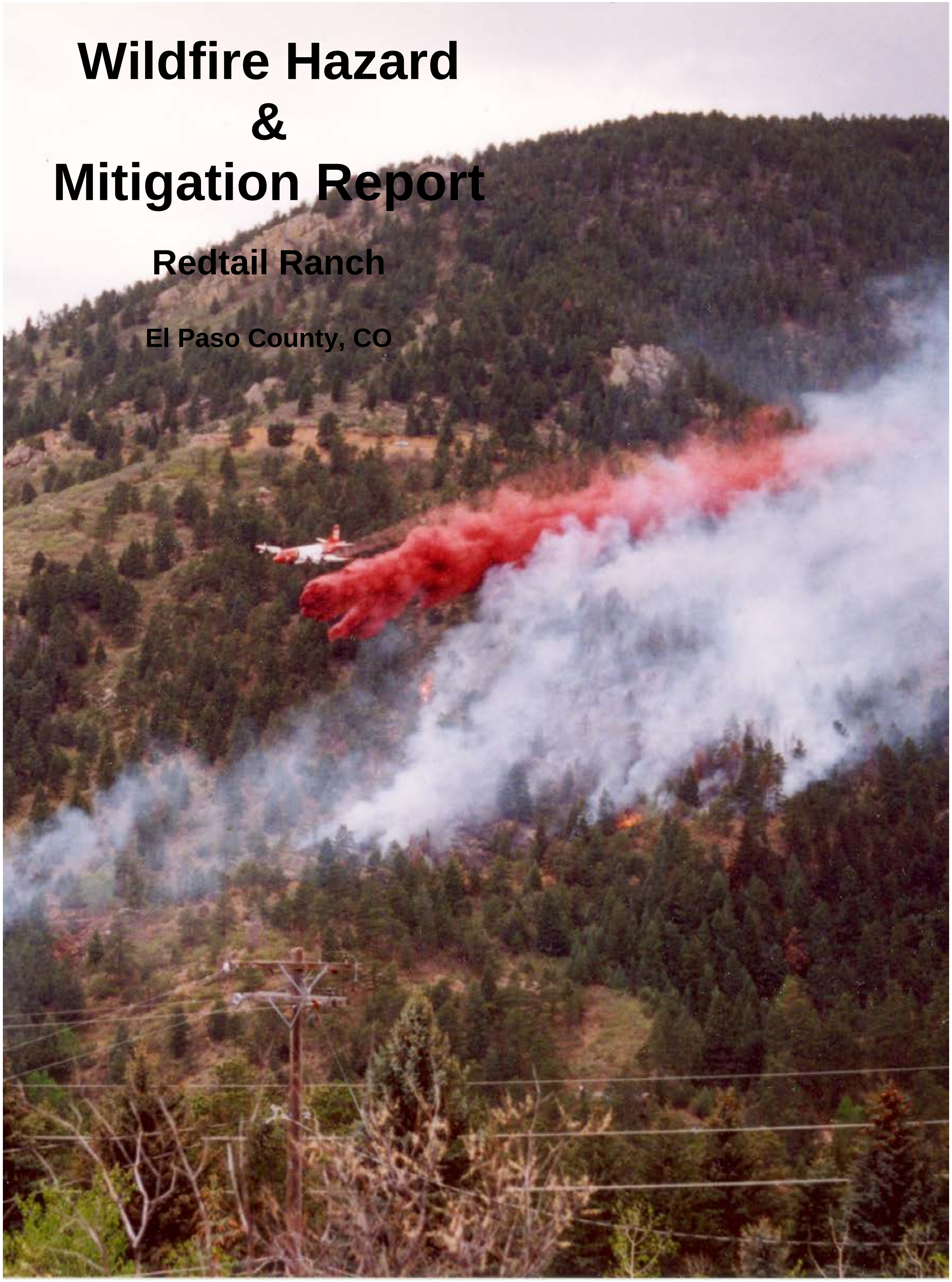
Wildfire Hazard & Mitigation Report

Redtail Ranch

El Paso County, CO



Wildfire Hazard Evaluation Report

For the

Redtail Ranch Subdivision

El Paso County, 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 Redtail Ranch subdivision in minimizing the dangers and impacts from wildfire hazards. Fire is a natural force and an historical part of the ponderosa pine 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 damages to structures and land uses even though properly permitted within designated wildfire hazard areas.

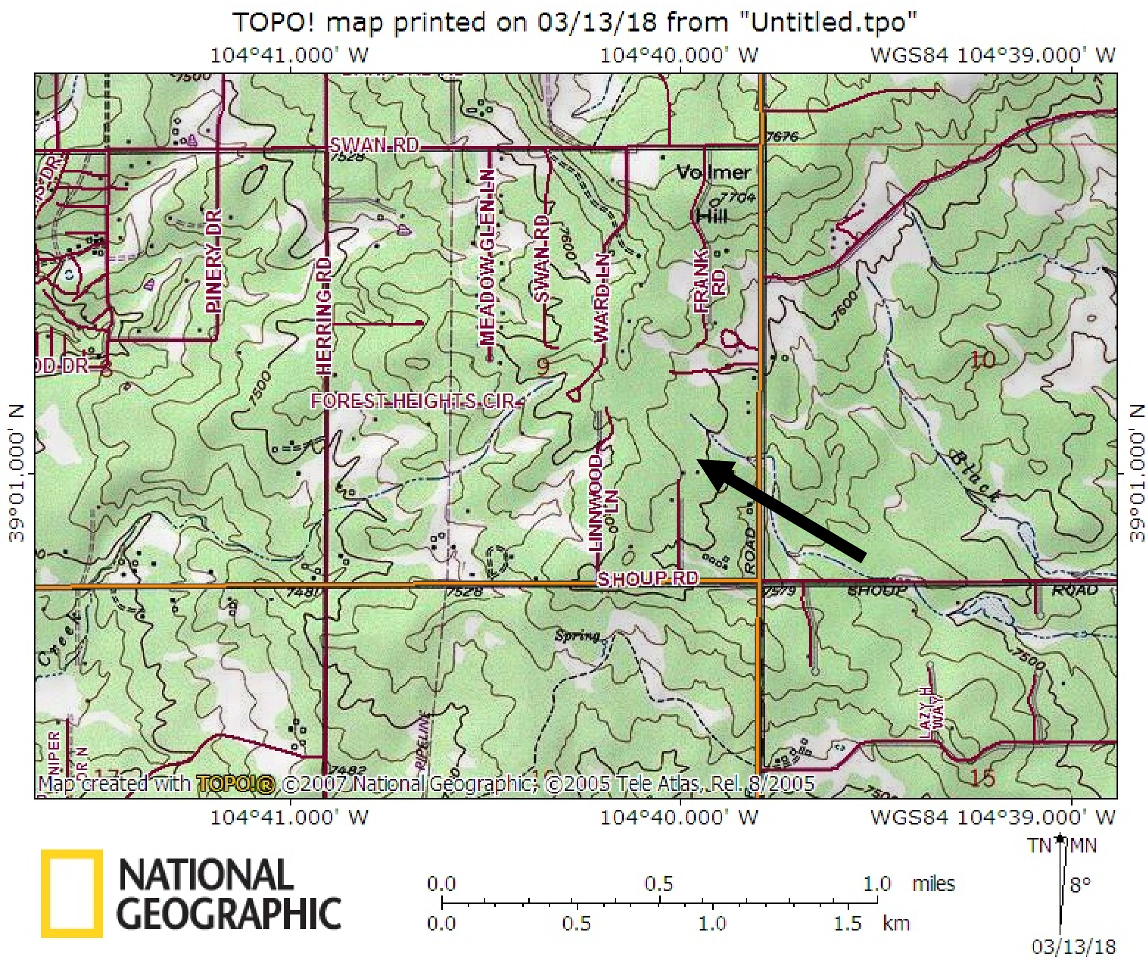
March 1, 2018

General Description

The Redtail Ranch is a private residential development planned for the Black Forest area in northern El Paso County, Colorado. The development plan proposes the subdivision of approximately 67.89 acres into 12 lots. The lots range in size from 5 up to 6.3 acres

The property is located along Vollmer Road, approximately 0.32 miles north of Shoup Road on unincorporated land (see Map 1 below). The parcels included under this report are listed with the following El Paso County Assessor's Schedule Numbers, 5209000128, 5209000129, 5209002006, and 5209002008.

Map 1. General Vicinity Map

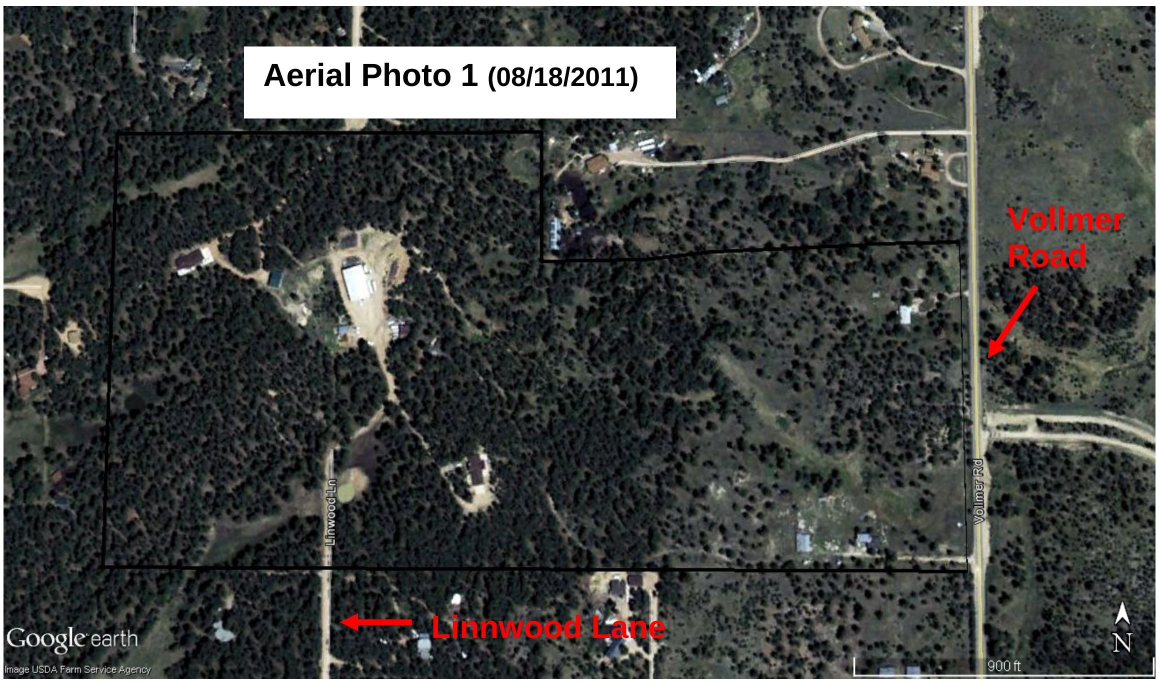


There is residential development surrounding the entire property. The Green Meadows subdivision is located to the northwest and Walker Estates to the northeast. The King subdivision lies to the southeast. In addition, there are unplatted properties as well.

The northern portion of El Paso County area does have a wildfire history. The Black Forest Fire burned in June of 2013. It would become the most destructive wildfire in Colorado's history. Over 14,000 acres were burned and upwards of 500 structures were destroyed.

The Milne fire, near Hanover, burned 3,275 acres of grassland. While this fire was not in the immediate vicinity of the proposed subdivision, it is applicable. This fire burned on February 27, 2017. This was the result of a prolonged period of dry and unseasonably warm weather with high and erratic winds during the fire. incident.

As can be seen in the Google earth aerial photo below, the western one-half of the property was considered to be heavily forested. The eastern one-half ranged from heavy to light but would have been considered as a fully stocked forest stand.

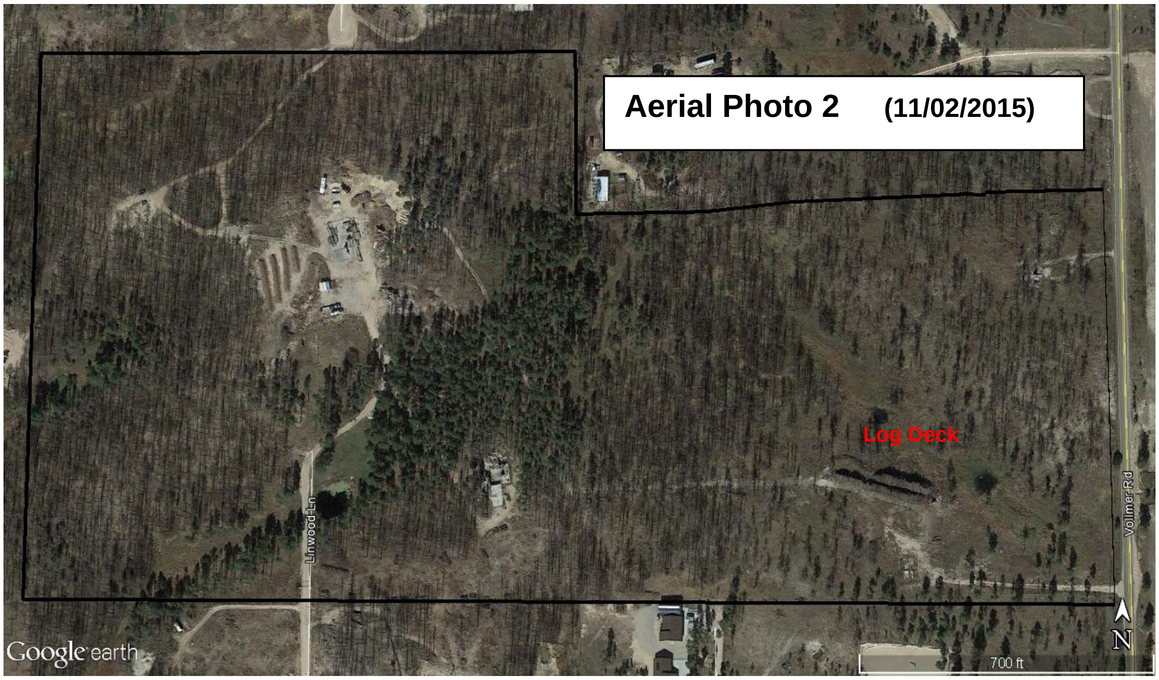


Based on the Wildfire Hazard Analysis Map (WHAM) from 1974, the property was rated as having a severe hazard for trees. There was also a low hazard rating for trees and grass on eastern portions of the property.

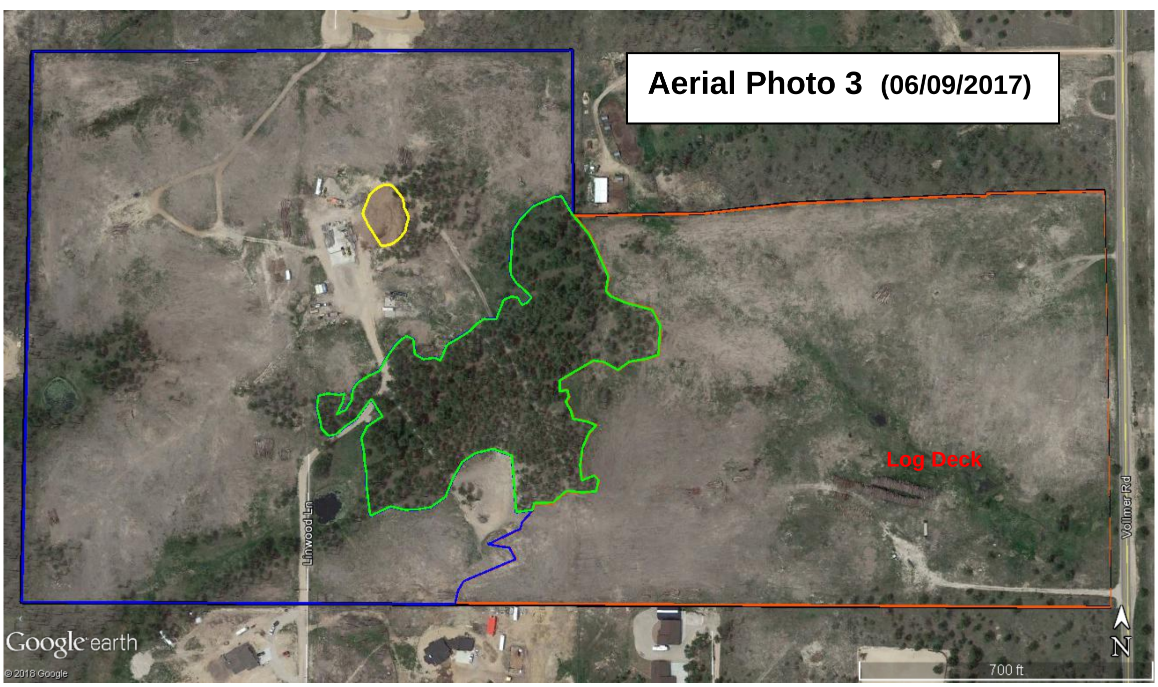
The property was subject to forest stand replacement from the Black Forest Fire. The next aerial photo (next page) depicts the property condition post wildfire.

This Google earth aerial photo was taken on November 2, 2015. It is readily evident that severe losses to both structures and the forest was experienced. It appears that the structures were subsequently lost to the wildfire as there is no evidence of their existence on the ground today.

Tree removal and salvage of the killed ponderosa pine appears to have only been active for a short period of time. Only two small areas had been treated by the time of the photo being taken.



The 'Log Deck' notation is placed to compare this photo with the next photo that represents the current condition.



The standing dead trees have now been completely cut down and the slash (dead limbs and tree tops) masticated. Structures that were destroyed or severely damaged by the wildfire have been removed and the debris disposed of.

Wildfire Hazard

While the property has been cleared of dead trees and the slash masticated or chipped, it might be assumed that a wildfire hazard no longer exists. That is not necessarily the case.

The Colorado Wildfire Risk Assessment Portal (CO-WRAP) was developed by the Colorado State Forest Service in 2012. The primary goal stated for this project is to "provide a consistent, comparable set of scientific results to be used as a foundation for wildfire mitigation and prevention planning…" This resulted in a web based mapping tool that provides wildfire risk assessment for Colorado. This tool was also used to assess the relative wildfire risk to the property.

Within the CO-WRAP mapping tool, wildfire risk represents "the possibility of loss or harm occurring from a wildfire." The wildfire risk for the subdivision is indicated as having a low to lowest risk.

The wildfire threat is defined as the likelihood of an acre burning. Within the CO-WRAP, the proposed development area is rated at the lowest wildfire threat level.

Based upon the fact that the Black Forest Fire burned through a similar fuel type in 2013, the wildfire threat analytic could be perceived as incorrect. In addition, the recent Milne fire (Feb. 27, 2018) burned rapidly in a low threat grass fuel model. This fire burned upwards of 5,000 acres on the southern plains of El Paso County. As there are currently a small number of residential structures present on adjacent properties, the risk of loss would appear to be relatively correct.

However, a disclaimer is provided as to the use of this tool. It is best used for broad landscape risk assessment and is not appropriate for site specific analysis such as the Redtail Ranch subdivision. So in order to properly assess the wildfire hazard of the property, a field inspection was undertaken. This was performed on March7th and 8th with forest inventory plots measured as part of the forest management plan requirement.

The majority of the subdivision is composed of grassland which includes 100 - 1,000 hour woody time lag fuel (masticated limbs, etc.). This woody fuel component is in contact or is pressed into the soils surface and is not readily available for rapid combustion. **So the overall wildfire hazard of this property should currently be considered as low.**

However, future atmospheric conditions, such as wet seasons, may support the growth of grasses and result in a wildfire hazard as was observed on the Carson Midway Fire on March 16, 2018. This fire consumed up to 3,300 acres in a short grass fuel bed.

Wildfire Behavior

This section discusses the role of the three major components that affect wildfire behavior; fuels, topography and weather. These three components will be examined in relation to the 'Redtail Ranch' development plan.

Fuels

The area was field inspected and the results of the WHAM and the CO-WRAP were modified 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 dead tree salvaged areas should now be considered grassland areas and are best described under Fuel Model 1 (see Appendix B). "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."

The western portion of the property can be further refined to GR 1 - Short, Sparse Dry Climate Grass (Dynamic) using the models developed by Scott & Burgan (2005). This fuel type encompasses approximately 55% of the total area or 28 acres. It is outlined in blue (see Aerial Photo 3, page 5).

This area has a west exposure which will reflect a hot and drier condition for grass growth. Visual inspection reveals isolated grass growth with a large wood chip surface layer. The fuel bed depth is only 2-4 inches (see Photo 1). The weeds in the foreground of the picture provide the tallest height of the fuel bed. The deeper brown hues are locations of grass growth and a relative absence of taller weeds delineated by the black arrow.

The wood chips are mixed in size and not very uniform. The depth of chips varies depending on the amount of slash that was masticated in any specific location. Generally, the chip depth is thicker near log decks.

Photo 1. This picture displays a view looking from the northwest corner of the property to the east along the northern fence line. Note the relative absence of surface fuels to carry a fire.

The eastern portion of the property (28 acres) can be refined from Fuel Model 1 to GR2, Low Load, Dry Climate Grass (see Photo 2). The difference between the two is an increase in the fine fuel load from 0.4 tons to 1.1 tons per acre and a decrease in the surface area volume. This area is outlined in orange (see Aerial Photo 3, page 5).

This can be seen in the influence of exposure on grass growth. While the same mix of fuel can be found on both slopes, the grasses tend to be taller in height (fuel bed depth) and have a larger presence across the landscape.

In addition, the small drainages are much more developed and appear to collect more precipitation. This can be observed in the number of small impoundments or ponds that hold water on this site. During the field inspection, water was present in the ponds. So eastern side of the property appears to have greater potential for grass growth in any given year.

The masticated woody debris is present but is not expected to contribute to the rate of spread of the burning flame front or the subsequent flame length.

Photo 2. This photo was taken from along the northern boundary on the eastern side of the property. Note the larger expanses of light brown colored grasses(arrow).

The risk, even though low, these two fuel models reflect should not be dismissed out of hand. As is being experienced right now in the late winter/early spring of 2018, wildfires do occur and can expand rapidly in these fuel models. The wildfire on Fort Carson that broke out on March 5th covered approximately 270 acres. The wildfire burned up to the footprint of the Navajo Village housing complex near Gate 5 and posed a significant threat of structure loss (see Photo 3).

An 1,800 acre wildfire broke out on March 9th on Fort Carson in similar fuel conditions. While this fire posed no threat to structures, it again points to the risk these two fuel types can pose under the proper burning conditions in spite of their low overall risk and the time of year.

So as is currently being experienced through out El Paso County, under severe weather conditions such as unseasonably high temperatures, low humidity combined with high winds, this fuel model can pose a significant hazard.

Photo 3. This photo was taken from Highway 115 looking down at the southern edge of the Navajo Village housing area. Note that the wildfire burned right up to the housing pad.

The final fuel model present is the forested area (6.3 acres) which can be considered as Fuel Model 9. This fuel model can be more closely defined as TL1, Low Load Compact Conifer Litter. This model can represent a recently burned forest, which is the case in this instance (see Photo 4). This area is outlined in green (see Aerial Photo 3, page 5).

While the fine fuel load rivals that of the Low Load Dry Climate Grass fuel model (1.0 - 1.10 tons/ac.), it has a much higher packing density which is essentially a compacted fuel bed. A compacted fuel bed is resistant to high rates of spread and long flame lengths. A fire in this fuel bed typically will smolder due to incomplete combustion and creep through the fuel bed which is the pine needles on the forest floor..

Photo 4. This picture depicts the compacted needle layer found on the surface of the forest fuel model. The Black Forest Fire consumed the larger surface fuels that may have been present but did not generate enough heat to consume the upper tree canopy.

One location of concern within the timber fuel model is a pile of chips from the milling operation. This area is approximately 0ne-quarter in size and is identified in yellow on Aerial Photo 3 (pg. 3).

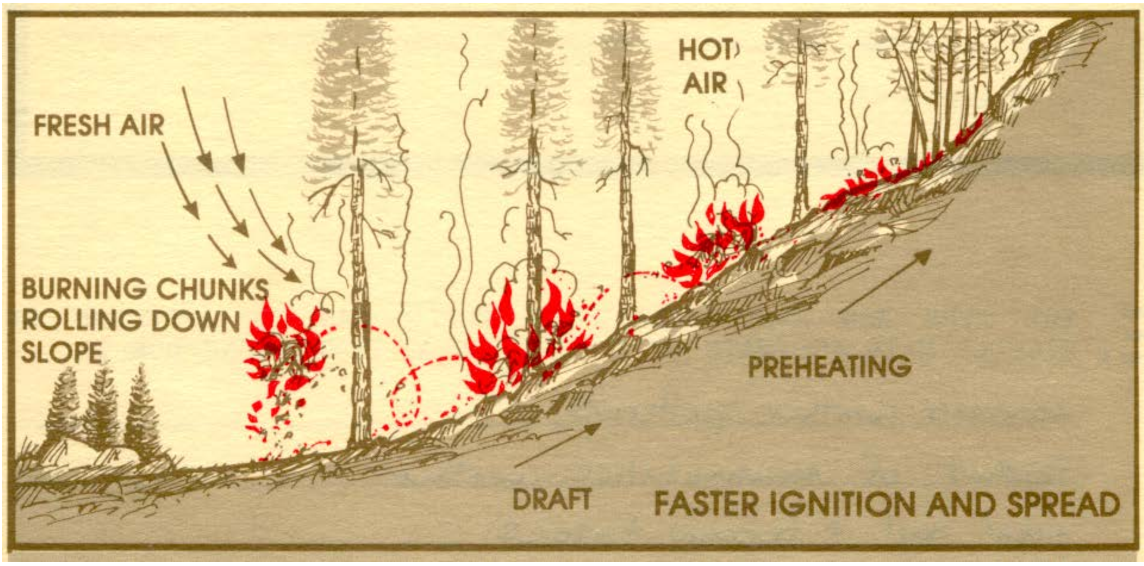
While this pile does not present a significant wildfire hazard, if the pile were to be exposed to combustion, it will be difficult to completely extinguish. This could result in a fire escaping from the chip pile area and spread to other locations.

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 influence 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



Graphic courtesy of the National Wildfire Coordinating Group

The topography of the property drains from the middle of the property to the east and to the west. The slope running from the southeast corner and up to the midline northwest corner of the east one-half of the property is 3%, a relatively flat position. The west one-half mimics the east at 3.6%.

Slopes exceeding 25% are considered extreme slopes in regard to their effect on wildfire behavior. The topography of the property should not unduly affect wildfire spread or intensity except on a very isolated basis.

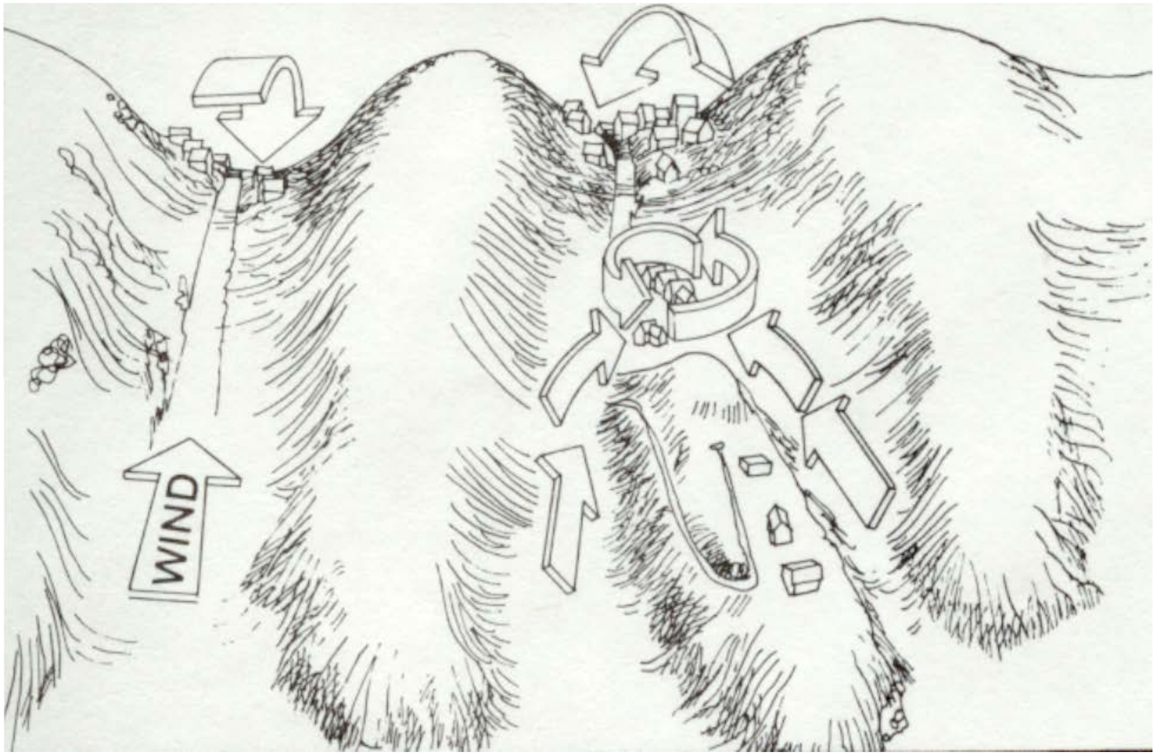
Weather

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 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 1,000-hour time lag fuels. This fuel requires a long period of time 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 spotting of the fire by embers transported by winds ahead of the fire's main flame front.

Figure 2. Drainages Tend to Draw in Fire



Graphic Courtesy of Colorado Springs Fire Department

There is a wide but long intermittent creek drainage within the proposed subdivision that may influence winds during a wildfire (see Figure 2 above). It runs from the southeast corner diagonally towards the mid northwest corner This could increase fire behavior on a localized basis if a sufficient fuel load is present and available to burn but it should not influence fire spread over a large portion of the property or outside of the property.

The threat most concerning is the one posed by high winds. While winter winds from the west are always a seasonal concern, hot dry summer winds flowing in from the south should not be discounted. While grasses that pose a low hazard in the spring during green-up, can become highly flammable only after a few days of exposure. These summer winds will eddy up the elevation gradient that leads to the Black Forest itself and may push a wildfire north and west.

Several common weather factors link three recent large wildfire events in the Pikes Peak region, the Hayman Fire in 2002, Waldo Canyon Fire in 2012 and the Black Forest Fire (2013). The presence of low humidity (4%), high day time temperatures (90^{o} F) and high wind speeds (20-25 mph.) with gusting conditions (30-40 mph.).

While these three weather factors were present over a very short time prior and during the Black Forest Fire, a single ignition at the right moment, can lead to catastrophic loss.

Finally, in the event of extreme fire behavior, the fire itself will exercise some degree of influence on its own environment.

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

Predicted Fire Behavior

Using the BehavePlus5 fire modeling system, the following predictions can be made for the grass land (1, GR4) fuel model. As grassland represents the majority of the subdivision, it would be the most expected fuel consumed during a wildfire. The inputs are based upon a 95-degree temperature day with a relative humidity of 4% with little cloud cover at 2:00 p.m. in the month of June. These are similar weather conditions that existed during the Black Forest Fire.

The prediction was based on using two different live fuel moistures. As this is a grass fuel, the moisture of the grass is a major factor in determining wildfire spread. At a moisture content of 15%, the spread of a wildfire will not be supported. In addition, as the future use of the grasslands will become residential development, it is reasonable to assume that the grass will have varying degrees of irrigation.

Under a scenario of the live fuel or green grass having a 200% moisture level which is almost mature and the fine fuels (1 hour time lag) at 1%, a wildfire could be projected to spread at a rate of 19.8 feet per minute. The flame length would be about three inches high. This fire should be readily suppressed by direct attack from responding units.

Under a different scenario, where the live fuels have a moisture content of just 30%, which is completely cured, a substantially different outcome occurs. A wildfire would spread at a rate of around 2,700 feet per minute. Flame lengths would reach upwards of 3 to 4 feet. These conditions will prevent a wildfire from being readily controlled. This model assumed a wind speed of 5 miles per hour. This type of wildfire behavior is what is probably being experienced at present in El Paso County.

For this fuel model to reach a high rate of spread, the live fine fuels need to be cured or dead. The relative humidity needs to be low and the temperature high.

Note that this model assumes an untreated grass fuel condition. If the grass is irrigated or even mowed to a lower height, it can be reasonably expected to reduce the availability of this fuel type to burn

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 or realized by the public. As noted earlier, the late winter of 2018 has seen multiple grass fire incidents with red flag warnings posted for areas east of the foothills and extending out into the plains.

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 near Monument, suppression forces arrived 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. For example, even with extensive mitigation in the Cathedral Pines subdivision, a residential structure was still lost in the Black Forest Fire. As previous local wildfire incidents have demonstrated, this loss can occur very quickly with little or no advanced warning.

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.

One technique in reducing the readily ignitable fuel level would be to remove fuels, such as dead leaves, fallen limbs and other small organic debris, from the site. However, it is not reasonable nor practical to remove these types of fuels from the entire property.

Based upon the burn evidence from the Black Forest Fire, within the timber fuel model, any existing fine ground fuels that are compacted should remain in place. Whenever possible these fuels should not be raked up or disposed of. The removal may allow the establishment of grasses or woody shrubs, which pose a higher wildfire risk. Retention of the compacted needle/litter layer prevents this from occurring.

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. For example, a landscape crew cutting plastic weed barrier fabric ignited a grass fire during windy weather conditions in November 2001. This fire spread through open space in the Jackson Creek development and reached approximately 80 acres in size before the spread was halted by Baptist Road in northern El Paso County.

It is suggested here that the reduction of the most ignitable fuel be performed 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 immediate proximity to the structure. It will also retard the spread of a fire off the site and provide suppression forces additional time to contain a fire quickly. This will probably be accomplished when the building footprint is developed.

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 will be unique for each lot that is developed and the subsequent position of the residential structure, it will be difficult to make specific recommendations here. However, it is recommended that each lot be treated prior to completion of the structure.

Specific information on the development of wildfire safety zones are available through the CSU Cooperative Extension Service in the Quick Guide Series Fire 2012-1, *Protecting Your Home from Wildfire: Creating Wildfire-Defensible Zones*. The web page is linked here at Creating Fire Safe Zones.

- **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 grass and timber fuel models are continuous. Obviously, the pasture/grasslands contain an unbroken line of fuel reaching from tree line to the east to Vollmer Road. On the west, the grass fuel bed is continuous from adjacent properties upslope to the tree line.

The proposed roads within the subdivision will interrupt the continuity of the fuels. These roads may be sufficient to act as a fuelbreak and retard a fire’s spread.

• **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 any of the fuel models to burn should be considered a year-round hazard and not limited to the summer months.

Recent weather patterns have contributed to a 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 the current 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 burning 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 seems to infer 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.

Roads and Driveways

Roads and driveways to individual lots should be constructed in accordance with NFPA 1141, *Fire Protection for Planned Building Groups*. Specifically, road widths should not be less than twenty-four feet to allow for simultaneous access of emergency equipment and evacuation of residents. If parking is to be allowed along the constructed roadway at least nine feet of improved width should be included.

Additional space along the roadways is important for on-street parking. There will be times when contractors, landscape companies and visitors along the roads may reduce the passable width of a road from on-street parking. This may result in a road being reduced to a single car width. Such conditions may increase the response time of emergency agencies. It is recommended here that the subdivision advise residents to encourage on-street parking users to keep their vehicles along one side of a road and discourage parking use on both sides of a road where it may reduce the passable road width.

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%. The entrance to any driveway from public roads should not exceed a ninety-degree angle. A turnaround should be provided at all structure sites on driveways over three hundred feet in length. These turnarounds should be within fifty feet of any structure.

Dead end roads should not exceed 600 feet in length when the area is classified as having an extreme wildfire hazard. All dead-end roads should have a turnaround at the closed end (cul-de-sac) of at least 100 feet in diameter. Under the current design plan, all the proposed roads are located in the grassland area which exhibits a low wildfire hazard which does not subject them to a maximum length.

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 so they are 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. **For this subdivision, 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 the majority of lots built on may have some level of irrigated greenbelt. Irrigated lawns around a structure are very effective fuel breaks and serve as defensible space in the event of a wildfire.

If a native landscape is preferred, the use of periodic irrigation helps 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.

If retaining a native landscape, particularly in the grassland, periodic mowing of native grasses will reduce the wildfire hazard and any subsequent spread.

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. Based upon the fire scarring of tree trunks from the Black Forest Fire, this should prevent flame lengths from reaching the building and causing an ignition.

There are many different sizes and types of rock available. Larger sized rock mulches can trap blowing litter providing an avenue for fire to contact a structure. It would be necessary to remove leaves, needles, and other combustible litter from a rock fuel break on an annual basis. Otherwise the protection initially provided by this technique may be lost.

Within the forested areas, the compressed needle layer should not be disturbed if possible. In its current state, the litter layer will not actively burn. If it is removed and exposes mineral soil, it may provide suitable conditions for grass and weed growth. When this type of vegetation dries, it will become a higher risk to actively burning during a wildfire incident.

Construction Considerations

As the fuels in this subdivision are trees and grasses, 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 the accumulation of needles 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 sofits. 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 sofit 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 is exhibited upon initial installation.

Combustible roofs become at risk due to the expected aerial firebrands that will be created as wildfire moves through the proposed development. The lodging of brands in combustible roof materials allows entrance for a wildfire into a structure. In this author's experience of fighting wildfire, it is difficult to defend a combustible roof.

Non-combustible roof materials should be used in the construction of all structures on this site.

An additional consideration is the construction of the roof itself. Whenever possible, complex roof designs should be avoided. Flammable material,

such as pine needles, may accumulate to the roof to wall edges such as a dormer or chimney. This leaves what may be a non-combustible roof vulnerable to ignition. Non-combustible materials such as metal flashing should be used at the intersections between horizontal and vertical surfaces if some exposed component would be considered combustible. Roof vents should have mesh screens installed to reduce the risk of embers entering the attic area.

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. Where the wildfire risk is low, the primary fuel involved will be grass on relatively flat slopes. A wildfire in these areas can be high in intensity but typically have a low duration. In other words, grass fires burn hot and fast. Therefore, there may not be enough heat buildup to ignite combustible siding materials. In these locations the use of non-combustible siding may not significantly reduce the risk to wildfire, particularly where a stone border is placed around the foundation.

Where a higher wildfire risk is found, such as in the ponderosa pine forest, the opposite can be true. During periods of drought, ponderosa pine needles develop an extra waxy layer of cuticle over the needles to retard moisture loss from the tree. The needles will become a hotter fuel when ignited. Depending on the proximity of trees, such as young reproduction or landscape planted pines, this additional fuel availability may be sufficient to ignite combustible siding materials.

Water Supply

At present, 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. It is assumed , the subdivision will be supplied with water by the existing wells on the property in the future

Currently, the Black Forest Fire/Rescue Fire Protection District has the following resources:

1 – Type 1 Engines: 500 gallons' total
4 – Type 3 Engines: 1,750 gallons' total
3 – Water Haulers - 6,000 gallons' total

There are two full-time staff members at Station 1 whose primary responsibility is medical emergencies. The primary resource for fire suppression is volunteer firefighters and has a wide range of response time and availability.

These resources are available for dispatch at the Station 1 located at Teachout Road and Burgess Road, approximately 3.1 miles from the subdivision. Station 2 is located on Hodgen Road between Black Forest Road and Herring Road (5.4 miles away) and is staffed by part-time employees. Based upon the apparatus resources available, there should be a sufficient water supply for any initial attack response on the proposed subdivision.

In the event of an extended suppression event, mutual-aid resources are quickly available from the Falcon Fire Protection District. The main station is located 12 miles from the subdivision.

The Black Forest Fire Protection District should be consulted with on any specific requirements of NFPA Standard 1142, 'Water Supplies for Suburban and Rural Fire Fighting' that may not be addressed here.

Home Owners Association

The Home Owner's Association (HOA) will be responsible for some or all of the implementation and annual inspection of the wildfire mitigation activity, particularly in regard to fuel availability. Specific activities should be developed through a Community Wildfire Protection (CWPP). This effort is supported through National Fire Protection Association (NFPA) through its Firewise Communities and Fire Adapted Communities Programs. Additional information can be obtained at the website through the link.

It is suggested here, at a minimum, that the HOA schedule cleanup days in the spring and in the fall. This will allow an opportunity for the community to work together to improve and maintain their wildfire safety. The Association should budget for the removal and disposal of the material that is collected.

In the event of a wildfire incident, evacuation becomes a major factor in the response efficiency of the fire suppression forces. Once the construction of residences within the development occurs, an evacuation plan should be developed in cooperation with the local fire protection district. This plan should result in the appropriate evacuation routes being designated and signage placed along those routes.

The HOA, at the very minimum, should develop an educational plan to help keep the threat from wildfire foremost in the community's mind. This may include articles in the HOA newsletter, presentations at meetings and even posting the wildfire hazard at the entrances to the Redtail Ranch community.

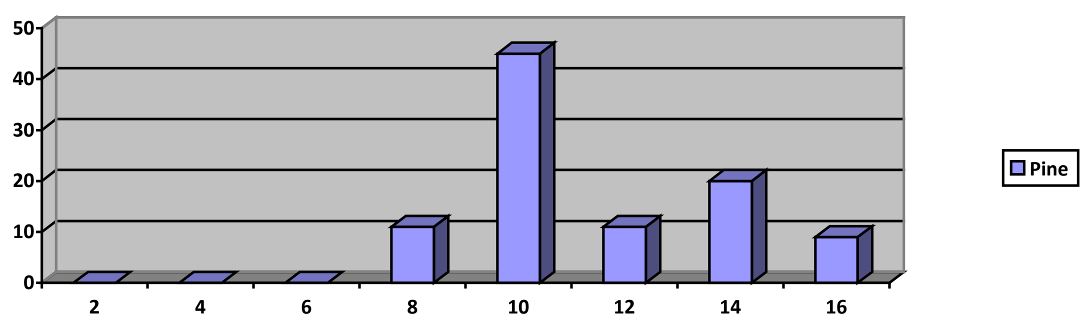
Forest Management

As part of the wildfire hazard evaluation, a forest inventory was performed, the results of which are included here. The intent of the inventory is to provide a current assessment of the forest resource and to provide activities that can be taken to ensure that health into the future. These activities will also maintain or reduce the low wildfire hazard that exists.

The residual forest is just over six (6) acres in size and lies approximately in the center of the property. Due to its small size and the subsequent removal of damaged and dead trees from the Black Forest Fire, no immediate treatments are required at this time.

The current forest is composed of ponderosa pine having an average diameter of 12.8 inches. The average height is 50 feet and the average number of trees per acre is 96.

The following chart depicts the range of diameters of trees tallied during the inventory and the respective number of trees within each diameter class.



From a forest health standpoint, particularly regarding susceptibility to Mountain Pine Beetle infestation, the remaining forest stand population is at an acceptable level. No further attention or treatments are required.

In the long term, individual trees may perish for a multitude of reasons. Any dead trees should be removed as they occur. Where possible, the stand should be allowed to remain undisturbed to promote establishment of trees from seed.

Finally, the ponderosa pine in the south west corner of property along Vollmer Road are infected with dwarf mistletoe. Dwarf mistletoe is a parasitic plant, commonly found within the Black Forest. As there are only a few scattered trees in this location, they should be cut down and removed. This will eliminate the threat of mistletoe infection on the property for the future.

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."

Fuel Model GR2 & TL1 Summary Pages

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, ¼-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.

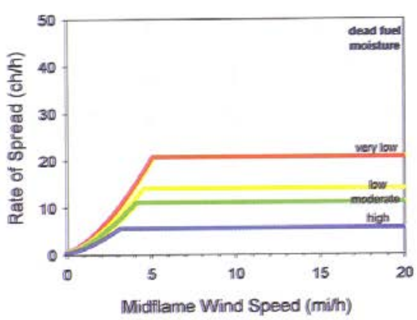
Photo 3: Open pine—grasslands on the Lewis and Clark National Forest

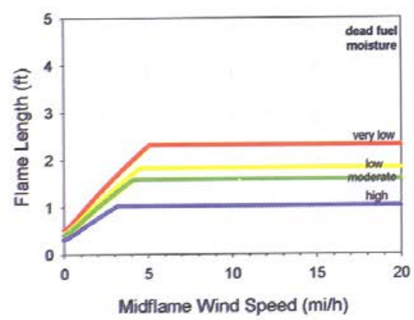
GR1 (101)

Short, Sparse Dry Climate Grass (Dynamic)

Description: The primary carrier of fire in GR1 is sparse grass, though small amounts of fine dead fuel may be present. The grass in GR1 is generally short, either naturally or by grazing, and may be sparse or discontinuous. The moisture of extinction of GR1 is indicative of a dry climate fuelbed, but GR1 may also be applied in high-extinction moisture fuelbeds because in both cases predicted spread rate and flame length are low compared to other GR models.

Fine fuel load (t/ac)	0.40
Characteristic SAV (ft-1)	2054
Packing ratio (dimensionless)	0.00143
Extinction moisture content (percent)	15



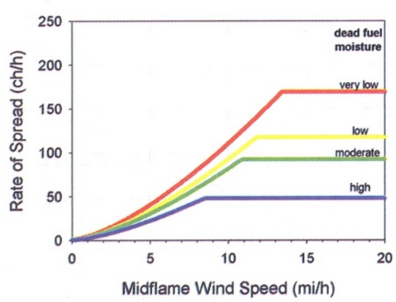


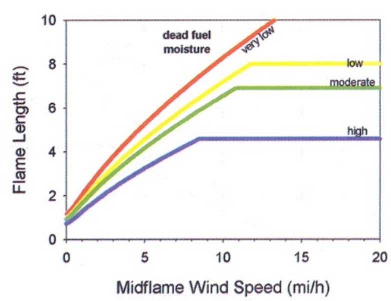
GR2 (102)

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, ¼-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.

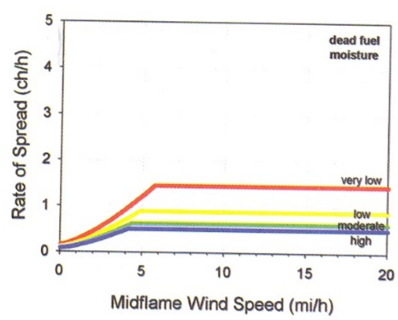
Photo 24. Closed stand of birch-aspen with leaf litter compacted.

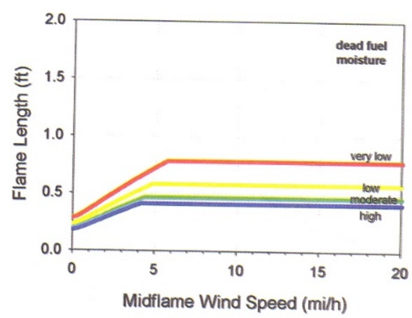
TL1 (181)

Low Load Compact Conifer Litter

Description: The primary carrier of fire in TL1 is compact forest litter. Light to moderate load, fuels 1 to 2 inches deep. May be used to represent a recently burned forest. Spread rate is very low; flame length very low.

Fine fuel load (t/ac)	1.0
Characteristic SAV (ft-1)	1716
Packing ratio (dimensionless)	0.04878
Extinction moisture content (percent)	30





Appendix B

Biocruz Inventory Results

BioCruz Program 3/19/2018 11:10:16 AM
BAF:10 Points Sampled:4 Avg # Trees/Plot:8
Stand Name: Redtail - Stand Total Species:All Species Living and Dead Trees
Limit of error at 1 Standard Deviation= 8%

	DBH	10	20	30	40	50	60	70	TOTAL
Stems	8	0	0	0	6	6	0	0	11
CUVOL	8	0	0	0	41	52	0	0	93
SCRIB	8	0	0	0	72	124	0	0	196
Stems	10	0	0	0	18	20	8	0	45
CUVOL	10	0	0	0	166	259	124	0	549
SCRIB	10	0	0	0	412	832	446	0	1691
Stems	12	0	0	0	3	8	0	0	11
CUVOL	12	0	0	0	41	155	0	0	197
SCRIB	12	0	0	0	133	590	0	0	723
Stems	14	0	0	0	5	9	4	2	20
CUVOL	14	0	0	0	83	207	124	73	487
SCRIB	14	0	0	0	307	839	532	319	1996
Stems	16	0	0	0	2	2	5	0	9
CUVOL	16	0	0	0	41	52	186	0	280
SCRIB	16	0	0	0	167	224	816	0	1207
Stems	TOTAL	0	0	0	33	44	17	2	96
CUVOL	TOTAL	0	0	0	373	725	435	73	1606
SCRIB	TOTAL	0	0	0	1090	2610	1794	319	5813