

Wildfire Hazard & Mitigation Report

El Paso County, CO



Wildfire Hazard Evaluation Report

For the

L. Johnson Property

El Paso, CO

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Warning and Disclaimer: The degree of protection from wildfire hazards intended to be provided by this plan is considered reasonable for planning purposes. It is based on accepted forestry and fire science methodology. This plan is intended to aid the Forest Lakes development in minimizing the dangers and impacts from wildfire hazards. Fire is a natural force and a historical part of forest and native grassland ecosystems. Therefore, unforeseen or unknown wildfire conditions, natural or man-made changes in conditions such as climate, vegetation, fire breaks, fuel materials, fire suppression or protection devices, and ignition sources may contribute to future damage to structures and land uses even though properly permitted and mitigated within designated wildfire hazard areas.

December 4, 2020

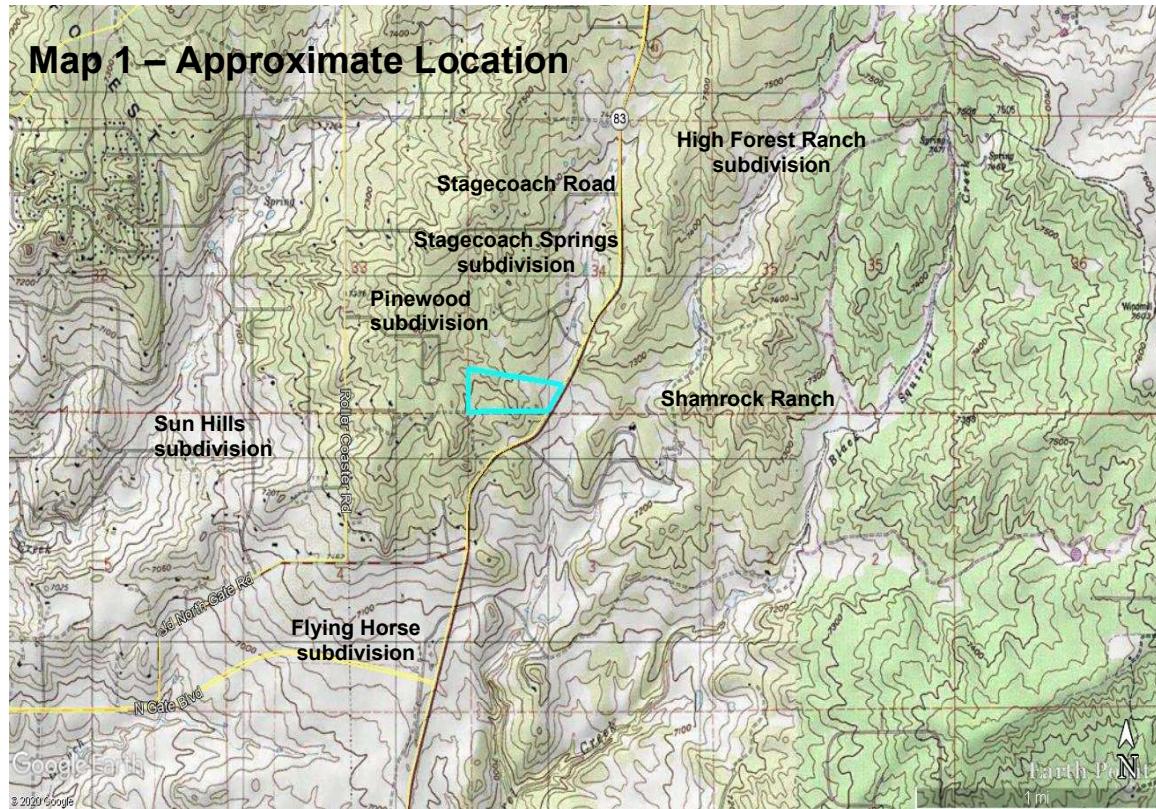
General Description

The L. Johnson Project is a private residential development planned for the northern portion of El Paso County, Colorado. The development plan proposes the subdivision of 28.62 acres into 4 lots. The size of three of the lots is just over five acres. The fourth lot is approximately 13 acres. The property is located 0.6 miles north of Old Northgate Road on the west side of State Highway 83 (see Map 1).

Elevations within the property range from approximately 7,253 feet at the northeast boundary and rise to the west along the north boundary to 7,340 feet at the northwest corner. The general topography is rolling hills which drain southeast towards Black Squirrel Creek.

The slope running from the southeast corner to the northwest corner is 4.6%. Individual hills may reach 10% over a limited distance. Roads, beyond the main driveway, that exist within the property are simple dirt-track trails.

This area does have a distinct wildfire history. The Black Forest Fire in June of 2013 burned 14,280 acres. The Johnson was within 0.75 miles of being reached by the fire prior to containment.



Wildfire Hazard

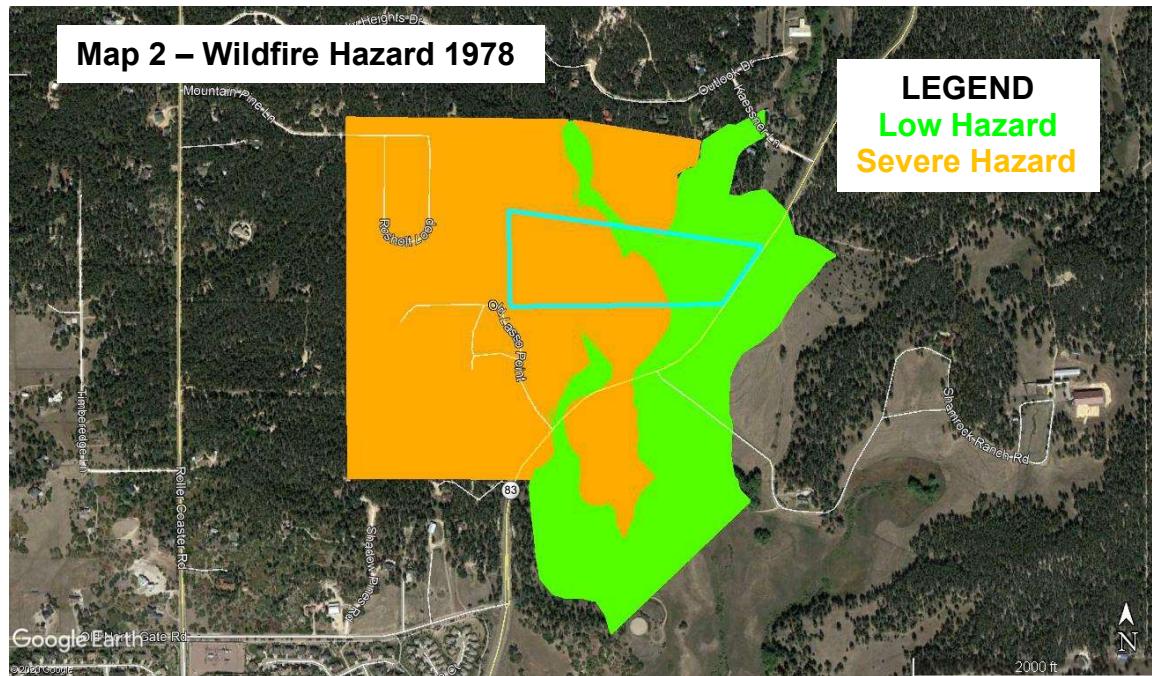
Based upon the Wildfire Hazard Area Map (WHAM) developed by the Colorado State Forest Service (CSFS) in 1978, the site of the proposed development of ‘Johnson’ subdivision contains a low hazard for meadows and a severe hazard for trees(see Map 2).

Since publication of these hazard maps, the CSFS developed a wildfire risk assessment tool in 2012 referred to as the Colorado Wildfire Risk Assessment Web Portal (CO-WRAP). This assessment was just recently updated to include events up to and including 2017.

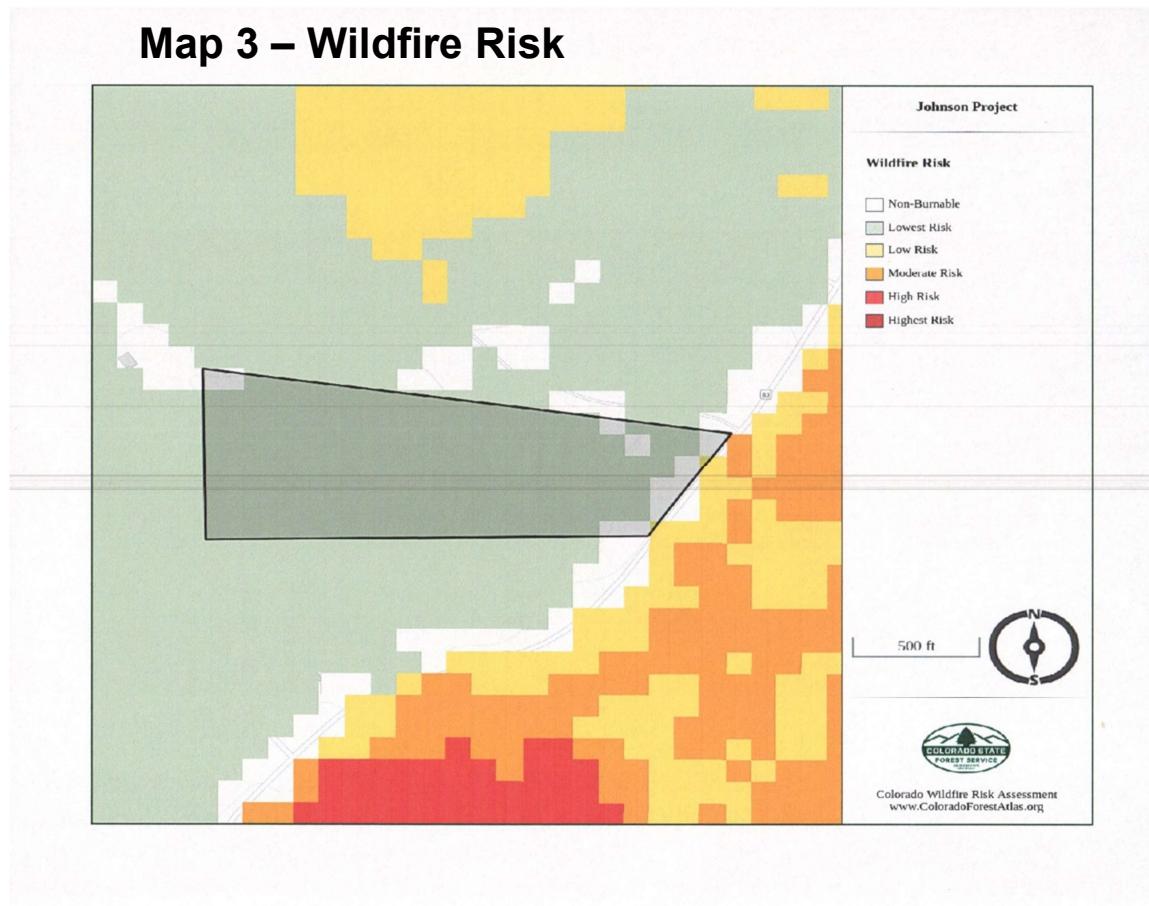
Within the assessment report, the wildfire risk (see Map 3) to the property is classified as the lowest. Wildfire risk is a composite rating which identifies the probability of loss or harm from a wildfire.

The Burn Probability is the annual probability of any location becoming subject to a wildfire event. The assessment gives the development area a very low to low ranking in this regard. However, the Fire Occurrence rating is almost the highest reaching the number 8 classification out of 9.

Fire occurrence considers the likelihood of a wildfire starting based on historical records. If the Black Forest Fire and other fires in the northern part of El Paso County are considered, this should not be a surprise to see such a high classification.



One distinction that can be drawn from the CO-WRAP assessment is the selection of the fuel model used in determining the wildfire hazard. The WHAM (Map 2) uses a simplistic approach and only delineates between grass, which would be a low hazard. shrub or forested fuels would range from medium to severe depending on density and continuity.



The assessment summary uses a Timber-Litter fuel model. Fuel models attempt to determine which type of fuel will support a wildfire's spread across a landscape. This is a much more dynamic approach as fuel models do not differentiate between small changes in the fuel beds over a short distance but considers them across larger areas.

A field inspection was performed on Friday, December 4th to determine if any change should be made to the wildfire hazard conclusions.

The fuel models delineated by the COWRAP assessment were confirmed. The east area is composed of grassland and it is mowed extremely low to the ground. This makes this area virtually non-burnable (see white pixels, Map 3).

The Timber-Litter layer is represented by the gray color on Map 3. It can be further refined to Long-Needle Litter, Fuel Model TL8. This fuel model burns

primarily in long-needle litter on the ground. In this instance, it is ponderosa pine needles. There may be a small quantity of grasses and other herbaceous plants, but these do not contribute significantly to the total fuel load.

The fine dead fuel load can run approximately 5.8 tons per acre. It is predicted that the rate of spread will be moderate, ranging from 330 up to 1,320 feet per hour. The flame length will be low, ranging from 1-4 feet.

Wildfire Behavior

This rating considers the role of the three major components that affect wildfire behavior; fuels, topography and weather. These three components will be examined in relation to “Johnson’ development plan.

Fuels

The area was field checked, and the results in the COWRAP Risk Assessment Summary were confirmed based upon the observed fuel models on the property. The USDA – Forest Service Intermountain Forest and Range Experiment Station in Ogden, Utah, developed these fuel model descriptions. They are used as aids in estimating fire behavior (see Appendix A).

The criteria for choosing a fuel model reflects that a wildfire will burn in that fuel type which best supports that fire. There may be more than one fuel model represented on any given area of land. In addition, current and expected weather conditions will influence the condition of these fuels.

The grassland areas along Highway 83 are best described under Fuel Model 1 (see Appendix A). “The fine, very porous and continuous herbaceous fuels that have cured or are nearly cured govern fire spread. Fires are surface fires that move rapidly through the cured grass. Very little shrub or timber is present, generally less than one-third of the area.”

Fuel Model 1 can be further refined to GR2, Low Load, Dry Climate Grass. This fuel model was developed by Scott & Brogan in 2005 (see Photo 1). The primary carrier of a fire is grass. Any oak brush, if present, will not significantly affect fire behavior.

Caution needs to be expressed here if the dead grass moisture is very low. With a moderate wind speed of 10 – 13 miles per hour, the rate of spread of a wildfire can exceed 160 feet per minute. Flame length in this instance may exceed 10 feet in length making direct attack extremely difficult.

However, this area appears to be treated throughout the year. The grass is being mowed to a very low height which makes this area non-burnable. The live, green limbs on the ponderosa pine have been pruned so they do not reach the ground. This condition renders this area into a very low or non-burnable state.



Photo 1. This photo depicts an example of Fuel Model 1 along Highway 83, looking from east to the west. In this instance, the area is mowed which reduces the fuel bed depth and potential rate of spread.

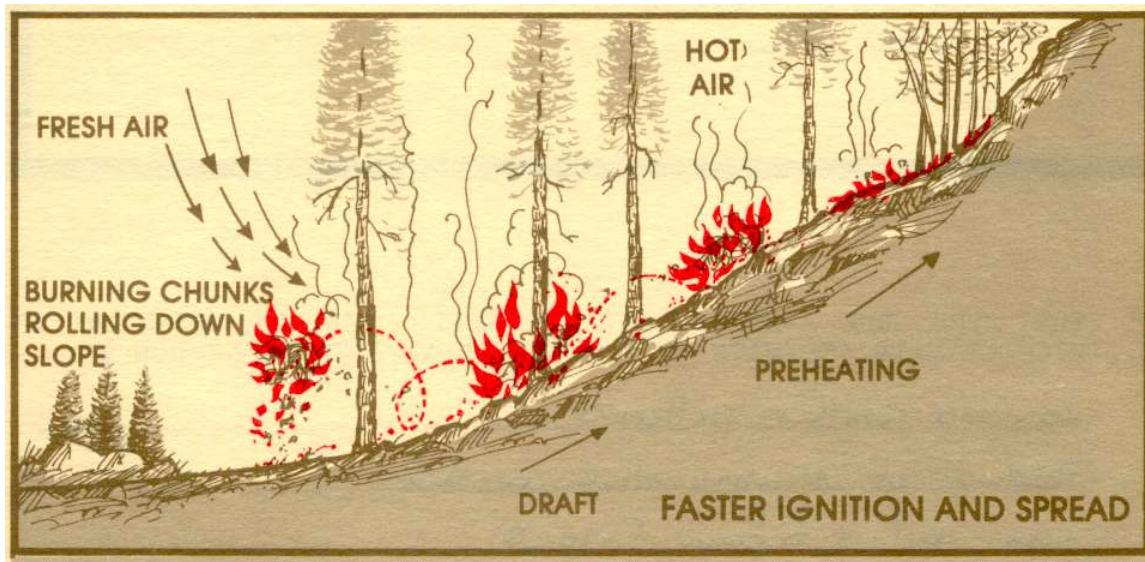
The Long-Needle Litter fuel model, TL8, has a very high extinction moisture content of approximately 35%. While the tight compact nature of the needles slows wildfire spread, moisture does not readily penetrate through the needle layer. This allows a fire to continue to burn even during higher night-time humidity.

Topography

The topography of the site is one of the main factors that will influence a fire spread. The aspect or compass direction that any slope faces influences the fuel type that exists and the amount of preheating these fuels receive by the sun. Aspect can also influence the effects of diurnal winds, as they move upslope during the daylight hours and down slope during the evening and early morning hours.

As the percent of slope increases, the rate of fire spread by convection increases. In other words, wildfires burn faster moving uphill (see Figure 1).

Figure 1. Slope Affects Fire Spread



The specific topography of the property is relatively flat from the southeast to the northwest. The slope, as mentioned previously is approximately 4.6%. This should have negligibly impact on a fire's spread assuming low wind conditions.

There may be instances where the slope exceeds 10% across small hills. These will be over a short distance and may cause torching in the ponderosa pine tree canopy. However, these slopes should not cause any barrier to control of a wildfire.

Slopes that are greater than 25% are considered extreme in their effect on wildfire behavior. This condition does not exist on or near this property.



Photo 2. Looking east to west uphill towards storage barn and current residence.

Photo 2 provides a view of a steeper slope in the southeast portion of property. While a wildfire will preheat the needle layer, there are insufficient dead ground or ladder fuels to ignite the green canopy. Any torching of trees would be a random event. It would not be expected for this slope to accelerate the spread of a wildfire.

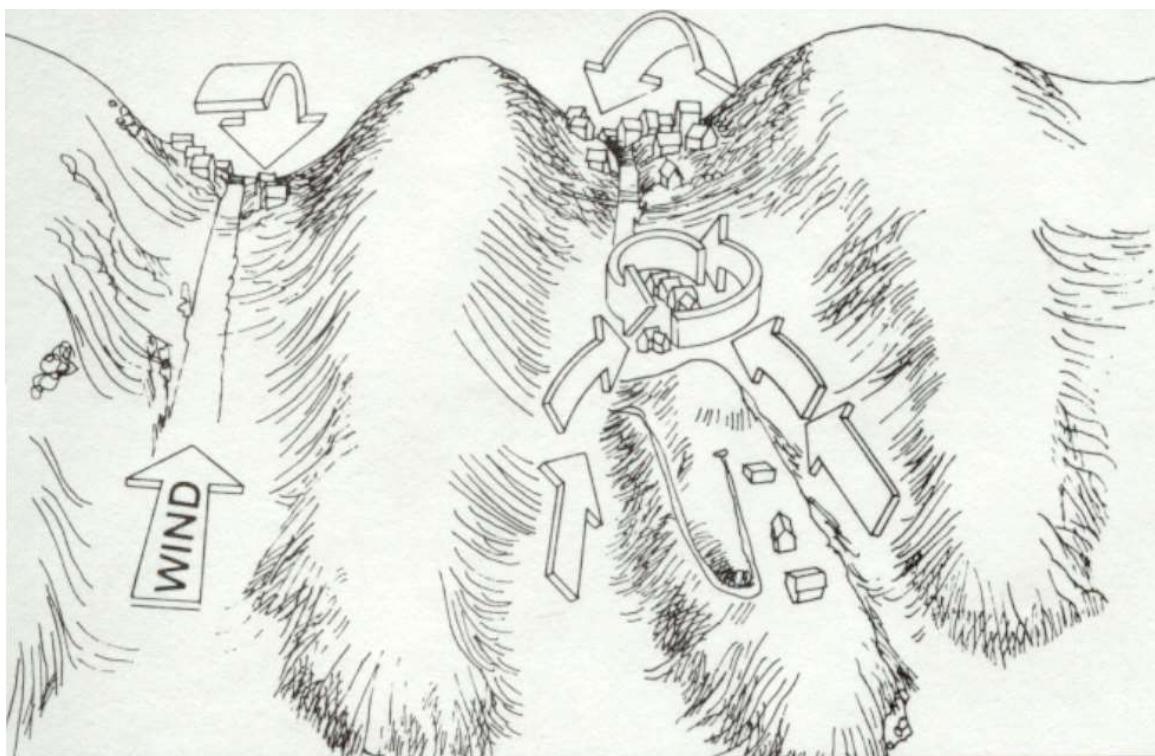
Weather

Weather is the most variable of all the factors. The accumulative effects of weather over time can influence vegetation curing and fuel moisture content.

Grasses, for example, are described as being one-hour time lag fuels. Time lag is a measure of the rate at which a given dead fuel gains or loses moisture. Hence grasses tend to be influenced by the weather conditions on an hourly basis. Wood fuels that are three inches in diameter or larger are considered 1,000-hour time lag fuels. This type of fuel requires a long period of dry or wet weather in order to affect its combustibility.

Winds can influence the direction and rate of spread of a wildfire. Of greater concern is the short spotting of the fire by embers transported by winds ahead of the main fire.

Figure 2. Drainages Tend to Draw in Fire



Graphic Courtesy of Colorado Springs Fire Department

Winds can influence the direction and rate of spread of a wildfire. Of greater concern is the short spotting of the fire by embers transported by winds ahead of the main fire.

The effect of wind on a fire were on display in April of 2018 during the 117 Fire in southern El Paso county. This fire grew to over 42,000 acres and destroyed 24 homes. The fuel bed consisted of native shortgrass and cholla cactus prairie. High winds carried embers across a railway bed and several county roads. The winds of over thirty miles per hour pushed the fire from Highway I-25 easterly past Hanover, more than ten miles in just one day.

More recently, the Wild Horse Fire near Turkey Creek along Highway 115 ignited this past October 11th. Wind speeds from 40-50 m.p.h. spread the grass fire to 670 acres in a short period of time.

While the weather may contribute greatly to a wildfire event, it is immune to outside influences.

Predicted Fire Behavior

Based upon history, one can expect that if an ignition occurs, a wildfire will spread rapidly and quickly uphill towards the proposed development. Using the USDA – Forest Service Fire Behavior Fuel Model, the following predictions can be made based upon an 80-degree temperature day with a relative humidity of 18% with little cloud cover at 1:00 p.m. in the month of July. The drainage used in this example is Beaver Creek and that the ignition originates just west of Bristlecone Lake.

The fire will spread quickly, at a rate in excess of 1432 feet per hour, or 23 feet per minute. Flame lengths will range from 2 to 2 ½ feet. The probability of fuels igniting in advance of the fire front is 100%. In the fifteen minutes that it may take for the fire to be noticed, reported to the fire department's dispatch office and for the arrival of the initial attack force, the fire could have traveled over 350 feet and be approximately 1.6 acres in size with a total perimeter distance approaching 1,254 feet.

As the fire moves up the Beaver Creek drainage to the west, the fire will be funneled uphill onto the south-facing slope. Here, the fire will accelerate its rate of spread to 2,102 feet per hour or 35 feet per minute. Again, in the time it takes to respond to the fire, it may have moved uphill 528 feet and be approximately 3 acres in size with a total perimeter of 1,782 feet.

It is predicted that local suppression forces will be able to contain the initial fire outbreak with mobile engines and hand constructed control lines within four hours of initial attack.

It should be noted that these predictions are based upon normal weather conditions prevailing over the course of a year. Weather conditions that were exhibited from the fall of 2001 through the present date are outside of normal conditions resulting in the catastrophic losses experienced throughout the western United States this past fire season. Again, the 117 Fire provides an insight in what fire behavior might occur even in the winter season.

If such conditions are present on or in the vicinity of the proposed development site, any wildfire event can be predicted to be more severe and resistant to initial control efforts.

The normal diurnal winds will accelerate the wildfire incident. If the normal diurnal wind patterns are present, a wildfire will move quickly uphill from the east and more slowly from the west. The drainages will draw the fire upslope by increasing wind velocity. This convective heat current will accelerate the pre-heating of available fuel upslope of the fire. It is expected that the fire will move upslope rapidly with high but short-lived heat intensity.

Finally, it should not be assumed that the main periods of fire danger would be in the summer months. As history has shown, out of season fire events are much more common than might be expected by the public.

Wildfire Mitigation

It should be noted here that the occurrence of a wildland fire on this property and any subsequent spread of a wildfire to adjacent land could never be eliminated. In the Spaatz Fire, suppression forces were able to arrive on scene in approximately four minutes after the fire was reported. Even with this rapid response, the wildfire reached a size of 67 acres before it was controlled.

The potential for loss can be reduced and the odds can be improved that initial response forces can be successful in keeping a wildfire to the smallest size possible and structure loss to a minimum. But even with the best efforts of suppression forces, there will always exist a level of risk of loss to a wildfire.

The only way to reduce the risk of loss from a wildfire is to modify the factors that influence fire behavior. Of the three factors discussed previously, the only factor that could be modified prior to a wildland fire is the fuels. The efforts in modifying fuels can be targeted to their arrangement, continuity and availability.

• Arrangement

The arrangement of fuel considers the size, shape and compactness of the fuel itself. Smaller fuel sizes have a greater surface area exposure for preheating. If these smaller sized fuels are only lightly compacted in spacing this results in easier ignition and increased combustion.

Fuels that are tightly compacted and larger in size have lower surface areas. This reduces the ease of ignition and combustion. The ponderosa pine needles layer is tightly compacted and larger sized dead fuels such as limbs are absent.

One technique in reducing the readily ignitable fuel level would be to remove fuels, such as dead needles, fallen limbs and other small organic debris, from the site. However, it is not practical or reasonable to remove these types of fuels from the entire property.

During the construction phase of any residential structure, the most likely source of ignition will come from personnel and activities. These sources of ignition may come from flammable chemicals, improperly discarded cigarettes, shorts in electrical equipment, and other means.

It is suggested here that the reduction of the most ignitable fuel be done in areas that are within fifty feet of the pad of any proposed residential structures. This will reduce the amount of small, flashy fuel in proximity to the structure. It will also retard the spread of a fire towards adjacent property and provide suppression forces additional time to contain a fire quickly.

Once a residential structure is built, a wildfire safety zone should be established. Wildfire safety zones are intended to slow a fire down so that it may be controlled and extinguished. There are three zones that comprise a wildfire safety zone.

The first zone is the one that contains the most opportunity for modification. The minimum width recommended is thirty feet and is divided into three segments.

As these zones may be unique for each lot that is developed, it is difficult to make specific recommendations here. However, it is recommended that each lot be treated prior to completion of the structure and the issuance of the occupancy certificate.

Specific information on the development of wildfire safety zones are available through the Colorado State Forest Service in the Quick Guide Series Fire 2012-1, *Creating Wildfire-Defensible Zones* at the following link:

https://static.colostate.edu/clientfiles/csfs/pdfs/FIRE2012_1_DspaceQuickGuide.pdf

- **Continuity**

The second factor affecting fuels that can be modified is their continuity. Is the fuel continuous or patchy in nature? Is the fuel layered in such a manner that it can leave the ground and spread into a vegetative canopy?

In this instance, the fuels in the Long-Needle Litter fuel model are continuous. While there are patches of mid-sized grasses, these are insufficient to generate enough heat to increase the rate of spread nor ignite the live green canopy of the ponderosa pine.

In a further effort to reduce the wildfire hazard, a mitigation thinning was performed in 2017. Ponderosa pine trees were thinned and pruned to remove potential 'ladder' fuel. Slash generated from the tree thinning was chipped and spread across the ground (see Photo 3). The wood chips further compressed the needle layer.



Photo 3. It is the needle layer that will carry a wildfire thru the property. Note the compressed nature of the needle layer, absence of fallen branches and lack of ladder fuels.

According to an interview with Mr. Johnson, there has been yearly maintenance to maintain the low wildfire hazard. Maintenance has involved removing dead trees and downed limbs and branches. This material has been either chipped or removed from the property.

Finally, as part of the mitigation effort, there is a fuel break that was cut along the western boundary. This creates a break between the neighboring untreated properties to the west. The intent is to reduce the risk of a canopy fire moving onto the property. The space between properties has had trees removed to create a gap where a canopy fire has a lower chance of spreading (see Photo 4).



Photo 4. Note the gap between the unmitigated property on the left to the treated area on the right of the photo. The trees that were removed provide for an open space in the green canopy to hinder the spread of a green canopy wildfire.

Logs were laid down to delineate the property boundary. The ground fuel in the gap is composed of compressed pine needles.

- **Availability**

The final consideration is the availability of the fuel to physically burn. This factor is influenced by the weather on a daily or yearly basis and cannot be readily influenced.

As was mentioned earlier, the availability of this fuel type should be considered a year-round hazard and not limited to the summer months.

In the meadows or grass fuel beds, the availability of this fuel has been reduced due to periodic mowing (see Photo 1).

The current weather patterns have contributed to a long-term drought situation that has influenced the availability of the fuels to burn. The trend of above average day time temperatures and below normal precipitation levels have allowed fuels to reach a higher state of availability than might normally be the

case, particularly during winter months. This may result in wildfire acting in a manner that might be more characteristic of late summer burning conditions.

Other Considerations

Firebrands & Secondary Ignitions

It is becoming more apparent that structure loss is not occurring during the passage of a burning wildfire front but from ignition of the structure by firebrands and secondary ignitions. Firebrands are burning materials or embers that are lifted into the air by convective wind currents. Firebrands can be cast hundreds of feet in advance of the fire front.

Research and case studies in Australia have found that there is a 50% probability of loss of structures that are 100 – 200 feet from the fire front. This would seem to indicate that firebrands are a major contributing factor of structure loss.

In the U.S., studies indicate there is 90% probability that a structure with a non-flammable roof and that is at least 100 feet from the fuel bed will not be lost during a wildfire. However, this statistic may be misleading as the Cedar Fire (CA) in 2003 indicated that 60% -70% of the structures lost were ignited by firebrands. This would also infer that solely relying on ‘defensible space’ for structure protection may not be adequate.

In a professional paper by Scott (2005), the exposure of a structure to embers and firebrands is discussed. In an inference to fuel mitigation in the ‘defensible space’ zones, Scott states that “In no case is complete removal of the forest canopy required to mitigate crown fire potential near a structure.” This infers that ‘defensible space’, while a good starting point, may not be the whole solution in preventing structure loss.

Currently, fire-safe construction is the recommended protocol for fire brand risk reduction by the professional wildfire community.

Driveways

There are no roads planned for this subdivision. The current driveway into the property will be extended to service the planned lots. The extended driveway has been approved by the Donald Wescott Fire Protection District which is the authority having jurisdiction.

Driveways to individual lots or residential structure should be constructed in accordance with NFPA 1141, *Fire Protection for Planned Building Groups*.

Driveways should provide a minimum width of twelve feet and a minimum vertical clearance of fifteen feet. The grade of any driveway should not exceed 12%. There should be fire apparatus access to within 150 feet of any point of the exterior of any residence (NFPA 1141, 6.6.1).

All dead-end roads should have a turnaround at the closed end (cul-de-sac) of at least 100 feet in diameter.

Wildfires across the West have seen a growing trend of fatalities, especially during mega-events. This may be due to delays in making a prompt evacuation or when fleeing a fire. Panic, due to proximity of flames, could lead to poor decisions in the moment.

It is suggested here to thin the trees along the extended driveway that lead to the residential lots. The intent is to create a modified fuel break by removing enough trees so that their individual tree crowns do not touch one another. This would be performed at a minimum of fifty feet on either side of the driveway. This may avert a level of panic if there was a canopy fire threatening to cross over the driveway.

From a detailed wildfire hazard assessment performed in a local subdivision, a common discrepancy found was inadequate or poor visibility of individual residential address numbers. Letters and numbers indicating specific street addresses should be a minimum of 4 inches in height with a ½" stroke. The numbers or letters should be strongly contrasting with the background color to readily visible from the main access road.

Landscaping

The vegetation that is used in the landscaping of the structure should be fire resistant. For example, ornamental junipers can be very flammable and easily ignited by aerial firebrands. Planting these shrubs near the exterior walls of any residential structures provide a readily available fuel source that could threaten the structure and divert suppression forces to protect the building instead of controlling the wildfire.

From the historical fire record of the region, the ignition of ornamental junipers around structures is a major contributor of damage and subsequent loss. **It is strongly recommended that the use of ornamental junipers in the landscape be prohibited within thirty feet of a structure's foundation.**

It is assumed that a native landscape will be prevalent. The use of periodic irrigation will help keep landscapes lush and green, thereby lowering their ability to ignite. There are many irrigation techniques available that can keep plants less susceptible to burning while still adhering to water conservation principles.

Another alternative to irrigated green space would be to line the footprint of the foundation of the structure with rock. If rock is used, it should be placed at a

minimum width of five feet from the foundation. This will prevent flame lengths from reaching the building.

There are many different sizes and types of rock available. It should be noted here that it would be necessary to remove needles, grasses and other litter from within this rock fuel break on an annual basis.

Construction Considerations

As the fuel in this subdivision are primarily needles and small woody debris, predictable sources of fuel that will burn and allow entry of a wildfire into the structure will be debris that is trapped under or next to the building or accumulation in the roof gutters. Porch, foundation, roof and attic openings should be screened off or enclosed to keep debris from accumulating and burning underneath. This is particularly important where wooden decks are planned at ground level. This was a factor in the loss of structures in the Waldo Canyon Fire. These location concerns were also expressed in a joint publication by [Green Builder Media](#) and the NFPA. This recently released e-book, 'Design with Fire in Mind', can be downloaded using the link. Go to the Resources tab and click on e-books.

It is strongly recommended that all decks that are planned at ground level be required to be sealed off and enclosed to prevent the accumulation of flammable debris underneath them.

In a wildfire risk assessment in a local development, a significant entry point for fire into a house was through the eaves, overhangs or soffits. These locations can trap embers and combustible gas or heat, that can ignite the structure.

Based upon recommendations from FEMA, overhangs, if used, should be enclosed with a flat, horizontal soffit with a one-hour fire resistance rating. The fascia should be constructed of non-combustible material.

The combustibility of a roof is the one of the most important factors in determining the risk of a structure to damage or loss from a wildfire. The use of combustible materials such as wood shingles does not necessarily increase their susceptibility to fire. However, as a wood shingle roof ages and is influenced by the weather, individual shingles may start to warp, curl, and lose the tightness that was exhibited upon initial installation.

Siding materials, while not as critical as compared to roof, can help to lower the overall risk of a structure to damage from a wildfire. Long-needle litter fires tend to burn slowly in most instances. The exception is under very fuel moisture conditions and wind over 10 m.p.h. There may not be enough heat buildup to ignite combustible siding materials. The use of non-combustible siding may not

significantly reduce the risk to wildfire, particularly where a stone border is placed around the foundation.

Water Supply

At the present time, there is no readily available water supply for ground suppression fire resources. The local fire protection districts will need to haul water into the site during a fire.

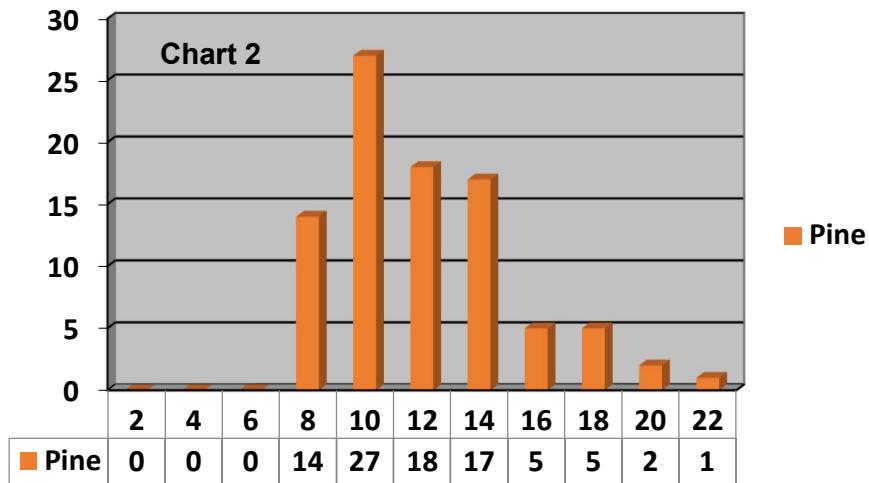
The Donald Wescott Fire Protection District is the responsible agency for initial attack on a wildfire. Station 2 is located less than one mile away, north of the property, at the intersection of Highway 83 and Stagecoach Road.

Forest Management

A forest is a living system and will not remain static but will continue to grow and change over time. Fortunately, this change is slow to occur in the Rocky Mountain West. But time has a way of going by and this change goes unnoticed.

To plan the future, an inventory of the forest resource was conducted. The tree diameters and heights were measured on ten variable plots. The measurements were then summarized using the BIOCRUZ program (Walker, 2003). A report is produced showing the average number of stems (trees) per acre in each two-inch diameter class (see Chart 2).

Examining the data total, the average number of ponderosa pine on the property is 89 per acre. The average diameter of these trees is 14.3 inches. The average height is 55 feet. A copy of the summary report is included in Appendix B.



The inventory data shows there are no trees in the 2-inch through 6-inch diameter classes. This is not unexpected as the wildfire mitigation treatment would have focused on removing the understory or smaller diameter pine. This has resulted in the high average diameter and the creation of a two-story forest stand.

This situation exposes the forest to an increased risk of attack by bark beetles, specifically mountain pine beetle (MPB). This insect prefers to prey on trees over eight (8) inches in diameter and in an overcrowded condition.

The first story stand contains over 85% of the total tree cover. This is the 8 inch through 14-inch diameter classes (76 stems). The remaining 15% can be considered as the second or dominant overstory. This would include the 16-inch through the 22-inch diameter classes (13 stems).

Based upon the growing stock level (GSL), a way to ascertain a preferred density of trees, a target density of 81 trees per acre at an average diameter of 14.3 inches would reduce the risk of an epidemic. MPB can attack individual trees in any given season, the long-term objective is to minimize the threat of extensive loss from an epidemic. This type of loss was experienced in the late 1970's through the mid 1980's.

To lower the overall diameter, trees should be removed from each diameter class. The first selection for removal should be those trees exhibiting poor form or vigor. The concept is to retain the healthiest trees and remove the least healthy. Trees that have received damage to the main trunk or crown, such as from wind or snow, could be considered for removal for form.

A second selection could involve removing some of the largest trees. While these may be the most preferred trees for retention, there is a large population in the 14-inch diameter class waiting to fill that void.

Large openings in the green canopy should be avoided. At present, the forest is considered as having a closed canopy. This canopy type shelters the ground and lowers the wind speed. This helps to reduce the influence of wind on a wildfire. If an opening is unavoidable, keep to one tree height in length if possible.

There is no evidence of dwarf mistletoe infection on the property or on immediately adjacent land ownerships.

Appendix A

Fuel Model Descriptions

Fuel Model 1 & 8 Summary Pages

Source: Anderson, Hal E. Aids to Determining Fuel Models for Estimating Fire Behavior, National Wildfire Coordinating Group, General Technical Report INT-122, April 1982.

“This report presents photographic examples, tabulations, and a similarity chart to assist fire behavior officers, fuel management specialists, and other field personnel in selecting a fuel model appropriate for a specific field situation. Proper selection of a fuel model is a critical step in mathematical modeling of fire behavior and fire danger rating.”

Low Load, Dry Climate Grass (GR2) Summary Page

Long-Needle Litter (TL8) Summary Page

Source: Scott, Joe H. & Burgan, Robert E. 2005. Standard fire behavior fuel models: a comprehensive set for use with Rothermel’s (1972) surface fire spread model. Gen. Tech. Rep. RMRS-GTR-153, Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 72 p.

“This report describes a new set of standard fire behavior fuel models for use with Rothermel’s surface fire spread model and the relationship of the new set to the original 13 fire behavior fuel models.”

FUEL MODEL DESCRIPTIONS

Grass Group

Fire Behavior Fuel Model 1

Fire spread is governed by the fine, very porous, and continuous herbaceous fuels that have cured or are nearly cured. Fires 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.

Grasslands and savanna are represented along with stubble, grass-tundra, and grass-shrub combinations that met the above area constraint. Annual and perennial grasses are included in this fuel model. Refer to photographs 1, 2, and 3 for illustrations.

This fuel model correlates to 1978 NFDRS fuel models A, L, and S.

Fuel model values for estimating fire behavior

Total fuel load, < 3-inch dead and live, tons/acre	0.74
Dead fuel load, 1/4-inch, tons/acre	.74
Live fuel load, foliage, tons/acre	0
Fuel bed depth, feet	1.0



Photo 1. Western annual grasses such as cheatgrass, medusahead ryegrass, and fescues.



Photo 2. Live oak savanna of the Southwest on the Coronado National Forest.



Photo 3: Open pine—grasslands on the Lewis and Clark National Forest

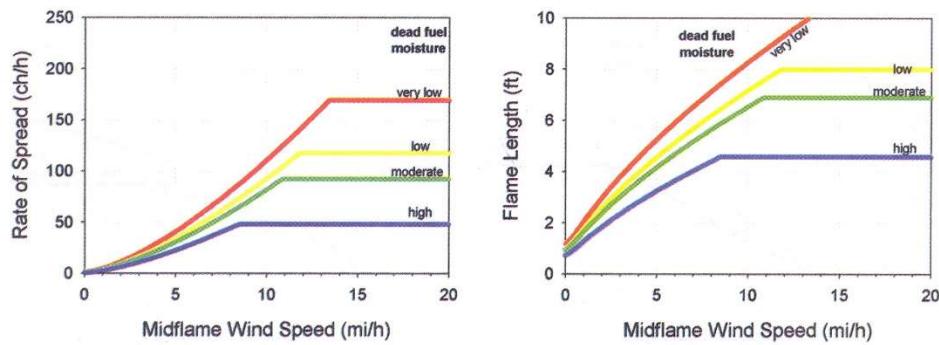
GR2 (102)

Low Load, Dry Climate Grass (Dynamic)



Description: The primary carrier of fire in GR2 is grass, though small amounts of fine dead fuel may be present. Load is greater than GR1, and fuelbed may be more continuous. Shrubs, if present, do not affect fire behavior.

Fine fuel load (t/ac)	1.10
Characteristic SAV (ft-1)	1820
Packing ratio (dimensionless)	0.00158
Extinction moisture content (percent)	15



Timber Group

Fire Behavior Fuel Model 8

Slow-burning ground fires with low flame lengths are generally the case, although the fire may encounter an occasional "jackpot" or heavy fuel concentration that can flare up. Only under severe weather conditions involving high temperatures, low humidities, and high winds do the fuels pose fire hazards. Closed canopy stands of short-needle conifers or 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. Representative conifer types are white pine, and lodgepole pine, spruce, fir, and larch.

This model can be used for 1978 NFDRS fuel models H and R. Photographs 22, 23, and 24 illustrate the situations representative of this fuel.

Fuel model values for estimating fire behavior

Total fuel load, < 3-inch, dead and live, tons/acre	5.0
Dead fuel load, 1/4-inch, tons/acre	1.5
Live fuel load, foliage, tons/acre	0
Fuel bed depth, feet	0.2

Photo 22. Surface litter fuels in western hemlock stands of Oregon and Washington.



Photo 23. Understory of inland Douglas-fir has little fuel here to add to dead-down litter load.



Photo 24. Closed stand of birch-aspen with leaf litter compacted.



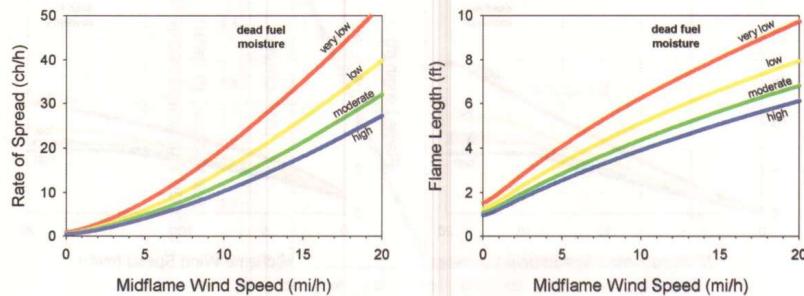
TL8 (188)

Long-Needle Litter



Description: The primary carrier of fire in TL8 is moderate load long-needle pine litter, may include small amount of herbaceous load. Spread rate is moderate; flame length low.

Fine fuel load (t/ac)	5.8
Characteristic SAV (ft-1)	1770
Packing ratio (dimensionless)	0.03969
Extinction moisture content (percent)	35



Appendix B

Inventory Summary

BioCruz Program 12/7/2020 10:22:48 AM
 BAF:10 Points Sampled:10 Avg # Trees/Plot:8
 Stand Name: Stand Name Species:All Species Living and Dead Trees
 Limit of error at 1 Standard Deviation= 12%

	DBH	10	20	30	40	50	60	70	TOTAL
Stems	2	0	0	0	0	0	0	0	0
CUVOL	2	0	0	0	0	0	0	0	0
SCRIB	2	0	0	0	0	0	0	0	0
Stems	4	0	0	0	0	0	0	0	0
CUVOL	4	0	0	0	0	0	0	0	0
SCRIB	4	0	0	0	0	0	0	0	0
Stems	6	0	0	0	0	0	0	0	0
CUVOL	6	0	0	0	0	0	0	0	0
SCRIB	6	0	0	0	0	0	0	0	0
Stems	8	0	0	6	0	8	0	0	14
CUVOL	8	0	0	27	0	62	0	0	88
SCRIB	8	0	0	46	0	118	0	0	164
Stems	10	0	0	0	7	13	8	0	27
CUVOL	10	0	0	0	68	173	125	0	366
SCRIB	10	0	0	0	183	565	440	0	1189
Stems	12	0	1	1	1	7	5	2	18
CUVOL	12	0	8	12	19	129	99	57	324
SCRIB	12	0	10	32	64	486	392	233	1217
Stems	14	0	0	1	3	3	9	2	17
CUVOL	14	0	0	13	50	61	250	58	432
SCRIB	14	0	0	44	186	244	1058	249	1782
Stems	16	0	0	0	1	4	0	1	5
CUVOL	16	0	0	0	16	104	0	29	148
SCRIB	16	0	0	0	67	439	0	128	633
Stems	18	0	0	0	0	2	2	2	5
CUVOL	18	0	0	0	0	65	78	87	230
SCRIB	18	0	0	0	0	291	356	404	1051
Stems	20	0	0	0	0	0	0	1	2
CUVOL	20	0	0	0	0	23	27	60	109
SCRIB	20	0	0	0	0	105	125	281	510
Stems	22	0	0	0	0	0	0	1	1
CUVOL	22	0	0	0	0	22	0	58	81
SCRIB	22	0	0	0	0	104	0	278	383
Stems	24	0	0	0	0	0	0	0	0
CUVOL	24	0	0	0	0	0	25	0	25
SCRIB	24	0	0	0	0	0	121	0	121
Stems	26	0	0	0	0	0	0	0	0
CUVOL	26	0	0	0	0	0	0	30	30
SCRIB	26	0	0	0	0	0	0	147	147
Stems	TOTAL	0	1	8	11	36	23	8	89
CUVOL	TOTAL	0	8	52	153	638	604	379	1834
SCRIB	TOTAL	0	10	122	499	2351	2493	1720	7196