project with the fire department. FMFD officials can help determine what kind of access and water supply options will work best for your site. While the guidelines in this appendix have been assembled by querying firefighters with extensive Wildland-Urban Interface firefighting and fire code experience, the FMFD is in the best position to offer site-specific information.

Appendix E

Four Mile Fire Protection District Collaborative Effort

THE NEED FOR A CWPP

In response to the Healthy Forest Restoration Act (HFRA) and in an effort to create incentives, Congress directed interface communities to prepare a Community Wildfire Protection Plan (CWPP). Once completed, a CWPP provides statutory incentives for the US Forest Service (USFS) and the Bureau of Land Management (BLM) to consider the priorities of local communities as they develop and implement forest management and hazardous fuel reduction projects. In the case of the Four Mile Fire Protection District (FMFPD), the need for a community-based hazard and risk assessment (HRA) was born from an internal need, not a federal directive. The district does border federal land; however, and a CWPP became desirable after the HFRA initiative.

CWPPs can take a variety of forms, based on the needs of the people involved in their development. CWPPs may address issues such as wildfire response, hazard mitigation, community preparedness, structure protection or all of the above.

The minimum requirements for a CWPP are:

- Collaboration between local and state government representatives, in consultation with federal agencies and other interested parties
- Prioritized fuel reduction in identified areas as well as recommendations for the type and methods of treatments
- Recommendations and treatment measures for homeowners and communities to reduce the ignitability of those structures in the project area

PROJECT FUNDING AND COORDINATION

The FMFPD utilized internal budgets in combination with a Western States Fire Mitigation grant to complete a district-wide hazard and risk assessment and the resultant CWPP. Methodology with a core of fire behavior science ensures an accurate hazard and risk assessment. Community education and private landowner assistance will be coordinated through the Four Mile Fire Department FMFD. The FMFD will continue to be instrumental in public education related to wildfire hazard reduction.

The District will continue to identify funding for the implementation of mitigation projects. A FMFD representative will coordinate all community-wide mitigation projects.

Homeowner cooperation and permission for projects on private land is more likely if there is a fire district representative overseeing the details in partnership with a Colorado State Forest Service (CSFS) representative. This also allows cross boundary projects to be implemented more effectively.

INTER-AGENCY COLLABORATION

Roles and Responsibilities

To be successful, wildfire mitigation must be a community-based, collaborative effort. Stakeholders and primarily the FMFD will have the greatest responsibility for implementing the recommended mitigation projects. The CSFS will also be a valuable participant in addressing cross-boundary projects throughout the district.

Nearly all of the recommendations from this report affect private land or access roads to private land. As such, their success will be largely dependent on the participation of landowners. The CSFS and FMFPD are committed to encouraging the participation of as many interested landowners as possible.

There are also recommendations for individual structures that are the responsibility of the homeowner. They will however, need a point of contact, most likely a member of the FMFD, to help them implement these recommendations. The best defensible space will be created with oversight and expert advice from fire department and or state personnel. One-on-one dialog will continue to build the relationship with community members. This level of involvement will allow agencies to keep track of the progress and update this plan to reflect the latest modifications at the community level. The FMFD web site may be visited at

www.fourmilefire.org or http://bcn.boulder.co.us/emergency/fourmile/ .

This site has useful information for citizens as well as a way to contact the fire department.

The Collaborative Process

> "The initial step in developing a CWPP should be formation of an operating group with representation from local government, local fire authorities, and the state agency responsible for forest management … Once convened; members of the core team should engage local representatives … to begin sharing perspectives, priorities, and other information relevant to the planning process."[1]

[1] *Preparing a Community Wildfire Protection Plan - A Handbook for Wildland-Urban Interface Communities,* March 2004, p. 5

Seven state, county, local and private agencies participated in the Four Mile Fire Protection District CWPP. These stakeholders include:

- Four Mile Fire Protection District/Four Mile Fire Department
- Sugarloaf Fire Department
- City of Boulder Open Space and Mountain Parks
- The Colorado State Forest Service
- Boulder County Land Use Department
- Southern Rockies Conservation Alliance
- Anchor Point

The true collaborative process was initiated with a meeting on October 18th 2006. The initial meeting intent was to bring all past, current and future efforts and needs to the table. Best practices and anticipated "roadblocks" were identified. The group was encouraged to utilize fuels, slope and aspect maps in refining their areas of concern and recommendations for fuels reduction projects. Another meeting was held on January 17th 2007 to present the draft CWPP findings to residents of the communities within the district. Over forty homeowners and residents attended the meeting. Representatives from Four Mile Fire Department, Anchor Point, Boulder County, the Colorado State Forest Service and the Four Mile Fire Protection District Board attended. Public comments included the following:

- The need for more outreach to citizens regarding planned and future mitigation actions
- Possible collaboration with private landowners regarding creating an additional escape route in the Melvina Hill community
- Investigate the use of Pennsylvania Gulch as a possible escape route
- Identify potential locations for shelter-in-place sites
- Develop standards and specifications for potential shelter-in-place sites
- More discussion regarding fire ecology and forest health issues
- Creation of detailed address signage standards

The Four Mile Fire Protection District Board suggested that the document, "Making Decisions About Wildland Fire Protection" be added to the CWPP. This document is included as a supplement in the final CWPP.

Copies of the draft CWPP on compact disk were made available to residents and the draft CWPP has been posted to the Four Mile Fire Department website (www.fourmilefire.org) with open access.

In addition to these meetings, a comprehensive survey was provided for fire department officers and to citizens via the web site, to stimulate additional input and discussion regarding the project.

FUNDING CWPP RECOMMENDATIONS

There are many sources of funds for implementing the recommendations within the CWPP. Some available grants and sources for more information are provided below.

- Agency: Homeland Security, Office for Domestic Preparedness
- Purpose: to assist local, state, regional or national organizations in addressing fire prevention and safety; the emphasis for these grants is the prevention of fire-related injuries to children.
- More information: http://www.firegrantsupport.com/

- Agency: Federal Emergency Management Agency (FEMA)
- Purpose: to improve firefighting operations, purchase firefighting vehicles, equipment, personal protective equipment, fund fire prevention programs, and establish wellness and fitness programs.
- More information: http://usfa.fema.gov/dhtml/inside-usfa/grants.cfm

- Agency: National Volunteer Fire Council
- Purpose: support volunteer fire departments
- More information: http://www.nvfc.org/federalfunding.html

- Agency: Community Facilities Grant Program
- Purpose: help rural communities; funding is provided for fire stations
- More information: www.rurdev.usda.gov/rhs/

- Agency: Firehouse.com
- Purpose: emergency services grants
- More information: www.firehouse.com/funding/grants.html

- Agency: Cooperative Forestry Assistance
- Purpose: assist in the advancement of forest resources management; the control of insects and diseases affecting trees and forests; the improvement and maintenance of fish and wildlife habitat; and the planning and conduct of urban and community forestry programs
- More information: www.usfa.fema.gov/dhtml/inside-usfa/cfda10664.html

- Agency: Forest Service, Economic Action Programs
- Purpose: Economic Action Programs that work with local communities to identify, develop, and expand economic opportunities related to traditionally under-utilized wood products. Expand the utilization of wood removed through hazardous fuel reduction treatments.
- More information: www.fireplan.gov/community_assist.cfm

- Agency: FEMA
- Purpose: Assistance to Firefighters Grant Program
- More information: www.usfa.fema.gov/dhtml/inside-usfa/apply.cfm and www.nvfc.org/federalfunding.html

DRY HYDRANT MANUAL

A Guide for Developing Alternative

Water Sources for Rural Fire Protection

From code originally developed for Summit County, Colorado

ALTERNATE WATER SUPPLY POLICY

SCOPE:

This policy is intended to offer guidance and assistance to the property owner, contractor and developer in meeting the requirements of the Uniform Fire Code and Chapter 14 (as amended) of the Uniform Building Code for the provision of adequate water supplies for rural firefighting. This policy does not necessarily meet ISO requirements for installation of a draft fire hydrant.

GOALS:

1. To reduce ISO ratings
2. To design each installation with the capability of flowing 1,000 gpm
3. To obtain points for fire mitigation
4. To function to protect life and property

DEFINITION:

A draft fire hydrant is a specially designed and constructed fire hydrant, which has been approved by the Fire Department having jurisdiction. This draft fire hydrant shall be connected to a year-round draft water source of sufficient capacity to meet the fire fighting needs of the property(s) involved. Fire hydrants which are connected to a pressurized municipal watercourse are not covered by this policy.

PERMITS

A. A review of the draft fire hydrant plans shall be completed by the Fire Department having jurisdiction prior to issuing a grading permit to allow construction of a draft hydrant. A site plan review shall be used to determine site-specific requirements including, but not limited to depth of pipe, required insulation materials, backfill requirements, and draft site requirement. Additionally, information containing drought conditions for the past 50 years may be required to be submitted.

B. A statement signed by the owner of the property on which the draft hydrant will be located, shall authorize access to and use of the draft fire hydrant by the Fire Department and its agents. The Fire Department having jurisdiction will be using water under the presumption of non-injury/non-consumption for fire emergency use.

ACCEPTANCE TESTING

A. All draft hydrants shall be subject to acceptance testing approved by the Fire Department having jurisdiction prior to being accepted as a water source. Acceptance testing shall include GPM verification of the water source. Maintenance and testing will return water within 200 feet of its drainage.

MAINTENANCE

A. Draft fire hydrants require bi-annual testing and maintenance. The hydrants should be tested with a pumper. Back flushing followed by a pumper test at a maximum designed flow rate, with records kept of each test, is required. Tests of this kind will not only verify proper condition, but also keep the line and strainer clear of silt and the water supply available for any fire emergency.

B. Any homeowner using the draft hydrant who has obtained points for mitigation or an ISO classification shall be responsible at all times for keeping the draft hydrant and its protective barriers free from obstruction by vehicles, materials, structures, snow, or other obstructions, and shall maintain the draft hydrant in a serviceable condition at all times.

C. It shall be the responsibility of the property owners using the hydrant for mitigation of ISO classification purposes to immediately notify the Fire Department having jurisdiction of any draft hydrant which is obstructed, damaged, or our of service for any reason.

DESIGN REQUIREMENTS

A. All draft hydrants shall be located within eight (8) feet of a road maintained year-round. Access to the system shall conform to the road and bridge standards in Appendix D "Access and Water Supply".

B. All draft hydrants shall have a single draft connection located a maximum of 30” measured from the grade level of the roadway where the fire apparatus will be parked to the top of the draft hydrant’s threaded connection. Additionally, life shall be determined by measuring from year-round low level of the water surface to the truck intake.

C. All draft hydrants shall have a draft tube running horizontally from the water source to the base of the riser consisting of a minimum of six (6) inch PVC. PVC pipe meeting AWWA specification C9000 with a SDR of 18 or less may be required through or under foundations and under driveways (Schedule 80 pipe or its equivalent may be deemed necessary in some instances). All joints must be sealed watertight, airtight and rootproof.

D. The piping shall be placed in bedding material of ¾” washed or screen rock or in native soils, providing that the native soils contain no sharp materials or stone larger than two and one-half (2.5) inches that may damage the piping.

E. The bedding material shall be placed to a depth of four (4) inches below the pipe and six (6) inches above the top of the pipe.

F. The draft fire hydrant pipe extending from the water source to the rise pipe connection shall have a grade of minimum .5% to a maximum 2% toward the water source. (This excludes the riser section immediately preceding the fire department connection).

G. All draft fire hydrants shall have a single draft connection consisting of an approved fitting and cap having a 6” male NST threads. (Size of connection shall be determined by the Fire Department having jurisdiction.)

H. No more than two elbows are recommended. Elbows may be 90 or 45 degree bends (See Figure 1).

INSTALLATION REQUIREMENTS

A. All draft fire hydrants shall be painted red in color (oil base paint) with reflective tape, to protect PVC pipe from the adverse effects of sunlight and to assist in the rapid location and identification by the Fire Department.

B. All draft fire hydrants shall be protected from damage by snowplows, motor vehicles, etc., by the installation of three (3) steel pipes buried three (3) feet into the ground with four (4) feet extending above the grade level of the roadway. The entire pipe shall be filled with concrete. The protective pipes shall be located in a triangle configuration approximately three (3) feet away from the draft hydrant. Steel pipes shall be painted with red oil base paint and reflective tape.

C. All draft hydrants shall be required to have a sign stating “draft hydrant” in a location acceptable to the Fire Department having jurisdiction.

The above policy is subject to change or modification by the Fire Department having jurisdiction.

MAXIMUM LIFT CONSIDERATIONS

Definition: Lift shall be determined by measuring from the lowest level of the water surface to the truck intake, which is 36” above grade.

Maximum vertical lift recommendations:

Elevation	Do Not Exceed
4,000 ft	13 ft
5,000 ft.	12 ft.
6,000 ft.	11 ft.
7,000 ft.	10 ft.
8,000 ft.	9 ft.
9,000 ft.	8 ft.
10,000 ft.	7 ft.

Making Decisions About Wildland Fire Protection

Fire protection is one of the considerations you may want to take into account in shaping the landscape around your home. Here are some ideas about how to come to terms with the possibility of wildland fire.

1. *It's <u>your</u> home.* It's where you live. The decision about whether and how to mitigate the fire danger to your home is fully within your control, and only you can make sure you will be happy with the results.

2. *Fire danger is just one of the attributes of mountain living - - and probably not the one you moved up here for.* Consider what is important to you about where you live, what makes your home special.

3. *Gather the information to understand the nature of the risk that wildland fire poses.* What are the likely scenarios? How much will the creation of your "defensible space" affect the chances of your house burning in a wildland fire? (Other factors will come into play as well: for instance, if the road you live on is too hazardous, fire officials may not be able to send firefighters up to your house.)

4. *What is your tolerance for this risk?* Do you need to protect against the worst case scenario in an extreme fire year?

5. *What is important to you about the trees around your home?* Appearance? Birds and other wildlife? View screen? Sound? Privacy? Overall sense of seclusion? Blocking of neighboring and distant lights? (Tree-marking for mitigation will be done during the day, of course, so if lights are a concern you might want to scout light blockage at night in advance. You and your neighbors may also want to consider installing shielded exterior lighting.)

6. *Fire mitigation does not necessarily need to be done in a day, or a season.* You can thin trees gradually, cutting more only after living with the effects of the cutting you've already done.

7. *There are many other steps you can take right away that may have little impact on your experience of home*, such as closing up eaves and moving woodpiles. What other protective measures can you take that will lessen the fire danger to your home in the right circumstances?

8. *The more you talk with your neighbors about how to manage mitigation efforts before trees are marked and cut, the more likely it is that you will all be happy with the outcome and avoid unpleasant surprises.*

9. *When you develop your mitigation plan, take the opportunity to further your own vision.* You can supervise and control the marking and thinning of trees to make sure now, while you have the chance to have it done in a way that is consistent with your idea of "home."

Board of Directors
Fourmile Fire Protection District