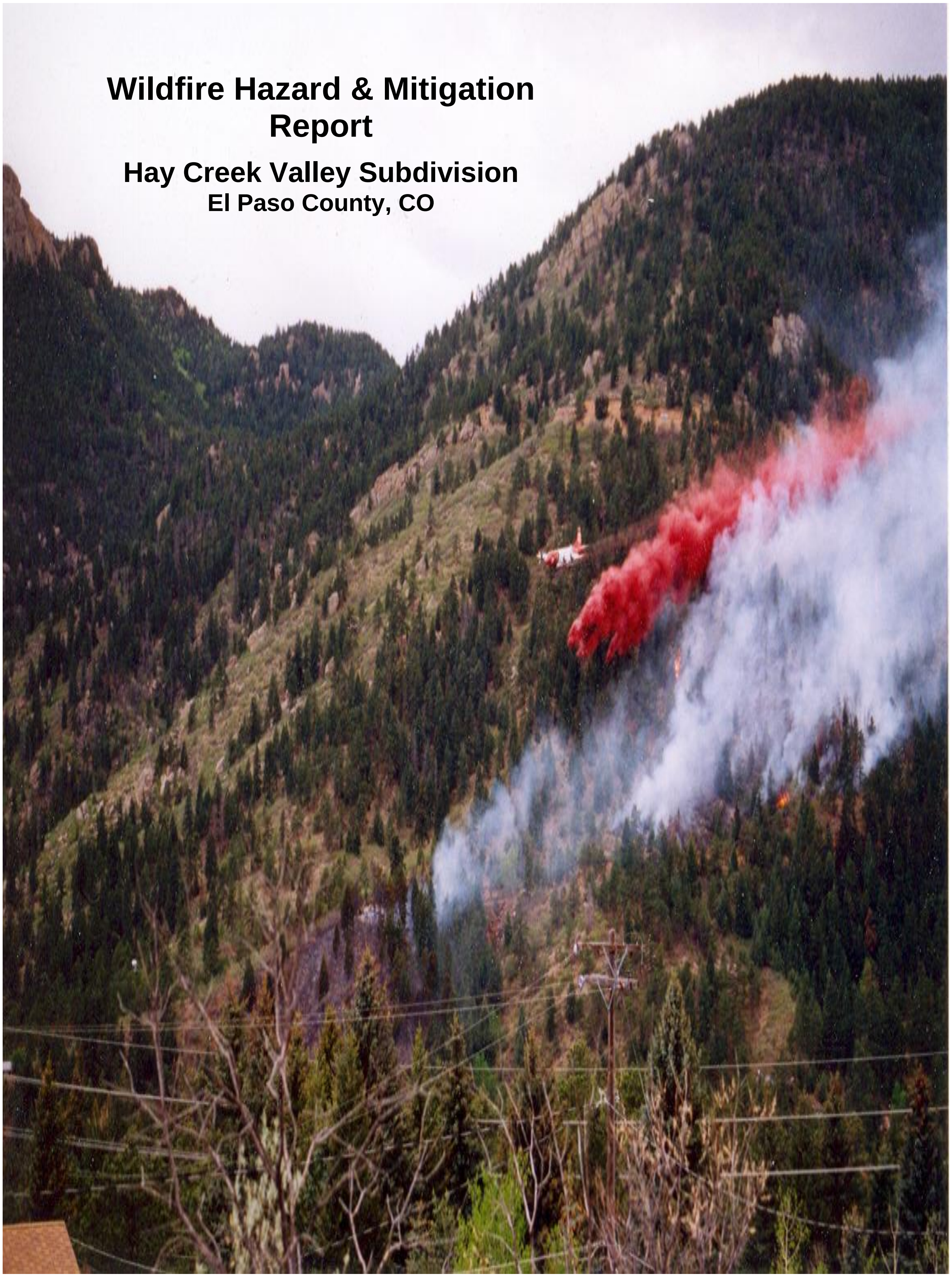
Wildfire Hazard & Mitigation Report

Hay Creek Valley Subdivision

El Paso County, CO



Wildfire Hazard Evaluation Report

For the

Hay Creek Valley
Subdivision

El Paso County, CO

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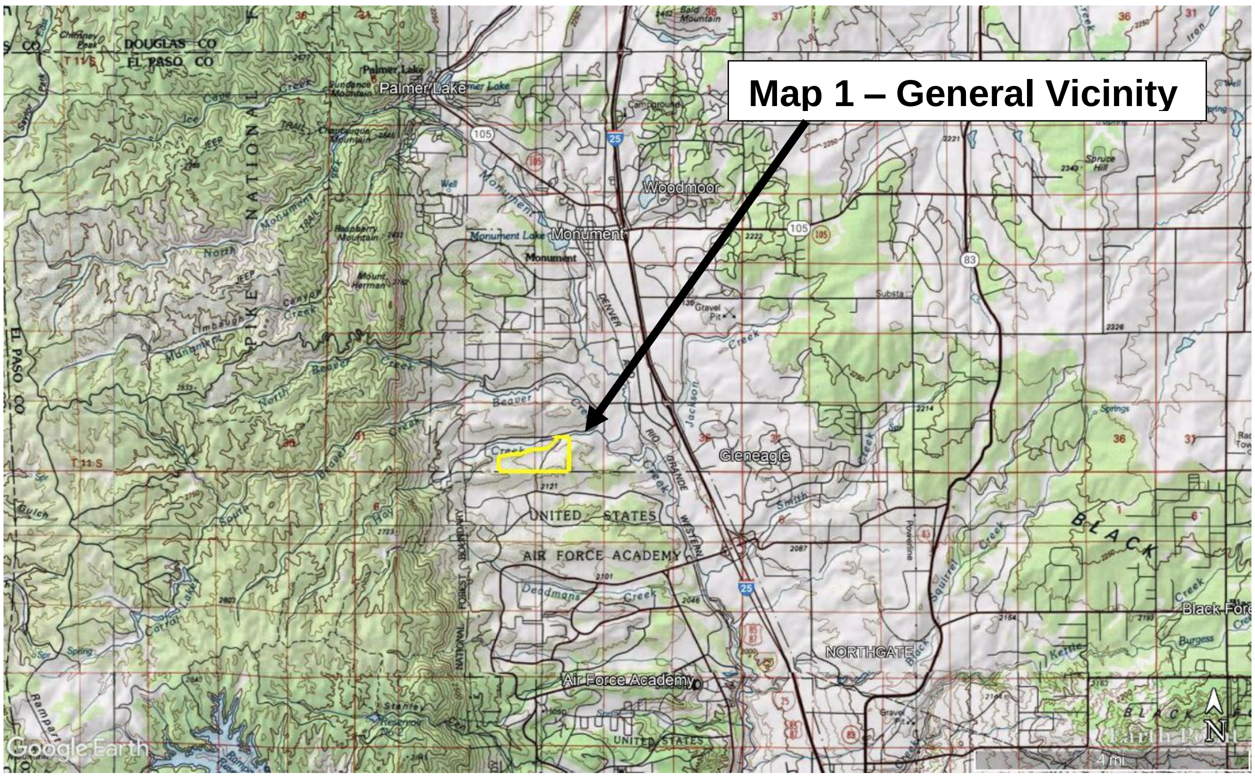
Warning and Disclaimer: The degree of protection from wildfire hazards intended to be provided by this plan is considered reasonable for planning purposes. It is based on accepted forestry and fire science methodology. This plan is intended to aid the Hay Creek Valley subdivision in minimizing the dangers 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.

September 22, 2022

General Description

The Hay Creek Valley subdivision is a private residential development planned for the Monument area in unincorporated northern El Paso County, Colorado. The development plan proposes the subdivision of approximately 213.41 acres into 20 parcels. The proposed parcels range in size from 5.5 acres up to 13.3 acres

The property is located south of Haycreek Road. The parcels included under this report are identified with the El Paso County Assessor's Schedule Numbers as 7100000267 thru 7100000270, 7133000001 and 7133007014.



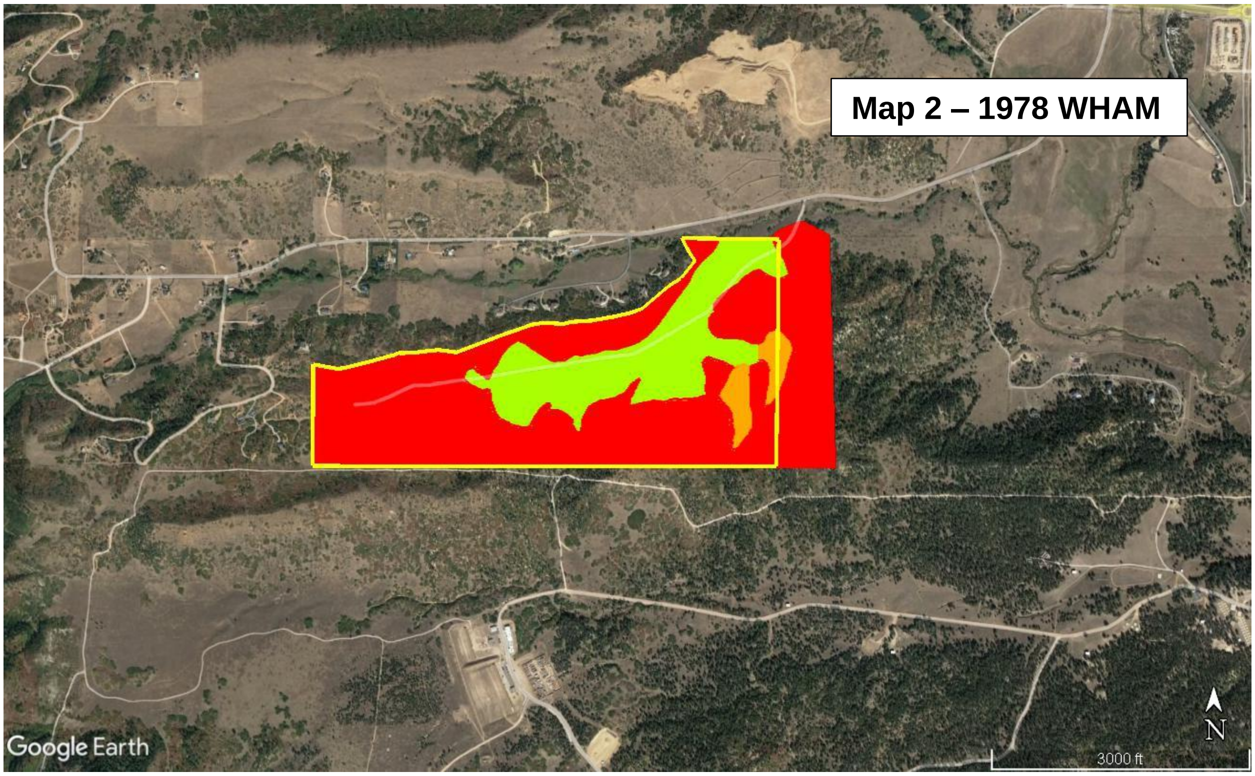
The United States Air Force Academy borders the property on the south. The Green Mountain Ranch Estates lies to the west. On the east, the property is bordered by the Dellacroce Ranch, LLC. The north boundary is bordered by several platted private properties.

The northern portion of El Paso County area does have a wildfire history. Most notably, the Black Forest Fire burned in June of 2013. It was the most destructive fire in Colorado history until the Marshall Fire in Boulder County in 2021. Over 14,000 acres burned, and 509 structures were destroyed.

Prior to the Black Forest Fire, in 1989, a wildfire ignited below Mount Herman which was referred to as the Berry Fire. On April 14, 2022, a small fire was suppressed in the same vicinity. Ignitions have repeatedly occurred in the area, with this past spring seeing several fires occurring along Interstate 25.

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 the Hay Creek Valley subdivision contains a severe hazard for brush (see Map 2).



Legend: Green = Low Hazard (Trees/Grass) Orange = High Hazard (Trees) Red = Severe Hazard (Brush)

Since the publication of this hazard map series, 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 recently updated to include events up to 2017. A copy is attached to this report.

Within the assessment report, the Wildfire Risk to the property is classified as high. Wildfire risk is a composite rating which identifies the probability of loss or harm from a wildfire. Risk identifies the greatest impacts from a wildfire to a range of assets, such as the level of Wildland Urban Interface. Wildfire Risk is determined uniformly across the entire state.

The Burn Probability is the annual probability of any location becoming subjected to a wildfire event. The assessment gives the proposed development a moderately high to high ranking in this regard. This is not unexpected due to the number of ignitions locally on private and Federal lands with the Waldo Canyon Fire of 2012 and the Marshall fire in 2021 weighing heavily on recent memory.

One distinction that can be drawn from the assessment is the selection of the fuel models used in determining the wildfire hazard. The WHAM (Map 2) uses a simplistic approach and delineates between grass, shrub and tree fuel beds.

The CO-WRAP assessment uses a detailed and distinct series of fuel models. This is a more dynamic approach, but it does not delineate between smaller fuel beds but considers them uniform across large areas. So even though there may be clusters of shrubs or grasses present, a refined timber fuel model is described incorporating these variations.

A preliminary field inspection was performed on June 14, 2022, to determine if any change should be made to the original wildfire hazard area map conclusions or the CO-WRAP assessment. Based upon the field inspection, **the wildfire risk was confirmed as high in the shrub and forested areas and moderate in the meadow area**.

There appears no forest management activity has been performed. A concern is what appears to be the invasion of Gambel oak in the understory of the ponderosa pine. This will provide a ladder fuel for a wildfire to leave the ground and ignite the forest canopy.

Photo 1. View of Gambel oak understory growing under the ponderosa pine forest.

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 Hay Creek Valley' development plan.

Fuels

The area was field checked, and the results of the WHAM and COWRAP Assessment 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 Gambel oak stands can be described under Fuel Model 6, "Fires carry through the shrub layer where the foliage is more flammable…but this requires moderate winds greater than 8 mi/hr. Fire will drop to the ground at low speeds or at openings in the stand." This can be seen on the eastern extent of the slopes, particularly on the north where bare mineral soil separates clumps of oak (see Photo 2).

These oak stands can be narrowed further under GS2, Moderate Load, Dry Climate Grass-Shrub. This fuel loads represents approximately 140 acres or over 65% of the property. This is found uphill of the meadow on the north and south facing slopes.
The amount of oak thins as the slope reaches the top of the ridges. Mountain mahogany and low growing current become the primary shrub species.

The ponderosa pine forest can best be described under Fuel Model 9 (see Appendix A). "Fires run through the surface litter faster than Model 8and have longer flame height. Concentrations of dead-down woody material will contribute to possible torching out of trees, spotting or crowning." Dried or frost killed leaves still attached to the Gambel oak in the understory could support this type of wildfire behavior as well.

Fuel Model 9 can be further refined to TL8, Long-Needle Litter (see Appendix A). This fuel model was developed by Scott & Brogan in 2005. The primary carrier of a fire is moderate forest litter with a low shrub understory. This fuel type encompasses over 13% of the total area. This is in the southeast portion of the property.

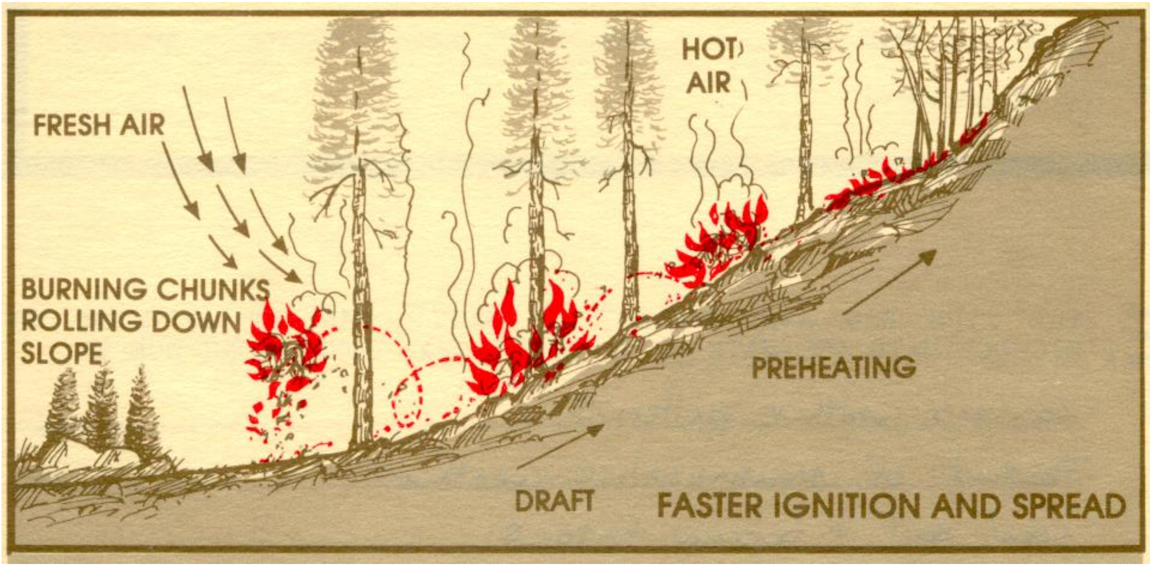

Photo 2. This depicts the opening in the Gambel oak. In the eastern extent of the oak stand, gaps of bare mineral soil are exposed (red arrows).

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.

In this instance, one of the most important attributes of topography is the percent of slope on which the development is proposed. 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 slopes is steep over relatively short distances. The slopes range in steepness from 20-25%. Slopes more than 25% are considered extreme slopes in their effect on wildfire behavior (see Map 3).

Conversely, the slope profile within the meadow or grassland is around 4-5%.

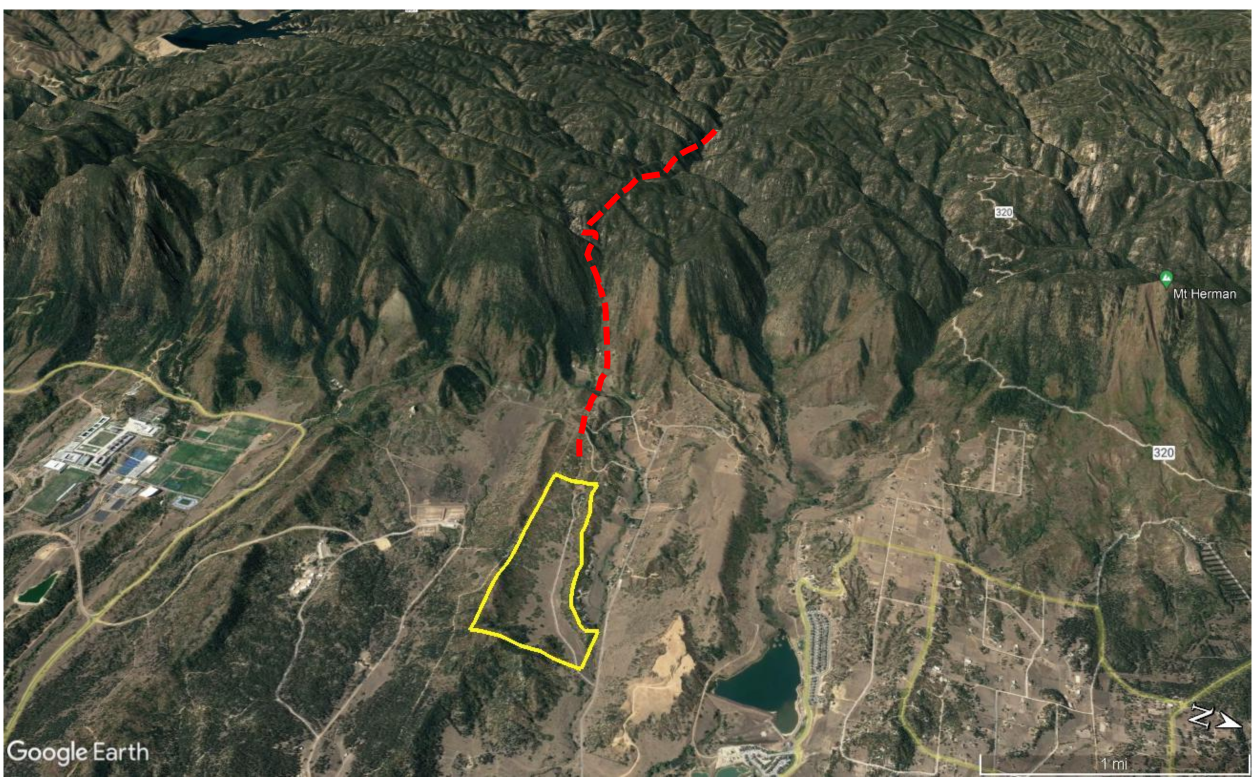
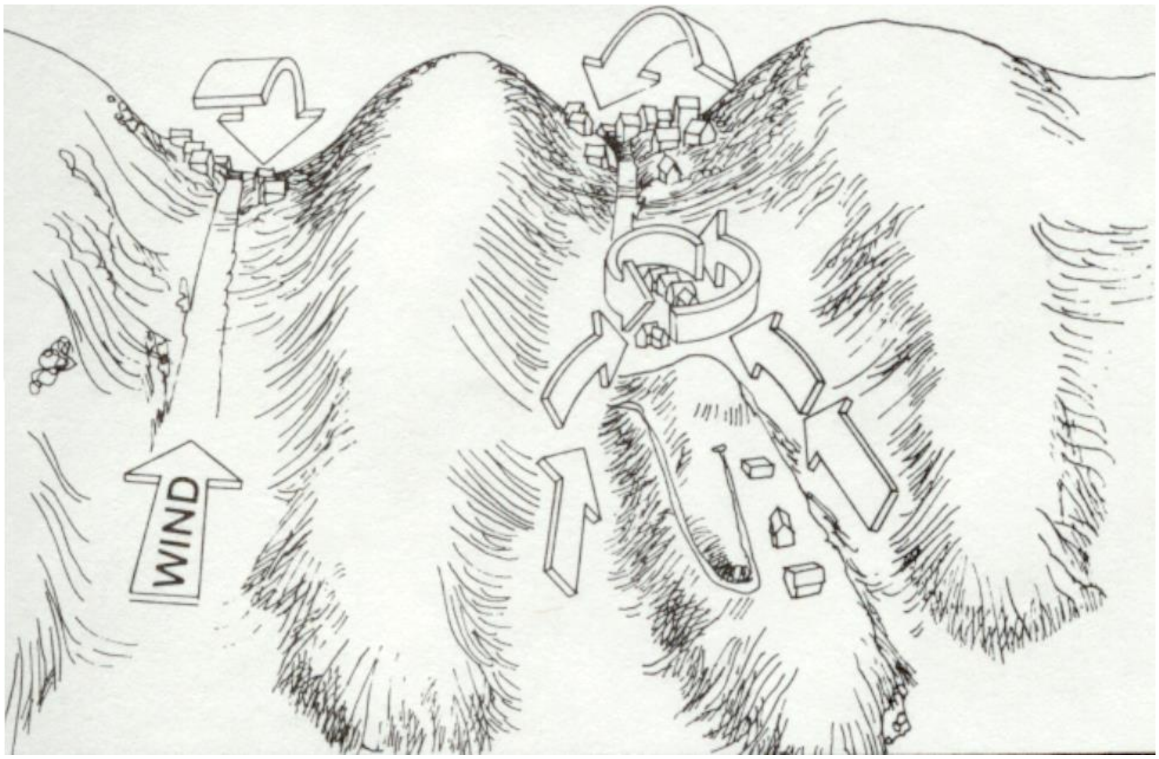


Photo 3. Mountainous Topography off the site of the property may accelerate wind speeds downhill towards and across the meadow (red line).

Figure 2 depicts the effect the drainages or box canyons have on a fire. These topography features tend to funnel a wildfire uphill within a narrow profile and the preheating effect tends to ignite the side slopes of the drainage. Structures placed at the mouth of the drainage are most at risk from a wildfire. Placing residential structures at the top of the slopes on the ridgeline should be avoided, if possible.

Figure 2. Drainages Tend to Draw in Fire



Graphic Courtesy of Colorado Springs Fire Department

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 time of dry or wet weather 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.

The effect of wind on a fire were on display most dramatically this past winter (December - 2021) during the Marshall Fire in Boulder County. This fire grew to over 6,200 acres and destroyed 1,084 homes. The wind gusts up to 115 miles per hour where reported. The wildfire reached the town of Superior, three miles away, in just one hour.

It should be noted that this level of high wind activity is not uncommon along the foothills where the proposed subdivision is located. 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.

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

Predicted Fire Behavior

Using the USDA – Forest Service BehavePlus fuel modeling system 5.05 , 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.

Using the inputs of the 1-hour dead moisture being 7%, the 10-hour and 100-hour dead fuels are both set at 10%; live herbaceous (grasses) and live woody stems are set at 200%. This would be an expectation of mid-summer growth. It could be a windy day, or the site is experiencing strong downdrafts from thunderstorms, so the windspeed is set at 20 mph. Slopes steepness is set at 20%.

Based on these inputs, a wildfire would spread at a rate of 6.6 feet per hour with a flame length of one-tenth of a foot or a couple of inches.

If the inputs are changes to reflect a growing season plagued by long term drought, the outcome is decidedly different. The 1-hour dead fuel moisture is lowered to 3%. The 10-hour and 100-hour dead fuels have dried to 5%. The live fuel moisture is 50%, reflecting with early dry growing season conditions. The live woody fuel moisture is composed of leaves and fine stems that have matured and is set at 100%, which would normally be a late growing season condition.

The wind speed of 20 mph and a slope of 25%, remain the same as in the previous example. With the drier conditions, flame lengths would exceed 13 feet. The rare of spread blows up over 12,000 feet per hour or 200 feet per minute.

The probability of fuels igniting in advance of the fire front is 88%. 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 3,000 feet or over one-half mile from its ignition point. At that distance, the wildfire could exit the property and continue onto UAFA or other private property.

It is predicted that local suppression forces will not be able to contain the initial fire outbreak with mobile engines and hand constructed control lines.

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 winter of 2022 through the present date have been outside of normal conditions resulting in the catastrophic losses experienced throughout the western United States this past fire season. Again, the Marshall 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.

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.

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 proposed development. However, it is not practical 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 is 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/client-files/csfs/pdfs/FIRE2012_1_DspaceQuickGuide.pdf

If residential structures are to be built in the meadow area, the grasses could be

Photo 2. The grasses could be mowed to a short height which will retard a wildfire's rate of spread and intensity.

mowed regularly to reduce the overall height of the grass. This in turn will mimic a compressed fuel bed which does not burn readily.

In the pine forest, the oak understory should be cut and removed. The current arrangement of the oak provides a high likelihood of a wildfire leaving the ground and entering the live green canopy and spread from tree to tree. This allows a ground fire to become a canopy fire, which is much more difficult to suppress.

***Photo 4. The Gambel oak provides a heat source for a fire to leave the ground*.**

- **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 shrub-grass fuel model are continuous. They extend west to east and up and down the slopes. If structures are built on the lower half of the slopes, there should be thirty (30) feet of open space between the structure and the nearest clump. This should reduce the risk of any flame touching the structure.

Where the oak has a density so thick to make it difficult to walk through, it may be prudent to create openings between thickets. This should break the continuity of a wildfire above the ground through the thickets and return it to the ground. This makes suppression efforts much more effective.

Along the most northern area of the west border, the USAFA mowed the Gambel oak down to ground level. This appears to be a strategy to create fuel break between it and the property. A wildfire would still burn through it under the right conditions. The main drawback to implementing this strategy on the subject property is that it requires regular maintenance to keep its effectiveness which could fall onto one or two landowners.

- **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. Drought conditions and early fall frosts may inhibit the normal leaf drop from Gambel oak. This would leave a very flashy aerial fuel in place and available for rapid combustion and subsequent wildfire spread.

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 mid to 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.

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.

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.

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 junipers and any other lowing growing ornamental conifer in the landscape be prohibited within thirty feet of a structure's foundation.**

If a native landscape is retained, 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.

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.

In areas of extreme wildfire hazard or where lots have a slope exceeding 20%, it is strongly recommended that a five-foot width of stone be installed around the structure and that no plant material should be placed within this (or the first five feet of a larger) rock border.

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

Construction Considerations

As the fuel in this subdivision are needles and other 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.

The National Institute of Standards and Technology published results from experiments that examined how fire spread toward a structure is affected by combustible fences and mulch under conditions that may be encountered in a wildland-urban interface fire.

The study found that firebrands capable of igniting spot fires downwind were generated by nearly all combinations of fence and mulch tested. Mulch was placed under the fences to mimic debris that commonly accumulates under or around them. A target mulch bed at the base of a constructed structure tested the ability of firebrands produced by the burning fence and mulch (simulated debris) to ignite spot fires that threatened the structure.

The result was that all wood fences with mulch (simulated debris) at the base caused spot fires in the target mulch bed. In summary, fire spread is more likely with wood and wood-plastic composite fences than with fences made of vinyl or noncombustible materials such as stone, brick, or steel.

More details on this study can be found at Wind-Driven Fire Spread to a Structure from Fences and Mulch (nist.gov)

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 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. Where a high wildfire risk exists, such as in this subdivision, the wildfire intensity will ignite combustible siding material

In addition, the slope of the development that increases combustibility due to the preheating effect created by the slopes. These slopes range from as low as 10% upwards to 35%. Slopes more than 15% are considered steep and play a major role in a wildfire spread and intensity.

It is recommended that where slopes exceed 15% in areas where the wildfire hazard is considered high, non-combustible siding materials should be used in the construction of structures.

Due to the increased loss of structures to wildfire events nationwide, there is growing emphasis on ‘hardening the structure’. A recent report published by Headwaters Economics discusses the costs of added protection during construction of a residential structure. A copy of the full report can be downloaded at: Construction Costs for a Wildfire Resistant Home, California Edition (headwaterseconomics.org)

The report lists several construction improvements that are relatively inexpensive to install.

Water Supply

The property lies within unincorporated land of El Paso County. At the present time, there is no readily available water supply for ground suppression fire resources. The local fire department will need to rely on water hauled into the site during a fire.

The subject property is surrounded on three sides by the Tri-Lakes Monument FPD and USAFA to the south. It is assumed that the Tri-Lakes Monument FPD would be the primary resource for initial attack on a wildfire. The USAFA would also assist in the event of a wildfire due to the proximity of the Academy's northern boundary.
Station 4 is located less than three (3) miles and one-half miles away, at 15415 Gleneagle Drive.

The apparatus available at Station 4 is 1 – Type 1 Engine, 1 – Type 6 Brush Truck and a Water Tender. There would be a total of 4,800 gallons available for suppression during the first response.

Forest Management

The dwarf mistletoe infection and its potential control is the highest priority for the forest stand on the property. Dwarf mistletoe is a parasitic plant which feeds off its host plant. In this instance, ponderosa pine is infected with this parasite.

Dwarf mistletoe does not directly kill the affected trees. It reduces their health as the mistletoe competes for water and nutrients. With the recent severe drought, this added stress does start to kill trees. In addition, this makes the tree susceptible to insects such as bark beetles. These insects attack and complete the process the mistletoe started.

Photo 5. The dwarf mistletoe infection as viewed from the top of the ridge. Note the cluster of dead and dying ponderosa pine (red arrow).

In 1977, Frank Hawksworth developed a 6-class rating system for dwarf mistletoe. By dividing the crown of a tree into thirds, a numerical number was assigned to the level of infection in each third. Zero if no infection was observed, one if it was lightly infected and two if the tree had a heavy infection in that third. The three numbers are added together to achieve the overall infection rating.

The best course of action would be to remove all infected trees whose numerical rating is four (4) or above with a long-term of complete eradication. Any smaller trees under the main canopy that have an infection rating over 1, would be removed as well. This would also reduce the wildfire risk.

Based upon the inventory results, the average diameter is 10.7 inches with approximately 350 pines per acre. And of those trees, 133 trees lie in the 2-4-inch diameter classes. This number of smaller trees represents 38% of the total number found on the property. It appears that the ponderosa pine will germinate readily from seed to generate replacement pine trees. While there would be an impact to eliminating the mistletoe infection, it would be short-term in nature.

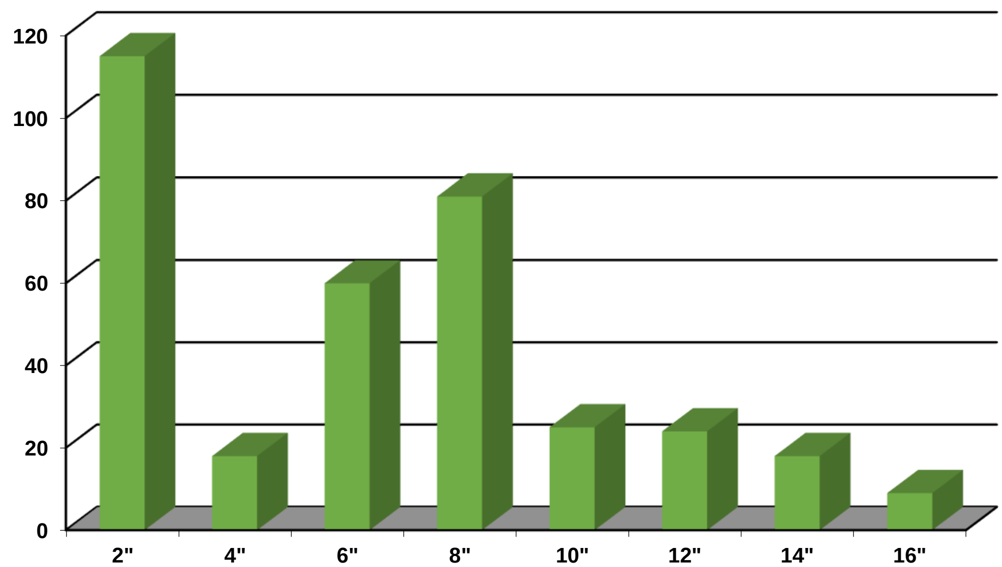
Photo 6. Closeup view of the dwarf mistletoe infection in ponderosa pine.

From a forest health standpoint, the pine forest is overstocked with trees. Assuming a target growing stock level (GSL) of 90 , there should be an average of 136 to 165 trees per acre. A GSL of 90 reduces the risk of an extensive outbreak of mountain pine beetle. GSL is a level of stocking designed to attain a targeted basal area when the stand reaches an average of ten inches or more in DBH. In this instance, the basal area is 90. Basal area is the cross-sectional area of a tree measured at breast height (4.5

feet above the ground), inclusive of bark and expressed in square feet. Basal area per acre is a common expression of timber density or stocking.

So as the ponderosa pine grows larger in diameter, the number of trees per acre would need to be removed to maintain the target GSL. For now, the priority would be to control the dwarf mistletoe and conduct a post treatment inventory to determine the next management treatments.

Chart 1. Comparison of Ponderosa Pine by Diameter Classes



From the chart above, the eight-inch diameter class may need to be reduced. Presently, there is an average of 81 trees per acre. The number of trees in the next diameter class (10”) drops to 25. So, it is feasible to reduce the eight-inch diameter class by as many as thirty (30) trees.

This chart is the result of a limited set of inventory plots. Additional plots should be inventoried after dwarf mistletoe control to accurately select additional ponderosa pine for removal.

Wildlife

During the inventory process, a small herd of elk was seen just to the south of the property on the USAFA. There was sign of elk observed in the forested area that appeared to be old. With the observation of the elk, the forest management recommendations should include their habitat requirements.

From the Natural Diversity Source (NDIS), the Colorado Division of Parks and Wildlife identifies the property as containing a residential elk herd and is a winter range for elk.

Elk prefers forest and edge habitat where they readily forage for grasses. A closed canopy forest is necessary for cover and mid-day resting. Tall and dense thickets of Gambel oak in shaded locations also fulfill this need.

The dwarf mistletoe control effort should not unduly impact the elk population. The infection lies within the forested area and not at the edges. The treated area could be seeded post treatment to ensure rapid ground cover with preferred grass and forb species. Fescues, wheatgrass and bunch grasses are preferred browse candidates.

The long-needle cover on the forest floor should be disturbed to expose mineral seed. This will allow any grass or forb seed to germinate. This also creates a required seed bed for ponderosa pine germination. This activity would benefit both the elk and the sustainability of the forest.

Tree cutting should be avoided during calving season. This can commence from late spring to early summer. Winter cutting can be conducted if elk do not seem to be using the location as daytime cover.

There is a winter turkey concentration area lying to the south of the southeast border of the property. A combination of oak shrub for food and large ponderosa pine to roost in is a preferred habitat. The absence of a nearby water source may inhibit year-round residence on the property.

Photo 7. A bull elk seen just south of the border with the USAFA. A total of six animals would emerge from the oak thickets where they were resting from the heat.

Appendix A

Fuel Model Descriptions

Fuel Model 6 Summary Page
Fuel Model 9 Summary Page

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."

Moderate Load, Dry Climate Grass-Shrub (GS2) 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."

Fire Behavior Fuel Model 6

Fires carry through the shrub layer where the foliage is more flammable than fuel model 5, but this requires moderate winds, greater than 8 mi/h (13 km/h) at mid-flame height. Fire will drop to the ground at low wind speeds or at openings in the stand. The shrubs are older, but not as tall as shrub types of model 4, nor do they contain as much fuel as model 4. A broad range of shrub conditions is covered by this model. Fuel situations to be considered include intermediate stands of chamise, chaparral, oak brush, low pocosin, Alaskan spruce taiga, and shrub tundra. Even hardwood slash that has cured can be considered. Pinyon-juniper shrublands may be represented but may overpredict rate of spread except at high winds, like 20 mi/h (32 km/h) at the 20-foot level.

The 1978 NFDRS fuel models F and Q are represented by this fuel model. It can be considered a second choice for models T and D and a third choice for model S. Photographs 15, 16, 17, and 18 show situations encompassed by this fuel model.

Fuel model values for estimating fire behavior

Total fuel load, < 3-inch dead and live, tons/acre	6.0
Dead fuel load, ¼-inch, tons/acre	1.5
Live fuel load, foliage, tons/acre	0
Fuel bed depth, feet	2.5

Photo 15. Pinyon-juniper with sagebrush near Ely, Nev.; understory mainly sage with some grass intermixed.

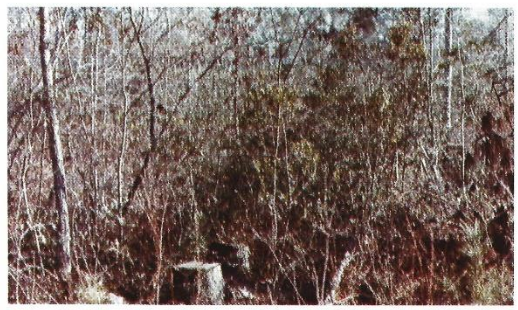


Photo 16. Southern hardwood shrub with pine slash residues.

Photo 17. Low pocosin shrub field in the south.

Photo 18. Frost-killed Gambel Oak foliage, less than 4 feet in height, in Colorado.

Fire Behavior Fuel Model 9

Fires run through the surface litter faster than model 8 and have longer flame height. Both long-needle conifer stands and hardwood stands, especially the oak-hickory types, are typical. 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. Closed stands of long-needled pine like ponderosa, Jeffrey, and red pines, or southern pine plantations are grouped in this model. Concentrations of dead-down woody material will contribute to possible torching out of trees, spotting, and crowning.

NFDRS fuel models E, P, and U are represented by this model. It is also a second choice for models C and S. Some of the possible field situations fitting this model are shown in photographs 25, 26, and 27.

Fuel model values for estimating fire behavior

Total fuel load, < 3-inch dead and live, tons/acre	3.5
Dead fuel load, ¼-inch, tons/acre	2.9
Live fuel load, foliage, tons/acre	0
Fuel bed depth, feet	0.2

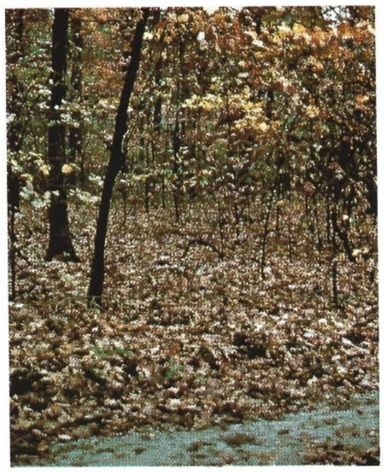


Photo 25. Western Oregon white oak fall litter; wind tumbled leaves may cause short-range spotting that may increase ROS above the predicted value.

Photo 26. Loose hardwood litter under stands of oak, hickory, maple and other hardwood species of the East.

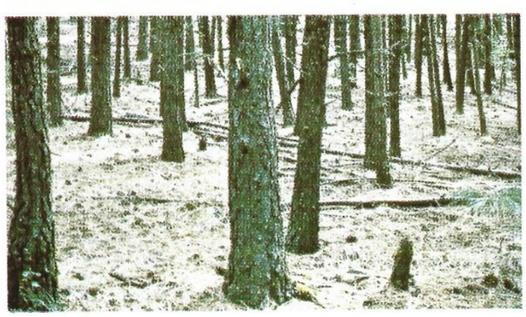
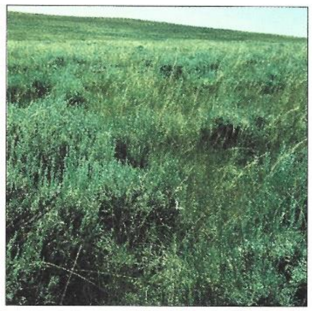
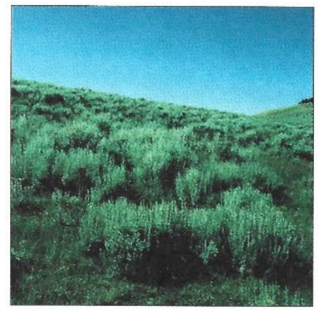


Photo 27. Long-needle forest floor litter in ponderosa pine stand near Alberton, Mont.

GS2 (122)

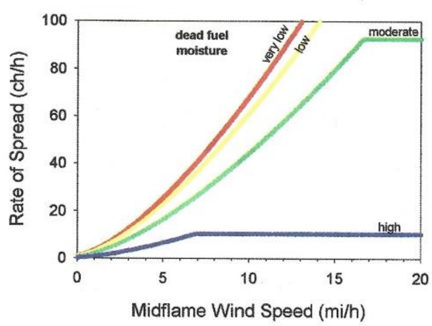
Moderate Load, Dry Climate Grass-Shrub (Dynamic)

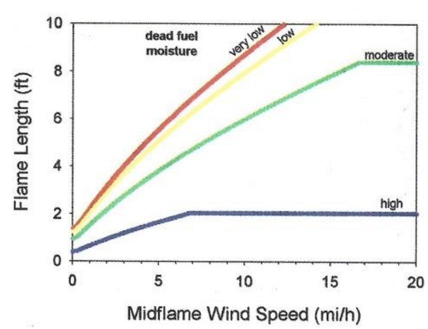




Description: The primary carrier of fire in GS2 is grass and shrubs combined. Shrubs are 1 to 3 feet high, grass load is moderate. Spread rate is high; flame length moderate. Moisture of extinction is low.

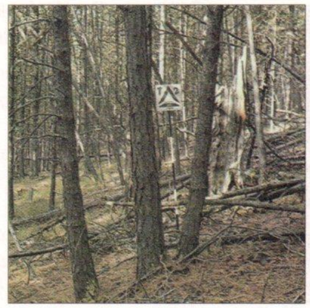
Fine fuel load (t/ac)	2.1
Characteristic SAV (ft-1)	1827
Packing ratio (dimensionless)	0.00249
Extinction moisture content (percent)	15





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