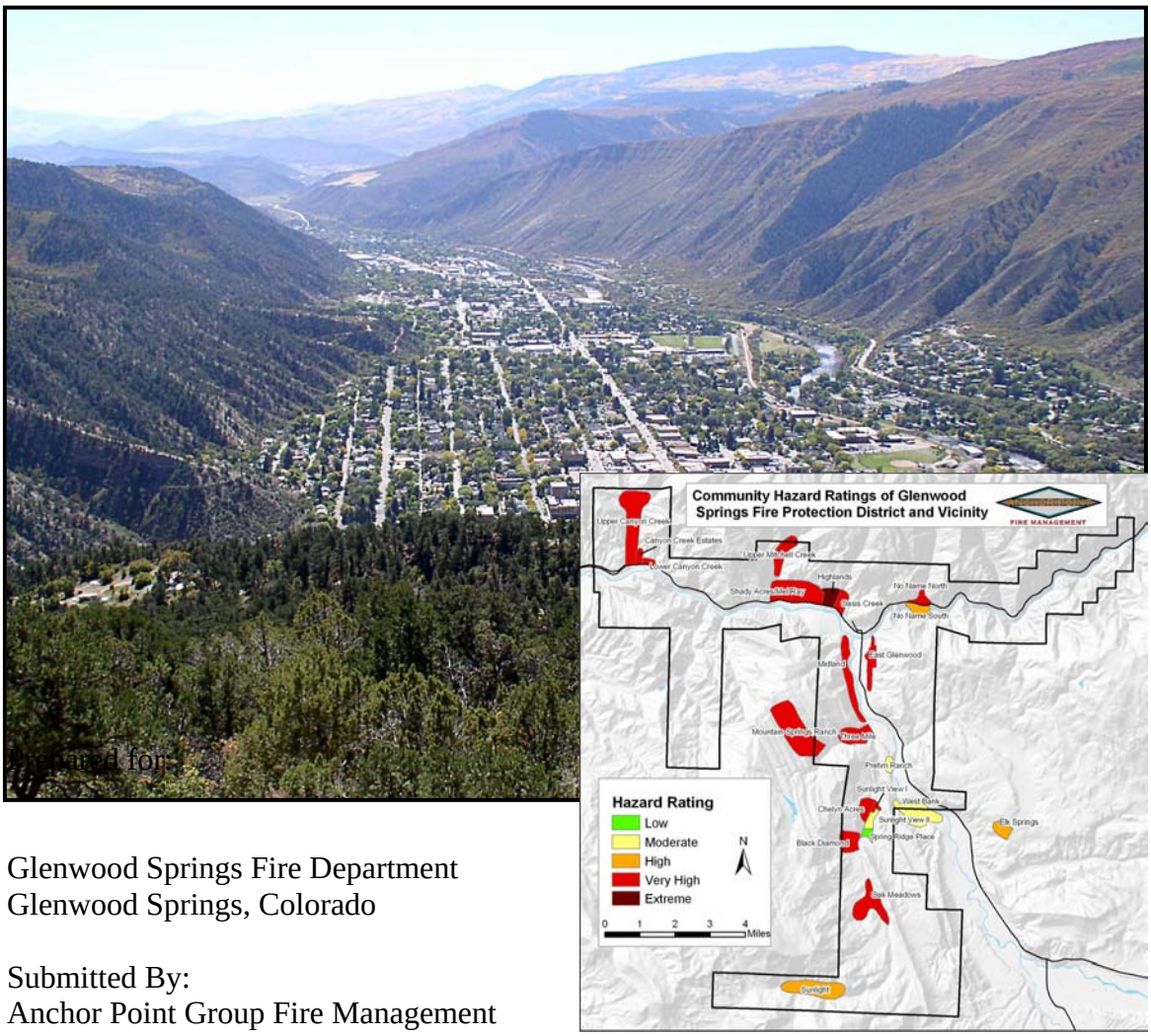
Glenwood Springs Fire Protection District

Wildland Urban Interface
Community Wildfire Protection Plan



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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 City of Glenwood Springs, Colorado, and the Glenwood Springs Fire Protection District (GSFPD). Wildfire hazard data is derived from the community wildfire hazard rating system (WHR) and the analysis of fire behavior potential. Because this data is extensive and/or technical in nature, detailed findings and methodologies are included in appendices rather than in 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 GSFPD Wildfire Hazard and Risk Assessment.

The GSFPD Community Wildfire Protection Plan (CWPP) is the result of a community-wide fire-protection planning effort that included extensive field data gathering, compilation of existing fire suppression documents, and a scientific analysis of fire behavior potential in the study area. This CWPP is the result of collaboration with various participants, including homeowners, the Glenwood Springs Fire Department (GSFD), and the Bureau of Land Management (BLM). The plan was compiled in 2006 in response to a contract from GSFD to convert their existing "Wildland Fire Hazard and Risk Assessment" (HRA) to a conforming CWPP.

This project meets the requirements of the federal Healthy Forests Restoration Act (HFRA) of 2003 for community fire planning by:

1. Identifying and prioritizing fuels reduction opportunities across the landscape. (See section Fuels Modification Projects beginning on page 40 of this document.)
2. Addressing structural ignitability. (See pages 36-39 and Appendix B.)
3. Collaborating with stakeholders. (See Appendix E.)

THE NATIONAL FIRE PLAN

In the year 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 report, prepared by a federal interagency group, was titled "Review and Update of the 1995 Federal Wildland Fire Management Policy" (2001).This report concluded, among other points, that the condition of America's forests had continued to deteriorate.

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

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

Congress increased specific appropriations to accomplish these goals. In 2002 we witnessed another severe season: more than 1,200 homes were destroyed and over seven million acres burned. In response to public pressure, congress and the Bush administration continued to designate funds specifically for 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, the act was signed into law.

Through these watershed pieces of legislation, Congress continues to appropriate specific funding to address five categories: preparedness, suppression, reduction of hazardous fuels, burned-area rehabilitation, and state and local assistance to firefighters. The spirit of the NFP is reflected in the Glenwood Springs 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 GSFPD.

The assessment estimates the risks and hazards associated with the occurrence of wildland fires 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 purpose of this report the following definitions apply:

Risk is 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 intrinsic values that the inhabitants of the study area have identified as being important to their way of life. These are values such as life safety, property conservation, access to recreation, and wildlife habitat. (See page 11 for a comprehensive overview.)

GOALS AND OBJECTIVES

Objectives

The primary objective of this analysis is to provide a comprehensive, scientifically based assessment of wildfire hazards and risks within the Glenwood Springs Fire Protection District. The assessment will aid stakeholders in developing short-term and long-term fuel and fire management plans. This initial level of pre-planning will assist land managers in making valid, timely decisions for planned and unplanned ignitions. The assessment estimates the hazards associated with wildland fire in proximity to communities. The hazard information, in conjunction with values-at-risk information, defines "areas of concern" for the community and allows prioritization of mitigation efforts. In addition to the primary objective, several task-specific goals are addressed within this study.

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:

   A report that quantifies the community's level of hazard 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 and education will help reduce the risk of unplanned human ignitions. It will also create an opportunity for GSFD to partnership with the community in reducing risks from wildfire through education and prevention.

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 social and fire management perspectives.

4. Promote improved levels of response:

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

COLLABORATION: COMMUNITY/AGENCIES/FIRE SAFE COUNCILS

Representatives involved in the development of the GSFPD CWPP are included in the following table. Their names, organizations, and various 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** GSFPD CWPP Collaborative Effort.

Table 1. CWPP Development Team

Name	Organization	Roles / Responsibilities
Michael Piper, Chief Ron Biggers, Deputy Fire Marshal	Glenwood Springs 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.
Dan Sokol	Bureau of Land Management, Glenwood Springs Office	Provides input and expertise on planning and hazard mitigation. Provides information on existing and planned projects on adjacent BLM lands.
Kelly Rogers, District Forester	Colorado State Forest Service	Facilitation of planning process and approval of CWPP minimum standards. Provides input and expertise on forestry, fire and fuels, and FireWise concepts.
Chris White, CEO Marc McDonald, Project Manager Mark McLean, GIS Project Manager Rod Moraga, Fire Behavior Analyst	Anchor Point Group LLC Consultants	Development of CWPP, decision-making, community risk and value assessment, development of community protection priorities, establishment of fuels treatment project areas and methods.

STUDY AREA OVERVIEW

The Glenwood Springs Fire Protection District (GSFPD) is located in Garfield County, 165 miles west of Denver, Colorado. The district includes the city of Glenwood Springs, the northernmost portion of the Highway 82 corridor, a portion of the I-70 corridor extending from east of No Name to west of the Canyon Creek exit and surrounding areas. GSFPD covers an area of 76 square miles, including the City of Glenwood Springs, and has approximately 13,000 residents. The primary access to the district is via Interstate Highway 70 and Colorado Highway 82.

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. Rankings and descriptions of communities as well as hazard and risk recommendations only pertain to the portions of those areas that lie within the boundaries of GSFPD unless otherwise noted.

The study area is considered to be in the Foothills and Montane zones (5,500’- 9,500’) of the western slope of the Northern Colorado Front Range.[1] A portion of GSFPD can be considered to be in the Sub-Alpine zone (areas above 9,500'); however this represents such a small and uninhabited portion of the district that it has no noticeable impact on fire in the Wildland/Urban Interface (see Figure 3). At the lower elevations the predominant vegetation is composed of Gambel's oak (*Quercus gambelii)*, piñon pine (*Pinus edulis*), Rocky Mountain juniper (*Juniperus scopulorum*) and various subspecies of big sagebrush (Genus *Artemesia*), see Figure 1. At higher elevations aspen (*Populus tremuloides*) and dense stands of mixed conifers are common primarily on north facing slopes.

For this project the most populated areas were divided into 23 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

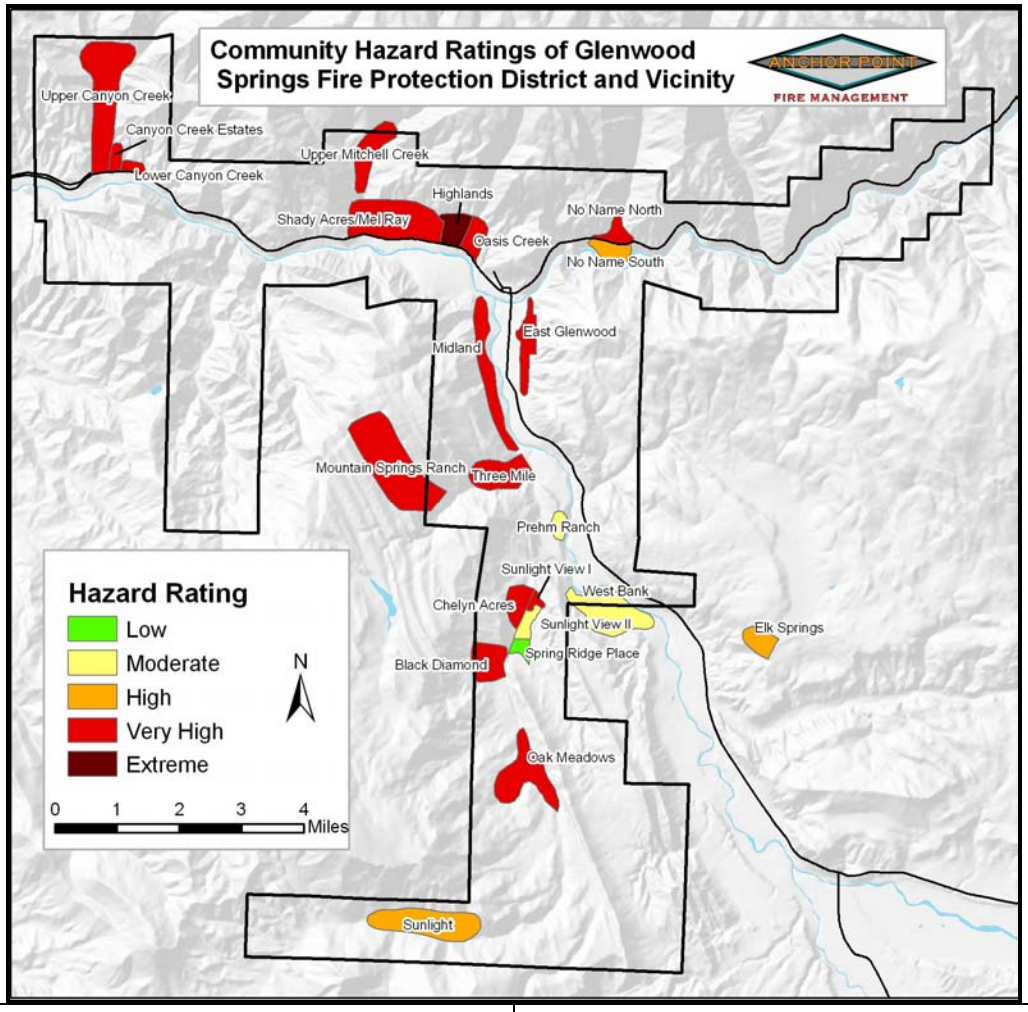
[1] Elevation limits for life zones were based on life zone ranges from: Jack Carter, "Trees and Shrubs of Colorado" (Boulder, CO: Johnson Books, 1988).

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.[2] The WHR model combines physical infrastructure such as structure density and roads as well as fire behavior components like fuels and topography, with the field experience and knowledge of wildland fire experts. **Figure 2** shows the communities that define the WUI study area. For more information on the WHR methodology please see **Appendix B**.

As a reference for the rest of this document, please see **Figure 3** and **Figure 4,** which show the general topography of the area. These graphic representations of the landforms within the study area (elevation and slope) will be helpful in interpreting other map products in this report.

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

Figure 2: Hazard Ranking of Communities in the Study Area



1. Highlands	**13. East Glenwood**
2. North No Name	**14. Three Mile**
3. Midland	**15. Oak Meadows**
4. Canyon Creek Estates	**16. Lower Canyon Creek**
5. Mel Ray/Shady Acres	**17. Sunlight**
6. Chelyn Acres	**18. South No Name**
7. Upper Canyon Creek	**19. Elk Springs**
8. Upper Mitchell Creek	**20. Sunlight View II**
9. Oasis Creek	**21. Prem Ranch**
10. Sunlight View I	**22. West Bank**
11. Black Diamond	**23. Spring Ridge Place**
12. Mountain Springs Ranch	

Extreme Very High High Moderate Low

Figure 3: Slope

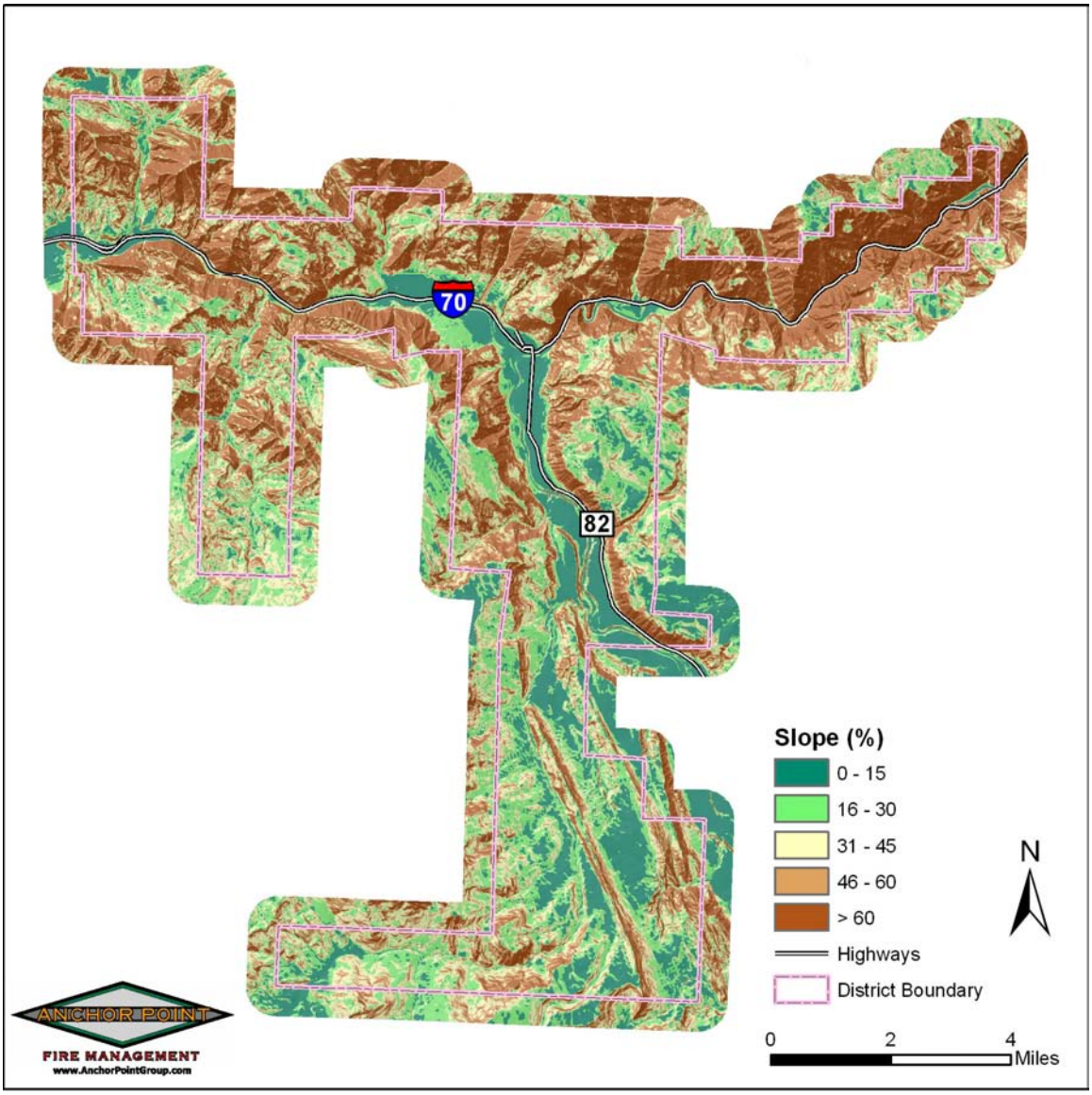
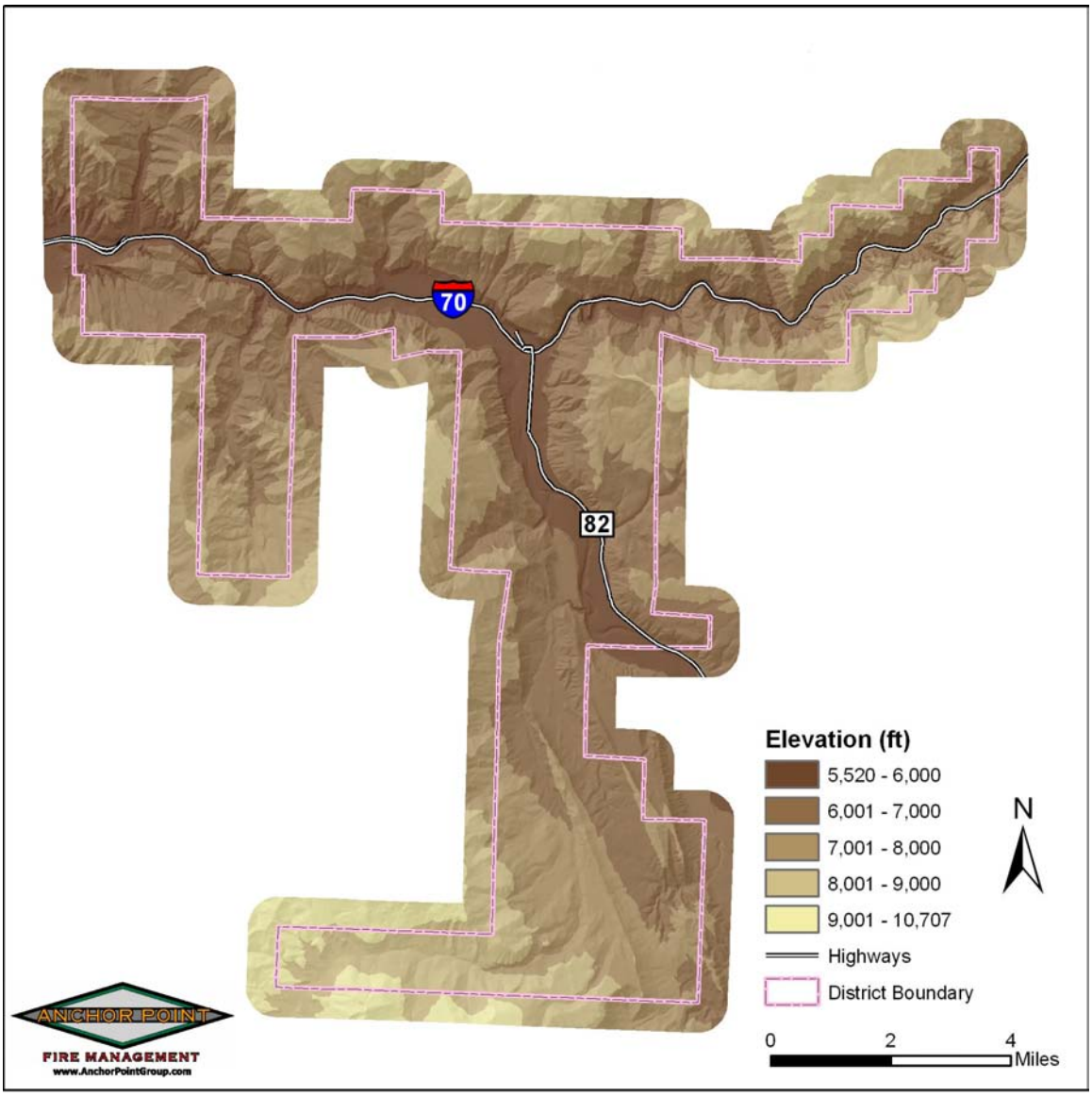


Figure 4: Elevation



VALUES

LIFE SAFETY AND HOMES

GSFD services approximately 8,000 residents in the City of Glenwood Springs and an approximate total of 13,000 in the GSFPD.[3] The most populated areas in the GSFD response area WUI, the study area for this document, were divided into 23 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 16 of the 23 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. These areas 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. Of the 63 counties in Colorado, Garfield County is the eighth fastest growing with a population increase of 8.7% between 2000 and 2003.[4] 202 new building permits for single family homes were issued from January thru September of 2006 in Garfield County.[5]

Most of Garfield 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.

COMMERCE AND INFRASTRUCTURE

In 2004 Garfield County had a per capita personal income (PCPI) of $29,064. The 2004 PCPI reflected an increase of 6.3% from 2003. The 2003-2004 state change was 4.6% and the national change was 5.0%. The 1994-2004 average annual growth rate of PCPI was 3.9%. The average annual growth rate for the state was 4.6% and for the nation was 4.1%.

In 2004 Garfield County had a total personal income (TPI) of $1,408,643,000. The 2004 TPI reflected an increase of 7.8% from 2003. The 2003-2004 state change was 5.8% and the national change was 6.0%. The 1994-2004 average annual growth rate of TPI was 7.4%. The average annual growth rate for the state was 6.9% and for the nation was 5.2%.[6]

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[3] http://www.glenwoodfire.com/
[4] http://www.epodunk.com/top10/countyPop/coPop6.html
[5] http://socds.huduser.org/permits/index.html?
[6] http://www.bea.gov/bea/regional/bearfacts/action.cfm

The earnings for people employed in Garfield County increased from $992,087,000 in 2003 to $1,089,131,000 in 2004, an increase of 9.8%. The 2003-2004 state change was 6.2% and the national change was 6.3%. The average annual growth rate from the 1994 estimate of $465,298,000 to the 2004 estimate was 8.9%. The average annual growth rate for the state was 7.1% and for the nation was 5.5%.[7]

Glenwood Springs is known worldwide as the home to the Glenwood Springs Hot Springs Pool and Lodge, the largest naturally heated outdoor swimming pool in the world. Also, 60% of the lands in Garfield County are publicly-owned state and national forestlands, making tourism one of the main industries in Glenwood Springs.[8] Gas & coal mining, sheep & cattle ranching, fruit and vegetable growing are the other main industries in the region.[9] Another significant component of the local economy is the quality of life that attracts professionals to establish residences. The 2002 NAICS Economic Census for Garfield County reported 235 business offering professional, scientific and/or technical services.[10] Wildfire, therefore, has the potential to cause significant damage to the local economy.

Recreation and Life Style

Glenwood Springs is known for its natural hot springs, large year round hot springs pool, skiing, and snowboarding. Recreational opportunities abound, attracting hunters, fishermen, mountain bikers, hikers, river rafters, skiers and snowmobilers. The Fairy Caves (now called the Glenwood Adventure Park) were the first real tourist attraction in Glenwood Springs, opening to the public in 1886. The Hot Springs Pool was completed in 1888. Soon after, the elegant Hotel Colorado opened its doors in 1893. The hotel staff was imported from the East Coast and Europe to add to the aura of wealth and privilege. The Hot Springs Pool, the vapor caves and the Fairy Caves, still are among the major attractions of Glenwood Springs today.[11]

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

Environmental Resources

Residents are clear that the preservation of wildlife is important to the quality of life of the area. The White River National Forest provides critical habitat to several species of concern including Canada Lynx, Colorado River Cutthroat Trout, Boreal Toad, Leopard Frog, Townsend's Big-Eared Bat and others. 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

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[7] http://www.bea.gov/bea/regional/bearfacts/action.cfm
[8] http://72.14.253.104/search?q=cache:_eFQgVyb_FMJ:www.glenwoodspringscolorado.com/Business-Directory.html+Tourism+economy+Glenwood+Springs+Colorado&hl=en&gl=us&ct=clnk&cd=3
[9] Ibid
[10] http://www.census.gov/econ/census02/data/co/CO045.HTM
[11] http://www.glenwoodchamber.com/pages/history.htm

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). [12] The USFS has made improving habitat effectiveness and ensuring the viability of these species one of their forest-wide objectives.[13] Wildfire, specifically severe wildfire, can have significant adverse effects on habitat effectiveness and species viability.

The Glenwood Springs CWPP process is in concert with the guiding principles of environmental stewardship. 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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[12] Peak to Peak Community Indicators Project 2003 Presented by Peak to Peak Healthy Communities Project ©Copyright 2003 Peak to Peak Healthy Communities Project

[13] White River National Forest Land and Management Resource Plan-2002 Revision, Chapter 1, page 1-4, Objective 1c.

CURRENT RISK SITUATION

For the purpose 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.

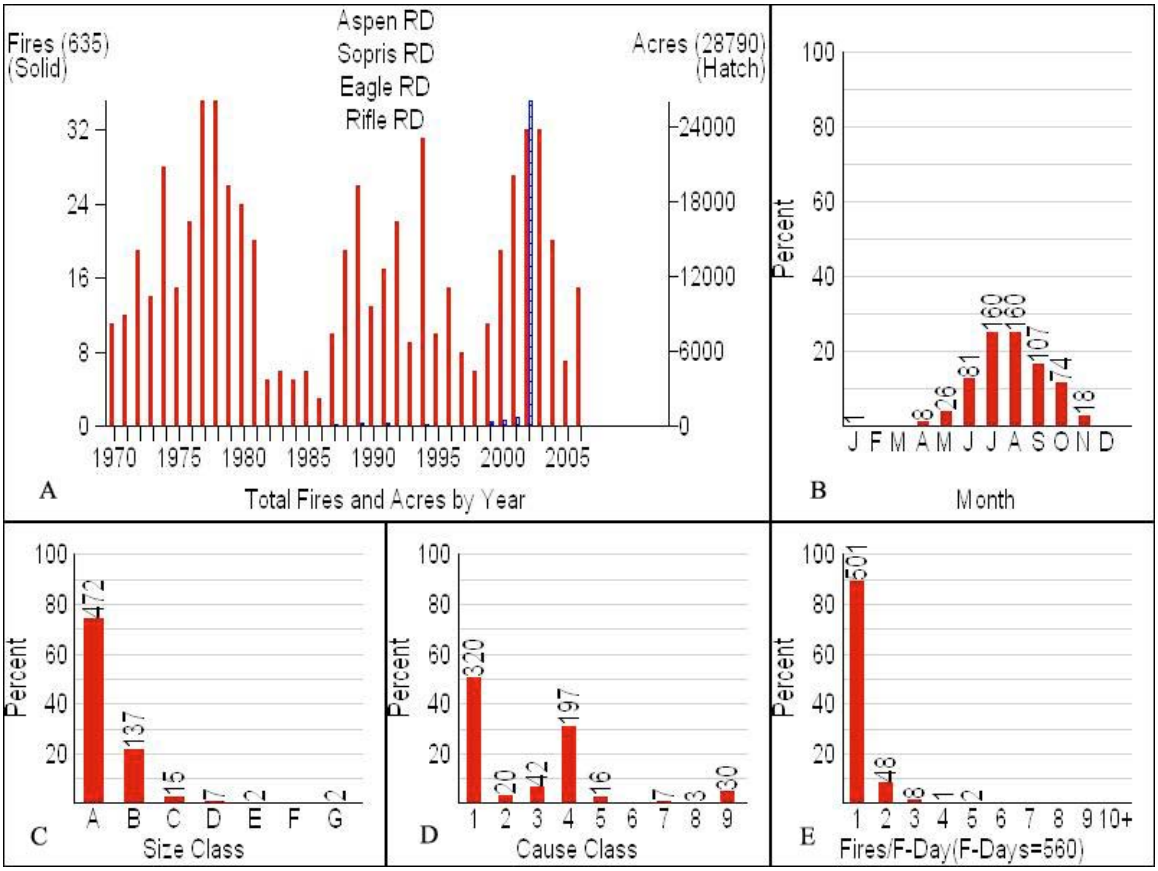
Hazard is the combination of the wildfire hazard ratings of the Wildland Urban Interface (WUI) communities and fire behavior potential, as modeled from the fuels, weather and topography of the study area.

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

- The city of Glenwood Springs is listed in the Federal Register as a community at high risk from wildfire (http://www.fireplan.gov/reports/351-358-en.pdf).
- The study 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).
- The study area has a recent major-fire history (fires larger than 100 acres). The last major fire to occur in the district occurred in 2002 (the Coal Seam Fire 12,209 acres), The South Canyon Fire (7/2/1994, 2,115 acres) resulted in the largest loss of life to wildland firefighters of any fire in the western United States in the last century.
- The Glenwood Springs Fire Department responded to 87 WUI ignitions between 2000 and 2003, the most recent year run data was available for (32 starts in 2000, 10 in 2001, 26 in 2002 and 19 in 2003).
- 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.

The surrounding federal lands report an active fire history. Fire occurrences for the Aspen, Eagle, Rifle and Sophris Ranger Districts of the White River National Forest were calculated from the USDA Forest Service Personal Computer Historical Archive for the thirty six-year period from 1970-2006. These areas represent federal lands in and adjacent to the study area, but do not include any data from state, county or private lands (See **Figure 6** on **Page 18**). The data have been processed and graphed using the Fire Family Plus software program and are summarized below.

Figure 5: White River National Forest Fire History 1970-2006



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 Equip-ment	3 Smoking	4 Campfire	5 Debis Burning	6 Railroad	7 Arson	8 Kids	9 Misc.

Figure 5a shows the number of fires (red bars) and the total acres burned (blue hatched bars) in the four ranger districts each year. While the number of annual fires ranges from four to over 30, there is little year-to-year pattern to the variation. Acres burned spiked dramatically in 2002 due primarily to the Coal Seam (12,209 acres) and Spring Creek (13,493 acres) fires. Smaller spikes in acreage burned occurred in the late 1970s, 1989 to 1991 and 1999 to 2001. It is interesting to note that the South Canyon Fire is not reflected in this data since this major fire did not occur within the boundaries of these ranger districts.

Figure 5b shows the percentage and number of fires between 1970 and 2006 occurring in each month of the year. July and August had the greatest number of fires followed by, September and

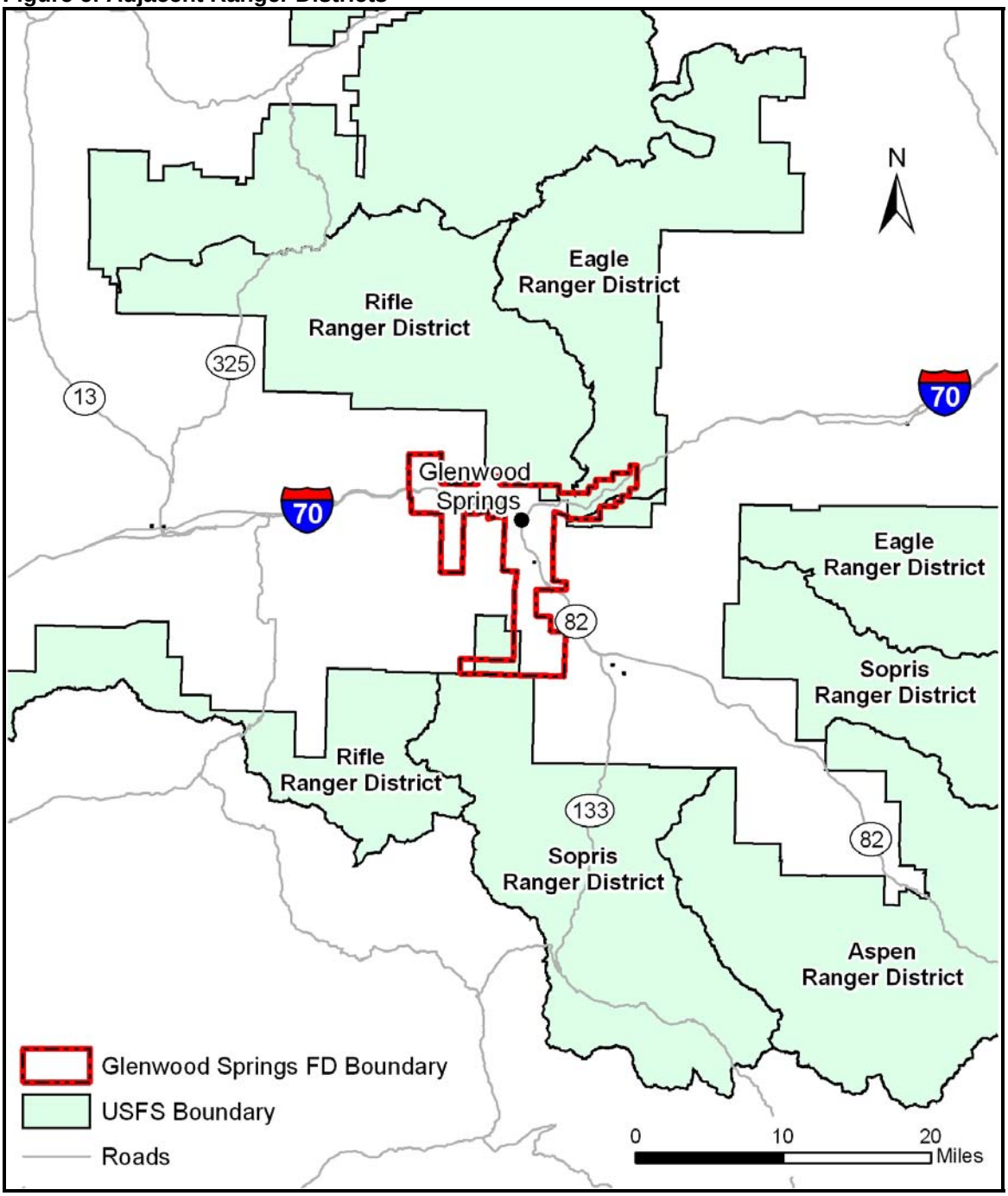
June. The fewest fires occurred between the months of December and April, which reflects the climate conditions for the area. It is interesting to note that fall fires are relatively common in the study area and the fire season extends later in the year than some other parts of the Colorado Rockies.

Figure 5c shows the size class distribution of fires. Approximately 74% of the reported fires (609 of 635) 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 for ignitions is lightning (50%); the next most common cause is campfire (31%). If we remove the miscellaneous cause category, natural causes represent a slim majority of ignitions (50% natural causes and 45% human caused), however it should be noted that these numbers are for national forest areas which lack the concentrated development and other human-related 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 (501) occurred on days that only had one fire start. Approximately 9% of fire days had two fire starts recorded and days with three or more fire starts represent less than 2% of all fire days. The statistics suggest that multiple start days are a rare occurrence compared to fire days with a single ignition.

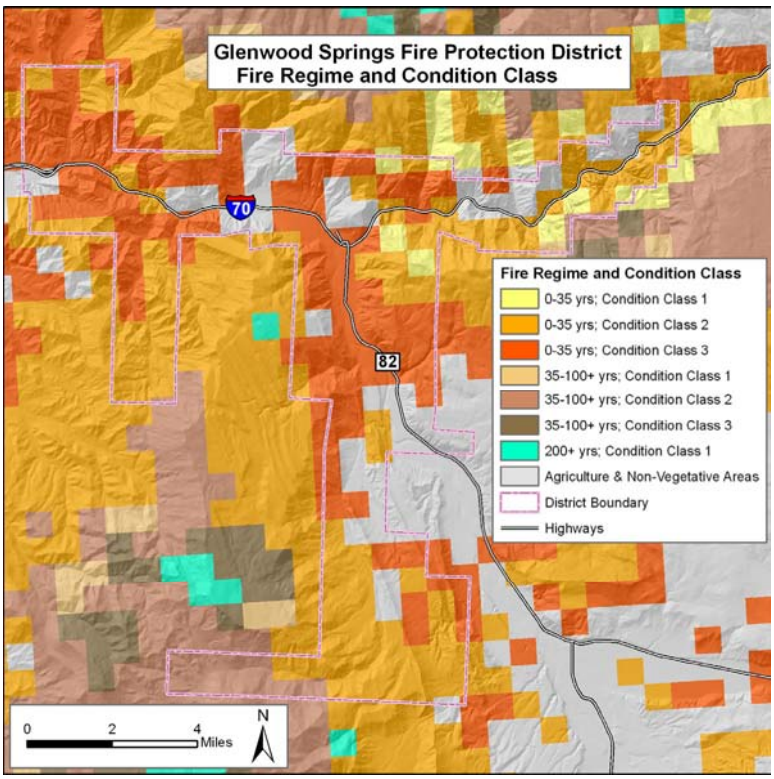
Figure 6: Adjacent Ranger Districts



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.

Figure 7: Condition Class Map



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.

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 study area. 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.).[14]

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

Table 2. Condition Class Descriptions15

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.

[14] Fire Regime Condition Class, website, http://www.frcc.gov/, July 2005.
[15] Ibid

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**.

FIRE BEHAVIOR POTENTIAL

From the fire behavior potential analysis carried out as a part of this study (see Appendix A), the fire behavior potential of the study area was mapped. These maps can be combined with the WHR and values-at-risk information to generate current and future "areas of concern," which are useful for prioritizing mitigation actions.

Figures 8-10 show fire behavior potential maps for average conditions. They graphically display potential crown fire activity, flame length, and rate of spread generated. These maps were generated with FlamMap 2.0 fire behavior modeling software (see **Glossary**). Weather observations from the nearby Rifle Remote Automated Weather Station (RAWS) site were averaged for a nineteen-year period (1987-2006) to derive relevant wind and fuel moisture variables for inclusion in FlamMap. The average conditions class (16th to 89th percentile) was calculated for each variable (1 hour, 10 hour, and 100 hour fuel moisture, woody fuel moisture, herbaceous fuel moisture, and wind speed) using the Fire Family Plus (see **Glossary**) computer software package. This weather condition class most closely represents an average fire season day.

The extreme conditions maps, **Figures 11-13**, were calculated using ninety-seventh percentile weather data. This means that the weather conditions of the four most severe fire weather days (sorted by Spread Component) in each season for the nineteen-year period were averaged together. It is reasonable to assume that similar conditions may exist for at least four days of the fire season during an average year. In fact, during extreme years such conditions may exist for significantly longer periods. Even these calculations may be conservative compared to observed fire behavior.

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 planning. When this information is used for tactical planning, it is recommended that 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, for use as a guideline for fire behavior potential. For a more complete discussion of the fire behavior potential methodology, please see **Appendix A**.

Figure 8: Flame Length Predictions (Average Weather Conditions)

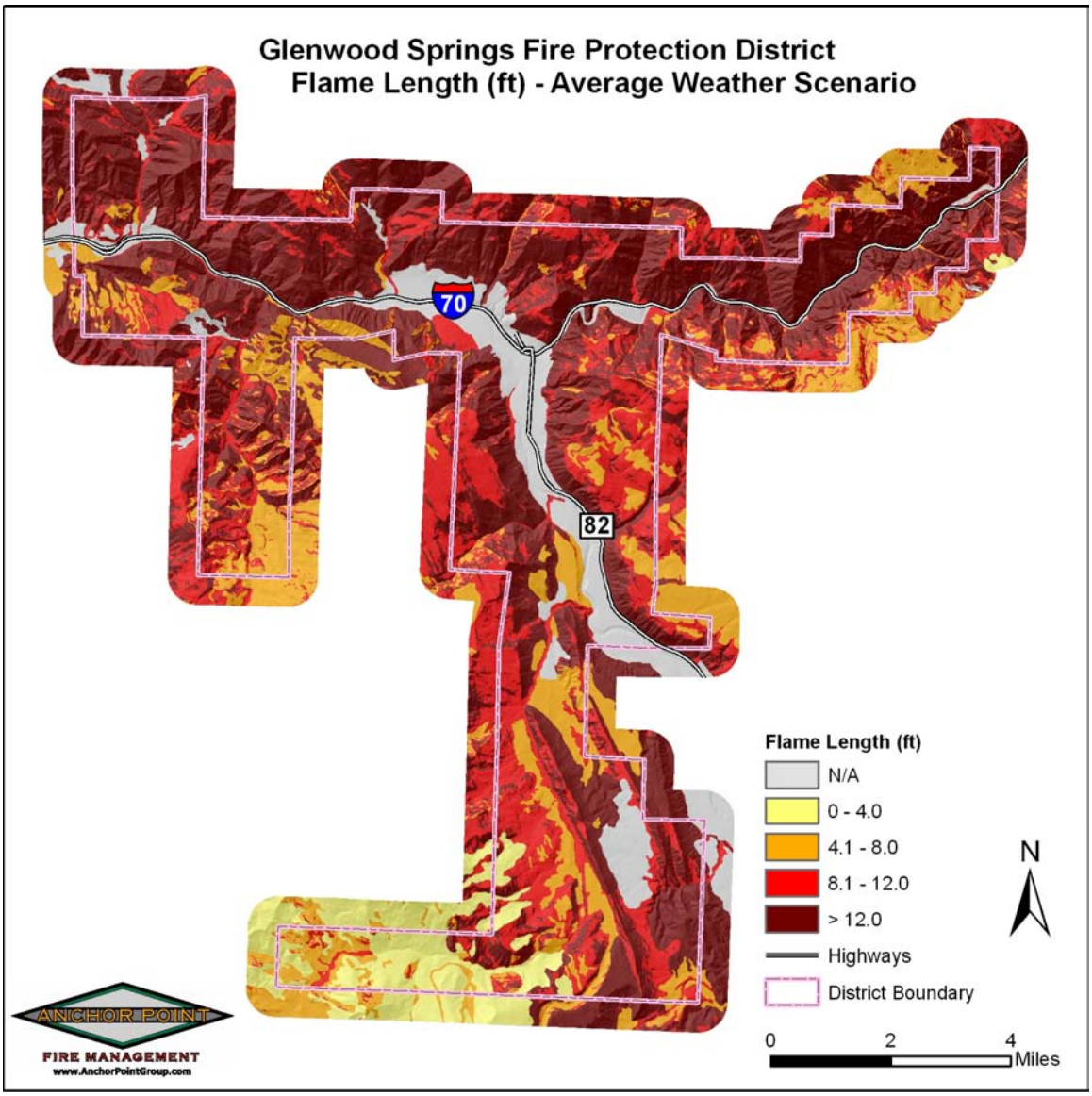


Figure 9: Flame Length Predictions (Extreme Weather Conditions)

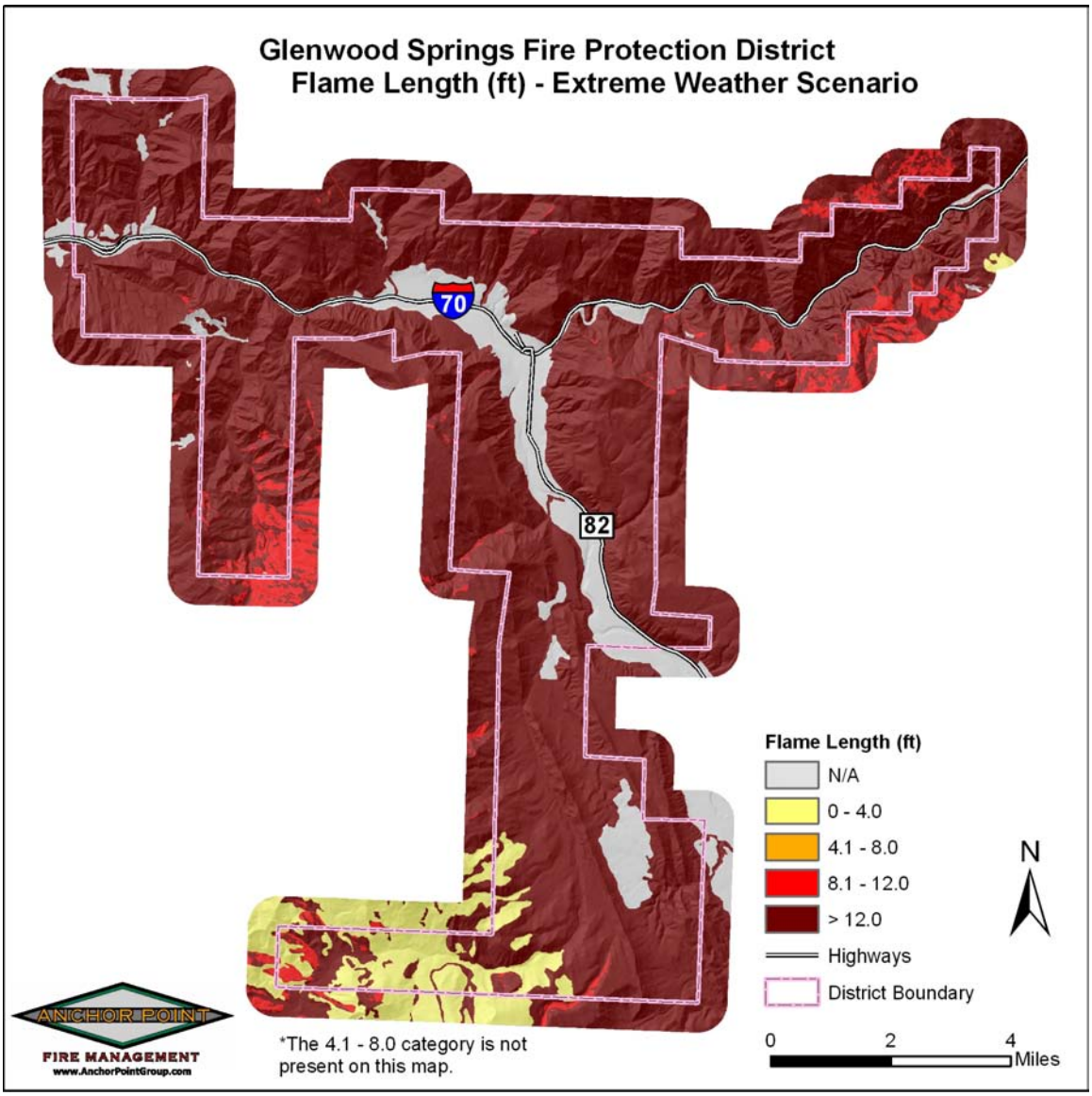


Figure 10: Rate of Spread Predictions (Average Weather Conditions)

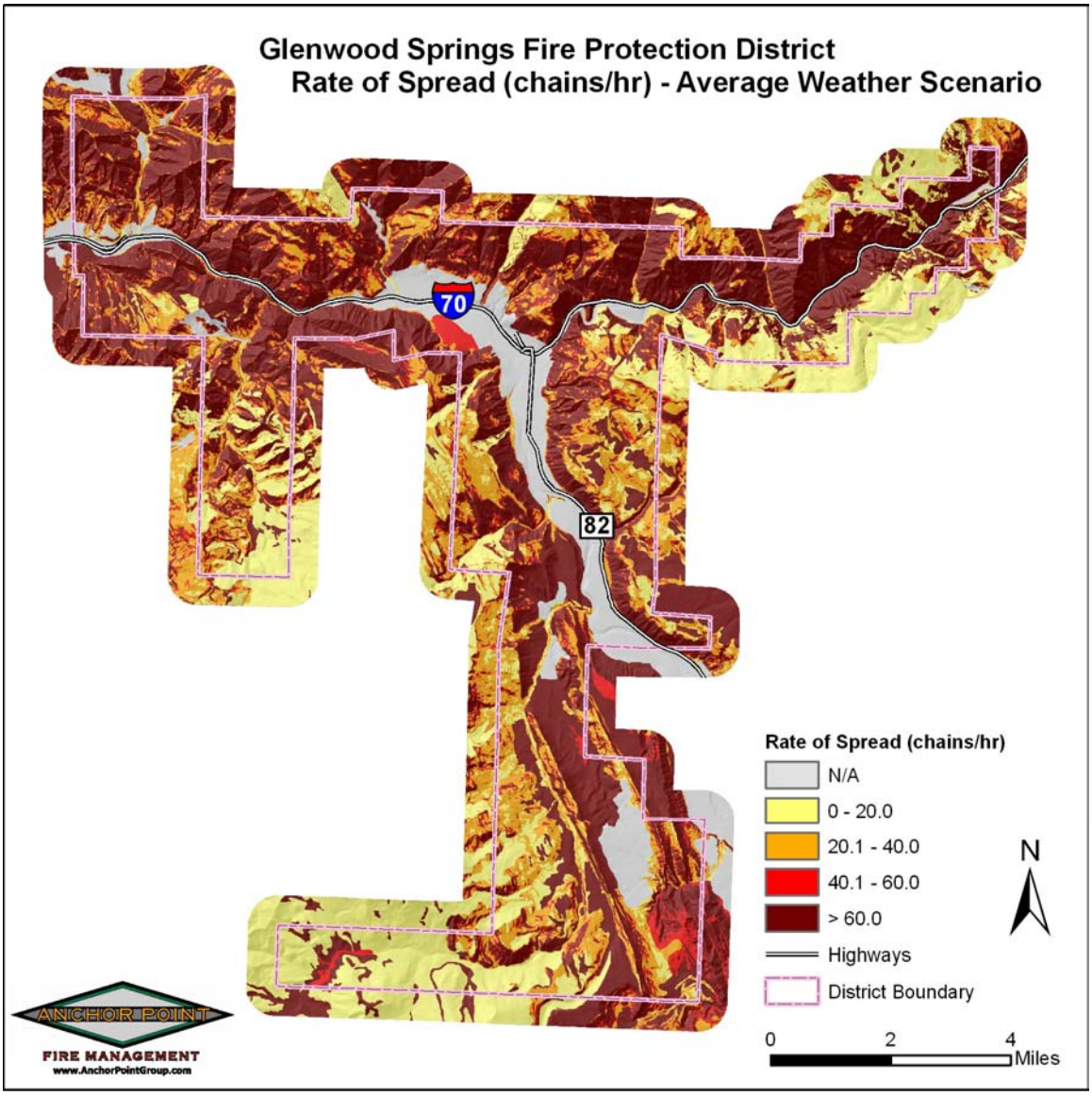


Figure 11: Rate of Spread Predictions (Extreme Weather Conditions)

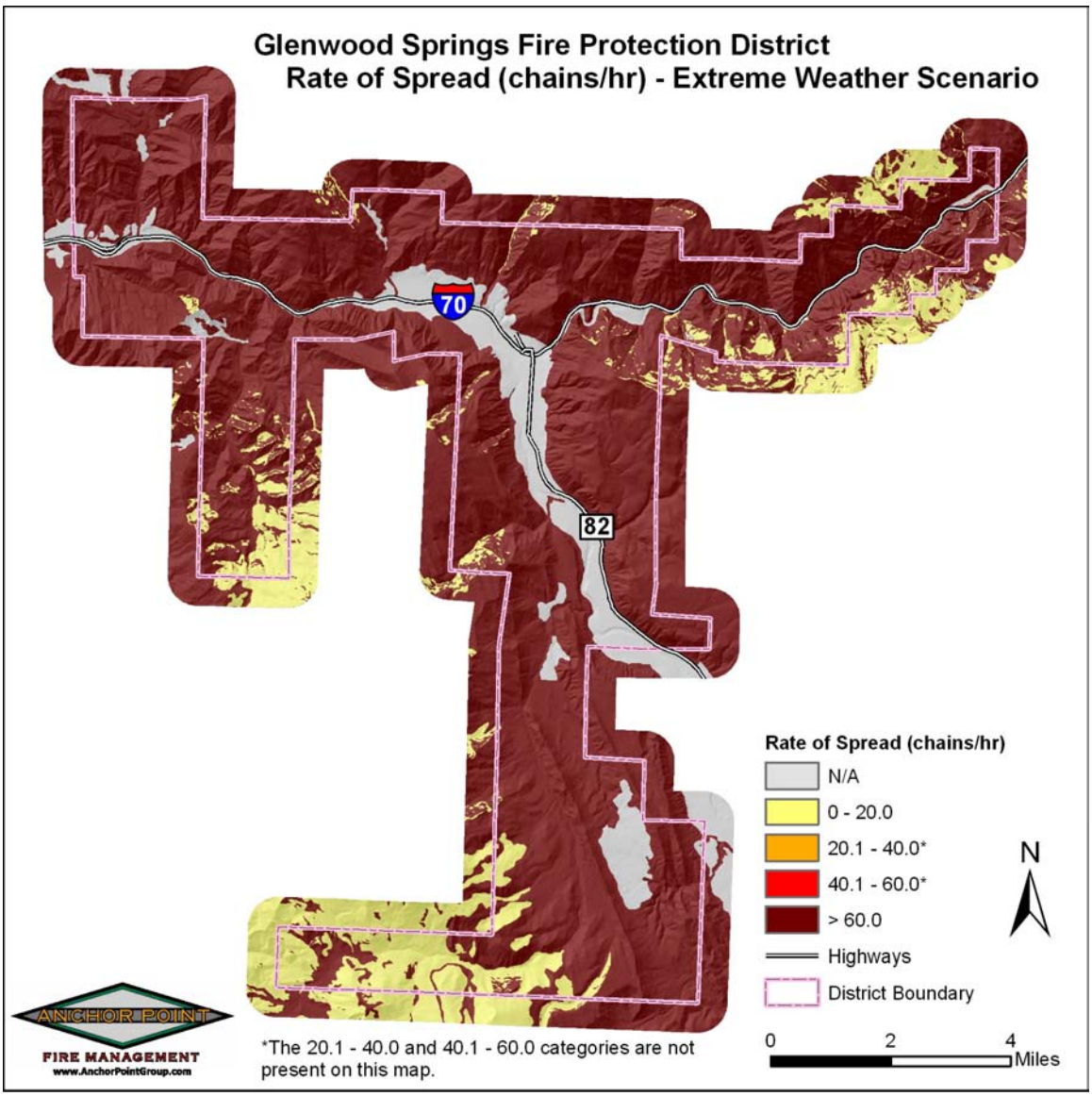


Figure 12: Crown Fire Activity Predictions (Average Weather Conditions)

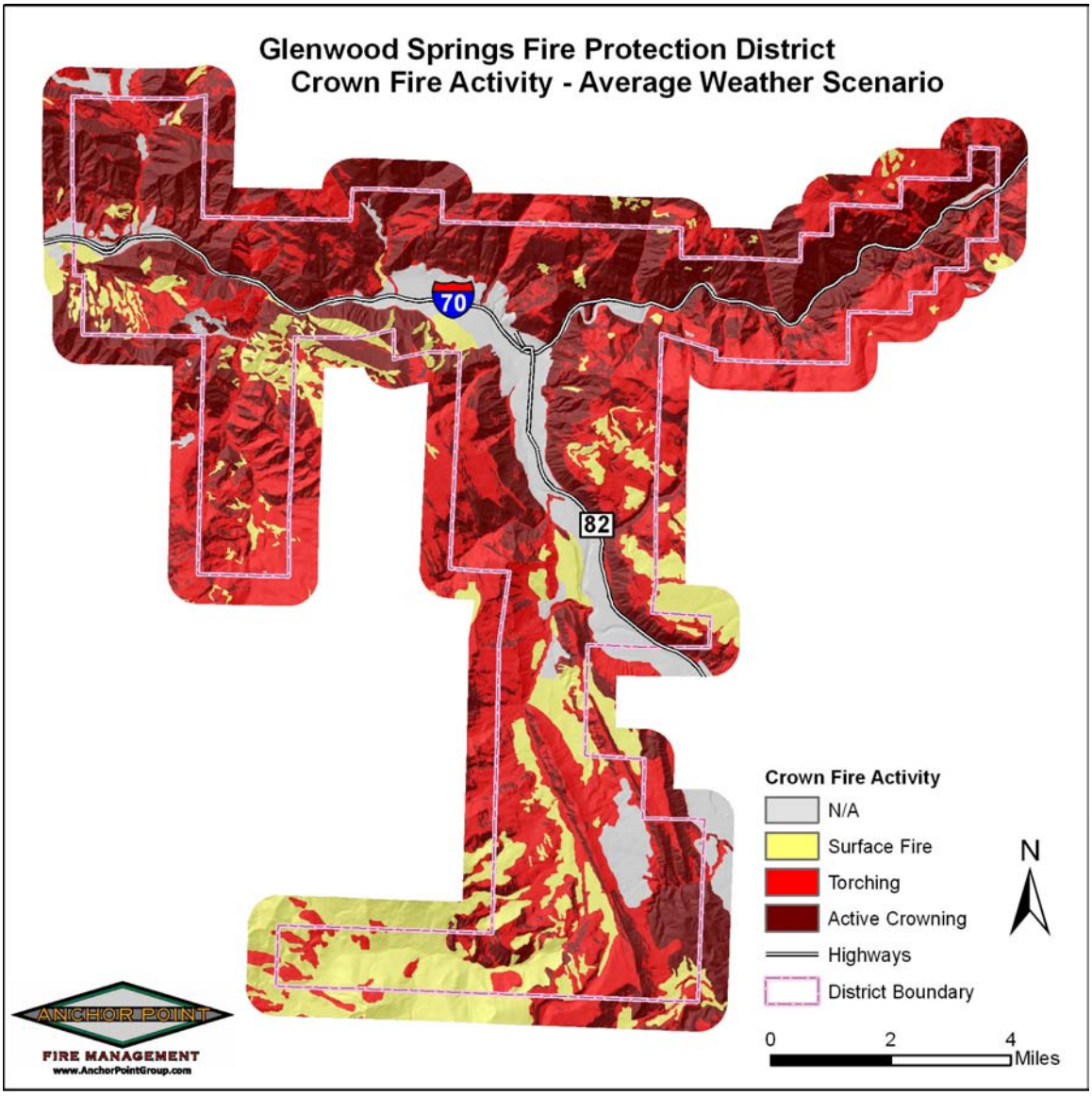
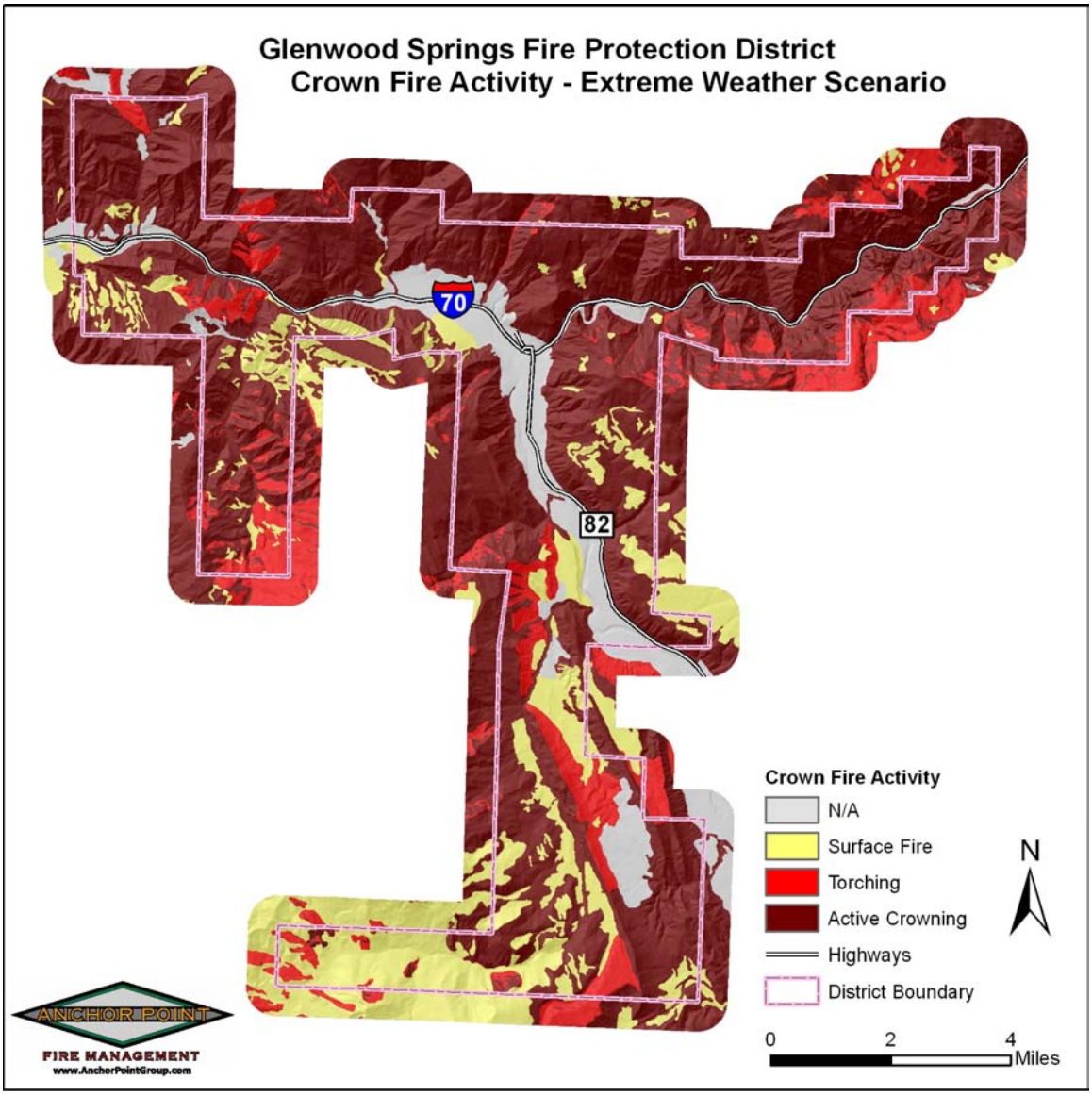


Figure 13: Crown Fire Activity Predictions (Extreme Weather Conditions)



SOLUTIONS AND MITIGATION

ESTABLISHING AND PRIORITIZING FIRE MANAGEMENT UNITS (FMUS)

An efficient method of prioritizing work efforts is to create Fire Management Units (FMUs). FMUs should be created prior to planning or initiating fuels management projects and other mitigation. There are unique vegetation and/or mitigation management activities recommended for each unit. Units may be functional or geographic. The local land management and fire management agencies (ideally with the input of the citizen's advisory council) must determine priority actions. The following FMUs have been identified for the study area; 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.

- Addressing, Evacuation and Shelter-In-Place FMU
- Public Education FMU
- Local Preparedness and Firefighting Capabilities FMU
- Home Mitigation FMU
- Fuels Modification Projects FMU
- Water Supply FMU

ADDRESSING, EVACUATION AND SHELTERING-IN-PLACE FMU

Addressing

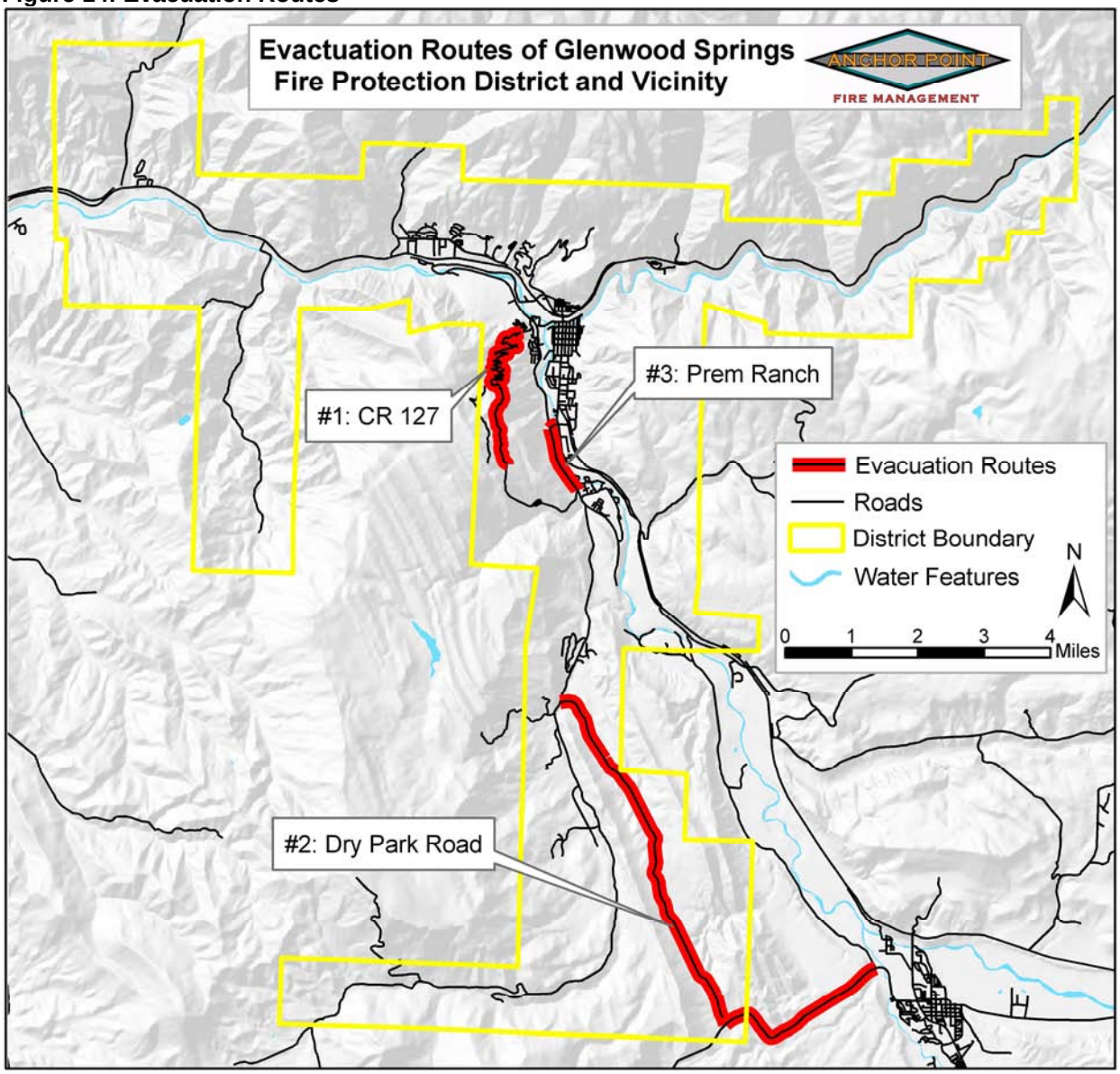
There are many areas within GSFPD that have missing or inadequate street signage and addressing. This problem was especially notable in the Highlands, North No Name, Upper Canyon Creek, Upper Mitchell Creek, Black Diamond, Mountain Springs Ranch, Three Mile, Oak Meadows and Sunlight communities. While residents may consider non-reflective wooden address signage to be decorative, it is an impediment to quick and effective response. We consider proper reflective signage to be a critical operational need. 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 firefighters. Recommendations for address markers can be found in **Appendix D**.

Evacuation Routes

Three roads that could serve as alternative evacuation routes to the primary access have been identified. Of these, only one is potentially important and its usefulness may be compromised by rough terrain and poor surface condition. These routes are highlighted in the overview of the district shown in **Figure 14**.

1. **CR127**: Priority level-High. According to our information CR127 has been improved enough to provide a viable escape route from the Mountain Spring Ranch and upper Three Mile communities. This route escapes these areas to the north by connecting with West 9th Street. This is a potentially important route as ignitions occurring in the Three Mile Road drainage and on the slopes below the Mountain Springs Ranch area could easily cut off the primary access to these areas (Three Mile Road). This road currently has a gate and requires 4WD especially in wet conditions. It may also be possible to escape Mountain Springs Ranch via two 4WD roads that connect to South Canyon; however a BLM easement and much surface improvement would be needed for this to be effective.
2. **Dry Park Road (CR125)**: Priority level-Low. If the access along Four Mile Road were to be cut off it would be possible to escape from the Spring Ridge Place, Chelyn Acres, Black Diamond and Sunlight View I and II communities to the south by using Dry Park Road to connect to County Road 108 and then to Carbondale via Hwy133. This is assuming that evacuees could get out of the neighborhoods, which may not be possible especially in Chelyn Acres and Black Diamond. It is unlikely that fire conditions would close Four Mile Road. If they did, it is likely that the fire would have already burned through some or all of the neighborhoods on the west side of Four Mile Road. It is unlikely that this is an important escape route from wildfire.
3. **Prem Ranch**: Priority level-Low. If for some reason the bridge that is the primary access from Hwy 82 into the West Bank neighborhood were to be compromised, it is possible to evacuate the portion of West Bank that is within GSFPD through Prem Ranch. This access is gated and, due to position and fuels, is much more likely to be threatened by wildfire than the primary access. This access is likely to be more useful for fire fighting resources than evacuating citizens.

Figure 14: Evacuation Routes



ACCESS ROUTE RECOMMENDATIONS

- See *Access Route Fuels Modification Recommendations* in the *Fuels Modification Projects FMU* section of this report.
- In order to reduce potential 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. Golf courses and large irrigated greenbelts may make good safety zones for firefighting forces. Local responders are encouraged to preplan the use of potential staging areas with property owners. Priority level-High.
- Identify and pre-plan primary escape routes for all WUI communities. Emergency management personnel should be included in the development of preplans for citizen evacuation. Priority level-High.
- Educate citizens on the proper escape routes, and evacuation centers to use in the event of an evacuation. Priority level-High.
- 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. Priority level-High.
- Perform response drills to determine the timing and effectiveness of escape routes and fire resource staging areas. Priority level-Moderate.

Shelter-In-Place

The communities of Highlands, Oasis Creek, Upper Canyon Creek, Upper Mitchell Creek, Canyon Creek Estates, Three Mile, Black Diamond, Oak Meadows and North No Name 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 that are designed as alternatives to evacuation through hazardous 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.

Shelter–in-place should only be considered when the structure is determined to be “stand alone” in structural triage terms. In order to be "stand alone", 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 an ignition resistant roof type, heavy timber may be acceptable. Eves 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 more important concepts:

- Close all doors and windows and shut down all ventilation systems such as air conditioning, heating, and attic fans.
- If there is adequate time and water, consider plugging downspouts and filling any gutters with water. The sand bags that mountain residents commonly have are good for this purpose.
- 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. Propane, and other volatile compressed gas, tanks 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. Do not wear polyester or other synthetics that may melt to your skin when exposed to high temperatures.
- When the fire arrives retreat to the room in the house farthest away from the flaming front.
- Take drinking water with you and drink often to avoid dehydration.
- 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. Much work has been done 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% of the outdoor concentrations in 30 minutes. In two hours the concentrations may

reach 60% to 65% of the outdoor levels.[16] 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**.

PUBLIC EDUCATION FMU

The area around Glenwood Springs is experiencing continual development. Increasing property values have resulted in recently constructed high value residences mixed in with older residences, seasonal cabins, ranch 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

- Use 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

- Encourage homeowners associations and mortgage lenders to eliminate covenants and deed restrictions requiring the retention of dangerous vegetation. Request that these groups promote the development of defensible space and firewise plantings.

- 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 planned and unplanned 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

[16] "Handbook of Chemical Hazard Analysis Procedures" (Washington, D.C.: FEMA, 1990).

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 FIRE FIGHTING CAPABILITIES FMU

Glenwood Springs Fire Department (GSFD) provides suppression services for the study area. The department has three fire stations. Station One is located in West Glenwood on Mel Ray Drive, Station Two is located in downtown Glenwood Springs on 8th Street and Cooper Avenue and Station Three is located on Four Mile Road (County Road 117) south of the intersection with Midland Ave. The previous Dry Park Station, at the intersection of Four Mile Road and Dry Park Road, has been replaced by Station 3. Mutual aid is available from the Basalt, Carbondale, Burning Mountains, Rifle and Aspen Fire Departments. GSFD maintains three type I pumpers, one 100' aerial apparatus, one type III interface engine, two 1,800 gallon water tenders, both with foam capability, one type VI engine, three command vehicles, three ambulances, and a hazardous materials response trailer.

GSFD employs 21 full time career firefighters, 22 part-time reserves, and nine volunteers. Two of GSFD's firefighters have NWCG (National Wildfire Coordinating Group) S-130/190 training (basic wildland fire fighter training and fire behavior). One firefighter is qualified as a Single Resource (Crew Boss/Engine Boss level or higher).

Although there are five fire departments in Garfield County (GSFD, Carbondale, Rifle, Burning Mountains and Grand Valley) only 33% of the county is within a fire jurisdiction. There are already areas of increasing growth near Glenwood Springs, such as Spring Valley and most of Mountain Springs Ranch, which are not within a fire department service area. There are also areas like West Bank and Elk Springs that are in two different fire jurisdictions. Both of these situations result in reduced service to residents and complications for responding agencies. The need for more firefighters is clear. The ability to add and adequately train additional firefighters will be critical to the successful defense of this rapidly growing and increasingly complex Wildland Urban Interface.

RECOMMENDATIONS

- Priority level-High. 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:
    - Priority level-High. Continue to ensure all firefighters have wildland Personal Protective Equipment (PPE).
        - (See NFPA Standard 1977 for requirements).
    - Priority level-High. 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.
    - Priority level-Moderate. Consider the purchase of an additional type VI (4WD) engine.
    - Priority level-Moderate. 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 handline 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 GSFD officers revealed radio communications are poor or nonexistent in the following areas:
        - No Name and other areas in Glenwood Canyon
        - South Canyon

All Garfield County emergency services agencies will switch to 800 MHz radios in the spring of 2007. Additional repeaters currently being installed may solve some of the existing communications problems, however due to the nature of 800 MHz (more direct line of site is required than for the lower frequency VHF radios currently in use, but 800 MHz is also less susceptible to multipath and reflected signal cancellation) new problem spots may arise. It is our recommendation that communications be reevaluated throughout the district once the new system is fully operational.

Federal land managers (USFS, BLM) will continue to operate on the existing VHF band. In order to have universal communication on wildland fires, responders will be required to maintain VHF radio equipment which will still have the current problem areas. The suggestions that follow will need to be evaluated for cost/benefit effectiveness by the fire department before implementation. Due to the restrictions of terrain, it is unlikely more powerful base stations or portable radios will make any impact on VHF communication problems. Some areas may see slight improvements in base station reception by increasing the height above average terrain of the base station antenna. However, the best solution is to increase the number of VHF repeaters in the problem areas. 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 only reliable in the I-70 and Hwy. 82 corridors, grants and other sources of funding could be pursued in order to solve this operational problem. If it is not possible to obtain a repeater frequency, which is likely, and the new 800 MHz system does not improve communications in these areas, then satellite phones may be a reasonable additional tool for incident communication (Priority level-Low to Moderate depending on cost effectiveness).

- Jurisdictional Boundaries:
    - Priority level-High. As mentioned earlier in this section there is a need to include nearby populations within a fire protection district and to resolve the balkanization of some existing neighborhoods. If it is not possible to pursue jurisdictional changes we strongly recommend some other course of action be pursued. If nothing is done to alleviate this situation, the problem will only become increasingly more difficult to deal with.

HOME MITIGATION FMU

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

The community-level assessment has identified 16 of the 23 communities in the study area to be at extreme or very high risk. Construction type, condition, age, the fuel loading of the structure/contents and position are contributing factors in making homes more susceptible to ignition under even moderate burning conditions. There is also 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.

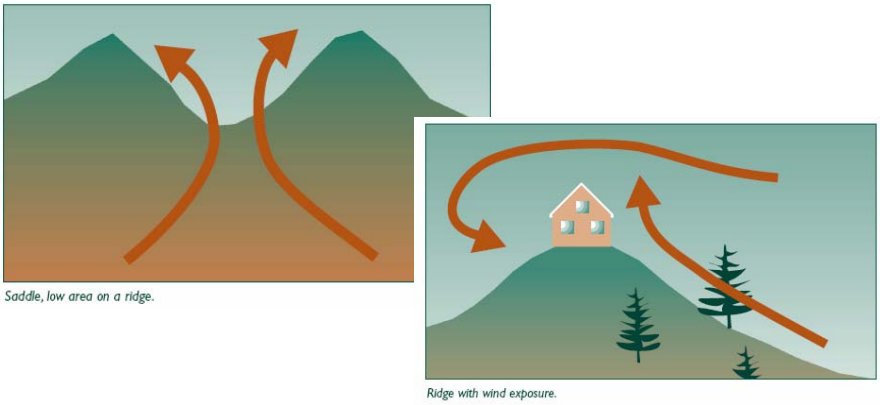
Table 3 illustrates the relative hazard rankings for communities in the study area.

- A rating of 5 or less indicates an area of extreme hazard.
- A rating of 6 to 15 indicates a very high hazard.
- A rating of 16 to 25 indicates high hazard.
- A rating of 26 to 35 indicates moderate hazard.
- A rating of 36 or greater indicates a low 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.

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 15: Saddle & Ridge Top Development[17]



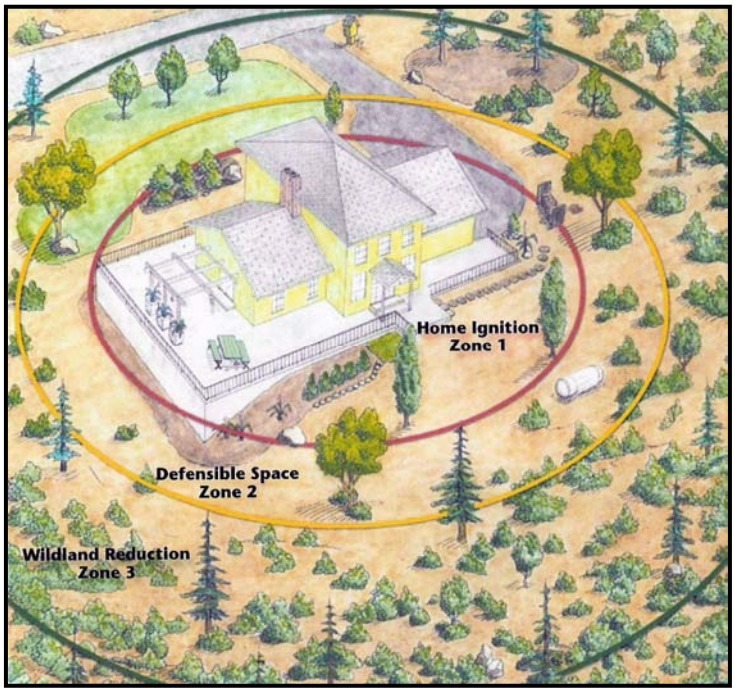
An aggressive program of evaluating and implementing defensible space for homes will do more to limit fire-related property damage than any other single recommendation in this report.

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 question is how much should be removed. 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. Then 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 (see **Figure 16**). Steep slopes and/or the presence of dangerous topographic features as described above may require the defensible space distances to be increased.

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.

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

Figure 16: Defensible Space Zones[18]



RECOMMENDATIONS

- Priority level-High. Conduct a parcel level wildfire hazard analysis for the homes in the study area. Completing this process will facilitate the following important fire management practices:

    - Establish a baseline hazard assessment for homes in these communities
    - Education of the community through the presentation of the parcel level Hazard-Risk Analysis at neighborhood public meetings
    - Identification of defensible space needs and other effective mitigation techniques
    - Identification and facilitation of "cross-boundary" projects
    - Community achievement of national FIREWISE status
    - Development of a Pre-Attack/Operational Plan for the FMU and eventually the entire study area. A pre-attack plan assists fire agencies in developing strategies and tactics that will mitigate incidents that occur

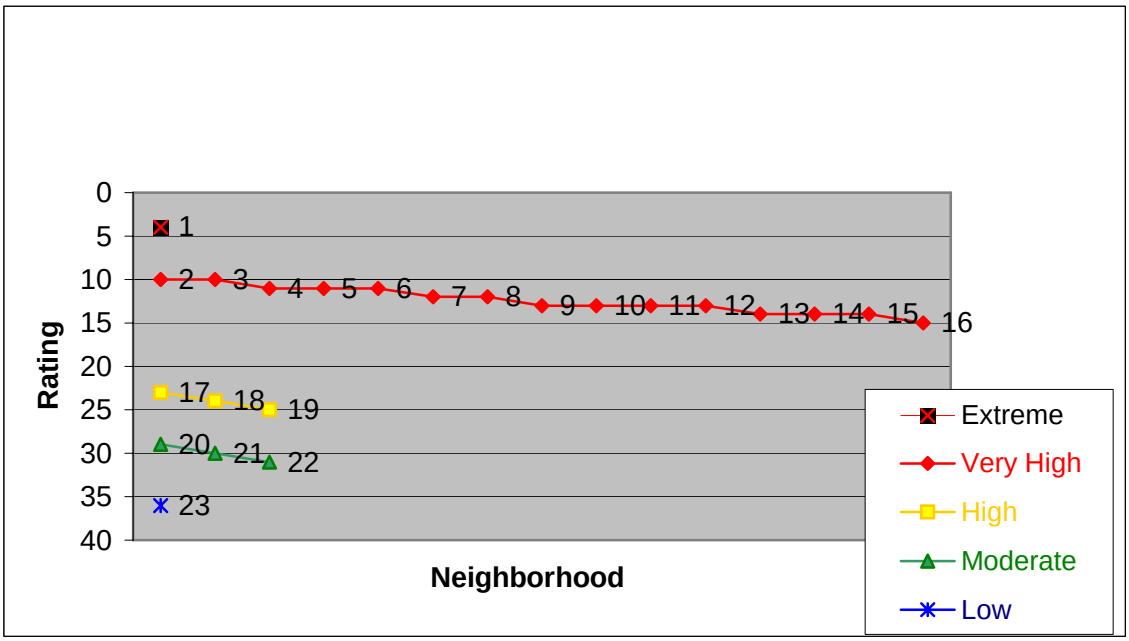
- Priority level-High. Add reflective address signs at each driveway entrance to all homes (See Appendix D for recommendations).

- Priority level-High. Use the structure triage methodology provided in **Appendix C** to identify homes not likely to be defendable.

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

- Priority level-Moderate. Improve access roads and turnarounds to create safe access for firefighting resources. See "Glenwood Springs Hazard Assessment Emergency Access and Water Supply" (**Appendix D**).

Table 3. Hazard Ratings by Community



1. Highlands	**13. East Glenwood**
2. North No Name	**14. Three Mile**
3. Midland	**15. Oak Meadows**
4. Canyon Creek Estates	**16. Lower Canyon Creek**
5. Mel Ray/Shady Acres	**17. Sunlight**
6. Chelyn Acres	**18. South No Name**
7. Upper Canyon Creek	**19. Elk Springs**
8. Upper Mitchell Creek	**20. Sunlight View II**
9. Oasis Creek	**21. Prem Ranch**
10. Sunlight View I	**22. West Bank**
11. Black Diamond	**23. Spring Ridge Place**
12. Mountain Springs Ranch	

LANDSCAPE SCALE FUELS MODIFICATIONS FMU

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 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 being said, however, fuelbreaks have proven to be effective in limiting the spread of crown fires in Colorado.[19] 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 compared 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 the study area were generated by the FlamMap model and classified into three standard ranges (surface fire only, passive crown fire and active crown fire). In areas where active 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) that are 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 to stop fires from backing down the other side or spotting into the next drainage. This is sometimes not practical from a WUI standpoint as 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; however it may be easiest to achieve as an extension of defensible space work or an extension 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

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

the defensible space of homes and the fuelbreak is less than ten acres. Another tactic that is commonly used is to position fuelbreaks along the bottom of slopes. In most of the study area this would require the cooperation of many individual landowners. In some areas, like Midland, the only way to separate residences from fuels is to locate the fuelbreak mid-slope above homes. This would provide some protection from backing fires and rolling materials. It would make sense to locate fuelbreaks mid-slope below homes, where this is possible, 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 some portions of the study area.

Fuelbreaks are often easiest to locate along existing roadbeds (see the "**Access Route Fuels Modification Recommendations**"). The minimum recommended fuelbreak width is usually 200 feet. As spread rate and intensity increases with slope angle, the size of the fuel break 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 4**). Fuelbreaks that pass through hazardous topographic features should have these distances increased by 50%.[20] Since fuelbreaks can have an undesirable effect on the esthetics of the area, crown separation should be emphasized over stand density levels. That is to say that isolating groupings rather than cutting for precise stem spacing will help to mitigate the visual impact of the fuelbreak. Irregular cutting patterns that reduce canopy and leave behind islands with wide openings are effective in shrub models.

Another issue in mechanical thinning is the removal of cut materials. 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, but 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. Fuelbreaks should not be constructed without a maintenance plan.

One of the most difficult issues in establishing and maintaining fuelbreaks is securing cooperation and participation of landowners. Ownership maps of the area indicate that implementation of fuels reduction projects recommended here and in the "Access, Evacuation, and Sheltering-In-Place FMU" section, would require the approval of several public land management agencies as well as private landowners. These entities include the City of Glenwood Springs, the United States Forest Service, the Bureau of Land Management and possibly others.

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

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

Special Considerations for Fuel Treatments in Oak Brush

In the majority of the Extreme, Very High, and High hazard communities in the study area, the dominant fuel is Gambel's Oak (fuel models 4 and 6). When burned, Gambel's Oak produces significantly more energy than other common Southwestern trees: 52% more than Aspen, 42% more than Ponderosa pine, 36% more than Lodgepole pine and 24% more than Rocky Mountain juniper.[21]

Gambel's Oak is extremely fire tolerant and is seldom actually killed by fire. The USFS Fire Effects Information website reports that following a fire that had consumed all above-ground vegetation, herbaceous plants and litter, Gambel's Oak quickly reestablished in densities greater than those present before the burn. In a Colorado study Gambel's Oak increased 100% to 150% in density and 10% to 40% in frequency following a single burn. Fuels reduction by prescribed fire seems to be most effective in Gambel's Oak when performed during the summer growth period when the plant's carbohydrate reserves are at their lowest. This, of course, is the time when prescribed burning would be least desirable from a control standpoint. Even if it were possible to burn during this period, evidence suggests that it would still require repeated, high-severity fires to reduce Gambel's Oak.[22]

The preferred method of control is mechanical thinning combined with herbicide application to prevent sprouting and new growth. Thinning with heavy machinery is not likely to be a popular tactic in interface areas. Hand thinning with chainsaws is likely to be the most acceptable method to residents. Ideally herbicide should be applied within the first hour after cutting to prevent sprouting or alternatively, to emerging sprouts three to six weeks after cutting. USFS information indicates that treatment is most effective if done during the period of low carbohydrate reserves just prior to the full leaf stage. Evidence indicates that herbicides that are applied during periods when carbohydrate reserves are high may actually stimulate root sprouting in Gambel's Oak therefore, the timing of fuels reduction efforts becomes more important in Oak brush than other fuels.[23] Coordinated efforts between private landowners and public land managers are critical to prevent fuels reduction efforts that actually result in an increased fuel load.

[21] USDA Forest Service Fire Effects Information website (http://www.fs.fed.us/database/feis/index.html), 2000.
[22] Ibid
[23] Ibid

BLM/USFS Current and Planned Projects

The Upper Colorado River Interagency Fire Management Group is composed of the BLM Glenwood Springs and Grand Junction Field Offices and the USFS White River and Grand Mesa National Forests. The Fire Management Group supports city and county WUI hazard reduction efforts through fuels reduction on adjacent federal lands and by funding WUI planning efforts. Major funding for the "Glenwood Springs Fire Protection District Wildland Fire Hazard and Risk Assessment" (2003) was provided by a BLM grant. The following is a list of planned and proposed fuels reduction projects under consideration for fiscal years (October 1-September 30) 2004-2009 that could impact GSFPD. For the purpose of BLM/USFS project descriptions; "planning" involves project design and coordination with adjacent property owners, fire districts and other stakeholders. Other activities included in the planning stage would be any resource work and inventories necessary for compliance with the National Environmental Policy Act (NEPA).

- **Lookout Mountain Communication Site**: (Completed in 2004) Twelve acres surrounding the tower and structures on the Lookout Mountain Communication site were targeted for defensible space construction and fuels reduction. This project reduces hazards in the WUI by reducing the risk of losing emergency response communications. We believe this is an important project as it protects a critical communication infrastructure resource.
- **Four Mile Project**: The proposed fuels reduction project in the Four Mile Road area involves three adjacent communities, Chelyn Road, Black Diamond Road, and Oak Meadows. The reduction of fuels on the BLM and USFS lands indicated by the proposed project map could have a noticeable impact on the intensity of fires in these populated areas, especially when combined with mitigation efforts on private land. Please see specific recommendations for Chelyn Acres, Black Diamond, and Oak Meadows in the recommendations section below.
- **Mountain Springs/Three Mile:** Fuels reduction work on federal lands in this area could reduce the intensity of fires in the residential areas as well as improve access safety for firefighting forces. This project may also involve the granting of an easement for and the development of, alternate escape routes from the Mountain Springs Ranch community into South Canyon.
- **Glenwood Gondola Project**: From the borders indicated on the BLM proposed project map (draft 5/12/03) this project, could significantly impact the Oasis Creek community.
- **Midland Project**: (This potential project is scheduled for planning in fiscal year 2007, with possible implementation in fiscal year 2008.) A small but important portion of the Midland community is being considered for hazardous fuels reduction on the BLM land to the west of residences. This project would provide a fuelbreak between the homes and steep slopes with heavy loads of shrub fuels, primarily Oak Brush.

In accordance with the National Fire Plan, federal land managers in this area have demonstrated a willingness to preplan treatments with local fire departments and landowners to create cross-boundary hazard reduction efforts. It is important for GSFD, the city of Glenwood and private landowners to coordinate all fuels reduction projects so they complement these BLM/USFS efforts.

ACCESS ROUTE FUELS MODIFICATION RECOMMENDATIONS

The primary transportation corridors through the district are I-70, Colorado Highway 82 and Four Mile Road. 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 in the number of structures that could be defended in a wildfire. Existing and natural barriers to fire should be incorporated into the project dimensions.

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

- Highlands
- North No Name
- Chelyn Acres
- Upper Canyon Creek
- Mitchell Creek (especially above the fish hatchery)
- Oasis Creek
- Black Diamond
- Mountain Springs Ranch
- Three Mile
- Oak Meadows
- Elk Springs

In addition to the escape routes suggested previously, other possibilities should be defined and similar fuels reduction projects employed. For example, aerial photographs show that it may be possible to construct an escape route from the northern portion of the Highlands community to the golf course by using natural clearings and old trails. If field checking shows this is possible, the additional access would improve the safety of residents and firefighters. In areas where multiple routes exist, consider separating access routes for responders and escape routes for citizens in pre-attack plans.
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 and shrubs for removal. It allows greater consideration for the elements of visual screening and aesthetics. Enlarging the project dimensions, allows more options for vegetative 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

- 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 lower)
- 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 FUELS MODIFICATION RECOMMENDATIONS

The following recommendations are in addition to, not in place of, the fuels reductions mentioned in the "Access Route Fuels Modification Recommendations" and the BLM/USFS projects listed above.

Of the communities assessed in this study, the following are recommended for fuel breaks:

- **Highlands** – Priority level-High. In addition to the thinning along the access road that was discussed in the "Access, Evacuation and Sheltering-In-Place FMU", fuels reduction should be undertaken in the ravine between Highlands and Oasis Creek. Homes that are located above heavy loads of Oak brush, especially those above ravines, need extended defensible spaces. If enough homeowners are interested, it may be possible to tie these individual treatments into a landscape scale fuel break that would slow fire spread and reduce the intensity of fires occurring on the slopes below the homes.

- **Oasis Creek** – Priority Level-High. As mentioned before, there is a critical need to thin fuels in the ravine between Oasis Creek and Highlands. The ravine to the east of Oasis Creek is also a critical fuels reduction need to protect access into the community as well as the Transfer Trail. If this work was done, a fuel break could be used to connect the two ravines and isolate Oasis Creek from the steep slopes to the north. Thinning on the slopes to the south of homes is also recommended and could be tied into a similar project in the Highlands community.

- **Oak Meadows** – Priority Level-High. Decadent Aspen stands mentioned in Appendix B could be cleaned up to provide a good natural barrier to north/south fire spread. Thinning along the old railroad grade would also help prevent ignitions occurring along the road and in the eastern part of the community from spreading rapidly into the upper slopes and ravines. Any work done here should be coordinated with the BLM project that is under consideration.

- **Mel Ray/Shady Acres** – Priority Level-High. It would be advisable to tie a fuelbreak in from the golf course to the thinning along Mitchell Creek Road mentioned in the "Access Route Fuels Modification Recommendations" section. This would help isolate this community from the steep slopes to the north. Even though the western parts of this area burned during the Coal Seam fire, there is still a significant fuel load present. Fuel loading combined with the close together

wooden structures that dominate this community makes fuels reduction especially important.

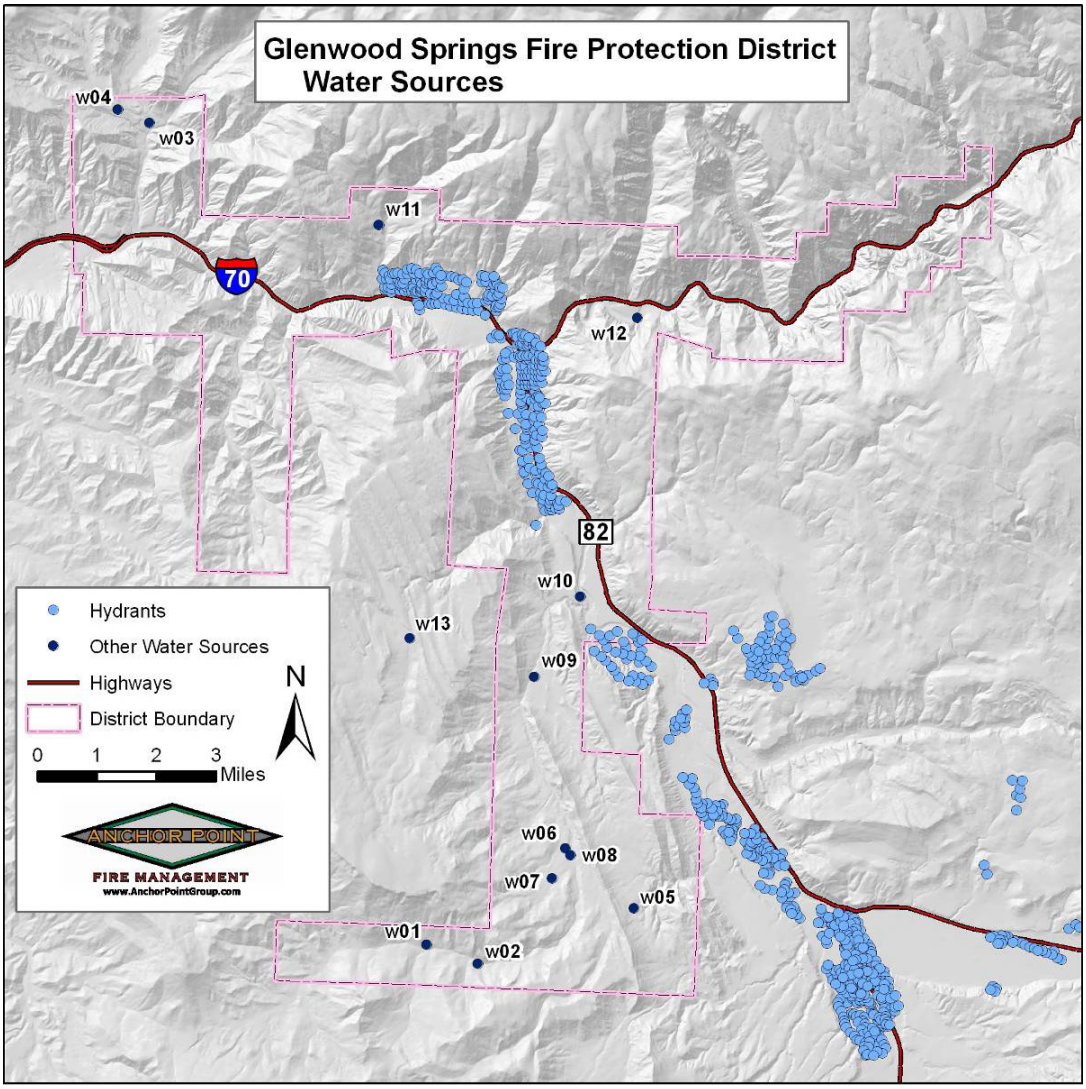
- **Midland** – Priority Level-Moderate. Combine private landowner efforts with the BLM project mentioned above to create a fuel break between the homes and the steeper slopes of heavy fuels to the west. It would also be desirable to thin vegetation between Midland Avenue and residences to the west.
- **Chelyn Acres** – Priority Level-Moderate. A fuel break could be extended from the power line cut to the south and tied into Fourmile Creek. Thinning between residences and Fourmile Creek should also be considered to protect access and reduce the spread of ignitions occurring from the road. This work should be coordinated with the BLM fuels reduction project in this area.
- **Black Diamond** – Priority Level-Moderate. Thinning and improvements along the access road to the Black Diamond Mine may help slow the spread of fire from the west into this community. This area lacks good anchor points for a fuelbreak. Any work done here should be coordinated with the proposed BLM project.
- **Canyon Creek -** Priority Level-Moderate. A fuels reduction project on the BLM lands on both sides of the access into the Upper Canyon Creek area would reduce the intensity of fires in that community. These treatments would be most effective if combined with defensible spaces and fuels reduction in the private lands surrounding the road.
- **Elk Springs** – Priority Level-Moderate. Elk Springs needs a fuelbreak to separate this community from the steep slopes of continuous piñon/juniper to the west. The fuelbreak could be anchored into Spring Valley Road to the south and jeep trails to the north. None of this area is within a fire protection district.

There are some communities in the study area that have a notable amount of standing dead and diseased trees. Tree mortality due to Ips beetle infestation is becoming an increasing problem in Highlands and other communities. Cooperation between public and private landowners in removing dead and diseased trees and treating for beetles is recommended.

WATER SUPPLY FMU

Like most of the mountainous areas of Colorado, water in the study area is a critical fire suppression issue. The City of Glenwood Springs has an excellent network of hydrants. In most of the interface communities, however city hydrants are not available. In the spring of 2006 GSFD contracted for an on-the-ground evaluation of alternative water sources in these areas. Twelve additional water sources were identified and pre-planned for these areas. Approximate locations of hydrants and these supplemental water sources within the study area are shown in Figure 17.

Figure 17: Water Supply Locations in the Study Area



Field verification showed that the hydrants listed on this map, which was provided by the Glenwood Springs Planning Department, did indeed exist in the areas depicted. Several communities were found, however, where hydrants were present, and appeared to be in good condition, but are not shown in **Figure 17**. These communities are listed below:

- North and South No Name
- Canyon Creek Estates
- Sunlight View I and II
- Oak Meadows
- Spring Ridge Place

Even with the additional water sources identified in the 2006 project, homes exist in several communities which are located more than 1,000 feet from the nearest water source or hydrant. These communities include:

- Chelyn Acres
- Black Diamond
- Upper Canyon Creek
- Upper Mitchell Creek
- Mountain Springs Ranch
- Three Mile (above the trailer park)
- Lower Canyon Creek
- Sunlight

Some of these areas (Chelyn Acres, Lower Canyon Creek and Three Mile), are adjacent to areas where hydrants are present, however there are some homes located in all the communities listed above which are a considerable distance from reliable water sources for fire suppression. Improvement of the water supply in these communities constitutes an important FMU.

GSFD is equipped with a good supply of water tenders and portable tanks (See the "Local Preparedness and Firefighting Capabilities FMU" section); however, firefighting efforts can be enhanced by improving water supplies in the FMU.

RECOMMENDATIONS

- Priority Level-High. In Upper Canyon Creek, Upper Mitchell Creek and along Four Mile Road, there are private ranches and landowners with water supplies suitable for fire suppression. For example, the Storm King Ranch in Upper Mitchell Creek has its own water source for fire suppression. During the Coal Seam fire, the ranch effectively suppressed the fire on its property. Wherever such private water sources exist, agreements should be sought with the property owners for the use of the water during emergency suppression operations. When such agreements are reached, the water source should be included in fire department pre-plans with information including maps, access information such as gate codes or key locations, the size and type of the water source, whether or not it is accessible to aircraft and equipment and connections needed for use. This information will be important for the successful use of the water supply by outside resources unfamiliar with the area.
- Priority Level-High. Consider the installation of a large, 10,000 to 20,000 gallon, community cistern in the western portion of Chelyn Acres. The nearest water supply for this community is the hydrant system in Sunlight View 1.
- Priority Level-High. In Upper Canyon Creek private water sources should be identified and preplanned. Homes above mile 2.5 should have on-site cisterns or draftable all-season ponds because they are a long way from other water sources.
- Priority Level-High. The Mountain Springs Ranch area is desperately in need of additional water supply. At the current level of development, the area could be covered by three or four large, 10,000 to 20,000 gallon, cisterns or by individual, 1,800 to 2,500

gallon, on-site cisterns for homes located more than 1,000 from draftable ponds. If development continues a comprehensive pre-plan including water sources should be considered for this community.

- Priority Level-High. Homes in the Three Mile Community west of the Three Mile Trailer Park need cisterns. Three Mile Creek is not a reliable draft source due to low flows and difficult access. Individual cisterns are probably the best solution for isolated homes, however a community cistern could be considered for the grouping of homes on the south facing slopes north of the road and approximately 3/4 of a mile west of the trailer park.
- Priority Level-Moderate. In Upper Mitchell Creek homes above the fish hatchery should have on-site cisterns, or draftable all-season ponds.
- Priority Level-Moderate. One or two large, 10,000 to 20,000 gallon cisterns should be added in the Lower Canyon Creek area to prevent the need to shuttle water from Canyon Creek Estates.
- Priority Level-Moderate. Standardize connection size, sex, and thread type for dry hydrants and cisterns. 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. A standard should be adopted by a cooperative effort between the water district, GSFD and mutual aid agencies. Our recommendation would be 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 Glenwood Springs 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: This is 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: This is Geographic Information System (GIS) software that is 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): 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 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. This is derived from fire behavior modeling programs using the following inputs: fuels, canopy cover, historical weather averages, elevation, slope, and aspect.

Fire Danger: In this document we do not use this as a technical term 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. The hazard rating is 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): This is 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 categorizing and 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. Fuelbreaks 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 (as defined by the insurance industry) 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 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 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 “Addressing, Evacuation, and Shelter-In-Place FMU” section in the main report.

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

Spotting: Refers to the 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: This is a fire that burns in the surface litter, debris, and small vegetation on the ground.

Timelag: Time needed under specified conditions for a fuel particle to lose about 63% 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 sixty-point scale analysis designed to identify factors that 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. This is sometimes referred to as Urban Wildland Interface, or UWI.

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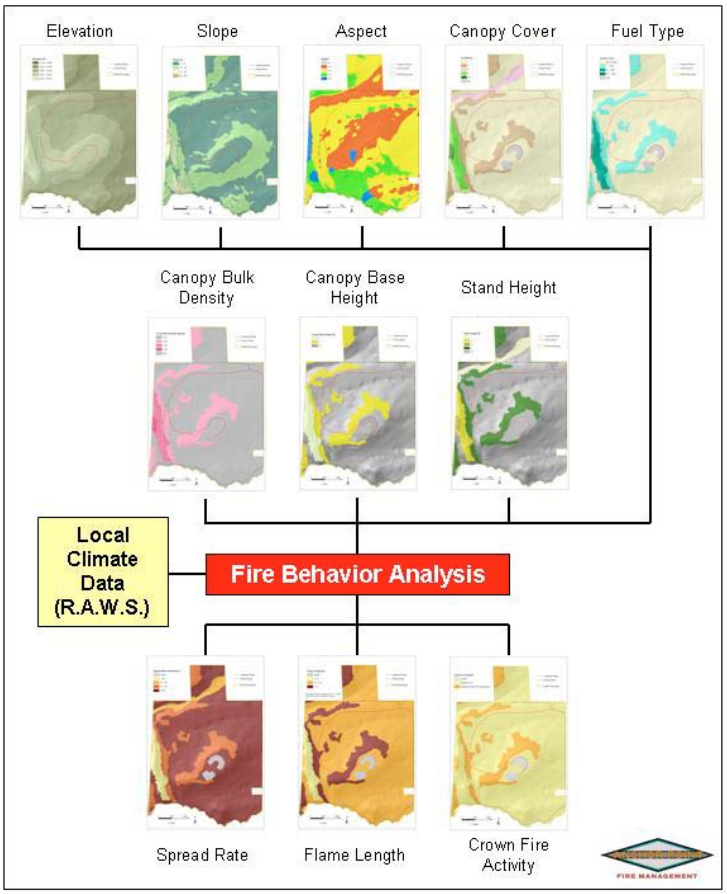
APPENDIX A

FIRE BEHAVIOR POTENTIAL ANALYSIS METHODOLOGY

PURPOSE

The purpose of this document is to describe the methodology used to evaluate the threat represented by physical hazards—such as fuels, weather and topography—to values-at-risk in the study area, by modeling their effects on fire behavior potential.

Figure 1. Flow Chart



The fire behavior potential analysis reports graphically the probable range of spread rate, flame length, and crown fire potential for the analysis area, based upon a set of inputs significant to fire behavior. The model inputs include aspect, slope, elevation, canopy cover, fuel type, canopy bulk density, canopy base height, stand height, and climate data. The model outputs are determined using FlamMap[1], which combines surface

[1] Mark Finney, Stuart Brittain and Rob Seli., The Joint Fire Sciences Program of the Rocky Mountain Research Station (USDA Forest Service, Missoula, Montana), the Bureau of Land Management and Systems for Environmental Management (Missoula, Montana).

fire predictions with the potential for crown fire development. Calculations for surface fire predictions (rate of spread and flame length) are based on the USDA Forest Service's BEHAVE[2] model.

BEHAVE

The BEHAVE fire behavior prediction and fuel modeling system was employed to determine surface fire behavior estimates for this study. BEHAVE is a nationally recognized set of calculations used to estimate a surface 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 fuels, weather, and topography. Requested values depend on the modeling choices made by the user.

Assumptions of BEHAVE:

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

FlamMap

Anchor Point uses FlamMap to evaluate the potential fire conditions in the fire behavior study area. The Glenwood Springs Fire Department (GSFD) response area includes the city of Glenwood Springs and the Glenwood Springs Fire Protection District (GSFPD) and encompasses 48,838 acres (76 square miles). The study area for the fire behavior analysis covers approximately 76,460 acres (119 square miles). This area includes the Fire Department response area and a half-mile buffer in all directions. The use of this buffer provides the district with an analysis of potential fire behavior on adjacent lands. From both a planning and tactical perspective, it is important to evaluate exposures beyond the jurisdiction. The study area is broken down into grid cells of 10-meters per side (10M). Using existing vector and raster spatial data and field data, ArcGIS spatial analysis capabilities are used to calculate model inputs for each 10M cell. These values are input into FlamMap, along with reference weather and fuel moisture (long-term weather observations statistically calculated from the Rifle Remote Automated Weather Station information). The outputs of FlamMap include the estimated Rate of Spread (ROS) (from BEHAVE), Flame Length (FL) (from BEHAVE) and Crown Fire Activity for a fire in that 10M cell. The model computes these values for each cell in the study area independently, so the data in each cell is unaffected by adjacent cells.

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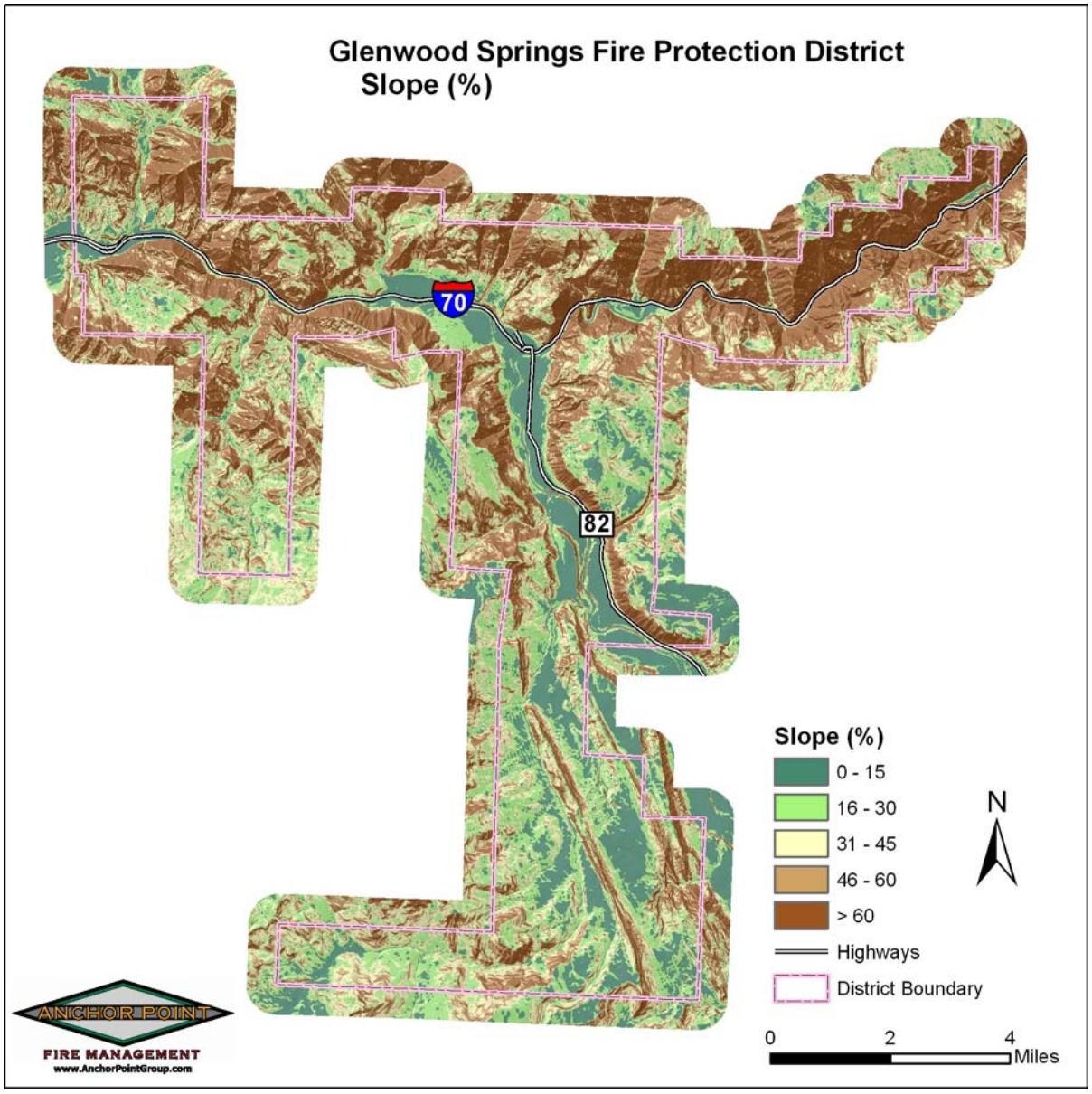
[2] Patricia L. Andrews, producer and designer, Collin D. Bevins, programmer and designer, The Joint Fire Sciences Program of the Rocky Mountain Research Station (USDA Forest Service, Missoula, Montana) and Systems for Environmental Management (Missoula, Montana).

Fire Behavior Inputs

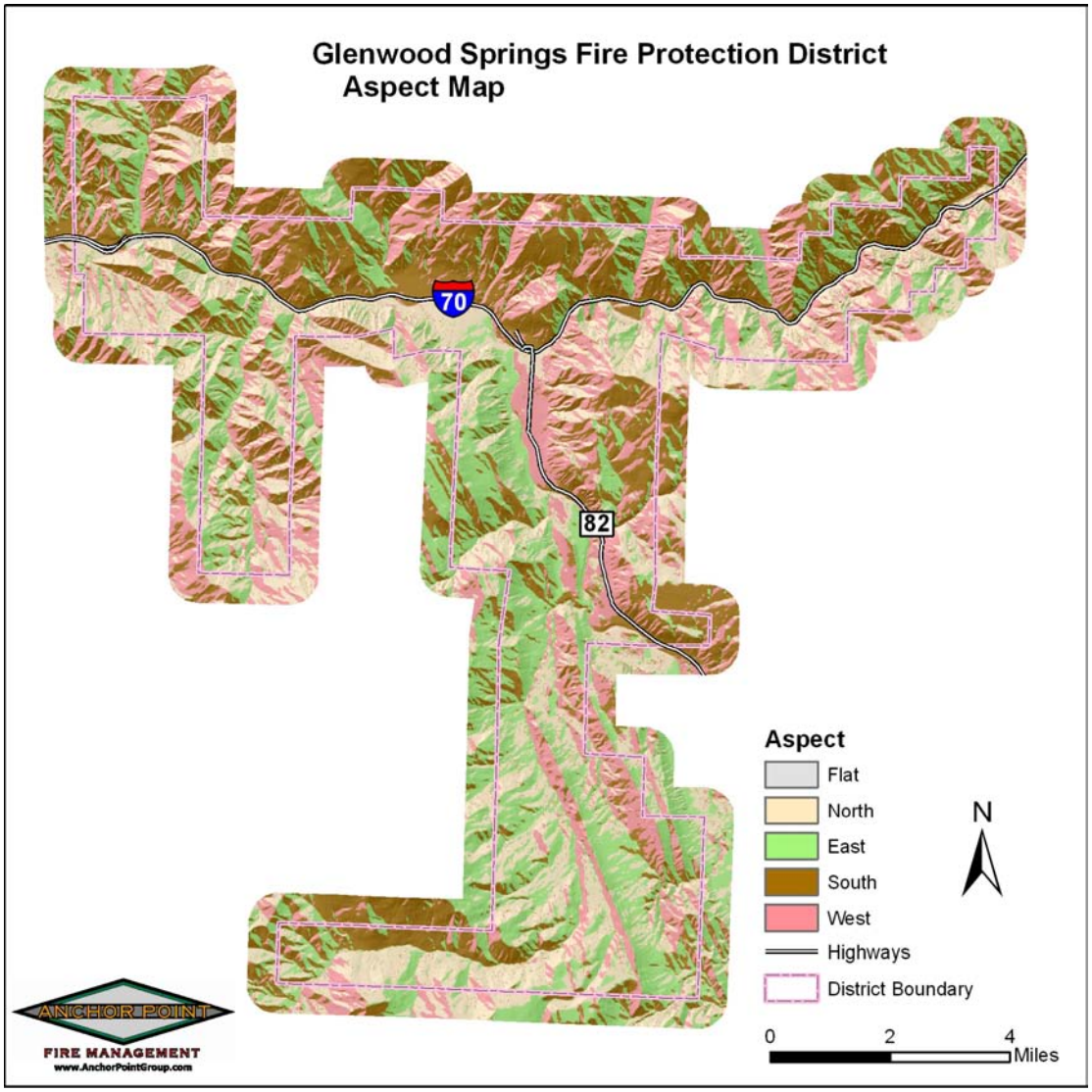
The major factors influencing fire behavior are fuels (type and coverage), weather, and topography (aspect, slope and elevation). The following pages contain a brief explanation of each.

Figure 2. Percent Slope



Slopes are shown here as percent (rise/run x100). Steeper slopes intensify fire behavior and thus will contribute to a higher wildfire hazard rating. Rates of spread for a slope of 30% are typically double those of flat terrain, when all other influences are equal.

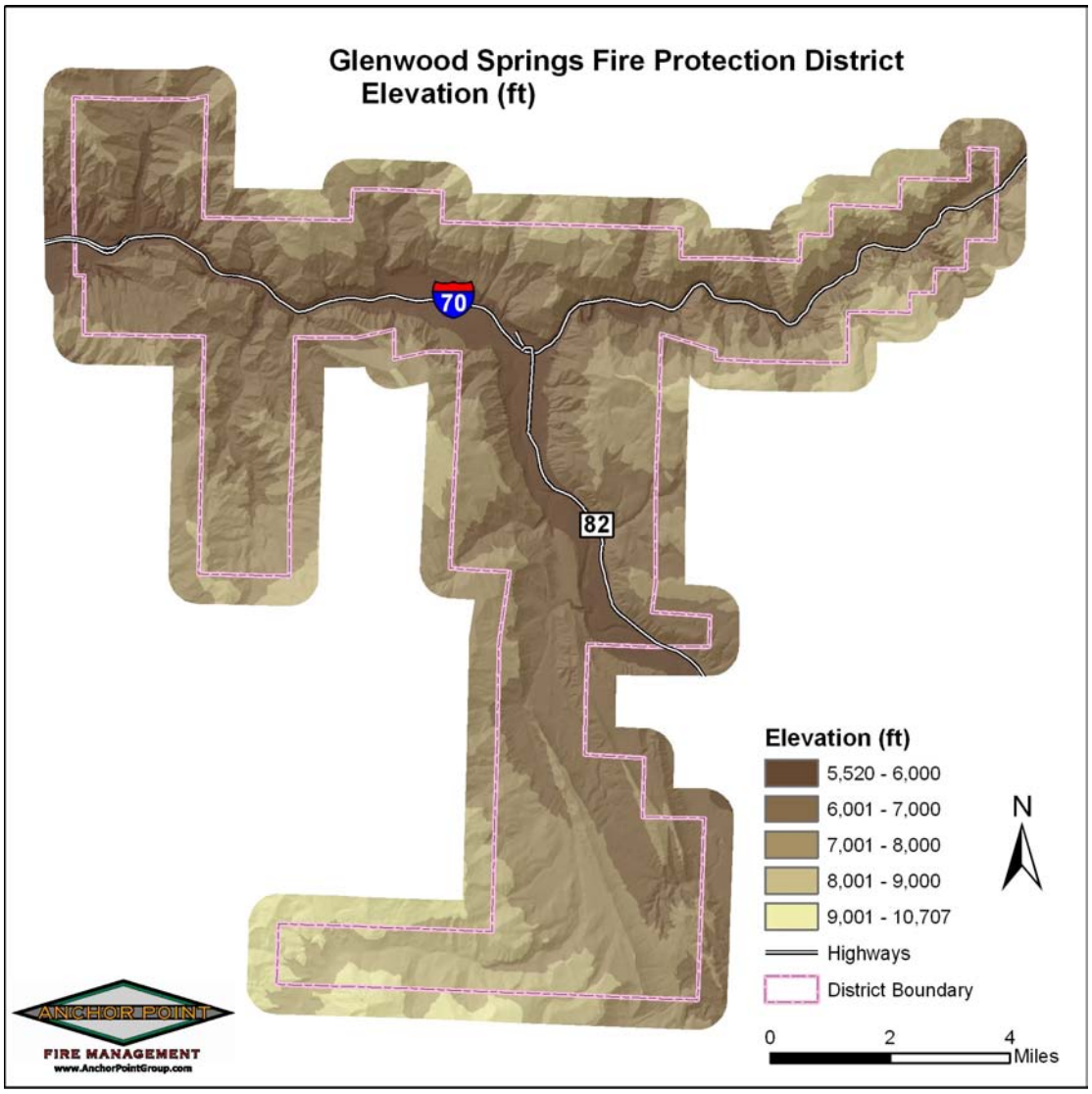
Figure 3. Aspect



Aspects are shown as degrees from north ranging from 0 to 360 according to their orientation. Aspects are influential in the type and quantity of vegetative fuels. Fuels on south facing slopes tend to be drier and more lightly loaded than fuels on north facing slopes, when all other influences are equal. Aspect also has an influence on plant species dominance.

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

Figure 4. Elevation



Elevations within the study area range from 5,500′ to over 10,000′. As elevation increases, environmental conditions, fuel species, and characteristics change.

Fuel Models and Fire Behavior

Fire behavior fuel models are a set of numbers that describe fuels in terms that a fire behavior model, in this case FlamMap, can use. There are seven characteristics used to categorize fuel models.

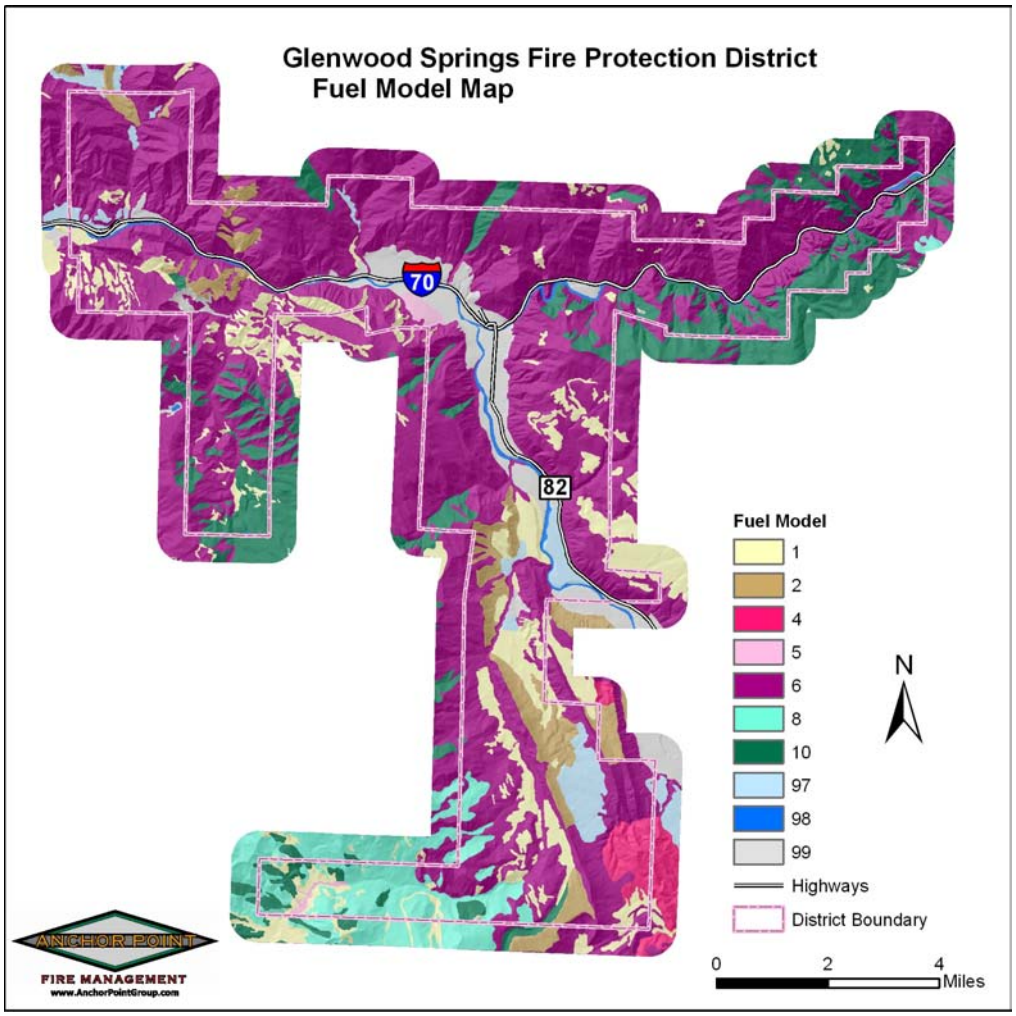
- Fuel Loading
- Size and Shape
- Compactness
- Horizontal Continuity
- Vertical Arrangement
- Moisture Content
- Chemical Content

Each of the major fuel types present in the study area are described below in terms of the characteristics that coincide with that fuel model. Fuel model descriptions are taken from Anderson's *Aids to Determining Fuel Models for Estimating Fire Behavior*[3], a national standard guide to fuel modeling, unless otherwise noted. **Vegetation for the project area may or may not be specifically listed in the description**. Plant species are only an aid to help visualize the characteristics of the model. The photos are taken from the project area and show where the local vegetation fits in. A table showing a range of surface fire behavior based on the **BEHAVE** system is also included.

The study area is represented primarily by seven fuel models (FM): FM 1, 2, 4, 5, 6, 8, and 10. Other fuel models may exist, but not in quantities sufficient to significantly influence fire behavior in the Wildland Urban Interface.

Figure 5 displays the fuel types graphically for the study area..

Figure 5. Glenwood Springs FPD Fuel Models



[3] Anderson, Hal E., *Aids to Determining Fuel Models for Estimating Fire Behavior*, National Wildfire Coordinating Group, NFES 1574, April 1982.

Fuel models 97, 98, and 99 in the map legend indicate areas of insignificant combustibility such as water, rock, sand, etc.

FUEL MODEL 1

Figure 6. Short 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.

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.

FUEL MODEL 1

Rate of spread in chains/hour
(1 chain=66 ft) (80 chains/HR = 1 MPH)

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

Figure 7. Open Canopy Shrubs with Grass Understory

Characteristics

Fire spread is primarily through the fine herbaceous fuels, either curing or dead.

Common Types/Species

Open shrub lands and pine stands or scrub oak stands that cover one third to two thirds of the area may generally fit this model. Such stands may include clumps of fuels that generate higher intensities and that may produce firebrands. Some piñon-juniper may be in this model.

Fire Behavior

These are surface fires where the herbaceous material—in addition to litter and dead-down stemwood from the open shrub or timber overstory—contributes to the fire intensity.

FUEL MODEL 2

Rate of spread in chains/hour
(1 chain=66 ft) (80 chains/HR = 1 MPH)

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	138.5
12.0	5.9	16.3	32.3	53.3	79.3	110.0

10-hr fuel 5%, 100= 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 4

Figure 8. Mature Oak Brush stands greater than 6 feet high

Characteristics

This model consists of stands of small diameter trees or large shrubs with continuous closed crowns. There may be high amounts of small dead limbs retained on the lower portion of trees. There may also be high amounts of woody and needle litter associated with the stand.

Common Types/Species

Typical candidates for this fuel model are: stands of mature shrubs six feet tall or higher, such as California mixed chaparral; the high pocosin along the east coast; the pinebarrens of New Jersey; shrubs such as common juniper; closed jack pine stands of the north-central states.

Fire Behavior

High rates of spread can be experienced in this model. Fire is carried through the foliage as well as the fine live and dead woody material of tree crowns. Fire spread is also enhanced by the amount of dead woody material on the ground.

FUEL MODEL 4

Rate of spread in chains/hour
(1 chain=66 ft) (80 chains/HR = 1 MPH)

Fine Dead Fuel moisture %	Mid-flame Wind Speed					
	2.0	4.0	6.0	8.0	10.0	12.0
2.0	30.4	70.6	120.4	177.9	241.8	311.3
4.0	27.0	62.6	106.8	157.7	214.4	276.0
6.0	24.8	57.5	98.1	145.0	197.0	253.7
8.0	23.5	54.4	92.8	137.1	186.3	239.9
10.0	22.6	52.3	89.2	131.8	179.1	230.6
12.0	21.7	50.2	85.8	126.7	172.2	221.7

10-hr fuel 5%, 100 = 6%, woody 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	13.9	20.5	26.2	31.3	36.1	40.5
4.0	12.6	18.5	23.6	28.3	32.6	36.6
6.0	11.7	17.2	22.0	26.4	30.4	34.1
8.0	11.2	16.5	21.1	25.2	29.1	32.7
10.0	10.9	16.0	20.5	24.5	28.3	31.7
12.0	10.6	15.6	19.9	23.8	27.4	30.8

FUEL MODEL 5

Figure 9. Mixed Shrub Regeneration in Recently Burned Areas

Characteristics

This model consists of continuous stands of low brush. Generally, heights do not exceed six feet. The stands will have a grass or scattered grass understory. Usually shrubs are short and almost totally cover the area.

Common Types/Species

Young, green stands with no dead wood would qualify: laurel, vine maple, alder, or even chaparral, manzanita, or chamise. Mountain grasses are also associated with this type.

Fire Behavior

The fires are generally not very intense because surface fuel loads are light, the shrubs are young with little dead material, and the foliage contains little volatile material. Fire is generally carried in the surface fuels that are made up of litter cast by the shrubs and the grasses or forbs in the understory. Cured leaves retained on shrubs can cause greater intensities.

FUEL MODEL 5

Rate of spread in chains/hour
(1 chain=66 ft) (80 chains/HR = 1 MPH)

Fine Dead Fuel moisture %	Mid-flame Wind Speed					
	2.0	4.0	6.0	8.0	10.0	12.0
2.0	9.7	22.5	38.2	56.2	76.0	97.5
4.0	8.7	20.1	34.2	50.3	68.1	87.3
6.0	7.5	17.5	29.8	43.8	59.2	76.0
8.0	5.5	12.7	21.6	31.8	43.1	55.2
10.0	2.7	6.4	10.8	15.9	21.5	21.8
12.0	2.6	6.1	10.4	15.3	20.1	20.1

10-hr fuel 5%, 100 = 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	6.4	8.1	9.7	11.2	12.5
4.0	3.9	5.8	7.4	8.8	10.1	11.4
6.0	3.5	5.1	6.5	7.8	8.9	10.0
8.0	2.6	3.8	4.9	5.8	6.7	7.5
10.0	1.4	2.0	2.6	3.1	3.5	3.6
12.0	1.3	2.0	2.5	3.0	3.4	3.4

FUEL MODEL 6

Figure 10. Gambel's Oak less than 4 feet high

Characteristics

Shrubs in Fuel Model 6 are older than, but not as tall as, the shrub types of Fuel Model 4. They also do not contain as much fuel as FM 4.

Common Types/Species

A broad range of shrub conditions is covered by this model. Fuel situations to be considered include intermediate stands of chamise, chaparral, oak brush, low pocosin, Alaskan spruce taiga, and shrub tundra. Even hardwood slash that has cured can be considered. Piñon-juniper shrub lands may be represented but may over-predict rate of spread except at high winds, such as 20 mi/h (32 km/h) at the 20-foot level.

Fire Behavior

Fires carry through the shrub layer where the foliage is more flammable than fuel model 5, but this requires moderate winds, greater than 8 mi/h (13 km/h), at mid-flame height. Fire will drop to the ground at low wind speeds or at openings in the stand.

FUEL MODEL 6

Rate of spread in chains/hour
(1 chain=66 ft) (80 chains/HR = 1 MPH)

Fine Dead Fuel moisture %	Mid-flame Wind Speed					
	2.0	4.0	6.0	8.0	10.0	12.0
2.0	17.2	38.5	63.9	92.4	123.5	156.8
4.0	13.9	31.1	51.7	74.8	99.9	126.9
6.0	11.7	26.2	43.5	62.9	84.1	106.8
8.0	10.2	22.9	38.1	55.0	73.6	93.4
10.0	9.2	20.7	34.4	49.7	66.5	84.4
12.0	8.5	19.1	31.7	45.9	61.4	77.9

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	5.0	7.3	9.2	10.9	12.4	13.9
4.0	4.3	6.2	7.8	9.3	10.6	11.8
6.0	3.8	5.5	6.9	8.2	9.3	10.4
8.0	3.4	5.0	6.3	7.4	8.5	9.5
10.0	3.2	4.7	5.9	7.0	8.0	8.9
12.0	3.1	4.4	5.6	6.7	7.6	8.5

FUEL MODEL 8

Figure 11. Aspen Stands

Characteristics

Hardwoods that have leafed out support fire in the compact litter layer. This layer is mainly needles, leaves, and occasionally twigs because little undergrowth is present in the stand. Amounts of needle and woody litter are also low.

Common Types/Species

Closed canopy stands of short-needle conifers or hardwoods. Representative conifer types are white pine, lodgepole pine, spruce, fir and larch.

Fire Behavior

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

FUEL MODEL 8

Rate of spread in chains/hour
(1 chain=66 ft) (80 chains/HR = 1 MPH)

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 10

Figure 12. Mixed conifer stands

Characteristics

This 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 down material is present. There is also a large amount of dead, down woody fuels. Reproduction may be present, acting as ladder fuels. This model includes stands of budworm-killed Douglas-fir, closed stands of ponderosa pine with large amounts of ladder and surface fuels, and stands of lodgepole pine with heavy loadings of downed trees. This model can occur from the foothills through the sub-alpine zone.

Common Types/Species

All types of vegetation can occur in this model, but primary species are Douglas-fir, ponderosa pine and lodgepole pine.

Fire Behavior

Fire intensities can be moderate to extreme. Fire moves through dead, down woody material. Torching and spotting are more frequent. Crown fires are quite possible.

FUEL MODEL 10

Rate of spread in chains/hour
(1 chain=66 ft) (80 chains/HR = 1 MPH)

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 = 6%, woody 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 Used in the Fire Behavior Potential Evaluation

The weather inputs for FlamMap were created by using weather data collected at the Rifle Remote Automated Weather Station (RAWS).

Rifle Site Information

Latitude (dd mm ss)	39 ° 30' 43 " N
Longitude (dd mm ss)	107 ° 44 ' 57 " W
Elevation (ft.)	6,120

Weather observations from the Rifle RAWS were averaged for a nineteen-year period (1987-2006) to calculate these conditions. The average conditions class (16th to 89th percentile) was calculated for each variable (1 hour, 10 hour, and 100 hour fuel moisture, woody fuel moisture, herbaceous fuel moisture, and wind speed) using Fire Family Plus. This weather condition class most closely represents an average fire season day.

The extreme conditions class was calculated using 97th percentile weather data. In other words, the weather conditions on the four most severe fire weather days (sorted by Spread Component) in each season for the nineteen-year period were averaged together. It is reasonable to assume that similar conditions may exist for at least four days of the fire season during an average year. In fact, during extreme years such conditions may exist for significantly longer periods. Even these calculations may be conservative compared to observed fire behavior. The following values were used in **FlamMap**:

Average Weather Conditions	
Variable	**Value**
20 ft Wind speed up slope	16 mph
Herbaceous fuel moisture	6%
Woody fuel moisture	73%
100-hr fuel moisture	7%
10-hr fuel moisture	4%
1-hr fuel moisture	4%

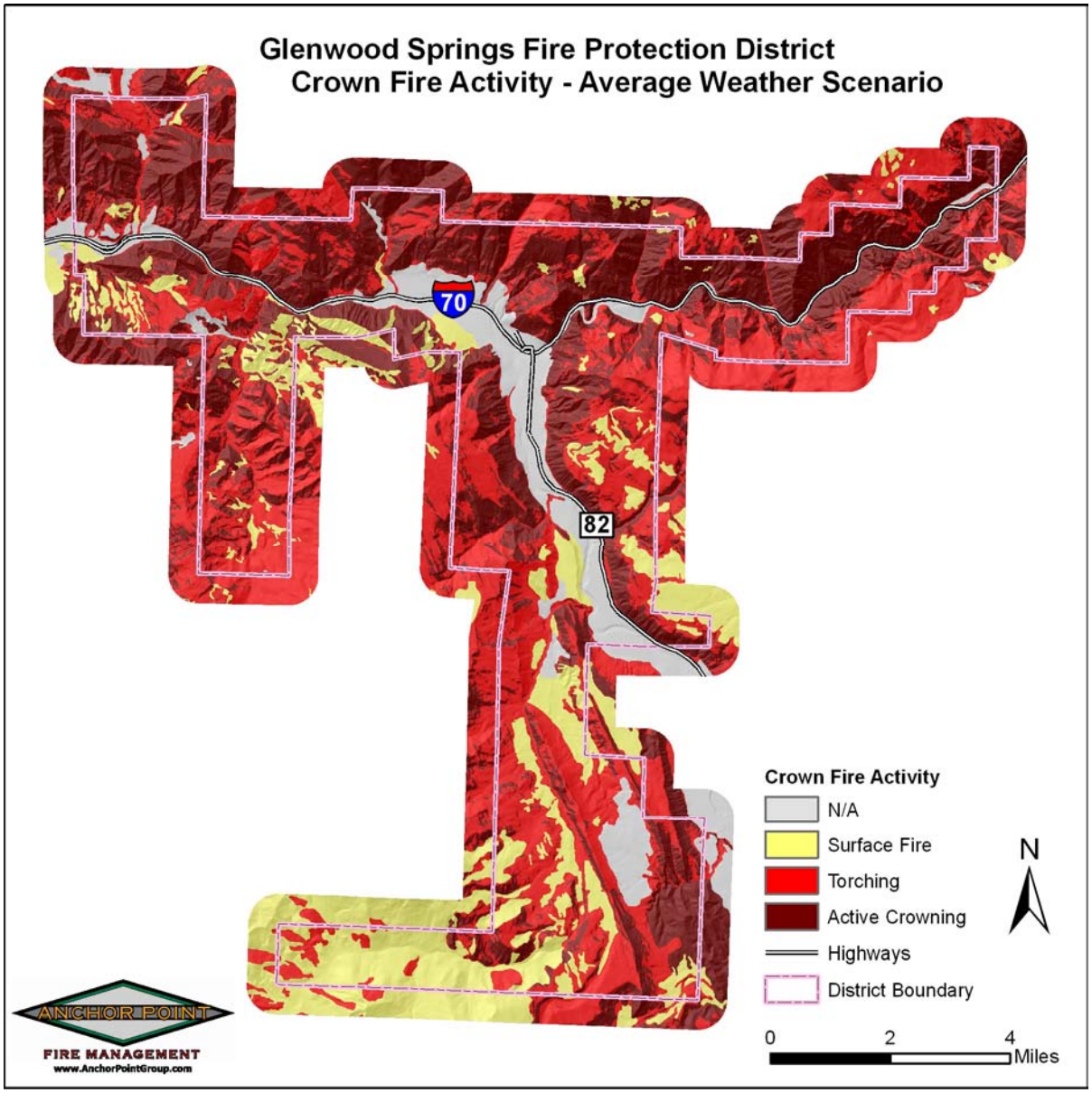
Extreme Weather Conditions	
Variable	**Value**
20 ft Wind speed up slope	35 mph
Herbaceous fuel moisture	7%
Woody fuel moisture	71%
100-hr fuel moisture	5%
10-hr fuel moisture	3%
1-hr fuel moisture	2%

(Note: Strong winds at 20 ft will feel significantly less noticeable on the skin at ground level. For example, a "gentle breeze" on the skin may constitute an 11 MPH 20-foot wind, adding one of the components necessary for extreme weather conditions.)

Fire Behavior Analysis Outputs

Crown fire activity, rate of spread, and flame length are derived from the fire behavior predictions. The following maps graphically display the outputs of **FlamMap** for both average and extreme weather conditions.

Figure 13. Predictions of Crown Fire Activity (Average Weather Conditions)



Crown fire activity values are generated by the **FlamMap** model and classified into four categories based on standard ranges: Active, Passive, Surface, and Not Applicable. In the surface fire category, little or no tree torching will be expected. During passive crown fire activity, isolated torching of trees or groups of trees will be observed and canopy runs will be limited to short distances. During active crown fire activity, sustained runs through the canopy will be observed that may be independent of surface fire activity.

Figure 14. Predictions of Crown Fire Activity (Extreme Weather Conditions)

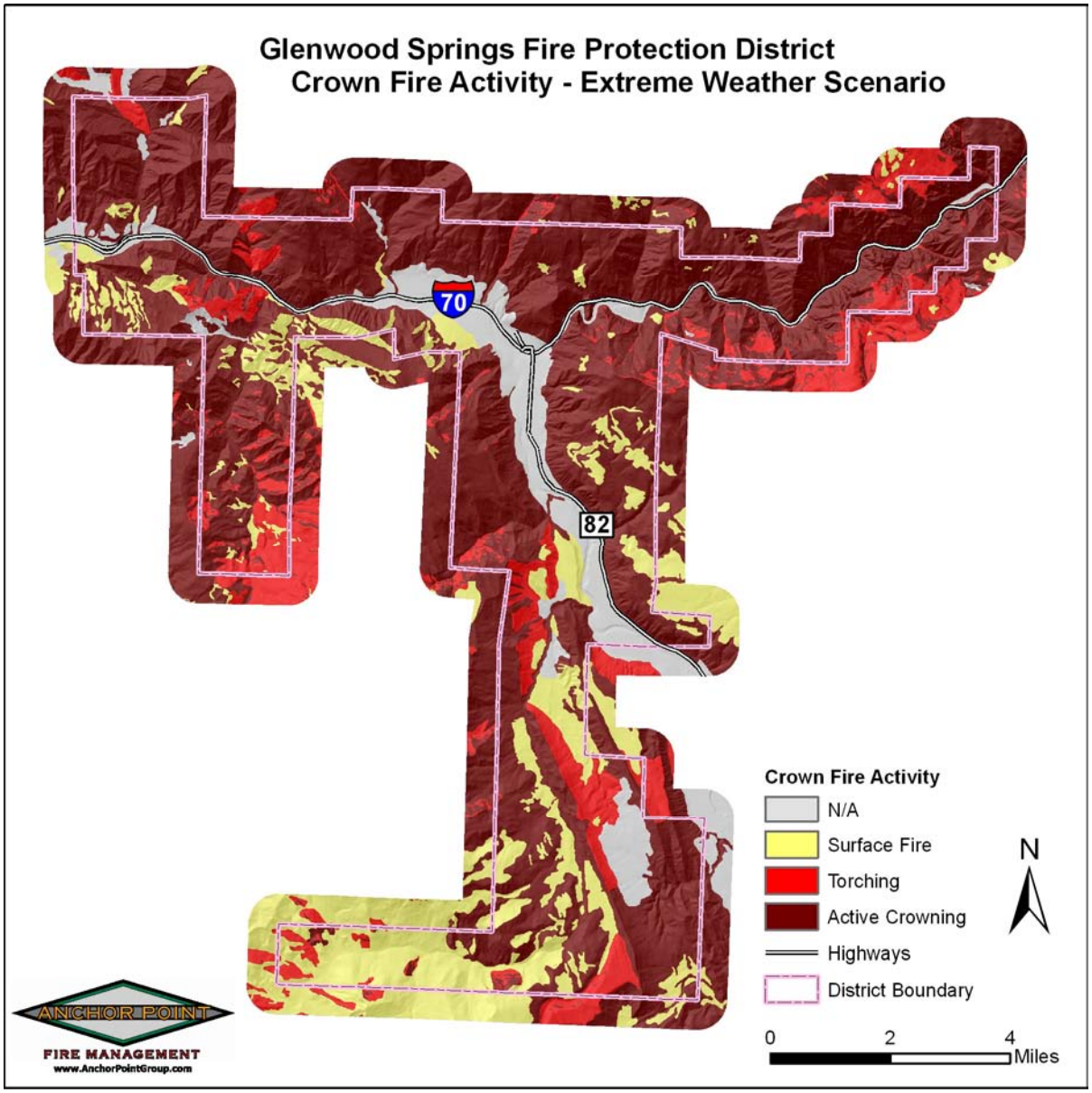
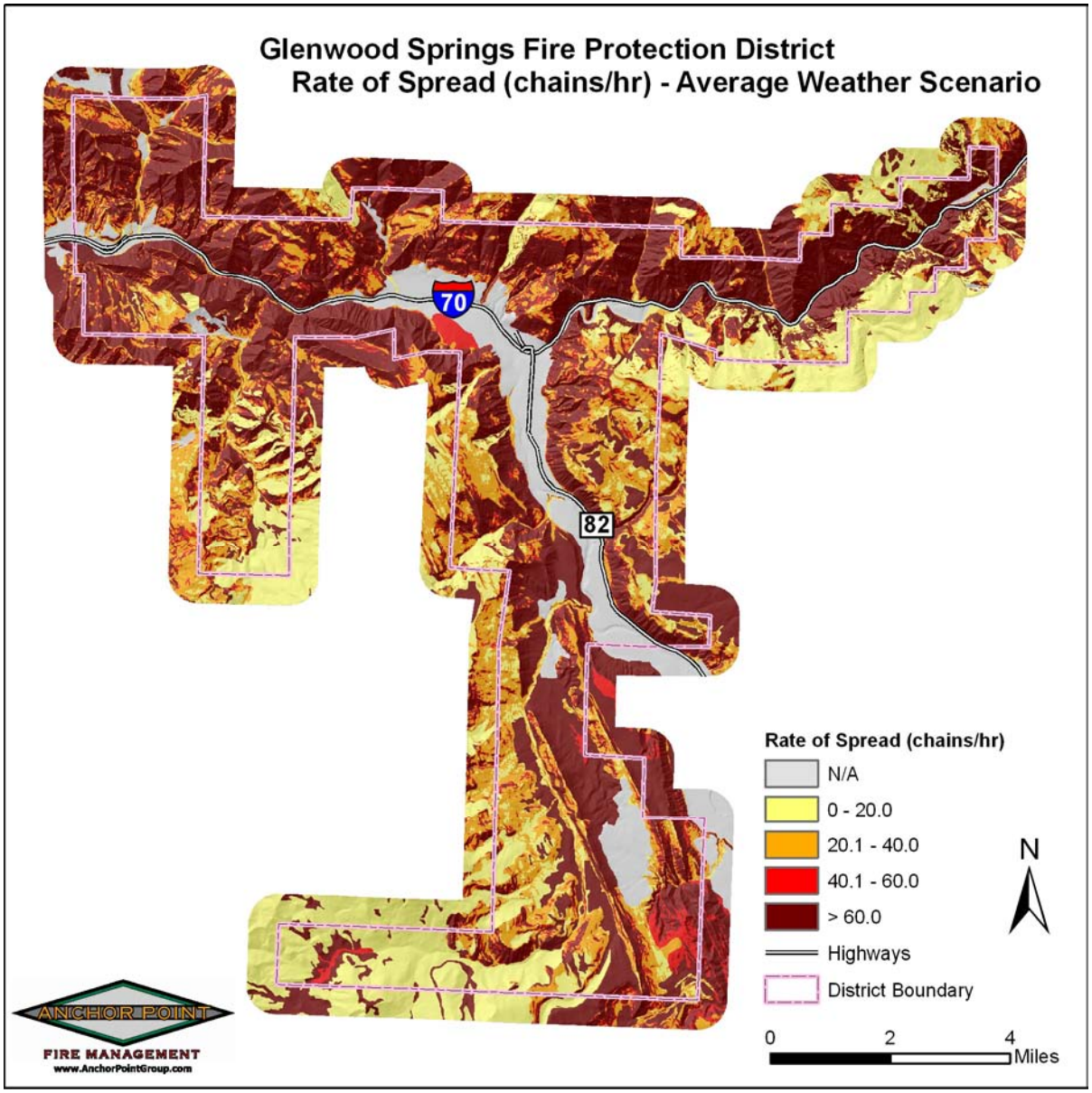


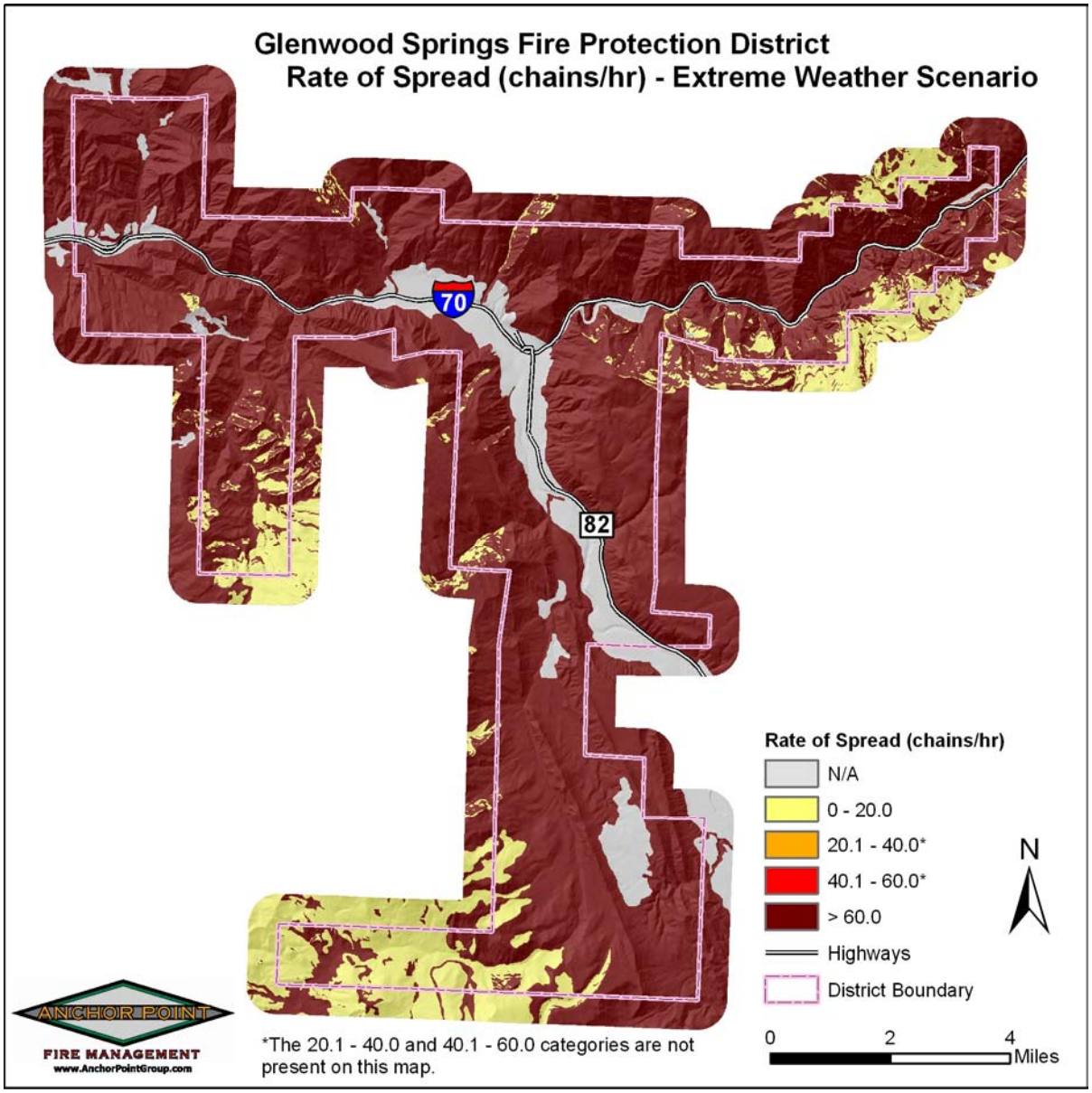
Figure 15. Rate of Spread Predictions (Average Weather Conditions)



Rate of spread in chains/hour
(1 chain=66 ft) (80 chains/HR = 1 MPH)

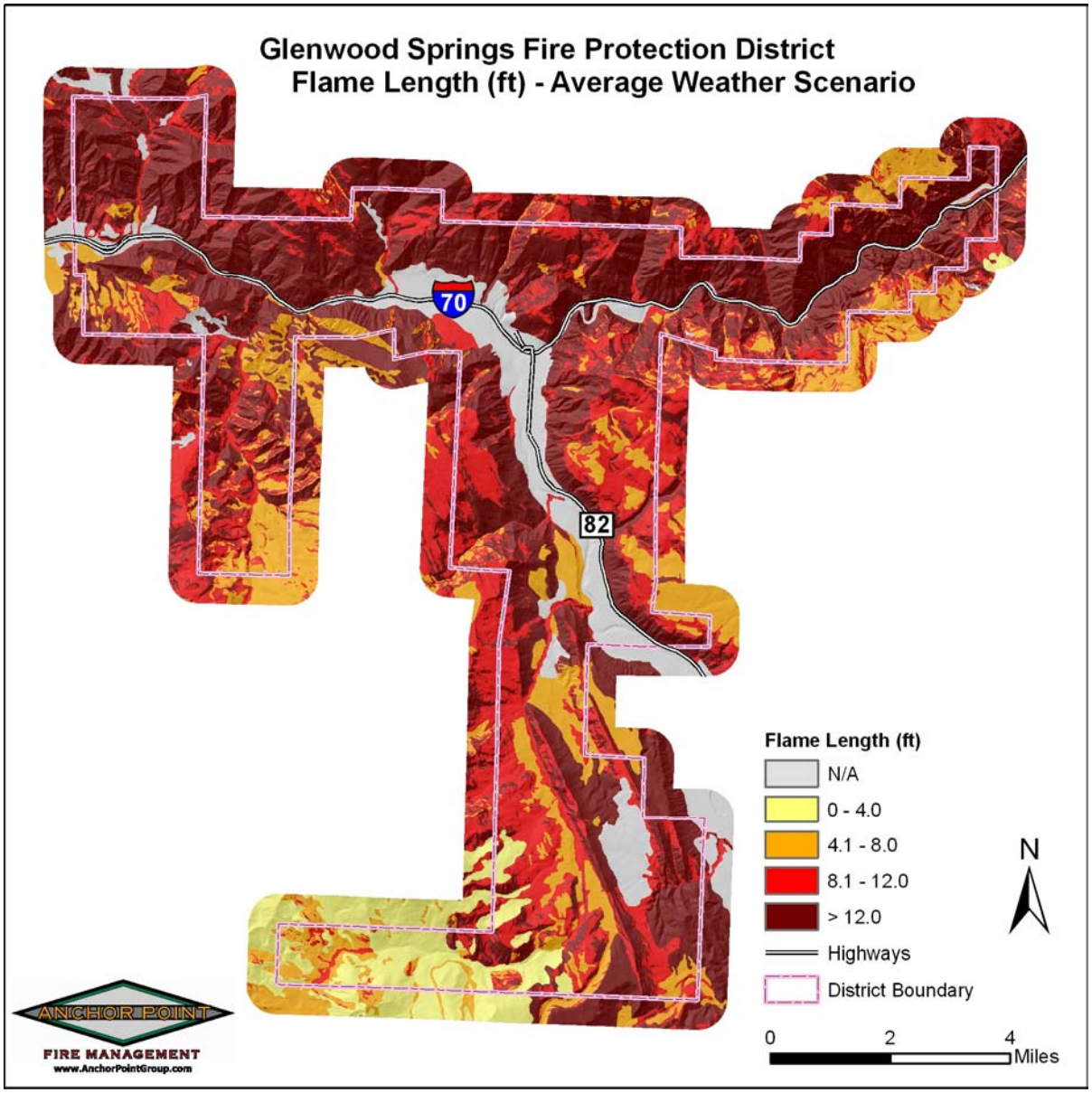
Spread rate values are generated by the **FlamMap** model and classified into four categories based on standard ranges: 0-20 ch/h (chains/hour), 20.1-40 ch/h, 40.1-60 ch/h, and greater than 60 ch/h. A chain is a logging measurement that is equal to 66 feet. One mile equals 80 chains. 1 ch/h equals approximately 1 foot/minute or 80 chains per hour equals 1 mile per hour.

Figure 16. Rate of Spread Predictions (Extreme Weather Conditions)



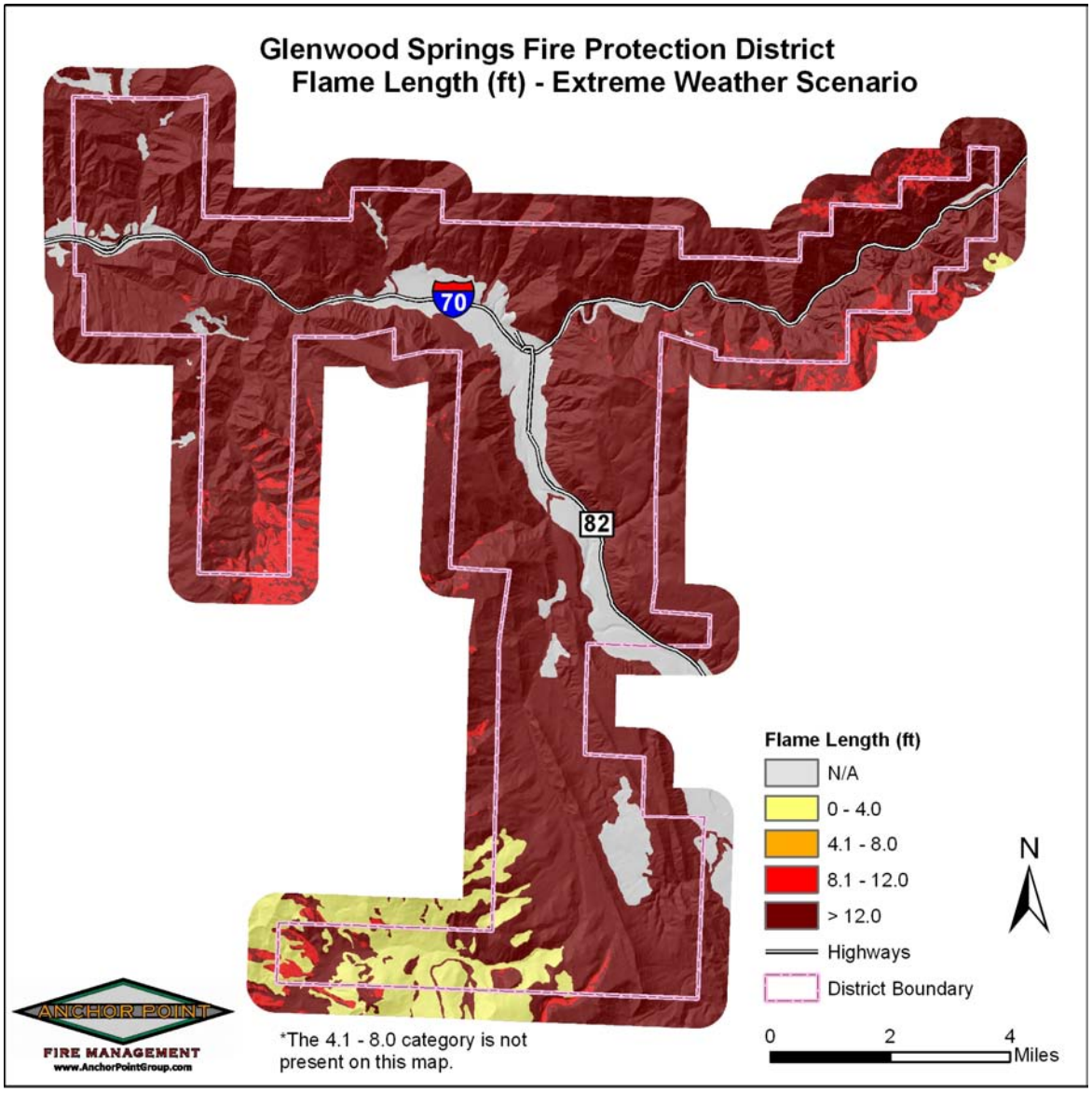
Rate of spread in chains/hour
(1 chain=66 ft) (80 chains/HR = 1 MPH)

Figure 17. 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, 8.1-12 feet and 12.1-60 feet. Flame lengths of 4 feet and less are acceptable for direct attack by hand crews. Flame lengths of 8 feet and less are suitable for direct attack by machinery. With flame lengths of greater than 8 feet, indirect attack and aerial attack are the preferred methods.

Figure 18. Flame Length Predictions (Extreme Weather Conditions)



Fire Behavior Interpretation and Limitations

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 (each 10 x 10 meter area).

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 planning. Whenever possible, fire behavior calculations should be done with actual weather observations during the fire. The most current ERC values should also be calculated and distributed during the fire season to be used as a guideline for fire behavior potential.

APPENDIX B

NEIGHBORHOOD IGNITABILITY ANALYSIS AND RECOMMENDATIONS

Purpose

The purpose of this appendix is to examine in greater detail the communities in the study area. Of the twenty-three WUI communities in the City of Glenwood Springs and the Glenwood Springs Fire Protection District, one was found to represent an extreme hazard, fifteen were rated as very high hazard, three as high hazard, three as moderate hazard, and one as low 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

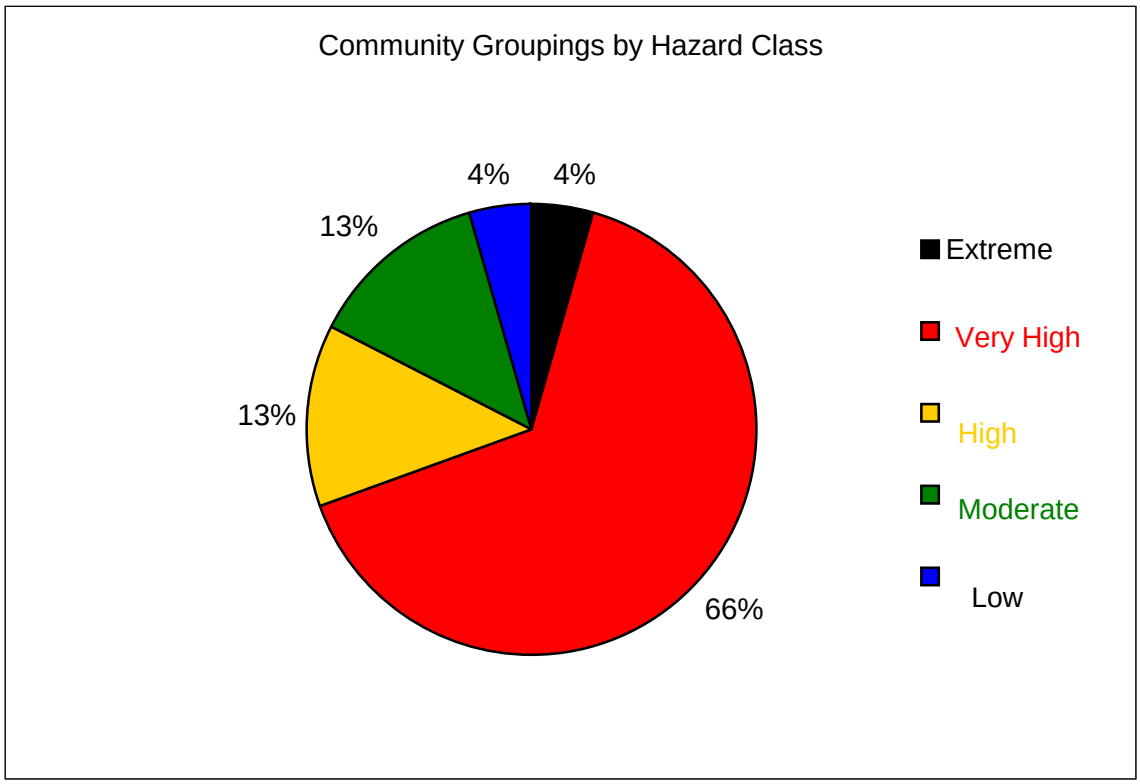

Community Groupings by Hazard Class
4%
4%
13%
13%
66%
Extreme
Very High
High
Moderate
Low

Figure 2

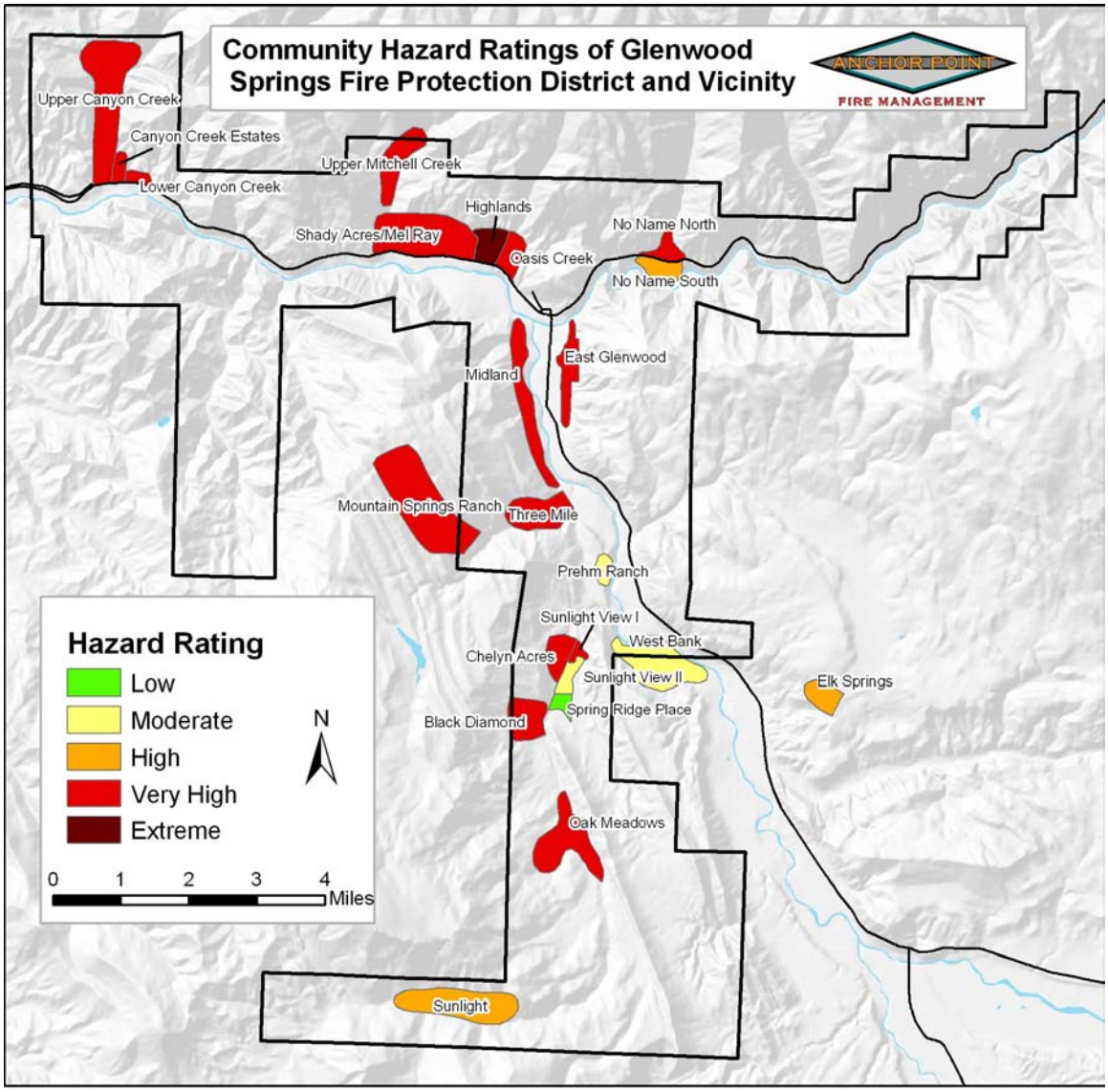

Community Hazard Ratings of Glenwood Springs Fire Protection District and Vicinity
ANCHOR POINT
FIRE MANAGEMENT
Upper Canyon Creek
Canyon Creek Estates
Lower Canyon Creek
Upper Mitchell Creek
Highlands
Shady Acres/Mel Ray
Oasis Creek
No Name North
No Name South
East Glenwood
Midland
Mountain Springs Ranch
Three Mile
Prehm Ranch
Sunlight View I
West Bank
Chelyn Acres
Sunlight View II
Elk Springs
Spring Ridge Place
Black Diamond
Oak Meadows
Sunlight
Hazard Rating
Low
Moderate
High
Very High
Extreme
N
0 1 2 3 4
Miles

Figure 3

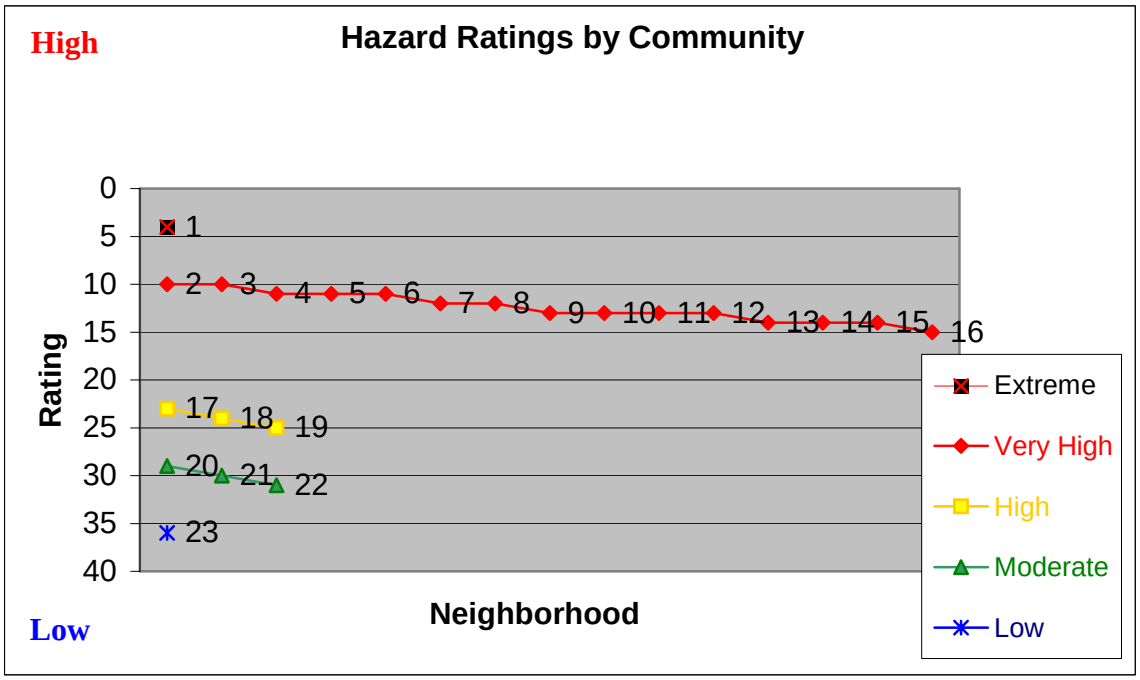


Table 1: Communities by Hazard Rating

1. Highlands	**13. East Glenwood**
2. North No Name	**14. Three Mile**
3. Midland	**15. Oak Meadows**
4. Canyon Creek Estates	**16. Lower Canyon Creek**
5. Mel Ray/Shady Acres	**17. Sunlight**
6. Chelyn Acres	**18. South No Name**
7. Upper Canyon Creek	**19. Elk Springs**
8. Upper Mitchell Creek	**20. Sunlight View II**
9. Oasis Creek	**21. Prem Ranch**
10. Sunlight View I	**22. West Bank**
11. Black Diamond	**23. Spring Ridge Place**
12. Mountain Springs Ranch	**24.**

Extreme Very High High Moderate Low

General Recommendations

A combination of adequate access, ignition resistant construction, and fuels reduction should create a safe environment 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 anyone living in the Wildland-Urban Interface:

1. Be aware of the current fire danger in the area.
2. Clean roof and gutters at least twice a year, especially during cure-up in autumn.
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. Reflective numbers should also be visible 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. Maintain your defensible space constantly.
    - 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 rated '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 were 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 extent of the defensible space is based on fuels, topography, and the design and materials of the structure.

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

Shelter-in-Place Areas: There are several ways to protect 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 pre-plan 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 *Addressing, Evacuation, and Sheltering-In-Place 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 used 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), which 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.

Many knowledgeable and experienced fire management professionals were queried about 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 United States.

The model was developed from the perspective of performing structural 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 60 points based on seven categories: average lot size, slope, primary aspect, average fuel type, fuel continuity, dominant construction type 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 seven 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. For example, 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 hazards 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.

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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.

Communities

1. Highlands

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:	<1 Acre
Fuel models found in the neighborhood:	4, 6
Water supply:	Hydrants
Hazards:	Steep slopes, ravines, inadequate roads

Description:

This neighborhood is made up primarily of expensive custom homes. Although the streets and most of the driveways are paved, they are steep. Most of the homes in this neighborhood would be quickly cut off by an ignition occurring in the heavy fuels below the road. Some turnarounds are only adequate for Type 6 engines and the main road would be marginal for structure protection engines in spots. Some driveways are overgrown. Access and egress would be difficult and dangerous in fire conditions. Address signage needs improvement. Homes are built mid-slope on slopes of up to 35%. There are steep ravines with heavy fuel loads of oak brush below homes. Ladder fuels are plentiful especially in the ravines below homes. Conifers in this neighborhood show heavy pine beetle infestation.

Comments & Mitigation Notes:

Reduce ladder fuels. Clean up dead and down material. Limb and thin fuels in ravines and on slopes below homes. Cut vegetation away from driveways. Cut and treat beetle-kill trees. Improve roads, signage, and turnarounds. Most homes need defensible space. Extended defensible spaces and adequate shelter-in-place areas are highly recommended. An adequate safety zone for firefighters should be constructed. A parcel level analysis of this neighborhood is recommended.

2. North No Name

Figure 5

Hazard Rating:	**Very High**
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:	4, 9
Water supply:	Hydrants
Hazards:	Ravines, inadequate access roads, and steep slopes

Description:

This area is much more hazardous than the area south of I-70. The only access is along the canyon bottom (12% slope), which dead-ends into the Jess Weaver Trailhead. The slopes above the homes are up to 60% making escape nearly impossible if the road is cut off. There is an unrated bridge that provides the only access to some homes. Access to many homes is narrow with difficult or absent turnarounds. There are missing or inadequate street signs and addressing. There is a heavy fuel load of large (>8 feet) Oak brush and mixed conifer (FM 4 and 9). The vegetative load is continuous and overgrowing many homes.

Comments & Mitigation Notes:

Thin conifers and oak brush, 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. Most homes in this area need defensible space. A parcel level analysis of this neighborhood is recommended.

3. Midland

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:	4, 6
Water supply:	Hydrants.
Hazards:	Steep slopes and inadequate driveways

Description:

Most of the homes in this area are built on the bottom third of a steep (40% to 60%) slope. There are numerous ravines with heavy fuel loads in the neighborhood. Many homes have steep driveways with inadequate or no turnarounds. Throughout most of the area, the only hydrants are located on Midland Avenue, which would require long hose lays up steep slopes to reach the homes. Most of the homes are older, more flammable construction types, and need defensible spaces. Fuels include king sage, piñon/juniper, and oak brush.

Comments & Mitigation Notes:

Many homes need defensible space, especially mowing grasses away from structures. Fuels below homes should be limbed and thinned. Fuelbreaks in the BLM land above the homes and in ravines between homes should be considered. As with all structures located in the canyon bottoms and on the lower portions of steep slopes, ignition resistant roofs are highly recommended to prevent structural 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. Canyon Creek Estates

Figure 7

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?	Yes
Average lot size:	<1 Acre
Fuel models found in the neighborhood:	6
Water supply:	Hydrants.
Hazards:	Steep slopes and ravines

Description:

Many of the homes in this neighborhood are located along a broad ridge with steep ravines on either side. The lower section slopes steeply to the I-70 frontage road. Due to this topography, there is only one way in and out, and the road could be easily compromised by ignitions occurring along the frontage road. Roads are steep in spots, but are in good condition and have adequate widths and turnarounds. Although from the front, most homes appear to have good defensible space, the back yards facing the ravines have heavy fuel loads of oak brush, making this area difficult and dangerous to defend. There is a large grassy park in the middle of this neighborhood that may make a good safety area.

Comments & Mitigation Notes:

Many homes need defensible space. Extended defensible spaces should be considered to prevent ignitions in the ravines from quickly involving the homes on the ridge. Fuelbreaks and thinning in the ravines and on the slopes below homes is strongly recommended. A fuelbreak separating the upper section of this area from the frontage road should also be considered. A parcel level analysis of this neighborhood is recommended.

5. Mel Ray/Shady Acres

Figure 8

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?	Yes
Average lot size:	**<**1 Acre
Fuel models found in the neighborhood:	6
Water supply:	Hydrants
Hazards:	Steep ravines, dead-end roads with no turnarounds, homes built close together, and many shake roofs

Description:

This older part of town includes the subdivisions of Shady Acres and lower Mitchell Creek. There are areas in this community with small wood-siding homes, many with shake roofs, located close together on small lots. Most homes are located mid-slope on slopes of up to 40%. There are high fuel loads of oak brush, piñon/juniper and king sage in ravines and touching homes. Most homes need defensible space and better addressing. Some homes and trailers were lost in the westernmost portion of this area during the Coal Seam fire.

Comments & Mitigation Notes:

Fuels reduction should be done downhill of homes and along roads. Most homes need defensible space and yard cleanup. Shake roof replacement, especially where homes are close together, is recommended. Glenwood Middle School would make a good evacuation center. There is a golf course here that would make a good safety zone. A parcel level analysis is recommended.

6. Chelyn Acres

Figure 9

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:	1, 6
Water supply:	Hydrants in Sunlight View I (about 1 mile)
Hazards:	Steep slopes, inadequate roads, no water supply, and ravines

Description:

This community needs its own water supply. An ignition near the creek could cut this area off from the nearest water supply, which is the hydrant system in Sunlight View I. Chelyn Acres Road (CR149) is too narrow for many engines. Most of the roads in this community have heavy vegetation on both sides and in some cases over the road. Homes are built on the bottom half of slopes as steep as 40%. There is a heavy load of Oak brush along the creek and near most of the homes. Many homes need defensible space.

Comments & Mitigation Notes:

There is an existing power line cut that could be maintained as a fuelbreak/escape route. Cut back vegetation, especially oak brush from the roads and away from homes. Thin and limb fuels along the creek and on the slopes below homes. Consider adding a 10,000 gallon cistern in the upper part of this community. Consider widening the hairpin turns on Chelyn Acres Road. A parcel level analysis is recommended.

7. Upper Canyon Creek

Figure 10

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:	1, 4, 6.
Water supply:	Draft water from ponds and streams at mile 2.5 (may be privately owned).
Hazards:	Steep slopes, narrow shelf road above mile 2, ravines, and poor water supply

Description:

This is an isolated area composed mostly of scattered, large home sites and ranches. The only access above mile two is over an unrated bridge. Although fuels here are patchier than in some of the other communities, a wind-driven fire could still cut off access in a number of spots. Most of the development is along the creek, and slopes of 35% on both sides of the canyon are common. There is a large development at about mile three that could increase concerns if it adds to the density of this area. Some homes need defensible space and most need thinning along driveways and private roads.

Comments & Mitigation Notes:

Water supply development is a critical issue here. Secure emergency water-use agreements with private ranches in the area to map and use ponds. Consider dry hydrants for larger all-season ponds. Thin vegetation along driveways and private roads. Widen narrow driveways and private roads. Add turnarounds to driveways. Reflective address signage is needed in this community. Consider shelter-in-place areas and preplanning safety zones. Some homes need defensible space. A parcel level analysis is recommended.

8. Upper Mitchell Creek

Figure 11

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:	6
Water supply:	Storm King Ranch has draftable ponds. Drafting from the fish hatchery might also be possible.
Hazards:	Steep slopes, ravines, inadequate roads, poor water supply, and natural chimneys above the fish hatchery

Description:

Only one of the five homes above the fish hatchery survived the Coal Seam fire. This portion of the community is extremely hazardous. Fuels are still dense even after the Coal Seam fire. Most homes are built along the canyon bottom. There is only one way in and out, and the road reaches 13% in spots. The road above the fish hatchery is very narrow and has no turnarounds. The canyon widens on its southern end and appears less hazardous. However, this area also lost structures during the Coal Seam fire. Some homes need defensible space.

Comments & Mitigation Notes:

Water supply is a critical issue here. The Storm King Ranch, which has its own water supply, received no damage from the Coal Seam fire. Agreements to use the Storm King Ranch water supply and water from the fish hatchery should be pursued. This area should also have a large community cistern to supplement the hydrant system in the Mel Ray/Shady Acres area. Many homes need defensible spaces, especially in the upper area. Improve address and road signage. A parcel level analysis is recommended.

9. Oasis Creek

Figure 12

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?	Yes
Average lot size:	<1 Acre
Fuel models found in the neighborhood:	1, 6
Water supply:	Hydrants.
Hazards:	Steep slopes, ravines, and homes built on the ridge-top

Description:

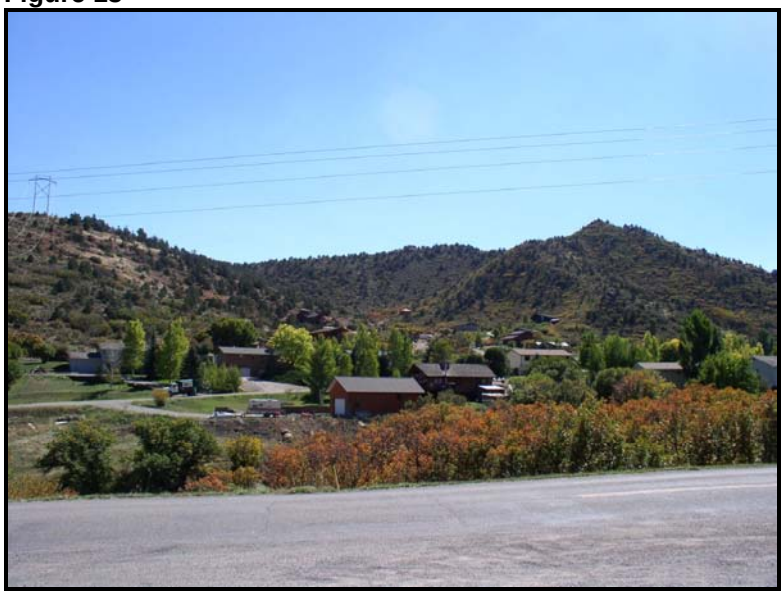
This area, which is adjacent to the Highlands community, is similar in many ways. Like Highlands, most of the homes are built along a broad ridge-top between two steep drainages loaded with oak brush. Better access, the presence of fuel model 1, less radical terrain and lower fuel densities make this area somewhat less hazardous than Highlands. Although there is only one way in and out, most roads are of adequate width for even large engines, and adequate turnarounds are more common. Fuels in the ravines below the homes are mostly oak brush. The south facing slopes above this community are primarily piñon/juniper with short grass understory. Glenwood Caverns and the Transfer Trail are to the east of this area.

Comments & Mitigation Notes:

This community has two major threats, the heavy fuel load in the ravines extends to the homes, and fire could easily cut off the access roads. A fuelbreak and thinning to reduce fire intensity in the ravines below the homes is recommended. Fuels reduction along the access is key to the defensibility of the area. Most homes need defensible space. A parcel level analysis is recommended.

10. Sunlight View I

Figure 13



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?	Yes
Average lot size:	**<**1 Acre
Fuel models found in the neighborhood:	4, 6
Water supply:	Hydrants
Hazards:	Steep slopes, ravines, and homes in saddles

Description:

This neighborhood is relatively flat near Four Mile Road, but continues up the steep (>30%) slopes to the east. There is a heavy fuel load of oak brush near the creek, in ravines, and along some of the upper roads. Fuels near homes in the upper area are mostly piñon/juniper. The combination of heavy fuel loads and dangerous topographic features would make homes in the upper area hazardous to defend.

Comments & Mitigation Notes:

Although the area near the creek is flatter and has many irrigated lawns, it is still threatened from ignitions occurring in the oak brush near Four Mile Road. Many of the homes are wood siding and have ornamental trees touching the structures. A large amount of thinning needs to be done in the ravines and along roads. Extended defensible space should be considered for the homes in the upper area, especially the homes in saddles. Many homes, even in the lower area, need defensible space. Reflective addressing is needed.

11. Black Diamond

Figure 14

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?	Yes
Average lot size:	1-5 Acres
Fuel models found in the neighborhood:	6, 8
Water supply:	Hydrants.
Hazards:	Steep slopes and ravines

Description:

Only about half of this community is in GSFPD. Most of the homes here are constructed mid-slope on slopes of up to 30%. Slopes of up to 40% are found in the western portion of this community, which is outside the study area. Fuel loads are primarily oak brush on the lower slopes, with aspen stands in drainages. Roads here are generally good, and homes are on larger lots, but the only access could easily be cut off by a fire in the heavy oak brush surrounding it. There is only one home in this community that has defensible space.

Comments & Mitigation Notes:

There is a significant aspen grove that could be developed as a fuel break between this community and Oak Meadows. The aspen grove is overgrown with oak brush and would need thinning and maintenance to be effective. Thinning of oak brush below homes and near roads and driveways is recommended. All homes need defensible space, and extended defensible space is recommended for homes built on the steeper slopes. Reflective address signage should be added to all homes. A parcel level analysis is recommended.

12. Mountain Springs Ranch

Figure 15

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:	**<**5 Acres
Fuel models found in the neighborhood:	1, 4, 6
Water supply:	None
Hazards:	No water supply, ravines, inadequate roads, homes in saddles, and steep slopes

Description:

The majority of this area is outside the GSFPD. It is covered in this study because the Glenwood Springs Fire Department has agreed to service it. This is a low density area with homes on large lots. Some of the homes are located mid-slope in heavy fuels and on ridge-tops. There are many homes with vegetation touching the structures. Wood and other flammable items are being stored too close to some of the homes. The primary access to this community is via a steep dirt road through heavy loads of shrubs, principally oak brush. This access could easily be compromised by ignitions occurring along Three Mile Road (CO RD 127). The secondary access is a rough track that runs behind the water tank and may be four-wheel-drive only under some conditions.

Comments & Mitigation Notes:

Clean up around structures. Remove or limb trees touching structures. This area desperately needs a water supply. The best tactic may be three or four smaller (2,000 to 5,000 gallon) cisterns, since the homes are so spread out. This area has potential for quite a bit more development, which could make larger cisterns more desirable. Road improvements to the secondary access, and fuels reduction along roads are also critical. Reflective address and street signage should be added. Most homes in this area need defensible space. A parcel level analysis of this neighborhood is recommended.

13. East Glenwood

Figure 16

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:	4, 6, 9
Water supply:	Hydrants.
Hazards:	Steep slopes, narrow side streets with inadequate turnarounds, and ravines

Description:

This area is located on the bottom third of the west-facing slope that defines the eastern edge of the City of Glenwood Springs. This area is differentiated from the rest of the urban area by the wildland fuels and topography present here. This area is characterized by primarily grass and conifer fuel models instead of the irrigated lawns and ornamental plantings that exist in the urban area. Since it is part of the city, there are multiple access points and a good hydrant system. There are however, some side streets and driveways that are not suitable for engine access. The streets have good reflective signage, but many addresses do not. Most of the homes do not have defensible space, and many have fuels touching the structures. This factor, combined with the steep topography and the high likelihood of human caused ignitions, makes this a hazardous area.

Comments & Mitigation Notes:

Improve narrow driveways and side streets if possible. Defensible spaces are critical to reducing the hazard in this area. Reflective address signage is recommended. As with all areas built on the bottom of steep slopes, ignition-resistant roofs are recommended to inhibit rolling materials and embers from igniting homes. A parcel level analysis is recommended.

14. Three Mile

Figure 17

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 Acre
Fuel models found in the neighborhood:	6, 9
Water supply:	None. The Hydrants along Four Mile Road are the closest water supply.
Hazards:	No water supply, steep slopes, and driveways not accessible to engines

Description:

This group of homes is built along the lower section of Three Mile Road (CO RD 127), from its intersection with Four Mile Road (CO RD 117) to just below the steep switchbacks that go to the Mountain Springs Ranch subdivision. There are several homes on both sides of the drainage, none of which have defensible spaces. There are structures with touching vegetation, untested bridges, driveways crossing the creek that would not be safe for engines, and long steep ravines above homes. Fuels are mostly heavy riparian types along the creek. Piñon/juniper and oak brush are dominant on slopes above the homes. The creek does not flow enough water to be a reliable draft source. The Three Mile Trailer Park, which is less than a mile from the intersection of Three Mile Road and Four Mile Road, has about twenty trailer homes.

Comments & Mitigation Notes:

Cut trees, bushes, and grasses away from homes. Thin vegetation along driveways, especially for the homes fronting Four Mile Road near the intersection. Most homes in this area need defensible space. Improve access to homes across the creek. Reflective address signage is needed. Consider installing a large community cistern (about 10,000 gallons) so that water won't have to be shuttled from Four Mile Road.

15. Oak Meadows

Figure 18

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?	Yes
Average lot size:	<1 Acre
Fuel models found in the neighborhood:	1, 3, 6, 8
Water supply:	Hydrants.
Hazards:	Ravines, homes with very close spacing, and high density in some areas

Description:

This area has more gentle slopes (15% to 20%) and open topography than most of the other very high hazard areas. The homes here are still built almost entirely mid-slope and surrounded with moderate to heavy fuel loads. Fuels range from grasses and heavy oak brush on east facing slopes to decadent aspen stands with oak brush understory in ravines. Roads are generally good, but could still be compromised by fires in the heavy brush below homes. This is a neighborhood that is experiencing rapid development. In some areas, wood siding homes are being built with less than fifteen feet between structures. This spacing, together with the heavy fuels and mid-slope positioning, is a very dangerous combination.

Comments & Mitigation Notes:

Vegetation needs to be cleared away from access roads. Fuel breaks should be considered along access roads and between homes and ravines with heavy fuel loads. The aspen stand in the major drainage between this community and Black Diamond would make a good fuel break if it was cleaned up and maintained. It is strongly recommended that the new construction be spaced further apart to prevent house-to-house fire spread. More ignition-resistant materials should be used and homes should be isolated as a group by fuel breaks. Most homes need defensible spaces, and better address signage.

16. Lower Canyon Creek

Figure 19

Hazard Rating:	**Very High**
Does the neighborhood have dual access roads?	Yes
Are there road grades > 8%?	No
Are all access roads of adequate width?	Yes
Average lot size:	<1 Acre
Fuel models found in the neighborhood:	1, 6
Water supply:	None. The hydrant system in Canyon Creek Estates is the nearest water source.
Hazards:	Ravines, no water supply

Description:

This is a community of fill-in homes located off the I-70 frontage road east of Canyon Creek Estates. Although the topography around the homes is mostly flat, they are located at the bottom of steep slopes and ravines with substantial fuel loads of piñon/juniper. There are considerable ladder and surface fuels near the homes.

Comments & Mitigation Notes:

This area would drop substantially in the hazard ratings with some mitigation work. A fuelbreak should be cut between the homes and the slopes and ravines to the north. Most homes need defensible space, and one or two large cisterns (10,000 gallons) should be added to prevent the need to shuttle water from Canyon Creek Estates.

17. Sunlight

Figure 20

Hazard Rating:	**High**
Does the neighborhood have dual access roads?	No
Are there road grades > 8%?	No
Are all access roads of adequate width?	Yes
Average lot size:	>5 Acres
Fuel models found in the neighborhood:	6, 8
Water supply:	Dry hydrant on the creek near the stables and one pond on FS300 are the closest reliable water sources.
Hazards:	Steep slopes, ravines, and inadequate water supply

Description:

The Sunlight ski area dominates this area. There are a few homes and seasonal inns, but most of the residents live in a large condo complex at the ski area base. Fuels are mainly aspen and mixed conifer with grass understory on the north slopes and oak brush and mixed conifer on south slopes.

Comments & Mitigation Notes:

This area has considerable ladder fuels, grass under story, and dead and down materials. Some of the structures are built in a steep ravine (see **Figure 20**). This area needs a better water supply. A large (10,000-20,000 gallon) cistern could be located near the condo complex as a supplement to the fire department connection fed by the creek. There are some ponds located below the ski area parking lot, but they are shallow and difficult for engines to access. Reflective address markers should be added along Four Mile Road. This is especially important because some of the structures are not easily visible from the road. Access is generally good, but the homes in the ravines would be in a very dangerous position in a fire. All of the structures need defensible space.

18. South No Name

Figure 21

Hazard Rating:	**High**
Does the neighborhood have dual access roads?	No
Are there road grades > 8%?	No
Are all access roads of adequate width?	Yes
Average lot size:	<1 Acre
Fuel models found in the neighborhood:	1, 6
Water supply:	Hydrants.
Hazards:	Steep slopes, isolated

Description:

This area is in a broad portion of Glenwood Canyon. The steep slopes on the south side (north aspect) are separated from the community by the Colorado River, and the slopes on the north side are separated by I-70. There is a railroad track that could provide an ignition source on the south side, but it would take significant wind to spot into this community. However, strong winds are common due to channeling by the canyon. Most homes are built on the south-facing slope rising off the river bank (about 10% to 15% slope). Fuels are grasses, sage, and mixed conifer

.

Comments & Mitigation Notes:

This area has good access and water supply, but would still be quite dangerous in a fire. The slopes of the canyon are greater than 60% on both sides. The channeling of winds through the canyon makes this area ripe for fast-moving fires. Homes are close together and positioned mid-slope, making them more difficult to defend. Addressing and road signage are generally good, but not all addresses are reflective. The best mitigation here would be good defensible spaces and ignition-resistant construction, especially ignition- resistant roofs.

19. Elk Springs

Figure 22

Hazard Rating:	**High**
Does the neighborhood have dual access roads?	No
Are there road grades > 8%?	No
Are all access roads of adequate width?	Yes
Average lot size:	1-5 Acres
Fuel models found in the neighborhood:	1, 6
Water supply:	Hydrants
Hazards:	Ravines

Description:

Like West Bank, this area is covered primarily by Carbondale FPD. It is included in this study because it contains two filings serviced by GSFD. These filings are in the northernmost portion of the neighborhood. Fuels are grasses and large (12 -20 feet tall) piñon/juniper. There are much steeper slopes and heavier fuel loads in the Carbondale coverage area. Access and water supplies are good in this area, and houses are further apart on large lots. The area still rates as high hazard because of heavy flammable fuels in and below this community, and the presence of homes built mid-slope and above ravines.

Comments & Mitigation Notes:

Many homes need defensible spaces. Extended defensible spaces should be considered for homes located above ravines and mid-slope in heavy fuel loads. Large piñon/juniper should be trimmed away from roads and thinned under power lines.

20. Sunlight View II

Figure 23

Hazard Rating:	**Moderate**
Does the neighborhood have dual access roads?	Yes
Are there road grades > 8%?	No
Are all access roads of adequate width?	Yes
Average lot size:	<1 Acre
Fuel models found in the neighborhood:	1, 6
Water supply:	Hydrants
Hazards:	None

Description:

Homes in this community are built in a flat area and most are on slopes of less than 10%. Access and water supply are good. Fuels are predominately grasses and planted ornamentals. Most homes have some defensible space in the form of irrigated greenbelt, but are too close together for complete defensible space. There is very little ignition-resistant construction beyond asphalt roofs. Slopes to the east have moderate loads of piñon/juniper and some homes on the eastern edge have more slope and heavier fuels.

Comments & Mitigation Notes:

Create adequate defensible space and add reflective address markers to homes that do not have them.

21. Prem Ranch

Figure 24

Hazard Rating:	**Moderate**
Does the neighborhood have dual access roads?	Yes
Are there road grades > 8%?	No
Are all access roads of adequate width?	Yes
Average lot size:	1-5 Acres
Fuel models found in the neighborhood:	1, 6
Water supply:	High volume draft hydrants and ponds
Hazards:	Flammable shrubs and grasses too close to some structures

Description:

This small gated community provides a secondary access into the densely populated West Bank area. There are only five home sites in this community and two homes have been built. There are moderate loads shrubs and grasses present. The existing homes have good access and water supply. There are some outbuildings of flammable construction type with fuels close to the structures.

Comments & Mitigation Notes:

Create defensible space and reflective addressing for homes that do not have them. Cut back brush where it is close to roads and driveways.

22. West Bank

Figure 25

Hazard Rating:	**Moderate**
Does the neighborhood have dual access roads?	Yes
Are there road grades > 8%?	No
Are all access roads of adequate width?	Yes
Average lot size:	1-5 Acres
Fuel models found in the neighborhood:	1, 6
Water supply:	Hydrants
Hazards:	Ravines

Description:

Only about five homes in the northwest corner of this community are in GSFPD. The rest of West Bank is in Carbondale's district. The homes in the GSFPD area are built on the lower third of the east-facing slope above the golf course. There are moderate loads of shrubs and grasses on the hillside, but the golf course and irrigated lawns make this less threatening than in other areas. Access and water supply are good. The density of homes, combined with fuels and slope position, make the Carbondale portion of this community more hazardous. If this area were to be rated as a complete community it would probably receive a more hazardous rating.

Comments & Mitigation Notes:

Defensible space and reflective addressing are needed. Consider having Carbondale annex this small number of homes into their district.

23. Spring Ridge Place

Figure 26

Hazard Rating:	**Low**
Does the neighborhood have dual access roads?	Yes
Are there road grades > 8%?	No
Are all access roads of adequate width?	Yes
Average lot size:	1-5 Acres
Fuel models found in the neighborhood:	1
Water supply:	Hydrants
Hazards:	None

Description:

This area is east of Four Mile Road and runs from Osprey Road to Dry Park Road. This community is very similar to Sunlight View II, which is immediately to the north. The homes here are on larger lots and the terrain is mostly flat. The dominant fuel is short grass. There is more development scheduled for this area.

Comments & Mitigation Notes:

Maintain defensible space around homes.

APPENDIX C

GLENWOOD SPRINGS CWPP
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 three categories:

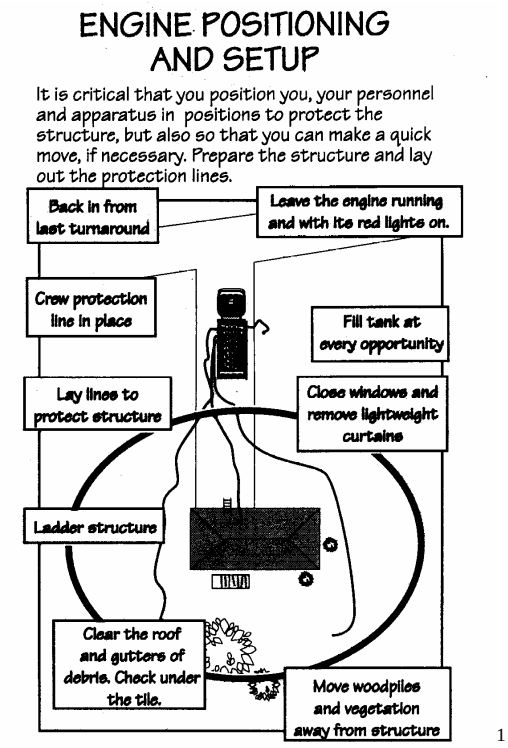
1. Stand Alone or Not Threatened
2. Defendable
3. Not Defendable.

- 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 (remember, in windy conditions, firebrands can enter almost any opening)

- 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
- Openings under porches or patio covers



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[1] Teie,William C.,1995, Firefighter'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 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 meant 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.

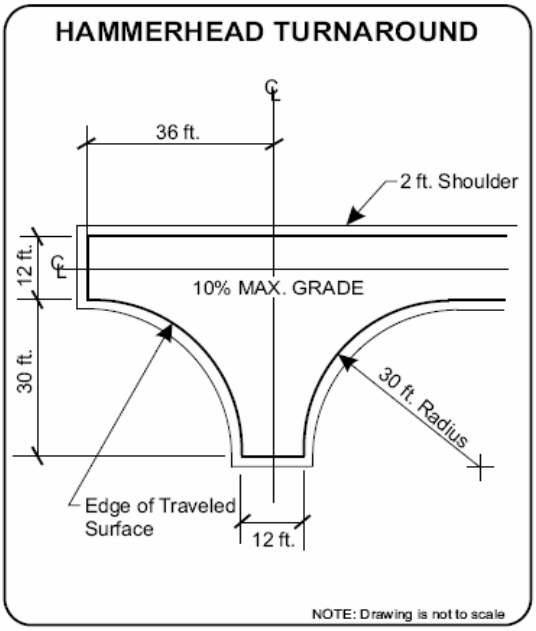
Access Guidelines

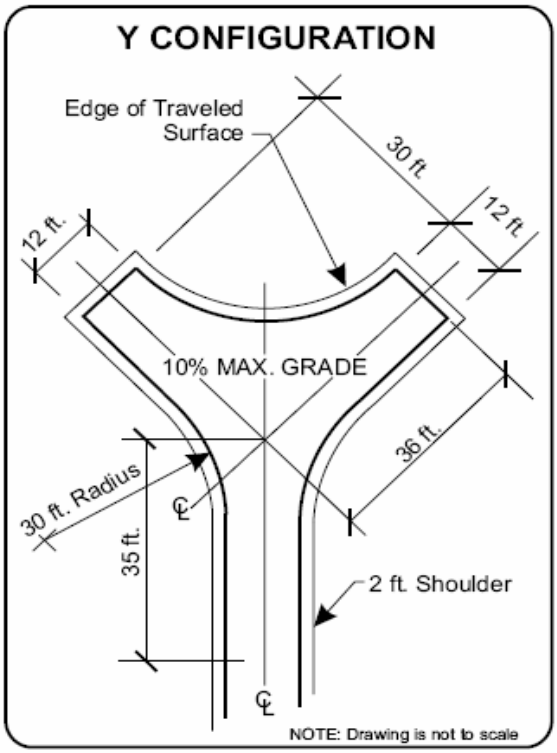
Driveway Turnarounds

Turnarounds unobstructed by parked vehicles should be located at the end of every driveway. They should be 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.

Driveway Width and Height

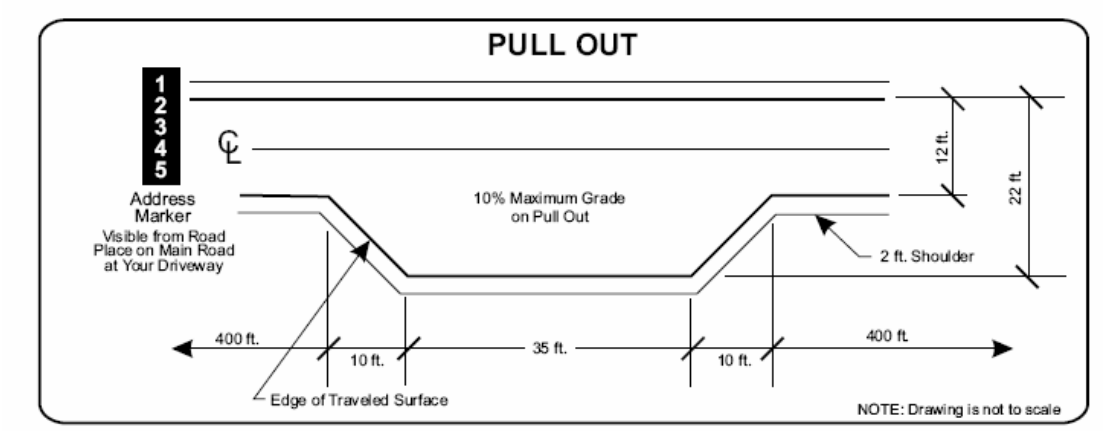
Driveways should have an unobstructed vertical clearance of 13 feet 6 inches. Trees may need to be limbed and utility lines relocated, to provide the necessary clearance. Driveways should have a 12 foot-wide drivable surface and 14 feet of horizontal clearance.





Driveway Pullouts

Driveway pullouts should be 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 be 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 access to multiple homes is provided by a single driveway, all addresses 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 simply to mark addresses on a common pole in the center of the fork. Further, 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 in many of the mountainous areas of Colorado, water is a critical fire suppression issue. Although the Glenwood Springs Fire Department (GSFD) has a good network of pressurized hydrants, 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

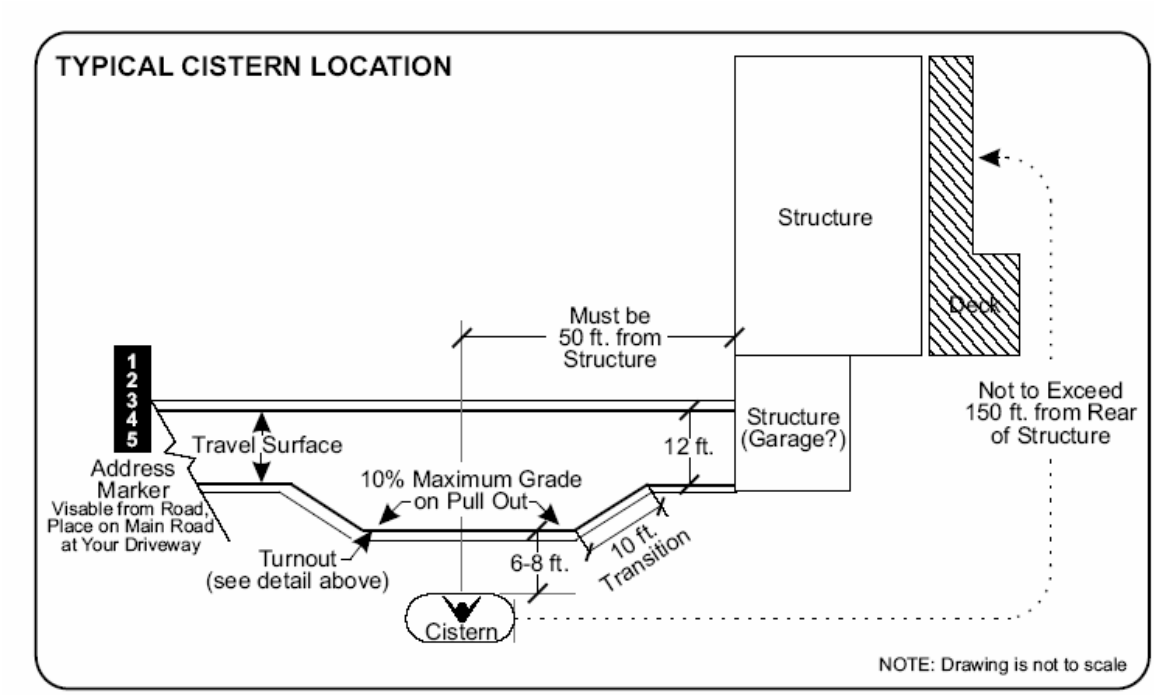
the use of cisterns and dry hydrant installations has been included to provide information about supplementing the existing system of pressurized hydrants. It is not intended to be a substitute for the existing hydrants. For more detailed recommendations regarding enhancement of the existing water supply 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 - 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 GSFD.



Dry Hydrants

Dry hydrant installations allow much faster and more reliable access to ponds and tanks than conventional drafting. Specific recommendations for dry hydrant locations may be found in the *Water Supply FMU* section of the main report. 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. GSFD 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 GSFD is in the best position to offer site-specific information.

Appendix E

Glenwood Springs 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 Glenwood Springs Fire Protection District (GSFPD), the need for a community-based hazard and risk assessment (HRA) was born from an internal need, not a federal directive. However, since the district borders federal land, 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 Glenwood Springs Fire Department (GSFD) used internal budgets in combination with a BLM grant to complete a district-wide hazard and risk assessment and the resultant CWPP. Methodology with a core of fire behavior science assures an accurate hazard and risk assessment. Community education and private landowner assistance will be coordinated through the GSFD. The GSFD will continue to be instrumental in public education related to wildfire hazard reduction. The fire department will continue to identify funding for the implementation of mitigation projects. A GSFD 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 BLM and USFS representatives. This collaborative management structure allows for more effective implementation of cross-boundary projects.

Inter-Agency Collaboration

<u>Roles and Responsibilities</u>
To be successful, wildfire mitigation in the interface must be a community-based, collaborative effort. Stakeholders and, primarily, the GSFD, will have the greatest responsibility for implementing the recommended mitigation projects. The BLM and USFS will also be valuable participants 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 Glenwood Springs Fire Department is committed to encouraging the participation of as many interested landowners as possible. There are also mitigation recommendations for individual structures which are the responsibility of the homeowner. Homeowners will, however, need a point of contact, most likely a member of the GSFD, to help them implement these recommendations. The best defensible space will be created with oversight and expert advice from fire department and or government forestry 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 GSFD web site is http://www.glenwoodfire.com/. This site has information for citizens, as well as a way to contact the district for more information or input regarding current and planned mitigation actions.

The Collaborative Process

"The initial step in developing a CWPP should be the 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]"

Five federal, local, and private agencies (stakeholders) participated in the Glenwood Springs Fire Protection District CWPP. These stakeholders are:

- The Glenwood Springs Fire Department
- The United States Forest Service
- The Bureau of Land Management
- The City of Glenwood Springs Planning Department
- Anchor Point

The true collaborative process was initiated with a meeting in 2003. The purpose of the initial meeting was to bring all past, current, and future efforts and needs to the table. The primary focus of the group was on the identification and delineation of communities, areas of concern, and values at risk. Best practices and anticipated "roadblocks" were identified. The group was encouraged to make use of the fuels, slope, and aspect maps in refining their areas of concern and their recommendations for fuels reduction projects. Twenty-three communities were delineated and analyzed for hazard and risk.

During the process of developing the hazard and risk analysis a meeting was held at the Glenwood Springs Field Office of the Bureau of Land Management. This meeting included Dan Sokal (BLM), Frankie Romero (USFS) and Marc McDonald (Anchor Point Group) the 2002 Upper Colorado River Interagency Fire Management Plan was discussed. The principle topics of discussion included:

- Values and areas of concern in the interface.
- Current and planned fuels reduction projects
- Cross-boundary project opportunities

Another meeting will be held on May 22, 2007 in the Glenwood Community Center. The purpose of this meeting will be to discuss the findings of the CWPP and to begin the process of prioritizing future actions based on the recommendations in the CWPP. Options for homeowners and land managers to reduce structural ignitability and protect values in their communities will be presented in this meeting as well as landscape scale and cross-boundary mitigation project

recommendations. In addition to homeowners in the study area and other interested members of the public the following collaborators and facilitators will be in attendance:

- Kelly Rogers – Colorado State Forest Service, District Forester
- Doug Paul – BLM, Mitigation/Education
- Angie Foster – BLM, fuel specialist
- Ron Biggers – Glenwood Springs Fire Department, Deputy Fire Marshall
- Chris White – Anchor Point Group, CEO
- Marc McDonald – Anchor Point Group, Project Manager

Funding CWPP Recommendations

There are many sources of funds available for implementing the recommendations within the CWPP. Some available grants and websites where more information can be found 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, and 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: to support volunteer fire departments
- More information: http://www.nvfc.org/federalfunding.html

- Agency: Community Facilities Grant Program
- Purpose: to 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: to 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 underutilized wood products and to 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