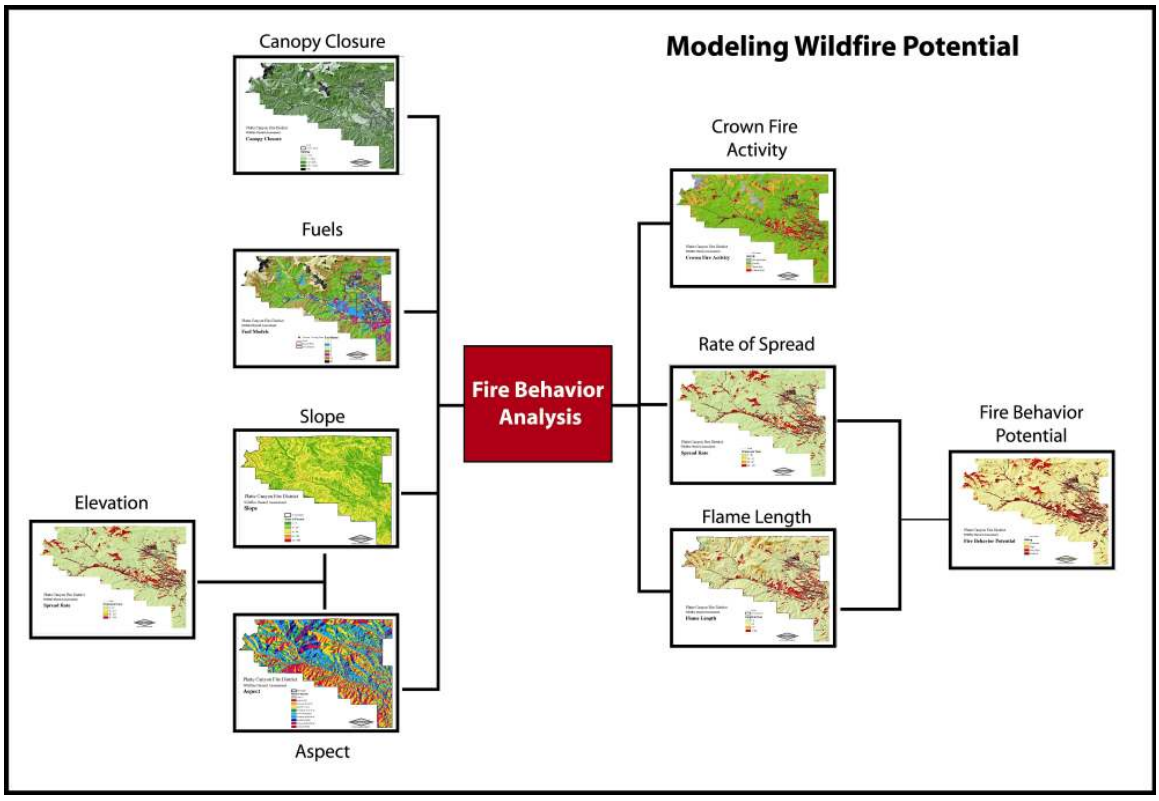
Appendix A

Fire Behavior Potential Analysis Methodology

PURPOSE

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

Figure 1: Model Description



BEHAVE MODELING

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

of calculations to estimate a fire's intensity and rate of spread given certain conditions of topography, fuels and weather.

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

Assumptions of **BEHAVE:**

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

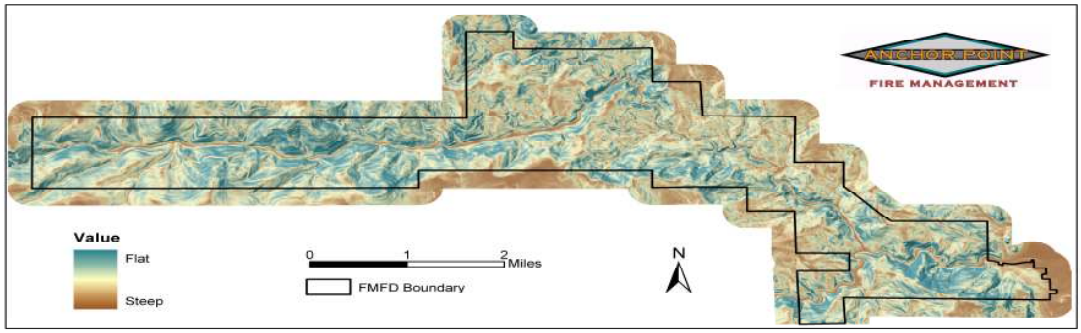
FLAMMAP

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

FIRE BEHAVIOR INPUTS

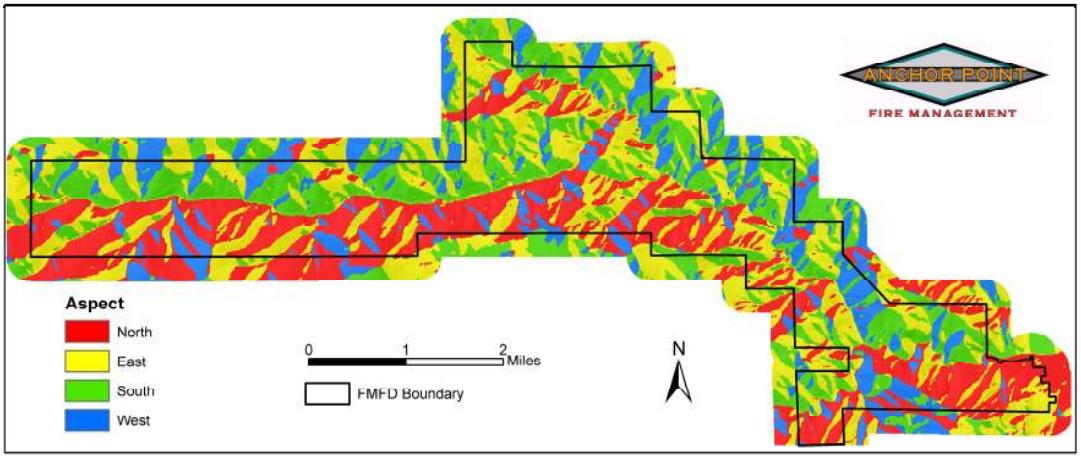
Fire behavior is dependant upon aspect, slope, elevation, canopy cover and fuel type. The following pages contain an explanation of each.

Figure 2: Slope



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

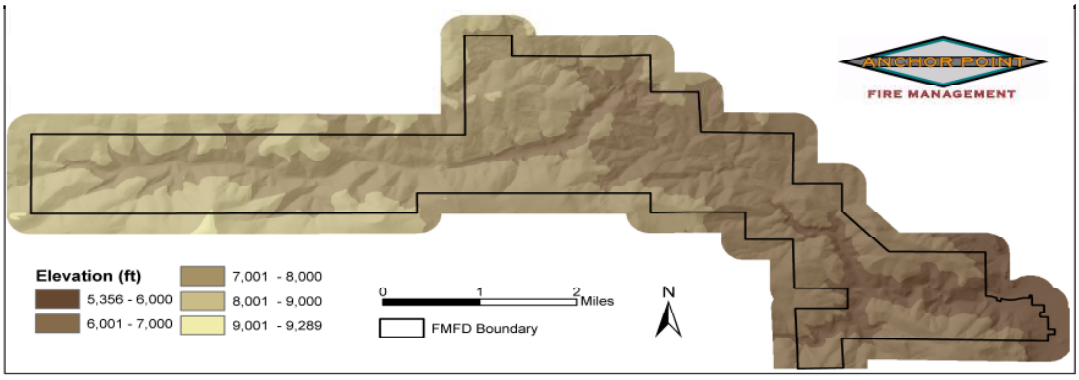
Figure 3: Aspect



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

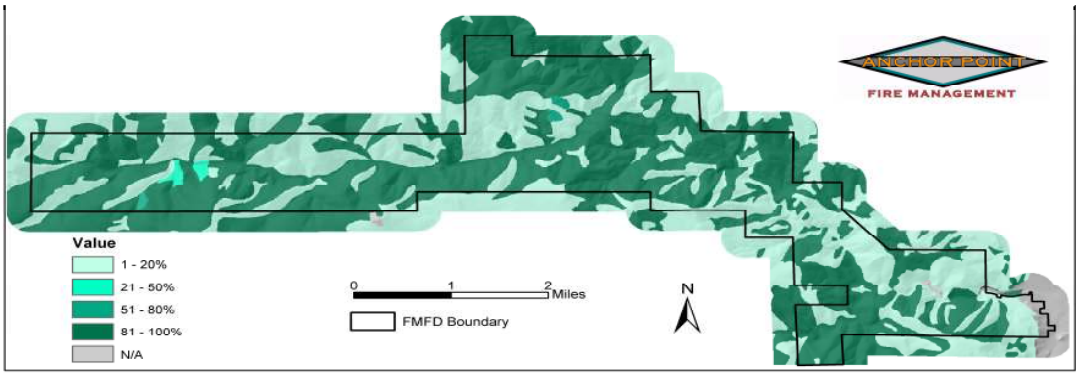
Classification	North	East	South	West
Range	315-45	45-135	135-225	225-315

Figure 4: Elevations



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

Figure 5: Canopy Cover



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

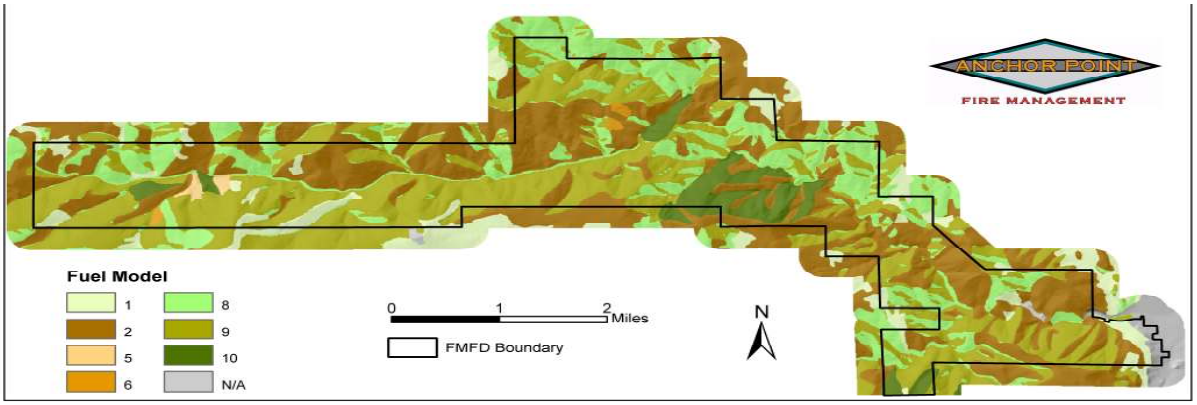
Fuel Models

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

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

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

Figure 18: Four Mile Canyon Fuels Map



FUEL MODEL 1[1]

Figure 19: Annual Grasses

Characteristics

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

Common Types/Species

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

Fire Behavior

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

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

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

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

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

Flame Length in Feet

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

FUEL MODEL 2[2]

Figure 20: Timber with Grass Understory

Characteristics

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

Common Types/Species

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

Fire Behavior

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

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

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

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

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

Flame Length in Feet

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

FUEL MODEL 8[3]

Figure 21: Timber Litter, Light Fuel Load

Characteristics

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

Common Types/Species

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

Fire Behavior

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

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

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

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

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

Flame Length in Feet

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

FUEL MODEL 9[4]

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

Characteristics

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

Common Types/Species

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

Fire Behavior

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

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

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

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

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

Flame Length in Feet

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

Fuel Model 10[5]

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

Characteristics

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

Common Types/Species

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

Fire Behavior

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

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

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

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

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

Flame Length in Feet

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

REFERENCE WEATHER

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

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

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

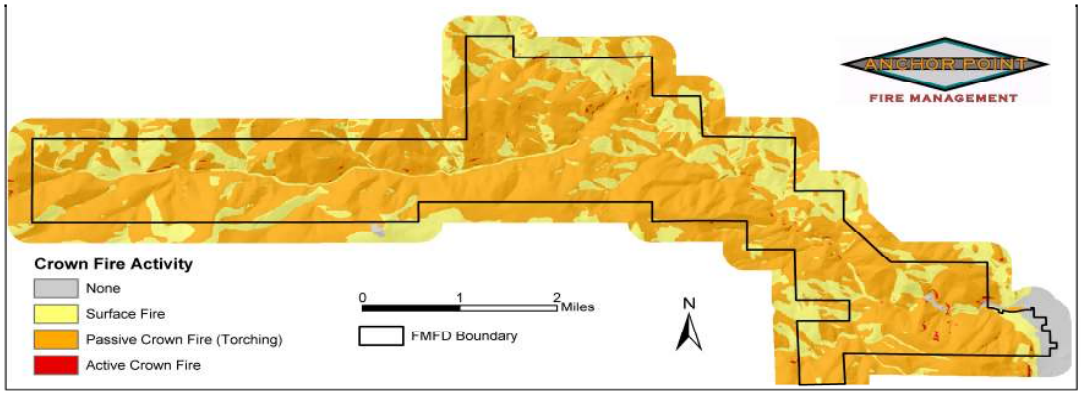
The "extreme conditions" maps were calculated using ninetieth percentile weather data. That is to say, the weather conditions existing on the eighteen most severe fire weather days in each season for the ten-year period were averaged together. It is reasonable to assume that similar conditions may exist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

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

FIRE BEHAVIOR ANALYSIS OUTPUTS

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

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



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

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

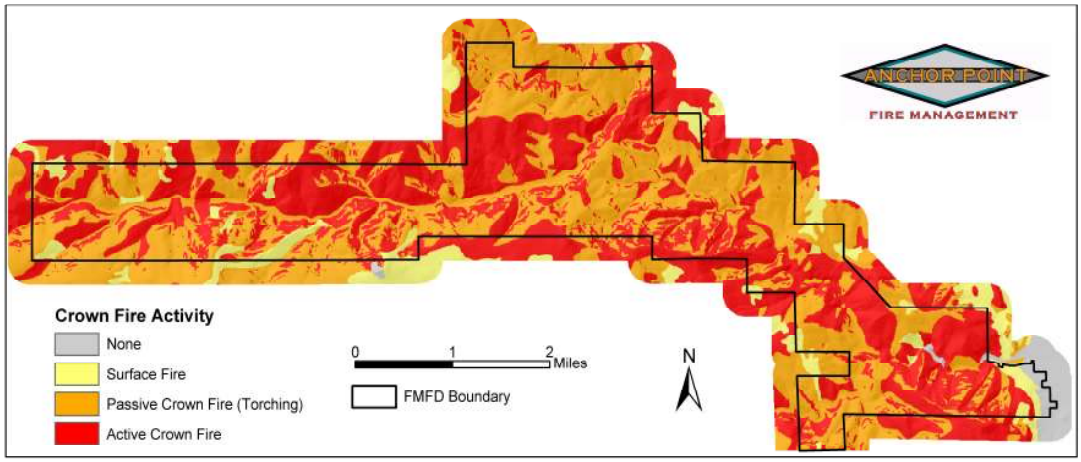
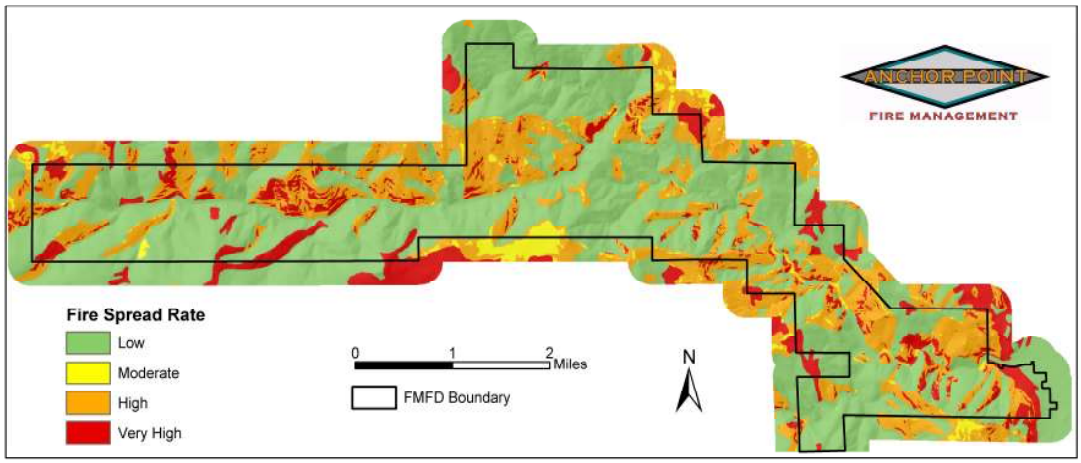


Figure 8: Spread Rate Predictions (Average Weather Conditions)



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

Figure 9: Spread Rate Predictions (Extreme Weather Conditions)

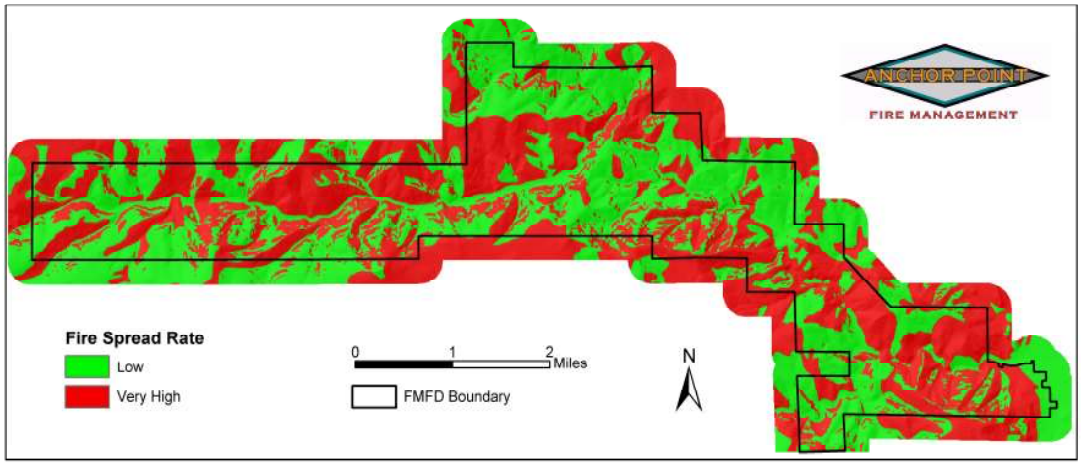
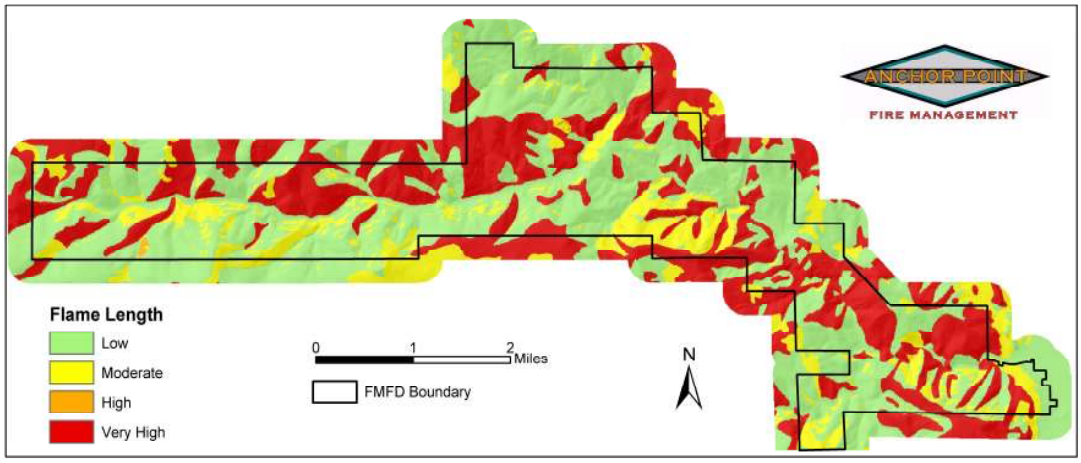


Figure 10: Flame Length Predictions (Average Weather Conditions)



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

Figure 11: Flame Length Predictions (Extreme Weather Conditions)

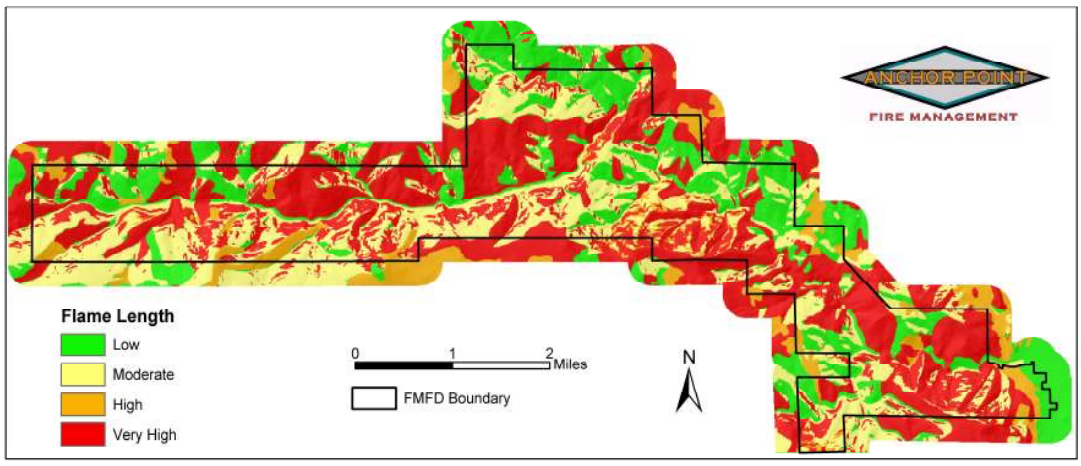


Figure 12: District Wide Fire Behavior Potential (Average Weather Conditions)

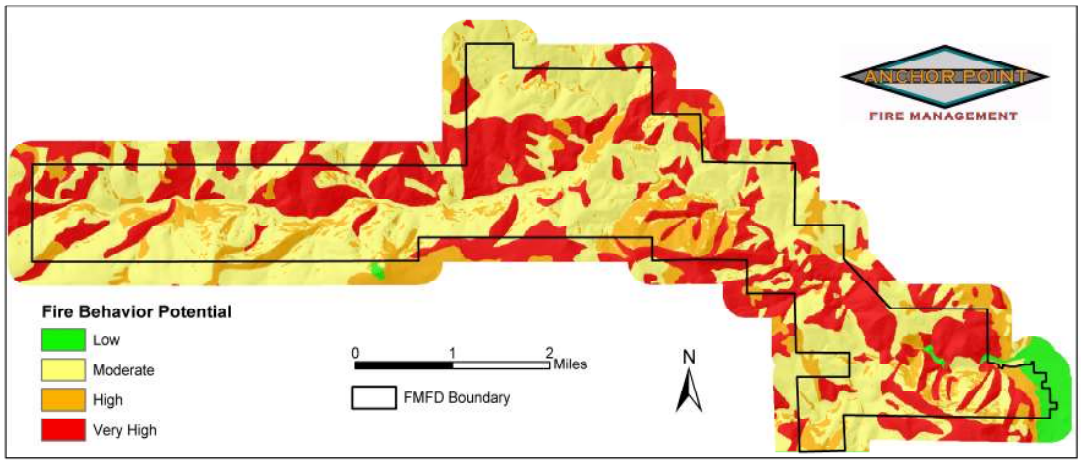
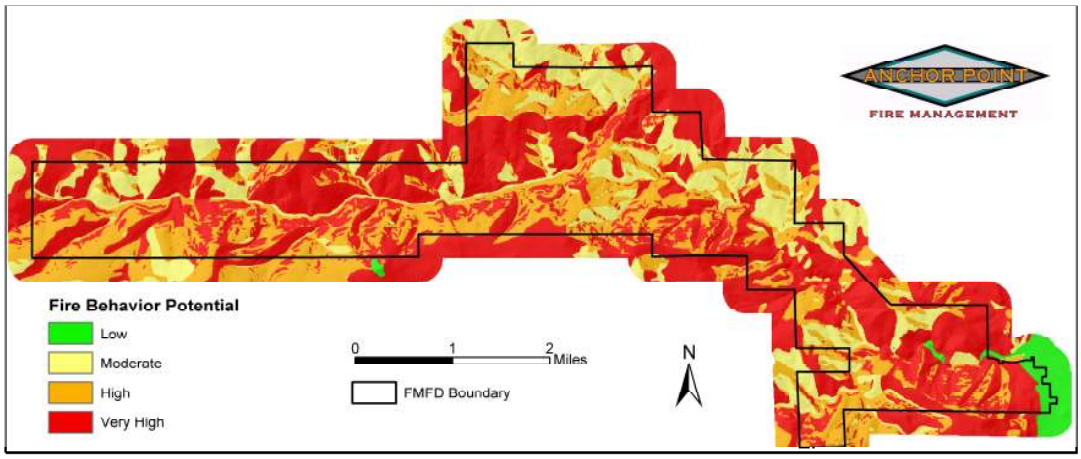


Figure 13: District Wide Fire Behavior Potential (Extreme Weather Conditions)



FIRE BEHAVIOR INTERPRETATION

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

Appendix B

Communities

Purpose

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

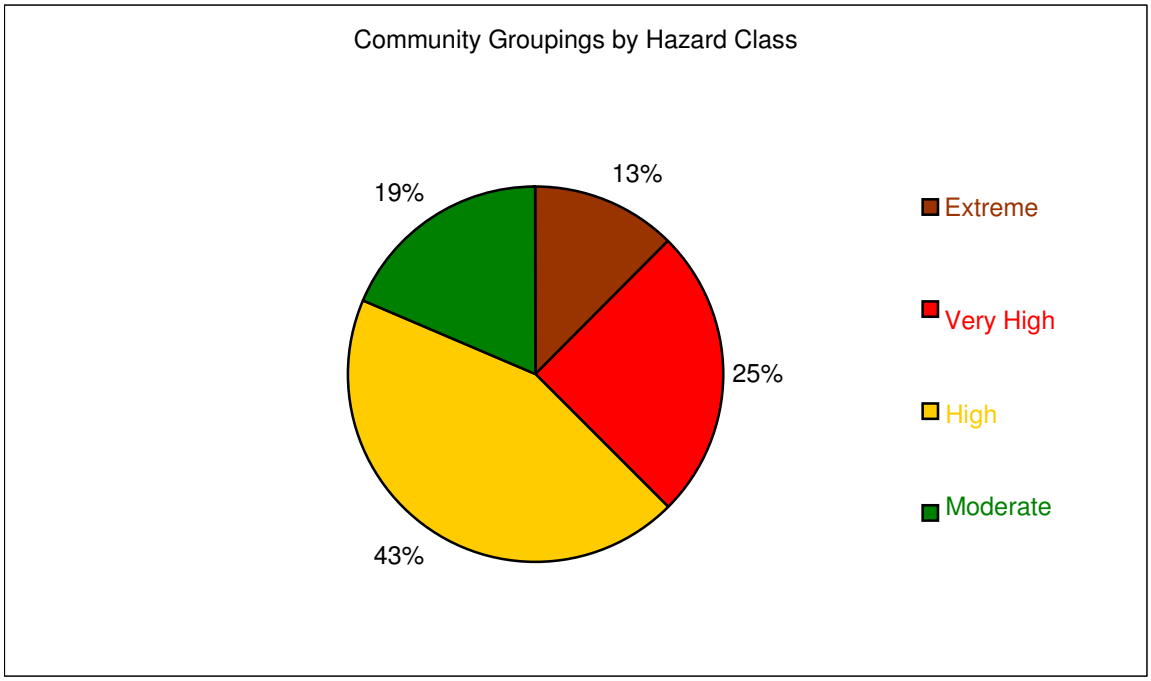


Figure 1

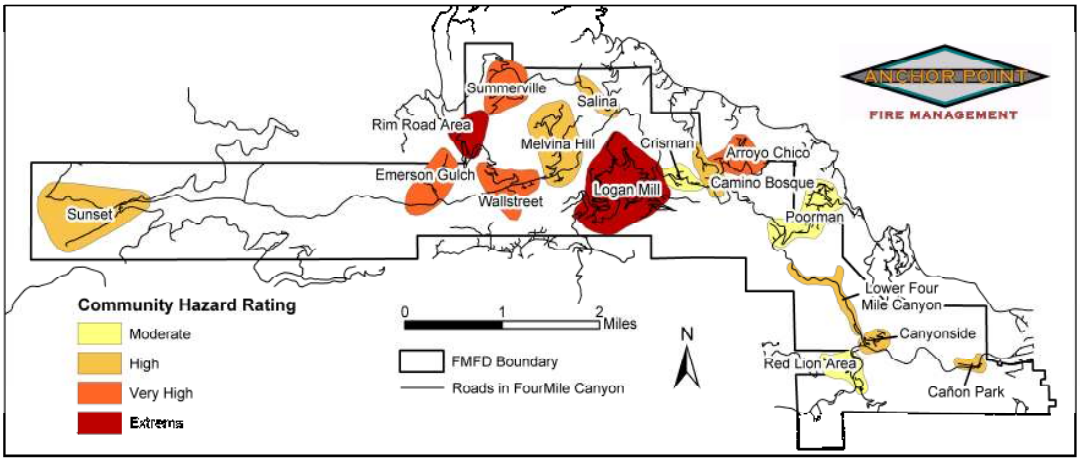


Figure 2

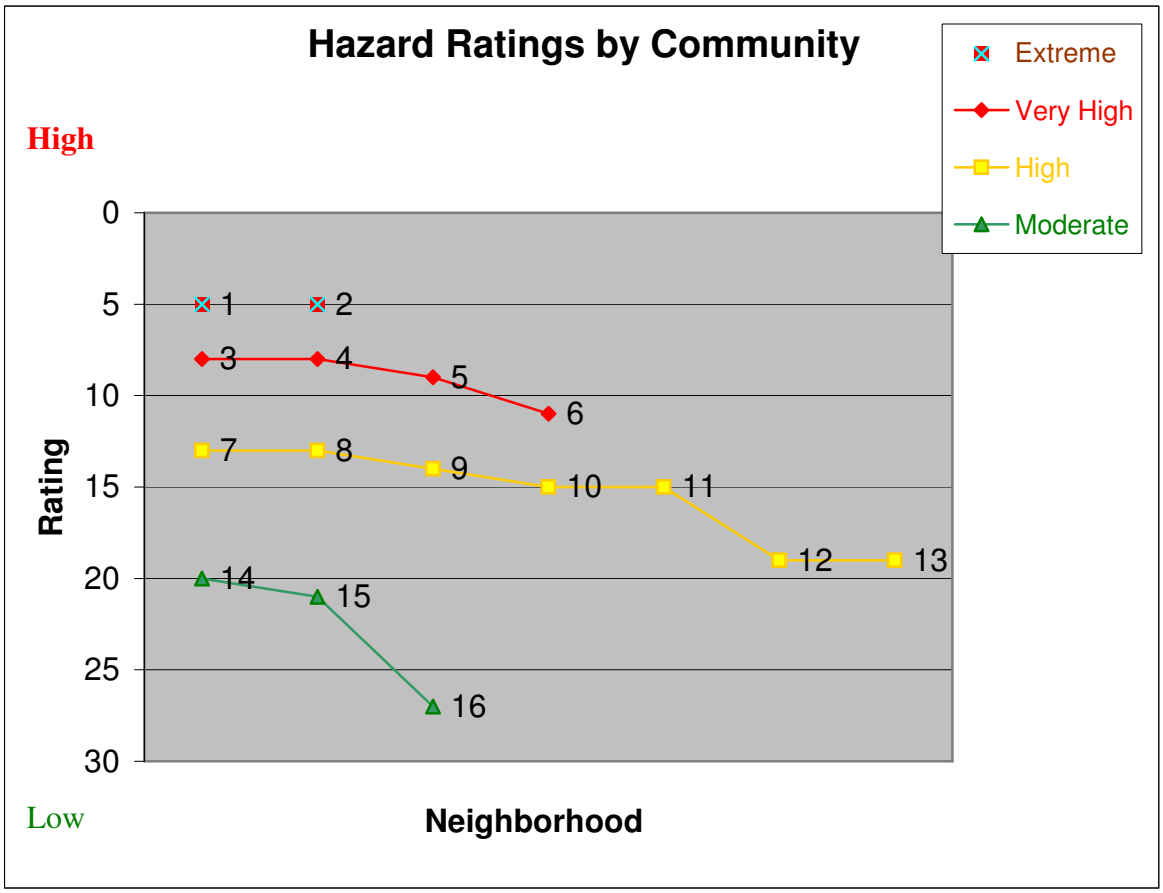


Figure 3

Table 1: Communities by Hazard Rating

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

Extreme Very High High Moderate

General Recommendations

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

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

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

Note

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

Technical Terms

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

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

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

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

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

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

Community Assessment Methodology

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

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

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

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

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

Communities

1. Rim Road

Figure 4

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

Description:

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

Comments & Mitigation Notes:

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

2. Logan Mill

Figure 5

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

Description:

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

Comments & Mitigation Notes:

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

3. Wall Street

Figure 6

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

Description:

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

Comments & Mitigation Notes:

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

4. Summerville

Figure 7

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

Description:

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

Comments & Mitigation Notes:

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

5. Emerson Gulch

Figure 8

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

Description:

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

Comments & Mitigation Notes:

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

6. Arroyo Chico

Figure 9

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

Description:

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

Comments & Mitigation Notes:

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

7. Sunset

Figure 10

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

Description:

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

Comments & Mitigation Notes:

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

8. Camino Bosque

Figure 11

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

Description:

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

Comments & Mitigation Notes:

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

9. Lower Four Mile Canyon

Figure 12

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

Description:

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

Comments & Mitigation Notes:

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

10. Melvina Hill

Figure 13

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

Description:

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

Comments & Mitigation Notes:

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

11. Cañon Park Area

Figure 14

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

Description:

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

Comments & Mitigation Notes:

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

12. Salina

Figure 15

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

Description:

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

Comments & Mitigation Notes:

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

13. Canyonside

Figure 16

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

Description:

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

Comments & Mitigation Notes:

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

14. Red Lion Area

Figure 17

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

Description:

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

Comments & Mitigation Notes:

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

15. Crisman

Figure 18

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

Description:

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

Comments & Mitigation Notes:

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

16. Poorman

Figure 19

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

Description:

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

Comments & Mitigation Notes:

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

Appendix C

Four Mile Canyon Hazard Assessment
Structural Triage and Preparation

Size Up Considerations

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

Fire Fighter Safety

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

Structural Triage Categories

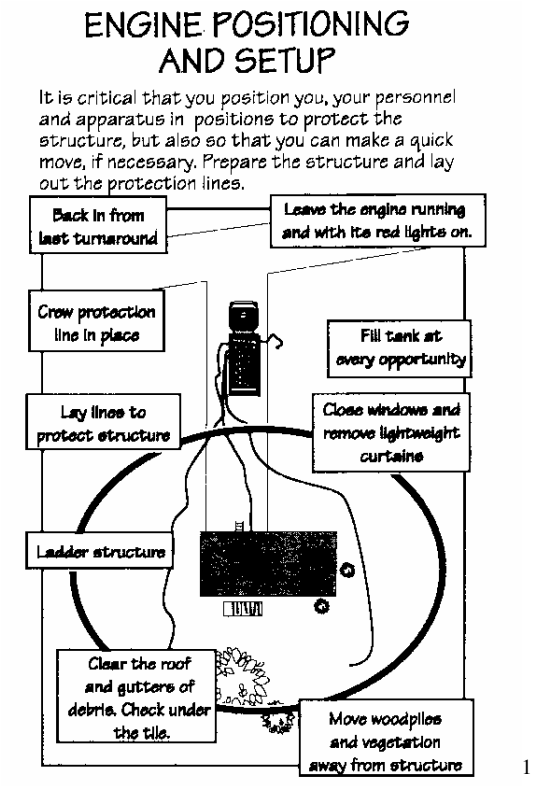
Sort structures into one of three categories:
1. Stand Alone or Not Threatened
2. Defendable
3. Not Defendable.

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

Apparatus Placement Considerations

Common Ignition Points

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



[1]

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

Appendix D

Access and Water Supply Recommended Guidelines

Introduction

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

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

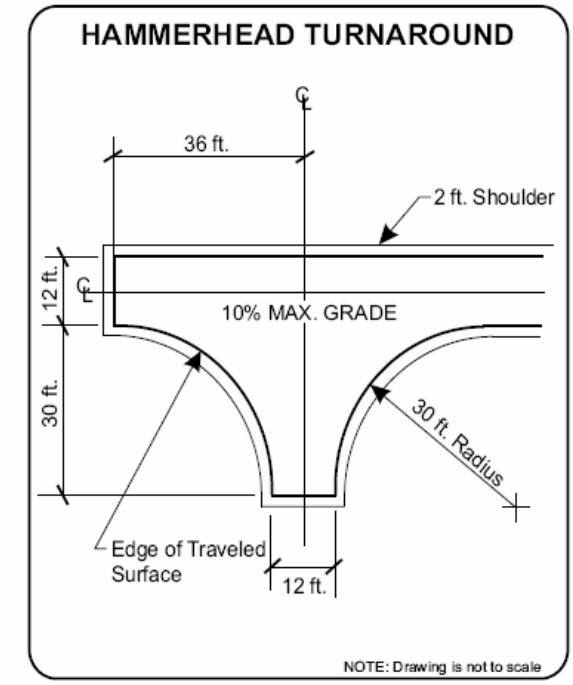
Access Guidelines

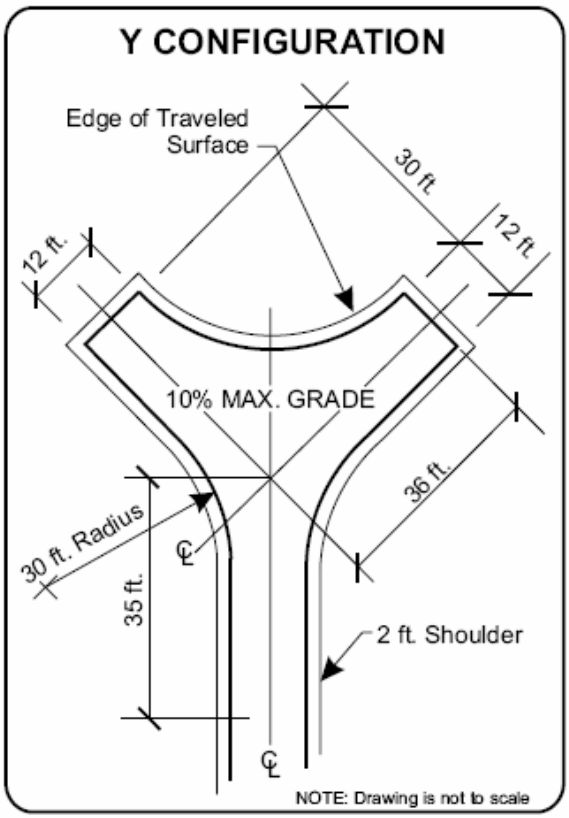
Driveway Turnarounds

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

Driveway Width and Height

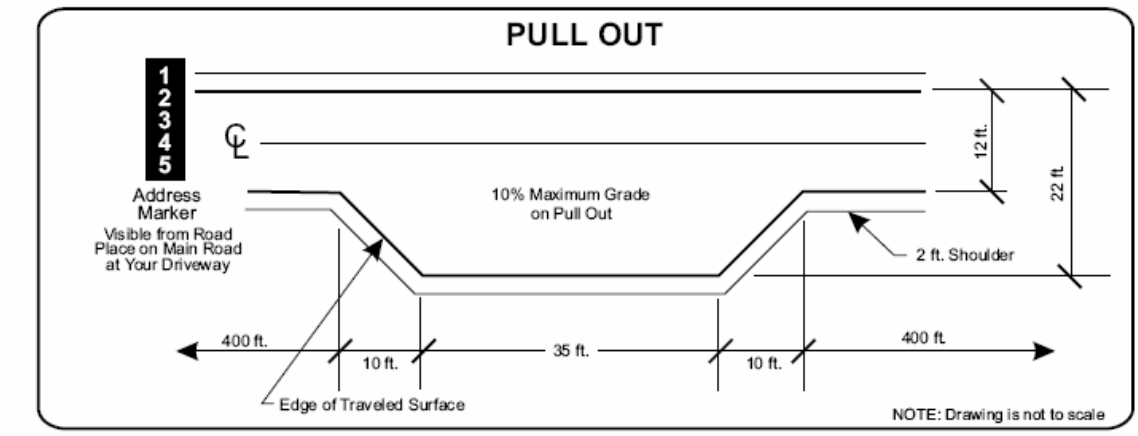
Driveways should have an unobstructed vertical clearance of 13 feet 6 inches. Trees may need to be limbed, and utility lines relocated to provide the necessary clearance. Driveways should have a 12-foot wide drivable surface and 14 feet of horizontal clearance.





Driveway Pullouts

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



Address Markers

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

Bridge Load Limits

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

Alternative Water Sources

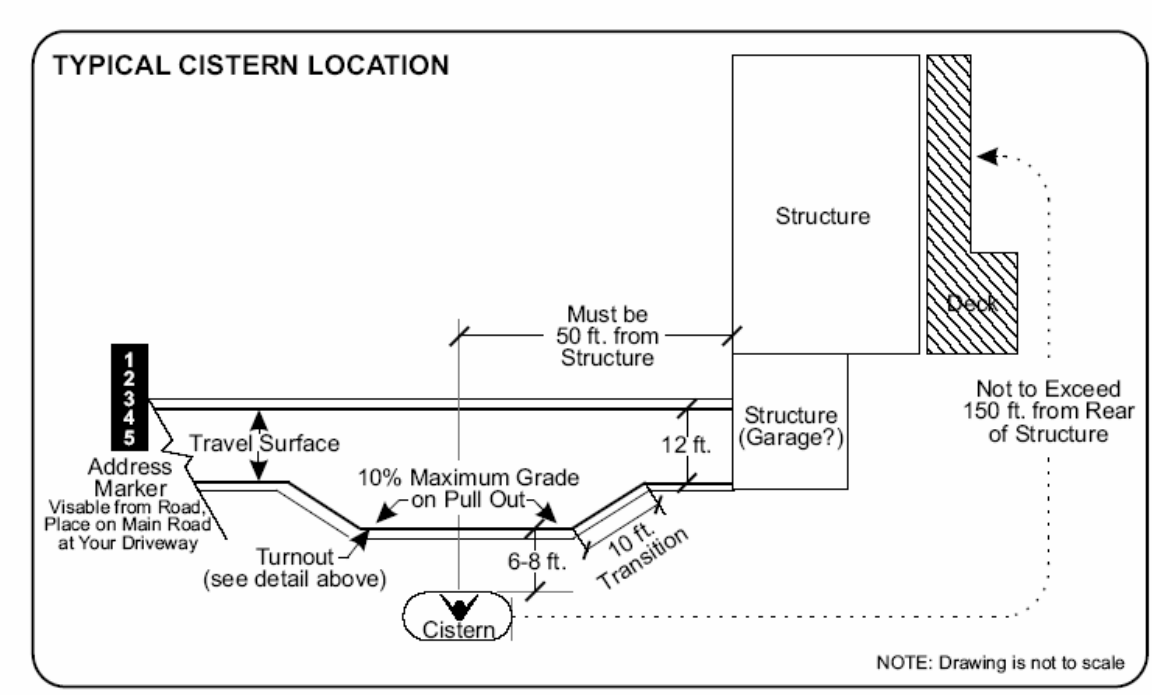
In the study area, like many of the mountainous areas of Colorado's front range, water is a critical fire suppression issue. Nine of the twenty-five water sources commonly used by the FMFD for fire suppression could be dry or too low to be effective during at least part of the fire season. The hazard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

Cisterns

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

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

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



Dry Hydrants

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

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

Appendix E

Four Mile Fire Protection District Collaborative Effort

THE NEED FOR A CWPP

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

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

The minimum requirements for a CWPP are:

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

PROJECT FUNDING AND COORDINATION

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

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

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

INTER-AGENCY COLLABORATION

Roles and Responsibilities

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

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

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

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

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

The Collaborative Process

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

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

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

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

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

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

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

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

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

FUNDING CWPP RECOMMENDATIONS

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

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

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

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

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

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

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

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

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

DRY HYDRANT MANUAL

A Guide for Developing Alternative

Water Sources for Rural Fire Protection

From code originally developed for Summit County, Colorado

ALTERNATE WATER SUPPLY POLICY

SCOPE:

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

GOALS:

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

DEFINITION:

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

PERMITS

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

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

ACCEPTANCE TESTING

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

MAINTENANCE

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

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

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

DESIGN REQUIREMENTS

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

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

C. All draft hydrants shall have a draft tube running horizontally from the water source to the base of the riser consisting of a minimum of six (6) inch PVC. PVC pipe meeting AWWA specification C9000 with a SDR

of 18 or less may be required through or under foundations and under driveways (Schedule 80 pipe or its equivalent may be deemed necessary in some instances). All joints must be sealed watertight, airtight and rootproof.

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

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

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

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

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

INSTALLATION REQUIREMENTS

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

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

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

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

MAXIMUM LIFT CONSIDERATIONS

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

Maximum vertical lift recommendations:

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