Crystal Park Community Wildfire Protection Plan

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Crystal Park
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Approval and Concurrence

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Approval

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Executive Summary

Community Wildfire Protection Plans (CWPP) are authorized and defined in Title I of the Healthy Forests Restoration Act of 2003 (HFRA) which was passed by Congress following the devastating wildfire season of 2002. The act emphasizes community planning and prescribes a framework for a community to assess its wildfire risks and develop specific plans to mitigate its wildland fire hazards. The purpose of this CWPP is to address the specific wildfire prevention and fire response concerns affecting the Crystal Park community.

Crystal Park is a 360 member Homeowner Association spread over 2000+ acres of overgrown, fuel dense forests and ground vegetation on challenging terrain coupled with limited access roads, all of which seriously hinders the ability to protect life, property and the community from wildfires with available resources. The desired end state is the protection of life, property and community through a series of deliberate actions.

This CWPP provides a geographic and vegetation description of the community and its adjacent areas. The Crystal Park community precisely fits the definition of a Wildland Intermix Community: structures are scattered throughout a wildland area; there is no clear line of demarcation; wildland fuels are continuous outside of and within the developed area.

The Risk Analysis combines historical data with current conditions to conclude that all of the conditions that contribute to wildland-urban fire disaster are present in Crystal Park. There are significant human and property values at risk, within and adjacent to Crystal Park. The heavy fuel load and steep slopes are the foundation for potentially extreme fire behavior. The overall degree of home ignitability is estimated to be quite high and the homeowner level of preparedness to respond appropriately to wildfire is at best uncertain. Restricted access could limit fire suppression response and eliminate the primary evacuation options.

The current state of wildfire preparedness is variable and difficult to assess. Overall, the community is not prepared for a major wildfire.

The Implementation Plan identifies five Lines of Effort along which action should be addressed in order to progress toward the desired end state of protecting life, property and the community. The Implementation Plan is designed to be tracked and modified as progress is made.

Introduction

Community Wildfire Protection Plans (CWPP) are authorized and defined in Title I of the Healthy Forests Restoration Act of 2003 (HFRA) which was passed by Congress following the devastating wildfire season of 2002. The act emphasizes community planning and prescribes a framework for a community to assess its wildfire risks and develop specific plans to mitigate its wildland fire hazards. Additional legislation passed by the Colorado General Assembly in 2009 requires that plans list and prioritize the community's mitigation projects. The HFRA promotes such community initiative by extending a variety of benefits to communities with wildfire protection plans in place.

Once a plan is completed, the community may apply for cost sharing to implement projects within the plan. Stated more directly, a CWPP is now a requirement for obtaining federal wildfire mitigation grants. In addition, residents of communities covered under a CWPP are currently eligible to subtract 50% of their fire mitigation expenses, up to a maximum of $ 2,500, from their Colorado taxable income. Residents should check with their tax advisors about this program.

The purpose of this CWPP is to address the specific wildfire prevention and fire response concerns affecting Crystal Park. The overarching goals of any CWPP are to protect lives first, homes second and all other interests third. This plan replaces the original Crystal Park CWPP published in 2006 and presents a comprehensive program to minimize the risks to life and property due to wildfire. Many of the objectives described in the original plan have been accomplished during the past six years. This updated plan will describe those accomplishments, provide refocus and direction for ongoing projects, and promote new community and individual efforts. The specific objectives are to:

- assess the wildfire hazard within and adjacent to the Crystal Park community;
- inform community residents regarding wildfire risks and mitigation options;
- recommend methods to reduce the ignitability of homes and other structures within the community;
- develop a prioritized list of projects to reduce the wildfire hazard within the community;
- assess the community's current wildfire response preparedness and identify areas for improvement.

The community of Crystal Park is operated under the direction of the Crystal Park Homeowners Association (CPHOA) and the Crystal Park Metropolitan District (CPMD). CPHOA is the landowner for all common property, and provides a management structure for the collective homeowners and undeveloped property owners. CPMD is a local government entity formed under the Colorado Special District Act (Article 1, Title 32 of the Colorado Revised Statutes) of 1981, and coordinates fire protective services for the community, to include resources and oversight for the Crystal Park Volunteer Fire Department (CPVFD). A CWPP Advisory Group (CWPPAG) was established to develop a draft CWPP for review and approval by the Boards of Directors (BoD) of both CPHOA and CPMD. Among the collaborators in the development of the CWPP are representatives of the CPHOA BoD, CPMD BoD, CPVFD, Colorado State Forest Service (CSFS), and the El Paso County Commissioners. The HFRA requires that, at a minimum, local government, local fire authority and a state forestry representative agree to the plan. While in development, this plan has also been presented and discussed in open meetings to solicit input and feedback from community residents.

The CWPP is divided into four sections, not including the introduction. Section I provides a description of the Crystal Park area. Section II provides a Risk Analysis. Section III defines the wildfire protection responsibilities of individuals and entities, and summarizes the current state of preparedness. Section IV describes the overview, process and elements that make up the Implementation Plan for this CWPP. Appendix A is the Implementation Plan, listing specific projects in table format. For informational purposes, Appendix C discusses fire behavior and firefighting strategies, and Appendix D discusses wildfire mitigation techniques and general forest management information.

Any realistic plan must take into account the budgetary and other resource constraints of the community. Some portions of this plan will require little or no funding and may be acted upon relatively quickly by utilizing existing programs and volunteer participation. Other portions, such as ongoing fuels treatment and enhancement of fire response capabilities, can constitute significant costs for such a small community, and progress toward such goals will depend greatly upon the financial resources available. As in the previous plan, the exact timing of projects or funding for the overall plan may not be explicitly predetermined, however recommendations for implementing and funding specific projects are presented in this document.

Acknowledging that any prospective plan such as this is a living document and subject to frequent revision, one additional goal of this new CWPP is to allow necessary updates without requiring major alteration or rewriting of the basic plan. Toward that end, many of the specifics which are most subject to change will be contained in appendices. This will allow the plan to evolve over time, with completed projects updated and new projects added in the appendices as needed. Revision of the basic plan should be necessary only when there are significant changes in the philosophy or overall approach toward protecting the community.

One of the most important benefits derived from this undertaking will be the continuing education of Crystal Park homeowners about the risks of wildfire and how those risks can be reduced both through individual and community actions. This plan should guide community members' and leaders' efforts toward applying their limited resources to achieve the most meaningful results, so that residents of Crystal Park can live here with a greater sense of safety.

I. Description of Area

A. Crystal Park

The Crystal Park Community is located in El Paso County within the USGS Manitou Springs Quadrangle. The approximate center point of Crystal Park lies at 38°50’ N latitude and 104°55’ W longitude. Crystal Park consists of approximately 2,000 acres, occupying parts of sections 7 and 8, most of 17, all of 18, and a quarter of 19 in R67W and about one quarter of section 13 in R68W. It lies within the watersheds of Sutherland and Ruxton Creeks and is bounded primarily by public lands. The elevation varies from just under 6,700 to almost 9,000 feet above sea level.

Crystal Park can conveniently be described as subdivided into lower, middle, and upper sections, which rise generally east to west. Although there is no clearly defined division between the three sections, they can be roughly delineated based on topography, elevation and distance along Crystal Park Road, also referred to as the main road. The lower section, with terrain consisting of steep foothills and a narrow boxed canyon, lies between the gated entrance and an area approximately 2 miles up the main road at an elevation of about 7,300 feet. The middle section has very steep slopes, often exceeding 100%, and extends to the end of the main road at an elevation of 8,400 feet. The upper section consists of a fairly broad valley or basin with an area of roughly 1 square mile, and rises to just under 9,000 feet. It is fronted to the south and west by steep mountain slopes topping out at over 10,000 feet.

The Crystal Park community precisely fits the definition of a Wildland Intermix Community: structures are scattered throughout a wildland area; there is no clear line of demarcation; wildland fuels are continuous outside of and within the developed area. Virtually the entire 2000 acres is forested. The forest makeup varies greatly, ranging from scrub oak thickets, to aspen groves, to dense stands of mixed conifers, to a few small areas almost resembling ponderosa pine savannah. Many of the south-facing slopes, particularly in the lower elevations, are vegetated with scrub brush, juniper, pinion pine and Gambel oak. Most of the higher, north-facing slopes are densely covered with mixed conifers, often dominated by Douglas fir. The remainder is mostly a mixed forest of ponderosa and limber pine, Douglas and white fir, aspen, and numerous species of shrubs. Other than a few very small “natural” clearings and a number of man-made “improvements” such as roads, helipads and a maintenance yard, there is practically no open space and no open grassland. A large majority of the developed home sites are moderately to heavily forested.

The Crystal Park Planned Unit Development (PUD) allows 360 memberships with each membership being entitled to a site of approximately 0.7 acres and one single-family residence. When the Homeowner Association was formed, several residents opted out of participation. Those residences, in Crystal Park I, are located within the boundaries of CPMD, but do not belong to CPHOA. At this time there are about 220 “built” home sites. The lower section of

Crystal Park is relatively densely populated with almost all of the residents being full time. The upper park is less densely populated than the lower section, with about two thirds of the homes being full-time residences and the rest being occupied anywhere from a few days to several months per year. The middle park is more sparsely populated than the other sections, with most of the houses lying along or just a short distance off of the main road. When or if Crystal Park is fully developed, the total number of houses will probably be somewhat less than 360 due to some homes occupying multiple sites. Subtracting the total acreage of the 360 home sites, the remaining area of over 1700 acres is and will remain common (community) property.

Crystal Park is a one-way-in, one-way-out community. Crystal Park Road, which was among the first roads into the Colorado Front Range, provides the only motor vehicle access. The 6-mile stretch of Crystal Park Road lying within the park was paved in 2002-2003. Entering Crystal Park from the northeast, it rises and twists through many curves and switchbacks all the way to the lower reaches of the upper park. With the exception of two very short one-way sections, it allows cautious two-way traffic and can accommodate large vehicles up to a maximum length of 50 feet. The portion of Crystal Park Road lying within the park is owned and maintained by the CPHOA.

B. Adjacent Property

Crystal Park is surrounded by a combination of federal, county, city and privately owned land. It is bounded to the south and west by the Pike National Forest (NF) with an area administered by the Bureau of Land Management (BLM) along the northwest border. To the north, forested areas and public open space along the southern edge of Manitou Springs merge with the Crystal Park boundary. Directly to the east and somewhat southeast is public land belonging to Colorado Springs. There are a few tracts of private property interspersed along the boundary between Crystal Park and the NF.

The NF forms virtually the entire southern and western boundaries of Crystal Park. This NF land forms the southern and western rim of the upper park's basin and consists of steep, heavily forested slopes. Other than one abandoned/closed road, there are no roads or maintained trails entering the NF from Crystal Park. About midway along the park's southern border, there is a parcel of private property, which is accessed only through Crystal Park.

Along the northern boundary, the more westerly portion is BLM land, extending down toward Ruxton Creek toward private property bordering the Pikes Peak Cog Railway, the Barr Trail and Manitou Incline. Moving eastward along the northern edge of the park, next there is a privately owned tract which is accessible only through Crystal Park. Still heading east along the same line, the land bordering the park is private property and transitions down steep slopes from the heavily forested Crystal Park property, to a wildland-urban interface merging into

Manitou Springs' residential areas. Along the eastern end of this northern boundary is a public open space recently acquired by Manitou Springs, consisting mostly of hills and steep ravines covered with grass, scrub brush and Gambel oak. This open space is currently projected for recreational use only and, other than the construction of hiking trails and some drainage improvements, no further development is expected. Crossing this open space is a dirt "two track" road which is gated at the Crystal Park end. Although this road is not regularly used or maintained, it could possibly provide emergency ingress/egress between Crystal Park and Manitou Springs.

The eastern portion of Crystal Park borders both private and Colorado Springs public land. There is a corridor of private property and residences as well as a commercial campground bordering the portion of Crystal Park Road which lies outside the Crystal Park entrance. The Crystal Hills Community is a densely populated development lying to the south of Crystal Park Road only about a quarter mile outside the Crystal Park gate. The public land to the east of Crystal Park quickly rises from low scrub-covered foothills up to steep forested slopes which then merge into the mid-elevation slopes of the southeast portion of the park. Foot trails traversing this area lead into the nearby popular hiking locations of "Section 16" and Red Rocks Canyon Open Space.

Crystal Park is a wildland intermix community surrounded by more wildland. Other than the gated entrance and an occasional National Forest boundary marker, there are very few markers or other features to identify the property divisions between Crystal Park and the adjacent lands. In almost all areas, the boundaries are virtually seamless in appearance, and significantly, the wildland fuels are equally seamless. If any future work is planned along or near Crystal Park boundaries, it will be important to contact the adjacent landowners to confirm property lines in advance.

II. RISK ANALYSIS

A. Wildland Fire Behavior

Estimating the risks of wildland fire includes attempting to predict the behavior of a wildfire within an extremely wide range of possibilities. Combining the innumerable variables present in a wildland-urban setting with the basic model of the fuel-oxygen-heat fire triangle results in an extremely complex set of possible outcomes, or fire behaviors. Fire can present itself in a wide variety of forms, everything from a smoldering ground fire to a raging crown fire, and the risks associated with each can vary greatly. Beginning about the mid-20th century, the casual observation and study of wildland fire evolved into a science, examining wildfire behavior to a breadth and depth far too extensive to address in these pages. However, an analysis of wildfire risks in Crystal Park requires at least a basic understanding of how a fire burns and the factors that influence wildland fire behavior. Some of the basics regarding wildland fire behavior are contained in Appendix C, Tab 1.

B. Community Values at Risk

In order to make informed decisions regarding what efforts and resources should be expended to protect certain values, it is first necessary to list some of those values. Crystal Park has many obvious values and assets worth protecting, and as stated in the opening lines of this plan, the most important are lives and property. Within the boundaries of Crystal Park however, there are other values, some less personal and many much less tangible, but all of which would be considered a loss on some level if destroyed by wildfire.

1. Life

Regardless of all other values at risk, human lives are the first priority. As stated in this plan and as exist in the plans of all emergency responders, the primary concerns are the lives of the public and the lives of the emergency responders. Crystal Park has over 200 residences with full or part time occupancy. The number of people placed at risk in the event of a wildfire in Crystal Park would depend on the time, location and severity of the fire. For a major fire in or near Crystal Park, evacuation of some or all of the area would be a likely response, and the limited egress could become a concern.

In addition to residents, emergency responders' safety could also be at risk if called to a fire in Crystal Park. Firefighters, medical personnel and police all need to be confident that their route into and out of an area is reasonably protected from fire. Firefighters will always consider "safety first" when deciding what strategies can be used on a fire and before deciding whether to enter a fire-threatened area.

2. Property

Crystal Park currently contains approximately 220 structures which are either full-time or part-time homes. Along with all the vehicles and other personal property that goes with these homes, the total dollar value is in the many tens of millions. There is other community-owned real property, such as the Crystal Park office, gatehouse, mailroom, clubhouse and pool, maintenance building, multipurpose building/fire station and a few lesser structures such as sheds; altogether worth several hundred thousand dollars. In addition to the buildings, Crystal Park also owns work vehicles and heavy road-maintenance equipment, valued at a few hundred thousand dollars. Some of these property assets are more vulnerable than others, and as with the other values that are potentially at risk, the wildfire threat to property will depend upon the time, location and severity of the fire.

A home is just more fuel to a wildfire, but to the homeowner the home is most likely the thing they value the most after the lives of their family and neighbors. When people are forced to react to the worst, some might reluctantly abandon their home, taking personal, irreplaceable items, and then rely on insurance to cover any losses. Other homeowners might choose to remain and try to protect their home. If their property has not been previously prepared, made defensible, then the homeowner’s attempt to defend their home may also be placing their life at risk.

3. Watershed

Crystal Park lies within the Colorado Springs Utilities watershed. Runoff from rain and snowmelt on Crystal Park property drains north into Ruxton Creek as well as east and northeast into Sutherland Creek and eventually into Fountain Creek. Damage or contamination within the park’s relatively small portion of watershed could potentially have much broader effects.

One of the lingering effects of a major fire can be severely damaged soils. The intense heat generated by extreme fire behavior can kill practically all trees and vegetation in portions the burn area and, in effect, cook the soil. The scorched soils and ash that remain can form an upper layer that is water resistant. Vegetation re-growth is severely delayed. For years after such a killing fire, precipitation runs off this nearly impermeable soil causing flash flooding, erosion and environmental degradation far from the burn area. Even the relatively light rains following the Waldo Canyon Fire produced localized flooding and erosion, with ash and mud slides in some areas. The areas receiving the worst burns during the Hayman Fire are still suffering from these effects a decade later.

Crystal Park has the heavy fuels and severe topography that, given the right weather conditions, could promote the kind of extreme fire behavior that results in this long-lasting soil damage. With such injury to the soil, the erosion problems which already exist to some degree in the park's steep terrain could be magnified to the point of causing significant long-term damage to downstream water supplies.

4. Forest environment

Crystal Park is a residential community and is far from being an unspoiled wilderness, but it is an area filled with diverse plant and animal life. The diversity of the forest is as evident to the casual observer driving up the main road as it is in this plan's vegetation maps. In the event of destruction on the level caused by an extreme wildfire, reestablishment of a mature forest would happen very slowly. The amount of regrowth occurring within the current residents' lifetimes would be unlikely to yield the wide variety of trees, shrubs, grasses and wildflowers that have developed here over many years.

If wildfire ever destroys the area's plant life, it will also destroy the habitat of the wildlife that now lives and roams in these hills. Crystal Park is home for a large number of mule deer and provides home and/or range for black bears, mountain lions, coyotes, and foxes as well as numerous smaller furry species. Avian species living in and above Crystal Park include golden eagles, wild turkeys, grouse, hawks, falcons, several types of woodpeckers and uncounted other feathered types, including a number of migratory species.

5. Historical

Another much less tangible value for many in the community is the history of the Crystal Park property. Crystal Park has been a destination for tourists almost since it's "discovery" in the 1870's. Much of present-day Crystal Park was once owned by John Hay, one of Abraham Lincoln's private secretaries and later U.S. Secretary of State under Presidents Wm. McKinley and Teddy Roosevelt. Lincoln's other private secretary, John Nicolay, was a frequent visitor. Crystal Park became a major tourist attraction in 1910, with the opening of an auto road that attracted many thousands of people for years. The present day clubhouse was once a dance and picnic pavilion in the auto road era. Additionally, Crystal Park contains some very old trees, in excess of 300 years old, and at least one Douglas Fir estimated to be 600+ years old. Although only a few tangible relics remain from this past history and even considering the fact that the memory of past occurrences cannot actually be lost to fire, destruction of the historical setting would be felt as a loss.

6. Aesthetic Values and Lifestyle

There is obvious irony in the fact that the major wildfire hazard in a wildland setting, the forest, is also one of the most cherished values of the people who choose to live there. For many residents, the great outdoors and the opportunity to live among the forested hills and mountains are what make the community the "unique" place they love.

The loss of such an environment, something insurance cannot pay to replace, would have practical as well as aesthetic effects. Assuming homes survived a major fire that destroyed the forest, real property values would certainly decline. Aside from that financial impact, an equally real loss for many residents would be the loss of lifestyle, the pleasure of living in the midst of so much nature. Loss of the forest environment and the outdoor activities that it fosters would dramatically alter the residents' quality of life and the character of the community.

C. Adjacent Values at Risk

The majority of the property surrounding Crystal Park is "unimproved" land, much of that being National Forest and other public holdings. In strictly financial terms, its destruction by wildfire would be significantly less of a loss than if it contained more residential or commercial developments. Even discounting any immediate financial concerns, a major fire could result in the destruction of a very significant amount of forest and wildlife habitat, as well as detrimental effects on the watershed.

Along the park's northern and eastern property lines, there are both developed and undeveloped private parcels within a few dozen to a few hundred yards. The developed parcels in this area, merging into Manitou Springs, are practically all residential and also lie within a wildland-urban interface. The continuity of the forest fuels along these park boundaries would present a risk to those properties comparable to the risks impacting Crystal Park residents. One factor mitigating some of the risk of fire spreading from Crystal Park to these adjacent private properties is the fact that virtually all of the parcels lie down slope from the park.

D. Fire History

Crystal Park has burned before. The first recorded fire in the region, known as the Big Burn, was in the early 1850's—most sources date it in 1854. Surviving stories of early trappers say that the fire was started on the flanks of Cheyenne Mountain by Arapahoe Indians as an act of war against the Utes. Strong winds pushed the fire north, passing near if not actually through Crystal Park, and up the Fountain Creek Drainage at least as far as Wilkerson Pass. The fire may have burned as far as Breckenridge and the western edge of South Park. It is documented that there was a large fire in Crystal Park in the spring of 1878, only extinguished by a significant snowstorm, and another fire on Cameron's Cone in 1874. In "The Story of Manitou" a book by Shadrick K. Hooper, published in 1890 there is an account by George Ruxton of a large fire in 1847, set by Arapahoes in an attempt to kill him. He states that the fire spread three miles in two directions, "on each side of the stream, and the mountain was a sheet of flame". The exact location of this fire is unknown, but it was somewhere near Manitou Springs and could well have reached Crystal Park.

Although fires on the scale of the Big Burn are extremely rare, during the past decade, the Colorado Front Range experienced the most destructive fires in the state's history. The Hayman Fire in 2002 and the Fourmile Canyon Fire in 2010 dramatically demonstrated the vulnerability of wildland-urban communities. With the Golden Gate Canyon Fire in 2011, the Lower North Fork Fire near Boulder in 2012 and the 2012 High Park Fire near Ft. Collins, the potential for frequent, destructive, even life-threatening wildfires in areas comparable to Crystal Park was made readily evident.

Overshadowing the destructiveness of all these previous major fires in Colorado, the Waldo Canyon Fire in June 2012 destroyed 346 homes, killed 2 people and burned over 18,000 acres within direct eyesight of Crystal Park. Within the first 12 hours, the fire quickly advanced to a point less than 2 miles from Crystal Park, resulting in the mandatory evacuation of Crystal Park residents. Only favorable winds kept the fire from approaching any closer than the north side of Highway 24 and prevented any direct threat to Manitou Springs and Crystal Park.

Within the last few years, there were several smaller wildfires in the immediate vicinity of Crystal Park which fortunately were suppressed before causing damage to homes or property. Most notable was the 2007 Manitou Incline Fire on steep slopes near the historic Manitou Incline Railway and within direct sight of Crystal Park. It was contained and eventually controlled by ground crews with aerial support. In August 2009 and July 2011, lightning strikes ignited small fires on slopes within one quarter mile of the park's southeast boundary. Also in July 2011 there was a fire in difficult terrain approximately 2 miles south of Crystal Park which needed aerial tanker support. In the slightly more distant past, there are reports of residents responding to extinguish fires ignited near their homes by lightning.

Prior to 2012, Crystal Park's most notable fire event, probably in the entire history of the community, was a major house fire in December 2011. Although destruction was limited to the structure, which unfortunately was a total loss, there was significant wildland exposure on all sides. Cold weather with minimal winds, along with a major firefighting effort, prevented any wildland extension. In this case, less friendly weather conditions would have very likely resulted in the fire escaping into the wildland fuels and threatening other nearby homes.

Crystal Park has been fortunate to have avoided a significant wildfire, at least within recent history and the memories of current residents. However, the frequency of wildfires in general, and especially the destructive wildfires and WUI fire disasters along the Front Range would seem to indicate that a wildland fire in Crystal Park is inevitable. It is not a question of if, but a question of when such a fire will occur.

E. Current Conditions and Hazards

1. Fuels

Old maps made in the 1890's by the Forest Service show extensive areas of the present Pike National Forest were severely burned, most likely in the Big Burn. Prior to the active suppression efforts in the 20th century, many forests in the lower Rocky Mountains naturally burned every 20 to 30 years. Frequent fires thinned the forest and prevented heavy buildup of fuels. Photographs from around 100 years ago depict Crystal Park slopes with far fewer trees and much less vegetation of all types. As in much of the western United States, a century of aggressive fire suppression coupled with unmanaged growth, has resulted in extremely dense forests in Crystal Park and the surrounding properties. This unnaturally dense vegetation is the primary fuel concern. Such overgrown forests are often stressed by inadequate amounts of water, sunlight and nutrients making the trees susceptible to insect and disease, and if ignited, can result in devastating wildfires.

The vegetation maps that are part of this plan clearly display the variety and extent of the forest. Much of the growth, particularly on the northern slopes and higher elevations, consists of closely spaced conifers. In some of these areas, closed canopies have inhibited undergrowth. In other areas where the canopy is more open, the proliferation of surface and ladder fuels is obvious. These heavy undergrowth conditions are also very evident in some areas where previous fuels treatments were completed within the last decade. Dense thickets of shade-tolerant Douglas firs have sprung up among and underneath the dominant trees.

Another major feature of the park's forests is the large expanse of Gambel oak which dominate many of the lower and south-facing slopes. Oak can be an extremely flammable plant, especially during prolonged dry conditions, and poses a significant fire hazard. It has also proven repeatedly that it is very resistant to removal or thinning and is one of the more difficult fuels to treat.

There has been a considerable amount of mitigation work conducted in various locations and fuel types around Crystal Park over many years. Many of these fuels treatment projects have relied heavily on volunteer labor, which is limited and often unpredictable. Some of the larger efforts have been carried out by paid sawyers, or a combination of paid and volunteer labor. The work has yielded obvious benefits, but considering the overall size of the property, represents relatively small-scale and in some cases only short-term improvements. In some areas that were treated in years past, the above mentioned proliferation of surface and ladder fuels, has virtually eliminated the previous gains.

Much of the more recent mitigation work has focused, very appropriately, on reducing fuel loads above and below the main road, with the goal of securing safer ingress and egress. This work has proven to be most often accomplished on the slopes above the road, where slash and timber can more easily be tossed down to the road for removal. About 2 miles of the main road's upper slope have been treated so far, with reasonably good results. However, regrowth along parts of this upper slope will require retreatment in the near future. Treating fuels below the road has been attempted on a few occasions, but the difficult labor involved in the uphill removal of cuttings has made these projects much less common and the benefits so far are minimal. Much of the main road's upper slope and much more of its lower slope still have very heavy fuel loads.

The other fuel source of concern is the structural fuels, in the form of homes, ancillary structures, landscaping and yard furnishings. In most parts of the Crystal Park, houses are widely spaced and the risk of direct fire spread between structures is small. There are clusters of homes in a few of the more densely built areas, but the HOA's requirements for minimum separation between homes make the probability of direct house to house ignition less likely. Of more concern is the proximity of wildland fuels to many flammable structures. (See Appendix C, Tab 2.) Some homeowners have taken steps to develop survivable or at least defensible space, but for a variety of reasons, many other homeowners have not. In the event of a major wildfire, not only could a number of these homes be identified as indefensible, but they could also pose a threat to the adjacent forest and other nearby homes.

2. Topography

Other than the difficulty it imposes on performing mitigation work, Crystal Park's terrain is a risk factor for another, more significant reason. Crystal Park is a mostly vertical community: every place is either uphill or downhill from any other place in the park. Within its 2000 acres, the elevation varies by about 2300 feet. There are virtually no flat areas, but neither is the terrain one long continuous slope. Instead, it is an irregular conglomeration of foothills, mountain ridges, canyons, saddles, valleys, chimneys and gullies. Other than on maintained roads, travel is pretty much restricted to foot, bike or ATV. On the steep, undeveloped slopes, foot travel is often the only option, and in some rugged areas even getting around on foot can be very difficult.

Crystal Park's verticality limits easy movement for everything except fire. The diverse collection of hills and valleys can significantly influence fire behavior, speeding it up slopes and through gaps, or channeling it in unexpected directions. Fire could easily move up the slopes and across the uneven terrain with a speed neither man nor machine could match.

3. Access

Access by man and machine is a very real concern when combating wildfire. As previously stated, Crystal Park is a one-way-in, one-way-out community, with all roads feeding into the main road and out the one and only gate. Also previously stated, in many areas along the main road, fuel loads are heavy, and fire in those areas could pose a threat to evacuating residents as well as a threat to responding firefighters. Crystal Park's 23 miles of secondary dirt roads pose similar threats, with heavy fuels along much of their length. In most cases, the secondary roads are considerably narrower than the main road and may be limited to one-way traffic in several areas.

Most of the secondary roads terminate with a dead end near the last home site on the road, and with few exceptions there is very limited space for turning around or positioning large vehicles, such as fire apparatus. Safe egress is a primary concern for firefighters, and with significant fire activity, safe egress from many areas of the park might not be possible. One representative of the El Paso County Fire Marshal's office suggested that in the event of a large fire, an incident commander might not allow firefighters to enter Crystal Park.

There are several named and unnamed foot trails leading out of Crystal Park, and in the past some of these trails were considered part of the park's evacuation plan. Because of legitimate and significant concerns regarding residents' safety and accountability, egress on foot is strongly discouraged and is no longer part of the evacuation plan. If residents are unable to evacuate from the Upper Park, they should proceed to the community Shelter in Place.

4. Sources of Ignition

One additional concern regarding wildfire hazards, which is actually of primary concern, is the risk of ignition. Discounting spontaneous combustion, a fire needs to be started by something. The most common sources of combustion for a wildland fire in WUI settings along the Front Range are human activity and lightning. Both of these potential ignition sources are prevalent in and around Crystal Park.

Even though open fires are prohibited by Crystal Park bylaws, accidental ignition by embers from unscreened chimneys, cigarette butts, engine exhausts, sparks from machinery and unfortunately the occasional open-fire bylaw violation are all potential human sources of ignition. Campfires, although not allowed in Crystal Park, are very common in the public lands surrounding the park, as evidenced by the numerous fire rings scattered throughout the bordering forest.

In addition to the many possible human causes, cloud to ground lightning is a frequent occurrence along Colorado's Front Range and the top natural source of wildfire ignition. El Paso County lies within the part of Colorado that experiences the greatest number of strikes per year, and the frequency of strikes increases dramatically during the warmer, dryer summer months. Lightning has repeatedly proven to be a very real hazard with regard to triggering fires in and around Crystal Park.

Eliminating all ignition sources would seem to be a sure way to avoid all chance of wildfire – if it were only possible. The hazards presented by human sources can be controlled to some extent by being aware of fire dangers; exercising caution when handling fire, smoking or using machinery; and by obeying local restrictions and official fire bans. Even if all human causes of wildfire were eliminated, lightning obeys only the laws of nature, and it will remain a significant and uncontrollable wildfire ignition hazard.

F. Conclusions

All of the conditions that contribute to wildland-urban fire disaster are present in Crystal Park. (See Figure 1.) There are significant human and property values at risk, within and adjacent to the park. The heavy fuel load and steep slopes are the foundation for potentially extreme fire behavior. The overall degree of home ignitability is estimated to be quite high and the homeowner level of preparedness to respond appropriately to wildfire is at best uncertain. Restricted access could limit fire suppression response and eliminate the primary evacuation options. History, right up to the present day, records the reality and increasing frequency of major fire outbreaks all along the Front Range and the enormous destructive potential of such fires. Given that the occurrence of wildfire is inevitable, ***the key to preventing WUI disasters lies in protecting people and reducing the ignitability of homes.***

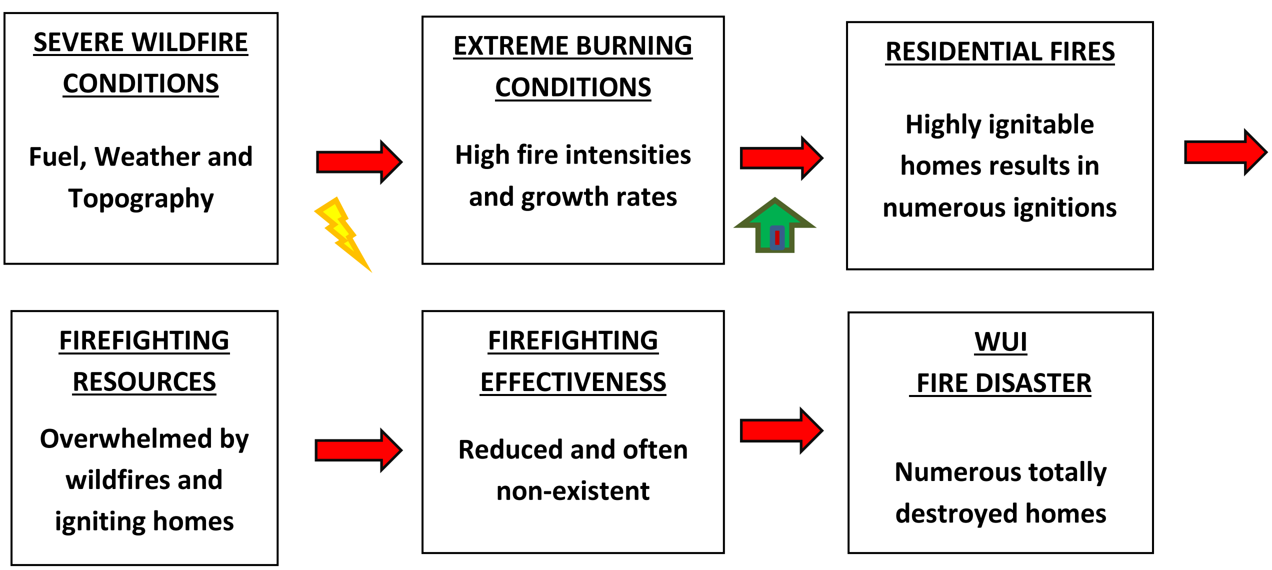


Figure 1 WUI Disaster Sequence: In the WUI, sources of ignition and the presence of homes are given. WUI fire disasters depend on a convergence of several conditions, including highly ignitable homes. If ignition resistant homes do not ignite, then firefighters can effectively protect homes, and the inevitable wildfire occurs without disastrous residential destruction.

III. WILDFIRE PREPAREDNESS

A. Crystal Park Homeowners Association

Over the past half-decade, the HOA BoD and membership as a whole have had a mixed but generally positive attitude toward the concept of Crystal Park providing its own firefighting response. Most recently, more residents and Board members have come to see the value of a community-based fire department, and attitudes overall have been more supportive. The HOA has entered into a use agreement with the Crystal Park Metropolitan District allowing the CPHOA multipurpose building to serve as the fire station and approved additional agreements concerning the use of CPHOA vehicles and fuel by the fire department.

The Forestry Committee has led the way in obtaining matching grants for hazardous fuels reduction and in coordinating volunteer mitigation workdays. The HOA has also promoted member preparedness, including encouraging residents to enroll in El Paso County's reverse 911 emergency notification system. As a result of the HOA and Forestry Committee efforts to date, Crystal Park was recently designated a Firewise Community.

B. Crystal Park Metropolitan District

The Crystal Park Metropolitan District (CPMD) is the local governmental entity established to coordinate fire protection services for the community. Its board of directors consists of five community members chosen by community residents in formal elections conducted through the El Paso County Clerk's Office. A small portion of the annual property tax paid by residents is allocated to the CPMD to support its fire protection efforts.

The CPMD provides firefighting infrastructure for the fire district, as well as administrative and financial support, and oversight for the CPVFD. The Metro District is directly responsible for coordinating the installation and maintenance of fire cisterns, which are strategically placed throughout Crystal Park as water sources, in lieu of fire hydrants. The CPMD also provides and posts address signs for every permanent structure in the community. The CPMD Board, in consultation with CPVFD leadership, approves and manages the procurement of firefighting apparatus and major equipment items. It also budgets CPMD funds to cover ongoing CPVFD expenses such as insurance and radio licensing.

C. Crystal Park Volunteer Fire Department

The CPVFD was founded in 2007, and is led and staffed by all-volunteer Crystal Park residents trained in both structural and wildland firefighting. The station is located in the upper park at an elevation of about 8400 feet. Although it is a new and fairly small department, the CPVFD has developed a wide range of capabilities, with the core capabilities being structural and wildland fire suppression. The department is now the primary agency responsible for fire response in Crystal Park.

With the establishment of the CPVFD, Crystal Park now has a more immediate response to wildland fires, particularly in the more distant reaches of the upper park. If notifications of fire starts are timely, this capability for a faster response should increase the probability that new starts can be quickly suppressed. The CPVFD firefighters are well trained in wildfire response but limited in numbers. If a wildfire gains traction and grows to any significant size, the department will be quickly overwhelmed. In such a situation the CPVFD will rely heavily upon support from other departments, and in virtually every case involving live fire, that support will be requested immediately. Even with the best response possible, limitations imposed by conditions on the ground will govern decisions about where and how firefighting resources are used.

In Crystal Park, fuels and topography are both major factors governing firefighting decisions. As stated previously, off-road travel is largely limited to foot traffic because of the steep terrain. Engine crews and other heavy equipment will be restricted to maintained roads. In some areas, the steep slopes are unsafe even for travel on foot. The scarcity of fuel-free areas anywhere within Crystal Park also seriously limits where and how firefighters may be employed. The adequacy of safety zones and escape routes would be questionable for anything more than a small surface fire. With a large fire in heavy fuels on difficult terrain, aerial attack and/or defensive strategies may be the only options available. See Appendix C, Tab 3 for more information regarding wildland firefighting strategies.

D. Other Agencies

For fire response prior to 2007, Crystal Park relied primarily on a contract with the Manitou Springs Fire Department (MSFD). Because of the capabilities demonstrated by the CPVFD, this contract arrangement with the MSFD was superseded in 2011 by an automatic mutual aid agreement, which calls for automatic response by both departments for a working fire in either district. In addition to the support from MSFD, Crystal Park is covered under a county-wide mutual aid agreement, and has previously received such aid from the Colorado Springs Fire Department (CSFD), the El Paso County Sheriff's Office (EPSO) Wildland Crew, and fire departments in other small communities nearby. Other mutual aid agreements extend beyond the county lines. In 2011, the CPVFD also received assistance from departments in Teller County and from the Fort Carson FD.

E. Homeowners

At this time it is difficult to estimate Crystal Park homeowners' overall level of awareness or preparedness for wildland fire. There is evidence that resident awareness of wildfire hazards ranges from well-informed to unconcerned. Individual readiness to respond effectively and safely to a fire spans a similarly wide range. Prior to the Waldo Canyon Fire, random sampling indicated that a significant portion of residents were unfamiliar with the requirement to register phones and addresses for reverse 911 notices. The opinions and suggestions verbalized by some residents point to a lack of knowledge regarding mitigation strategies and what constitutes effective mitigation. There is an obvious need for increased emphasis on homeowner education and follow-up to ensure information is received. These issues will be discussed further in section IV.

At present, the recommended primary response by a homeowner to a significant fire would be evacuation. The CPVFD has published an evacuation plan for Crystal Park, but anecdotal feedback suggests that many residents are unfamiliar with the plan and unsure of the notification procedures and recommended routes. If evacuation proved to be unsafe due to fire conditions along the evacuation route, residents would have the "last-resort" option to shelter in place at Crystal Park's only designated Shelter In Place (SIP) structure, the CPVFD fire station, which was designed and built with that purpose in mind.

A relatively small number of homeowners have obtained fire gel kits (simple systems allowing homeowners to apply fire resistant gel to flammable surfaces) for use if a wildfire poses an immediate threat to their home. Another few individuals have installed cisterns and/or sprinkler systems, or have discussed similar plans for defending their homes. To date, there have been no concerted efforts to determine how many residents have made plans or preparations to actively respond to a fire threat, or to evaluate how effective or safe their plans might be. Given the very real concerns regarding the safety of evacuation routes and the natural desire of some residents to protect their property, it would be prudent to explore additional or alternative response options for homeowners.

IV. Plans

The following sections present a discussion of the protective approaches and plans deemed most appropriate for implementation in Crystal Park. Sub-section F, Implementation Plans, will describe the methodology used to identify particular projects, timetables or resources required. Specifics will be provided in Appendix A, which will consist of a table listing the details of upcoming, current and completed projects. The table is designed to be modified periodically without requiring modification of the base plan.

A. Priorities

The three overarching objectives of this plan have been previously stated; protecting the lives of residents and emergency responders first, protecting the homes and property of residents second, and protecting all other community values third. The objectives and plans for addressing each of them will be covered in detail below, but the fact that they are discussed separately does not mean that they are separate issues. On the contrary, all are interrelated, and plans to address one objective will almost certainly impact the others. Similarly, the prioritization of the objectives does not necessarily mean that only the top priority objective will be addressed to the exclusion of the others. If the means and resources are available, projects addressing all three objectives could and should be undertaken simultaneously. On the other hand, if there are limiting factors, then common sense would dictate that projects addressing the higher priorities should be supported first. In some cases, Crystal Park may need to seek expert advice to help identify major hazards, determine relative risks and recommend timing of specific projects. Implementation of most aspects of the plan will depend greatly upon continuing community support in the form of funding approval, homeowner initiative and volunteerism.

B. Responsibilities and funding

1. HOA

The majority of Crystal Park is common property. As the community property landowner, the HOA, through the HOA BoD, has primary responsibility for coordinating, managing and funding work on and along the roads and in other common areas. The HOA's roles in wildfire protection include supporting fuel hazard mitigation on common property; improving roads and infrastructure for fire response; establishing and enforcing construction/mitigation standards; promoting policies which encourage homeowner initiative and preparedness; and disseminating information to residents.

With regard to fuels mitigation, the Forestry Committee is, in effect, the operational arm of the HOA. For several years, a portion of member dues paid to the HOA have been allocated for hazardous fuels mitigation, and the Forestry Committee has had and will likely continue to have the lead in managing HOA fuel mitigation funds and volunteer mitigation projects. Committee members also advise homeowners on home mitigation plans. CPHOA, through the Forestry Committee, has had good success over a period of several years in obtaining matching federal grants for fuels reduction. Searching out and obtaining grants from any available sources will be a necessary strategy in order to conduct fuel reduction projects on a meaningful scale.

The CPHOA possesses heavy equipment and employs operators essential to the upkeep and improvement of the park's roads and other property. With those resources to draw upon, the HOA plays an important role in sustaining and improving the fire response capabilities by maintaining passable roads, constructing turnarounds for emergency vehicles, installing fire cisterns, and site preparation or maintenance for helipads and Shelters In Place. The equipment and personnel performing these functions are paid for by CPHOA members, in the form of dues and fees collected by the HOA. Continuing or increasing this type of infrastructure support, as well as the HOA-funded fuel mitigation, will depend upon the willingness of members to approve the funding.

Home construction in Crystal Park is overseen by the Architectural and Site Committee following standards set forth in the Crystal Park Construction Guide. The current Guide standards incorporate some degree of fire-resistant construction, requiring class-A roofing and underground utilities. Any decisions to adopt additional fire-safe construction standards or promote/incentivize the use of fire-resistant building materials would fall within the purview of the HOA.

The HOA also has the lead in communicating with Crystal Park residents and non-resident members. Through the CPHOA website, mass (e)mailing of notices and newsletters and posting of notices in common areas, the CPHOA is the primary source of information regarding community concerns, interests, issues, initiatives, etc. Efforts aimed at developing, maintaining and expanding community interest and motivation toward the execution of the CWPP will rely heavily on the HOA's communications media to publicize and encourage support of fire-protection efforts. The HOA communication channels will also be essential in distributing guidance concerning wildfire protection and response procedures to all residents.

2. CPMD/CPVFD

The Crystal Park Metropolitan District BoD is an administrative governmental body tasked with the responsibility of overseeing fire-protection planning and supporting fire response services for the fire District, which is contiguous with the Crystal Park boundaries. The CPMD budget comes from a mil levy on property taxes paid by home owners in Crystal Park. CPMD funds pay for basic fire response infrastructure in the District and help cover ongoing operating expenses and major equipment purchases for the CPVFD.

The CPVFD is the operational component of the CPMD directly responsible for fire response and suppression, along with the lateral responsibilities of risk assessment and response preplanning. The CPVFD possesses technical expertise regarding fire behavior, structural ignitability and structure protection; and along with the Forestry Committee, advises the community leaders and individual Crystal Park members concerning wildland fuels hazards and mitigation strategies.

The fire department itself generates a relatively small funding stream from community fund-raisers and donations, so it relies heavily upon the CPMD tax base to cover overhead and major equipment acquisitions. The great majority of CPVFD equipment acquisitions to date have been made possible by grants, and although the availability and awarding of such grants is unpredictable, the future maintenance and growth of CPVFD's response capabilities may depend largely upon those grants.

Because the Metropolitan District and CPVFD have primary responsibility for fire protection in Crystal Park, increased and ongoing coordination between those agencies and the HOA's Forestry Committee in identifying fuel hazard mitigation priorities, strategies, and methods would be of great value to the community.

3. Homeowners

A significant focus of the action plans presented will be reducing structural ignitability. During extreme conditions, fire protection effectiveness – the ability of firefighters to defend homes - depends primarily on low home ignition potential. The authority and responsibility for reducing a home's vulnerability to wildfire rests with the homeowner. Thus, WUI fire disasters cannot be prevented without homeowners actively engaged in producing and maintaining low home ignition potential.

Although not a formal responsibility of homeowners, community volunteerism is an important part of the Crystal Park culture. Numerous homeowner volunteers serve on committees and boards, join the CPVFD, support Forestry work days, and organize grass-roots neighborhood fuel mitigation efforts. Such selfless contributions of time and labor are indispensable in getting things done without requiring the HOA to spend budgeted funds to do them. Hopefully those contributions will continue.

C. Protecting people

Protecting the lives of residents and responders is the top priority. Applying the principles of *Ready, Set, Go*, the International Association of Fire Chiefs program, the Implementation Plan's emphasis is on advanced homeowner preparation of the structure and its associated Home Ignition Zone (HIZ), in order to allow residents to focus on safe and timely evacuation in the event of a fire emergency. Future evacuation planning will focus on fuels mitigation to establish and maintain safe routes; timely and redundant notification; and accurate accountability.

1. Evacuation

a) Safe routes

With a major fire, the first life-protecting option for residents is evacuation, and the primary life-safety concern for firefighters is an escape route. Consequently, establishing and maintaining safe evacuation routes becomes a top priority. The fact that Crystal Park has one way in and one way out makes the issue of a safe evacuation route more important and more problematic. If people cannot exit safely via the main road, there are no other guaranteed options for evacuation. Depending upon the location of the fire and availability of aircraft, helicopter evacuation from one of the two helipads in the upper park could be an option. In addition to the concerns for the safety of evacuating residents, if the main road is not fire safe, firefighters, engines and other emergency response vehicles will not have access.

The current evacuation plan relies almost exclusively on safe egress via Crystal Park's surface roads, and the plan is adequate if there is timely warning of an approaching wildfire or if a fire within Crystal Park does not restrict use of any roads. On the other hand, because the consequences of fire compromising travel on the main or secondary roads are significant, exploring the feasibility of alternative routes/methods should be a priority. If evacuation via the main road is compromised, the availability of alternate routes and other options such as helicopter evacuation, sheltering in place or active homeowner defense could become very important.

Given the current conditions, vegetation within a few feet of the road can fuel a fire which can make the road impassable, but fuels encroaching along the roadsides are only the most obvious part of the problem. Because wind-driven flame lengths during a major fire can reach many times the height of the fuel, even vegetation that is some distance from the road may pose a threat. With Crystal Park's slopes, the fuels growing below the road are the greater problem, and fire in these down-slope fuels would generally present the greater danger for people and vehicles on the road. Even if flames do not present a direct threat to traffic, smoke can reduce visibility to the point that vehicle accidents can become the main hazard. Because of the importance of a safe, secure road for protecting the lives of residents, the great majority of past fuel reduction work has focused on the main road. Unless new information dictates a different approach, the main road should remain the top priority for common-property fuel reduction efforts.

Fuel reduction projects above and below the road should emphasize thinning of surface and ladder fuels, thinning closed canopies and eliminating dense fuels along the roadsides, with the minimum goal of preventing flame impingement upon vehicles using the road. Following available guidelines for fuel breaks, which may or may not be directly applicable to creating safe egress, thinning on slopes could extend as far as 200-300 feet below and 100 feet or more above the road. More information is needed to determine a recommended minimum distance for thinning to achieve safe egress along the road. If published guidance or standards for safe egress are not readily available, Crystal Park might need to seek expert opinions before committing scarce funds to extensive and expensive fuels reduction projects.

Fuel reduction zones along the main road can obviously reduce the fire intensity near the road, and can also reinforce the fuel break provided by the pavement. Under the right circumstances they might serve as a fire control line and stop a fire at the road; however their usefulness as a control line would be doubtful against extreme fire behavior such as firebrand spotting. The ultimate purpose of these fuel reduction zones along the road would be to reduce fire intensity and protect traffic on the road, and any additional benefit should be considered only a bonus.

Although much emphasis is given to maintaining the safety of Crystal Park Road as the sole evacuation route, most residents will also have to travel one or more of the many secondary roads to reach the main road. Most of the secondary roads present the same if not greater potential hazards for evacuees as the main road. Some of these unpaved roads may serve only a few home sites, but are usually the only route to and from those home sites, so ideally they should receive attention at least similar to that given the main road. In reality, providing the resources needed to address the fuel concerns along all of the secondary roads is at best a long-term issue. To begin to address the issue, this plan will recommend leveraging volunteerism by identifying pre-approved cutting zones along the roads. Establishment of open firewood cutting zones as well as policies allowing members to "adopt-a-road" or "adopt-a-zone" may be considered. In addition to cutting trees and removing firewood, members would be expected to do low thinning, remove ladder fuels and dispose of slash. In the longer term, the standards for fuels reduction to ensure safe egress along the secondary roads should match the standards used for the main road. Until then, for residents of those secondary roads that are particularly at risk, very early evacuation should be the primary strategy for any fire that may present even a remote danger.

b) Notification

As the community learned during the Waldo Canyon Fire evacuation, timely and complete notification requires redundant systems and intense management. An immediate plan is to improve El Paso Tell E911 registration. Additional plans may include working with cellular telephone companies to improve service in the area, a local low-power FM broadcast system for emergency information, streaming information over the HOA website, and warning sirens located throughout the community.

Notification redundancy is also planned through coordinated action of the CPHOA staff and the volunteer CPVFD Auxiliary, using CPHOA telephone rosters to insure positive contact is made with each resident, regardless of enrollment in E911.

Timely evacuation is dependent on early warning. For a fire event initiated outside the community, CPVFD coordination with partnering fire and emergency agencies provides a level of early warning. Among the various likely sources for a fire event starting within the community are human activity and lightning strikes. Human activity in many forms, not necessarily structure fire, is the main source of wildfire ignition. Natural ignitions – lightning – are a minority. Encouraging homeowners to invest in smoke and fire sensing and reporting systems is an approach for structure fires. This plan also considers lightning strike detection-and- warning systems as a potential beneficial project.

c) Accountability

Accountability of evacuees is simplified to some degree because of the single egress road. However, positive controls must be enforced to insure evacuees who depart from the Upper park safely negotiate the six mile road and exit through the gate. Evacuation procedures, including such accountability controls, have already been developed and posted by the CPVFD, but require additional and continuing emphasis.

2. Sheltering

Given the current limited options for evacuation, it is prudent to examine potential alternatives to evacuation. At present, Crystal Park's only planned alternative is to shelter in the fire station, which is located in the upper park. Although there are no established standards for a wildfire shelter-in-place facility, the community fire station/shelter-in-place was conceived and constructed by drawing upon the best information currently available. This plan addresses considerations for developing additional shelter-in-place locations, as well as investigating shelter-at-home options, taking into account existing programs such as Ready, Set, Go and possibly others. At this time, emphasis will be placed on evacuation, with sheltering considered only as the last resort.

3. Increasing awareness, individual pre-planning

Accurate information from qualified sources is essential in order for homeowners to make reasonable decisions regarding the steps that are prudent and effective in reducing their risk. One of the main objectives of this plan is to make such information more readily available to Crystal Park residents. Toward that objective, the appendices to this plan contain information and guidance gathered from a variety of sources such as Colorado State University Extension and Colorado State Forest Service (CSFS) web sites; the local CSFS District Forester;

research and reports published by USDA Forest Service scientists; and the U.S. Congressional Research Service, among others.

Additionally, a new initiative is proposed to provide a continual information engagement effort, or marketing, to promote topics such as wildfire awareness and mitigation; and to provide easy access to publications available, as well as general guidance regarding response options (evacuation, sheltering, etc.) The information engagement effort may include web based materials, handouts, meetings, and links to applicable regional web sites.

D. Reducing structural ignitability

Fire resistant building practices and maintaining a fire resistant HIZ are the main factors contributing to a home's survivability.

Years of research and post-fire investigations have consistently yielded evidence that a home's likelihood of surviving a major wildfire is most often determined by the home's structure and the conditions of the vegetation within approximately 30-40 yards of the home. This area which often dictates the home's loss or survival is known as the home ignition zone or HIZ. Indeed, the structure of a home and its surrounding landscape characteristics are more important than the intensity of the fire in determining whether a house burns. Because the HIZ is, for the most part, private property, the homeowner has the authority and responsibility for controlling/mitigating those factors that most directly contribute to such home destruction during a wildfire. See Appendix C, Tab 2 for more information on how homes ignite.

1. Home site assessments and homeowner education

Homeowner action is the key to reducing a home's risk of ignition. For mitigation actions to occur and achieve the desired results, homeowners must be aware of the wildfire hazards and the prevention options available to them. An important first step in reducing a home's ignitability is assessing its current level of risk. The CPVFD should take the lead to conduct preliminary home site risk assessments, which can be done without homeowner participation or concurrence. These preliminary assessments will primarily be used to evaluate CPVFD risk and to pre-plan how to best defend the structure from wildfire. Additionally the CPVFD should make the overall results of these preliminary assessments available confidentially to each homeowner, providing a simple ranking of the home's relative risk. At the same time, the homeowner should be offered and encouraged to request a detailed HIZ/Firewise assessment, which would require homeowner participation. This secondary assessment would be performed by CPVFD or Forestry Committee volunteers trained to the same NFPA/Firewise standards, and would provide the homeowner with specific mitigation recommendations tailored to his/her individual property.

2. Fire resistant construction

The last line of defense should be the first prepared. Fire lines may stop surface fires and fuel breaks may reduce the intensity of a fire, but fire lines and fuel breaks will not stop the firebrands that are generated by intense fires. To achieve the greatest level of protection from wildfire, homes themselves need to be constructed or adapted to provide the lowest possible potential for ignition. As stated previously, this plan emphasizes that the individual homeowner has the ultimate responsibility when it comes to reducing his/her homes ignitability, however, the homeowner may receive motivation and advice from other sources.

Current CPHOA construction standards for new construction require a class-A roof, underground electrical and underground propane tanks. This plan recommends that the HOA consider requiring higher standards or providing incentives to promote more fire resistant planning and the use of additional fire resistant materials for all new construction. For existing homes, the recommendations derived from the secondary, detailed assessment can provide guidance to owners for adapting older homes by incorporating more fire resistant features.

3. Fuel reduction in the HIZ

For new construction, homeowners must prepare a fire mitigation plan for their property, although follow-up to confirm execution of the plan rarely, if ever occurs. This CWPP includes specific guidelines for new home mitigation plans (e.g., must meet the CPVFD established guidelines) and some method of follow up to verify execution. This plan also recommends extending the range of both new and previously written mitigation plans to include the option of performing mitigation on common property within 200-300 feet of the home (Zone 3), and also recommends that applicable HOA policies be revised as necessary to promote HIZ mitigation extending onto common property.

E. Enhancing wildfire response

1. Assessment of current requirements/capabilities/strategies

A composite assessment of the wildland fire protection requirements, capabilities and plans needs to be developed for the community. This assessment begins with mapping current and proposed fire cistern locations, current and proposed roads, and current and proposed vehicle turn-around sites. It also begins with an independent Geographic Information Systems (GIS) analysis of the fire vulnerability of Crystal Park by neighborhood or zone. With the baseline data assembled, a composite map illustrating the collected data will allow for better siting of firefighter safety zones and fuel load reduction zones, as well as setting priorities for infrastructure improvement and mitigation of hazardous fuels.

2. Preplanning and Home Risk Assessments

CPVFD is the community authority for home risk assessment. Home fire safety and mitigation is the homeowner's responsibility, but the CPVFD should identify what must be done to make the structure survivable or defendable. To prepare for a fire event, homeowners should take steps to give their property a higher probability of being classified as survivable or defendable during structure triage. To assist homeowners with mitigation efforts, as well as for CPVFD response planning, the fire department strategy will employ a two-step process.

a) Pre-planning survey: An initial CPVFD survey of a structure and its surrounding area that does not require homeowner consent or presence, but rather can be conducted by making observations while standing on community property adjacent to a structure on private property. The purpose of the survey is to allow the CPVFD to assess current conditions, in the absence of a specific fire event, and make general plans for potential deployment of firefighting resources. Pre-planning surveys will use a simple rating system to identify current conditions and hazards. Each structure will be assigned one of four color-coded categories:
    1) GREEN: Low risk. The structure has a reasonable chance of surviving a wildfire event without intervention by the homeowner or firefighters.
    2) YELLOW: Moderate risk. The structure has a reasonable chance of surviving a wildfire event if firefighters are on scene to assist. The area is considered safe enough for firefighter deployment.
    3) ORANGE: High risk. The structure has challenges regarding its ability for either surviving or be defended against wildfire that prevent firefighters from remaining on scene to protect the structure. The area is not considered safe enough for firefighters to remain. Following fire front passing through the area, firefighters may be able to return and conduct suppression operations.
    4) RED: Very high risk. The structure is deemed not to be survivable or defensible. The area is not considered safe for firefighters to deploy or operate. Firefighters cannot safely conduct fire defense or suppression efforts around this structure and may be directed to focus on more defendable structures.

b) HIZ/Firewise Assessment: A detailed assessment of the structure and its surrounding area, conducted by CPVFD at the request of and in the presence of the homeowner. This second assessment consists of a detailed critique of the existing wildland fuels as well as the apparent fire resistance of the home, and gives the homeowner specific recommendations that, when completed, will create a wildfire defensible zone around the structure.

In the event that a wildland fire threatens homes in Crystal Park, the CPVFD and/or other assisting agencies may conduct a third assessment, structure triage, to evaluate the immediate threat to individual homes and make situation-based decisions regarding the need and capability to defend a particular home. The risk categories described above roughly correspond to the structure triage categories, but triage incorporates additional factors, such as fire intensity, weather conditions and available firefighting resources, among others, that cannot be determined during a pre-planning survey. Appendix C, Tab 3 addresses firefighting strategies/tactics and includes more information about structure triage and structure protection.

3. Homeowner response/home defense

Homeowners should be informed about products and techniques that will help make their house defensible or survivable. Information should be distributed to all homeowners about fire retardant gel, installing household fire cisterns, backup power and water pumping systems, fire detection and reporting alarms, and other technology or programs as they are identified.

Homeowner preparations are undoubtedly the key to protecting a home from wildfire. However, along with information on home defense options, homeowners should also be warned of the significant dangers inherent in planning to stay and defend rather than evacuate. Ready, Set, Go and other programs emphasize that home-defense preparations must be done early, correctly and thoroughly if staying to defend the home is going to be considered as option. Minimal preparation yields maximum risk. This plan does not offer information regarding active home defense by homeowners at this time, however, in the longer term, the subject should be examined as one of the possible alternatives to evacuation.

4. Fuel reduction zones in common areas

While the efficacy of fuel reduction zones or fuel breaks is unproven with regard to preventing WUI disasters, fuel breaks may enhance fire suppression activities by allowing firefighters access to locations where fire intensity is reduced.

Given the prevailing terrain and fuel conditions in Crystal Park, the choices of fuel treatment methods will be limited. Heavy machinery cannot maneuver safely off road on the steep slopes, but mechanized cutters may be useful in cutting the scrub brush and small trees growing on both sides of Crystal Park Road, so that option should be evaluated. Prescribed fires and wildland fire use would both be inappropriate in a populated, residential setting without extensive prior treatment of hazardous fuels. Less common methods such as grazing and chemical treatments are more suited to specific fuel types, and generally speaking would not be applicable, but in some cases could be considered.

Based on past experience, the most appropriate and practical treatment method for most common areas in Crystal Park will likely be thinning of surface, ladder and aerial fuels by sawyers, followed by removal of the cut fuels. While resident-volunteers have done a significant amount of thinning, contracted professional sawyers have proven to be the most efficient at thinning relatively large areas, particularly on the steeper slopes. Volunteers have sometimes done more of the timber removal after professional sawyers have done the cutting and chipping of slash, and that combination of efforts has been very effective on some projects.

Thinning below roads presents a significantly more difficult challenge, specifically, the inefficiency involved in the uphill removal of cut fuels. The Forestry Committee and CPVFD have experimented with various methods for hauling/dragging timber and slash uphill, but all have been very labor intensive and minimally productive for the amount of effort expended. The lop-and-scatter method of slash disposal is certainly an option to be considered when working below the road. The Forestry Committee should continue to explore other methods and machinery options for removing cut fuels uphill from treated areas.

The importance removing or mitigating cut fuels in treated areas should be repeatedly stressed. In the Fourmile Canyon Fire, some treated areas may have actually increased the fire's activity because slash from previous treatments had not been removed. These jackpots of dried fuel negated any positive effects achieved by the treatments. With regard to the disposal of cuttings, the best method, whenever available and practical, is chipping. Chipping reduces the biomass to a much more compact form, retaining moisture, reducing the availability of oxygen and making it slower to ignite and less likely to sustain fire. Because Crystal Park already owns a heavy-duty chipper, this should be the method used to dispose of slash whenever possible. Crystal Park should consider promoting a community slash disposal location where residents can haul slash to the chipper and, if authorized to operate the chipper, chip it themselves; or simply deposit slash for chipping by volunteers. Another community service to consider would be scheduled drive-by chipping conducted by volunteers. An alternate, acceptable, but less desirable method to dispose of slash is to lop and scatter it to a depth of no more than 12 inches. A depth of no more than 6-8 inches would be preferred. This method should be reserved for situations where terrain or distance to the chipper makes slash removal from the treated area impractical.

5. Improving suppression infrastructure

Secondary roads in Crystal Park were not designed for large vehicle operation. For firefighting access, roads need to be assessed and restricted areas improved to widen curves and create vehicle turn-around areas as well as operational areas for positioning firefighting vehicles and equipment. CPMD must plan and resource additional water cisterns, toward a proposed goal of 10,000 gallons of water within five minutes travel of any structure. Residents should be encouraged to install 1500-5000 gallon household cisterns to support firefighters at or near their location. CPHOA should work with the City of Manitou Springs to extend existing hydrant lines into Crystal Park, including the length of Sutherland Creek.

6. Increasing CPVFD capabilities

CPMD has resourcing responsibility for the CPVFD. A long range modernization program is required to systematically replace aging vehicles and upgrade communications equipment. CPVFD needs to continue to recruit and train volunteers to increase their capability.

F. Implementation Plan

1. Methodology

The methodology used for development of the Implementation Plan for the CWPP began with agreement on a problem statement:

Problem Statement

Crystal Park is a 360 member Homeowner Association spread over 2000+ acres of overgrown, fuel-dense forests and ground vegetation on challenging terrain coupled with limited access roads, all of which seriously hinders the ability to protect life, property and the community from wildfires with available resources.

This problem must be solved within the environment in which it exists. That environment includes individuals and organizations that are stakeholders within the community, as well as outside the community. The community has methods to communicate with and influence its members and residents. However, at times the community must reach out to coordinate with, request support of, or inform its neighbors who share interest in solving the problem. The environment of individuals and organizations can be described as belonging to either an Area of Influence or an Area of Interest. This distinction provides clarity that is beneficial when trying to determine how to inform and influence each stakeholder.

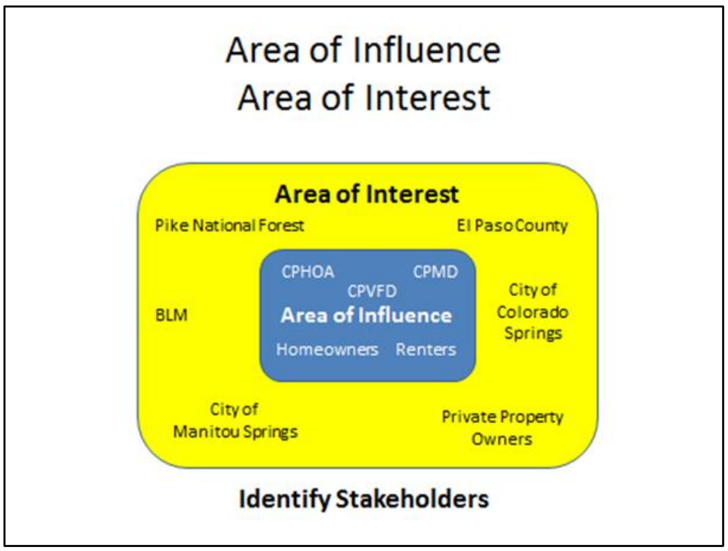


Figure 2 Area of Influence/Area of Interest

The next step was to define the desired end state. All efforts should be directed toward achieving this desired end state.

Desired End State

- Protect life through individual preparation, early warning, effective communication, adequate egress routes, shelter in place alternatives, and a properly trained, equipped and partnered fire department.
- Protect property through hazardous fuels reduction, forest management, fire resistant technology, and a properly trained, equipped and partnered fire department.
- Protect the community through hazardous fuels reduction, improved access, and a properly trained, equipped and partnered fire department.

To approach such a complex problem, the plan was developed along five Lines of Effort. A Line of Effort is a planning term defined as a line that "links multiple tasks and missions to focus efforts toward establishing the conditions that define the desired end state."[1] Lines of Effort allow leaders and decision makers to visualize how a variety of actions may work in combination to direct effort along in a unified direction.

For the Crystal Park CWPP, five Lines of Effort were identified:

1. **Fuels reduction:** All efforts directed at reducing fire fuels on open land and associated with homes and other structures.
2. **Accessibility:** All efforts directed at road and air access to Crystal Park to improve evacuation, firefighter access, and firefighter operations.
3. **Fire Fighting:** All efforts directed at improving firefighter capability, communications, interoperability, and assisting homeowner fire protection planning.
4. **Early Warning and Communication:** All efforts directed at early detection of wildland or structure fires, and providing emergency and fire related information to the homeowners.
5. **Information Engagement:** All efforts directed at informing homeowners and other agencies about CWPP related topics.

For each Line of Effort, a desired end state was defined. Within each Line of Effort, threads were identified to group action items of a common nature. As action items are accomplished, they support progress toward the Line of Effort desired end state. Progress

[1] Field Manual 3-07, *Stability Operations* (Headquarters, Department of the Army, Washington: GPO, October 2008), 4-9.

measured along the five Lines of Action demonstrates progress toward the overall CWPP desired end state: Protection of life, property and the community.

The five lines of effort and their respective end states are illustrated below. Appendix A, Tabs 1 through 5, contains a spreadsheet for each Line of Effort which includes the identified threads and action items. Appendix A, Tab 6 provides a composite list of Action Items recommended for execution by the appropriate agency. Priorities will be assigned to the Action Items after approval by the appropriate agencies.

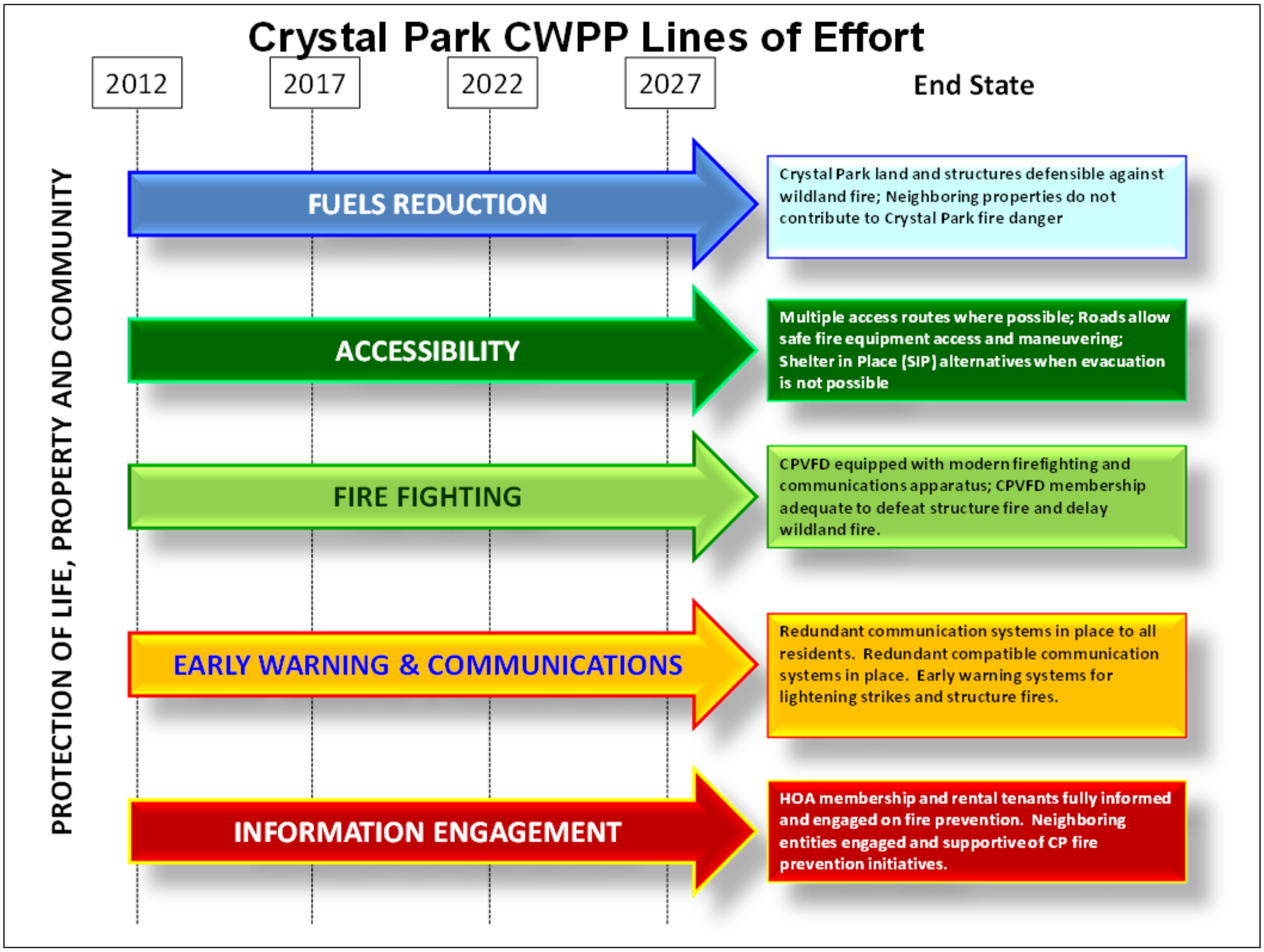


Figure 3 Lines of Effort

2. Implementation

The intent of the CWPP is for the appropriate entity (CPHOA, CPMD, CPVFD or CWPPAG) to address its respective action items within its established authority such that the combined effort leads the community closer to its desired end state. It is up to each entity to make informed decisions about generating or committing resources to accomplish action items.

3. Progress Tracking

The CWPP Advisory Group will track and report progress on a periodic basis. The tracking or reporting formats should be determined by the CWPPAG, and the information should be coordinated with and provided to the CPHOA and CPMD Boards of Directors, and to the CPVFD.

4. CWPP Maintenance and Modification

The CWPP Implementation Plan, consisting of the Lines of Efforts and Action Items, is designed to be modified as progress is made or new action items are identified without modifying the base CWPP. The CWPPAG is responsible for the maintenance and modification of the written plan. Modifications will be considered by CWPPAG based on input from any source, and may require agreement of one or both Boards of Directors.

Appendix A – Proposed LOE Options / Action Items

Tab 1: Fuels Reduction

Tracking Number	PROJECT	Authority	Lead	LOE Crossover
A	**Protecting People - increasing safety of evacuation and response**			
1	**Improve egress/ingress with fuel breaks along CP road**			
a	Identify and prioritize threatened/critical areas	HOA	Forestry/CPVFD	Access/Evac alternatives
b	Plan and schedule individual projects	HOA	Forestry	Access/Evac alternatives
c	Execute projects			
2	**Improve egress/ingress with fuel breaks on secondary roads**			
a	Identify and prioritize threatened/critical areas	HOA	Forestry/CPVFD	Access/Evac alternatives
b	Plan and schedule individual projects	HOA	Forestry	Access/Evac alternatives
c	Execute projects			
3	**Create firefighter safety zones/deployment locations**			
a	Identify/approve potential locations	CPVFD	CPVFD	Fire Fighting
b	Develop selected areas	HOA	HOA	Fire Fighting
B	**Protecting Property**			
1	**Support private property fuel hazard mitigation**			
a	Develop/publish homesite wildfire risk assessment (CPVFD preplanning)	CPMD	CPVFD	
b	Conduct HIZ assessment for fuels reduction planning	Homeowners	CPVFD/Forestry	
c	Encourage neighborhood/cluster fuels mitigation efforts		Information	
(1)	Identify neighborhoods	CPHOA/MD	Forestry	
(2)	Contact members and give presentations	CPHOA	Forestry	
(3)	Solicit neighborhood liaison	CPHOA	Forestry/homeowners	
(4)	Execute mitigation projects	CPHOA	Homeowners	
d	Establish policy/procedure/responsibility for homesite WPP followup	HOA	HOA	
2	**Increase fuel reduction efforts on common property**			
a	Extend HIZ beyond private property boundary	HOA	HOA	
(1)	Streamline approval process	HOA	Forestry	
(2)	Conduct thinning	HOA	Homeowner	
b	Promote increased volunteer mitigation work			Information
(1)	Publish local standards/guidelines/policy for volunteer work	HOA	CWPPAG	Information
(2)	Establish firewood harvesting - shaded fuelbreak zones *	HOA	Forestry	Information
(3)	Implement adopt-a-fuelbreak/adopt-a-FR-zone program *	HOA	Forestry	Information
3	**Implement more efficient/productive methods**			
a	Purchase or contract for heavy equipment - mowers/masticators	HOA	Forestry	
b	Hire sawyers/mitigation workers as HOA employees	HOA	HOA	
c	Develop options for slash disposal and timber removal	HOA	Forestry	
4	**Plan for continuing maintenance of fuel reduction zones**	HOA	Forestry	
C	**Protecting the Community and Other**			
1	**Enhance fire suppression efforts**			
a	Create wildland area fuel breaks	HOA	CPVFD/Forestry	Firefighting
b	Perform fuel reduction to allow safe site access for structure protection	HOA	CPVFD/Forestry	Firefighting
2	**Establish mitigation contacts/partnering with adjacent landowners**	HOA/CPMD		
3	**Research and apply for any/all available mitigation grants**	HOA/CPMD		
4	**Consider increased "fire-resistant" standards in CPCG**	HOA	HOA/A&S	
5	**Where applicable, gradually transition from conifer to aspen dominance**	HOA	Forestry	

Tab 2: Accessibility

Tracking Number	PROJECT	Authority	Lead	LOE Crossover
A	**Develop fire access roads**	CPHOA	RB&E	
B	**Develop fire equipment turn around areas(need to determine size)**	CPHOA	RB&E	Fire Fighting
1	Map potential turn around sites			
2	Determine if in-house or contract			
C	**Develop second egress from upper park (possibly establish a road from Upper Vista to Grand Horizon.)**	CPHOA	RB&E	
1	Develop second egress from Oak Ridge to Manitou	CPHOA	RB&E	
2	Develop second egress from middle park (reconnect upper sun to lower sun)	CPHOA	RB&E	
D	**Develop Last Resort Alternatives to Evacuation**			
1	Develop additional Shelter In Place (SIP) locations			
2	Investigate field expedient survival options			
3	Investigate in-house survival options			

Tab 3: Fire Fighting

Tracking Number	PROJECT	Authority	Lead	LOE Crossover
A	***Improve Water/Foam Availability Across the District***			
1	Increase Distribution Capability (Upper, Middle, Lower District)	CPMD	CPMD	
a	*Increase Water Tender Distribution Capability*	CPMD	CPMD	
b	*Add additional Water Pumping Stations to Increase "Capacity"*	CPMD	CPMD	
c	*Obtain Hydrant System Access Agreement for Sutherland Creek Area w/ Manitou*	CPMD	CPMD	
d	*Design FD Connections Gravity Distribution Architecture*			
2	Add additional Fire Water Storage across the district	CPMD	CPMD	
3	Develop Water Deployment Operational Staging Areas	CPMD	CPVFD	
B	***Improve Firefighter Safety***			
1	Develop Firefighter Safety & Deployment Zones	CPVFD	CPVFD	Accessibilty
2	Develop Fuel Load Reduction Zones	HOA	HOA	
a	*Improve Safe Firefighting Ingress & Egress (roads, helo)*	HOA	HOA	Accessibilty
b	*Develop New Firefighting Roadways (Upper/Lower Sun Valley, Sutherland/Neeper)*	HOA	HOA	Accessibilty
c	*Minimize Fuel Load/Characterization along major roadways*	HOA	HOA	Fuels Reduction
d	*Establish Middle and Lower District Helicopter Landing Zones*	HOA	CPVFD	
e	*Initiate Wildfire Response "Pre-planning"*	CPVFD	CPVFD	
C	***Implement Mutual Aid Memorandums of Agreement (MAA)***			
1	*Initiate MAA with Ute Pass (Grn Mtn Falls, Cascade) Agencies*	CPVFD	CPVFD	
2	*Initiate MAA with El Paso County*	CPVFD	CPVFD	
3	*Initiate MAA with Colorado Springs FD*	CPVFD	CPVFD	
4	*Initiate MAA with Ft Carson FD*	CPVFD	CPVFD	
5	*Initiate MAA with CSU Wildfire Team*	CPVFD	CPVFD	
6	*Initiate MAA with Colorado State Forest Service*	CPVFD	CPVFD	
D	***Improve Firefighting Response Communication***			
1	Install Repeater Towers for Encrypted Emergency Response Channels	CPMD	CPVFD	
2	Upgrade Radios to Motorola 6Ks	CPMD	CPVFD	
3	Initiate "Dispatch" Transition Strategy	CPMD	CPVFD	
E	***Document Evacuation/Sheltering Procedures***			
1	Develop Law Enforcement Implementation Plan (SOP)	CPVFD	CPVFD	
a	*El Paso Sheriff's Office*	CPVFD	CPVFD	
b	*Colorado Rangers*	CPVFD	CPVFD	
c	*Manitou Springs PD*	CPVFD	CPVFD	
2	Plan and Coordinate an Incident Command Accountability Methodology	CPVFD	CPVFD	
3	Develop and Execute Expanded Shelters in Place Construction Strategy	HOA	HOA	
4	Conduct Community Training & Education	CWPP	CPVFD	Information Engagement
a	*Public Outreach*	CWPP	CPVFD	Information Engagement
b	*Defensible Space*	CWPP	CPVFD	Information Engagement
c	*Shelter-in-Place*	CWPP	CPVFD	Information Engagement
d	*Evacuation*	CWPP	CPVFD	Information Engagement
F	***Develop CPVFD Wildfire Apparatus Modernization Program***			
1	Develop Type 6 Engine Acquisition Strategy	CPMD	CPVFD	
G	***Implement Fire District Wildfire Hazards Evaluation and Rating Assessment Survey***	CPVFD	CPVFD	
1	District WUI Subdivisions Determination	CPVFD	CPVFD	
a	*Lower Sutherland*	CPVFD	CPVFD	
b	*Lower Oak Ridge*	CPVFD	CPVFD	
c	*Lower Neeper Valley*	CPVFD	CPVFD	
d	*Lower Sun Valley*	CPVFD	CPVFD	
e	*Middle Railroad Grade*	CPVFD	CPVFD	
f	*Middle Day Spring*	CPVFD	CPVFD	
g	*Upper Eagle Mountain*	CPVFD	CPVFD	
h	*Upper Derby Rock*	CPVFD	CPVFD	
i	*Upper Waterfall*	CPVFD	CPVFD	
j	*Upper Palmer Trail*	CPVFD	CPVFD	

Tab 4: Early Warning and Communication

Tracking Number	PROJECT	Authority	Lead	LOE Crossover
A	***Establish early warning systems for key sources of ignition:***			
1	Lightning strikes--Vasaila	HOA	RB&E	
a	Purchased computer equipment and LTS 2005 software license			
b	Annual subscription to lightning strike database			
2	Structure fires	CPHOA	CPHOA	
a	Sensaphone 400 reporting fire alarm--costs to homeowners only (est $600 per home)		Homeowners	
b	FrontPoint central fire alarm system--costs to homeowners only (est $165 + $35/mo)		Homeowners	
B	***Establish integrated communications command for informing Park members during emergencies and evacuations***	CPHOA	CPHOA	
C	***Improve communications for:***			
1	Cellular service (important for reverse 911 calls)cell phone booster est $350 per home	HOA	Homeowners	
2	Communications from HOA office and CPVFD to CP members for evac & emergencies.	CPHOA	CPHOA	
3	Use redundant means to communicate. Consider low-power FM broadcast and			
4	streaming audio linked to public CP website			

Tab 5: Information Engagement

Tracking Number	PROJECT	Authority	Lead	LOE Crossover
A	**Identify Target Audiences**	CWPP	CWPP	
1	Area of Influence Targets			
2	b.Area of Interest Targets			
B	**Identify Themes for Messaging**	CWPP	CHVFD	
1	a. Fire Danger in Crystal Park			
2	b. Homesite mitigation process			
3	c. Installing a homesite cistern			
4	d. Crystal Park CWPP			
5	e. How Wildland Fires Burn			
6	f. Fire Retardant Gel			
7	g. Home alarm options			
8	h. Registering for E911			
9	i. Identifying trees and brush by level of ignitability			
10	j. Etc.			
C	**Identify preferend methods of messaging**	CWPP	CWPP	
1	a. E-mail			
2	b. Video			
3	c. Voice over PowerPoint			
4	d. Provide links to *Firewise* and *Colorado State Univ Extension Services* sites			
D	**Develop first message package**	CWPP	CWPP	
E	**Execute first message**	CWPP	CWPP	

LEGEND	
	Plan
	Policy Decision
	Action
	Informing

Tab 6: Action Items

#	LOE	LEAD	PROJECT DESCRIPTION	RESOURCES OR ACTIONS REQUIRED
A	A, FR	HOA	Conduct independent studies to develop a master plan for fuel reduction	
1	A, FF, FR	HOA	- Contract for vulnerability/threat assessment of CP property based on GIS (Geographic Information System) technology, with emphasis on roads and home clusters	HOA BoD approval/funding
2	A, FR	HOA	- Based on A1, consider obtaining expert opinion/ recommendations from wildland fuels mitigation professional for a comprehensive wildland fuels reduction plan	Accomplishment of A1 HOA BoD approval /funding
3	FF, FR	HOA, CPVFD	- Based on A2, develop a master fuel reduction plan for common areas, to include firefighter safety zones and fuel reduction zones (other than roads)	Accomplishment of A2 CPVFD /Forestry Committee effort
B	A, FR	HOA	Evaluate wildland fuel conditions which create hazards to evacuation via the main road and major secondary roads and take necessary steps to mitigate those hazards	
1	A, FF	HOA	- Prioritize mapping those areas of the access roads that need trees cut such that if they did catch fire, it could potentially cut off fire departments from ingress and egress and/or make evacuation impossible and then take action on it immediately by marking the trees for removal and cutting them. Suggest this be completed before 6/13, before anything else is done, whatever the cost.	HOA BoD approval/funding
2	FR	HOA	- Explore feasibility of acquiring/ contracting heavy equipment for cutting and/or removal of wildland fuels	Forestry Committee effort HOA approval/funding
3	A, FR	HOA	- Contract for increased use of sawyer crews or other fuel hazard mitigation services as recommended	AG / Forestry Committee input HOA BoD approval and funding Matching funds/grants

#	LOE	LEAD	PROJECT DESCRIPTION	RESOURCES OR ACTIONS REQUIRED
4	IE	HOA	- As a courtesy, inform El Paso County and City of Manitou Springs before undertaking major mitigation that will make Crystal Park Road more visible.	
5	A, FR	HOA	- Coordinate member-volunteer labor for areas and types of work deemed appropriate	Forestry Committee effort HOA communication media
6	FR	HOA	- Establish plan/schedule for future maintenance(follow-on fuels treatment) of treated areas	AG/Forestry Committee effort
C	IE, FF, FR	HOA, CPVFD	Promote homeowner action to develop and maintain defensible/ survivable space on private property and increase home ignition resistance and defensibility	
1	IE, FF	CPVFD	- Conduct pre-planning assessment for 100% of developed properties, provide individual homeowners with a general risk category and offer/encourage them to request a detailed HIZ/Firewise assessment	
2	IE	CPVFD	- At homeowners request, CPVFD conduct detailed HIZ/Firewise assessment and provide homeowner with recommendations to reduce wildfire risks	Homeowner request CPVFD effort
3	FR	HOA	- Revise Forestry Committee CPHOA Policies to encourage removal of fuel hazards on common land when HIZ extends beyond private property boundary (with necessary consideration of adjacent boundaries)	Forestry Committee review HOA BoD Approval
4	FR	HOA	- Revise the CPHOA Construction Guide to require execution of home wildfire mitigation plan for new construction and establish follow-up procedures to ensure compliance	A&S Committee input/review HOA BoD approval
5	FF	HOA	- Revise the CPHOA Construction Guide to include increased “fire-resistant” standards for new construction	A&S Committee input/review HOA BoD approval

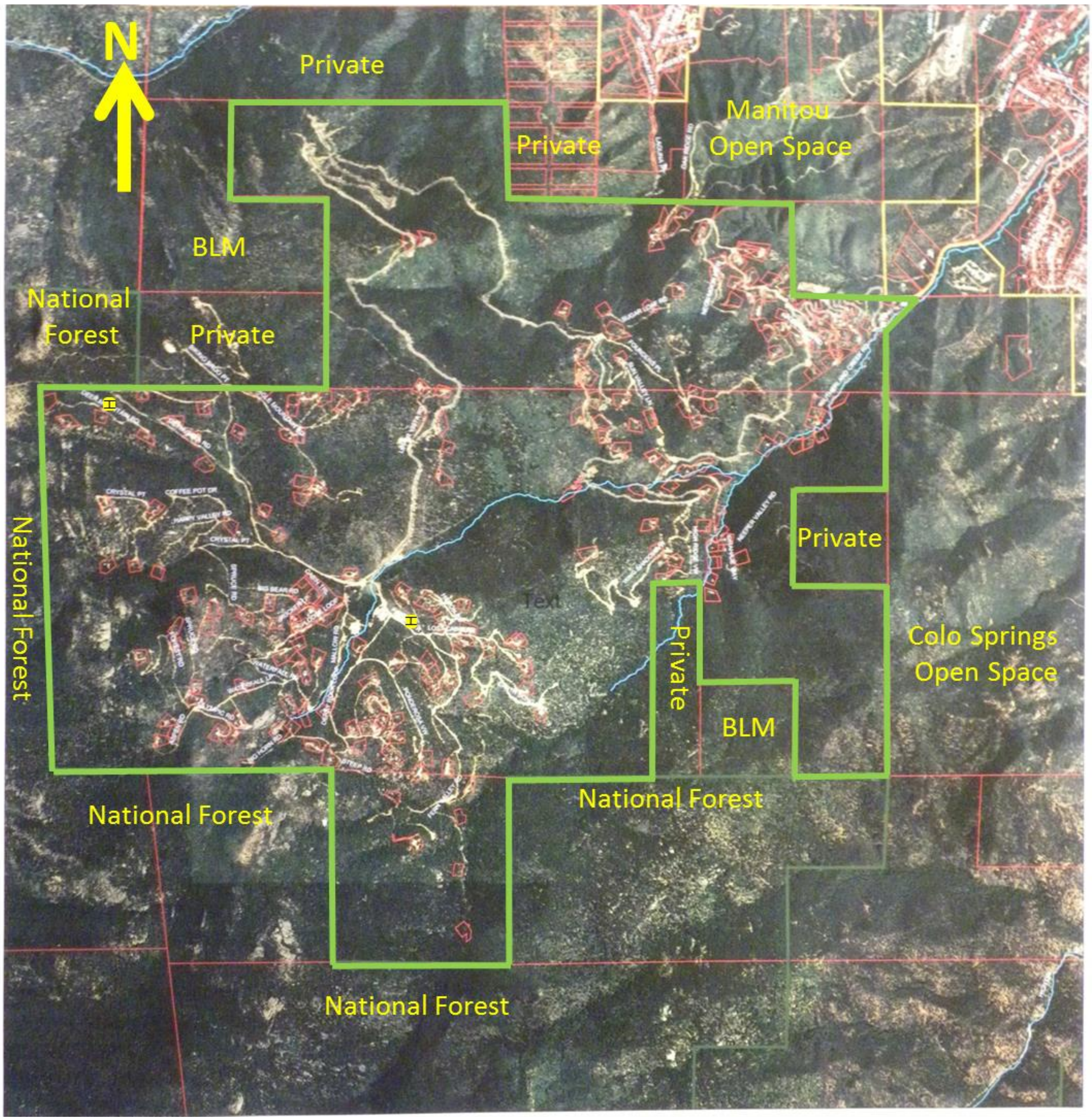
#	LOE	LEAD	PROJECT DESCRIPTION	RESOURCES OR ACTIONS REQUIRED
6	FF	HOA	- Establish a new HOA policy to provide incentive for homeowners to purchase water storage cisterns, e.g. by having a policy allowing HOA installation	CPVFD input and coordination A&S Committee input/review HOA BoD approval
7	FR	HOA	- Consider policy allowing HOA funding assistance for residents without necessary means to carry out fuels mitigation on their property	HOA BoD approval HOA funding
8	IE	HOA	- Provide members a copy of Firewise Construction Design and Materials (by Peter Slack, CSFS, 1999) when site plan is submitted	A&S Committee review HOA BoD approval
9	FR	HOA	- Consider a $2000 “fire protection impact fee” on each new home constructed in the Park. That money could be placed in a dedicated fund for use on prioritized items related to fire, such as mechanized thinning equipment, additional mitigation, “hardening” Park buildings, etc.	A&S Committee review HOA BoD approval
D	IE, FR	HOA	Execute a paradigm shift in HOA/Forestry policies and resident attitudes; move toward easing restrictions and promoting increased wildland fuel reduction on common land	
1	IE	HOA	- Continuously inform residents regarding need for wildland fuels management, and resulting benefits of reduced wildfire hazards and improved forest health	AG compile information HOA media for distribution
2	FR	HOA	- Establish fuel reduction zones, i.e., adopt-a-zone or free-cutting zones, in common areas, with emphasis given to areas bordering secondary roads, and publish cutting guidelines/ expectations for resident-volunteers	AG/Forestry Committee input HOA BoD approval Forestry Committee management
3	FR	HOA	- Eliminate or increase limit for members removing firewood from Crystal Park	AG/Forestry Committee input HOA BoD approval
4	FR	HOA	- Consider allowing non-members to remove firewood with sponsorship/supervision of member	AG/Forestry Committee input HOA BoD approval

#	LOE	LEAD	PROJECT DESCRIPTION	RESOURCES OR ACTIONS REQUIRED
5	IE, FR	HOA	- Encourage and support neighborhood mitigation efforts that involve treating fuels on adjacent common land and consider HOA funding assistance for shared sawyer work	Forestry Committee guidance/coordination Use of HOA equipment HOA BoD approval/HOA funding
E	A, FF	CPMD HOA	Assess and plan for upgrade of community infrastructure to support emergency responses and fire suppression efforts by CPVFD and other agencies	
1	FF	CPMD	- Map and prioritize locations for additional water storage cisterns with goal of providing 10K gallons within 5 minutes of every residence	CPMD BoD approval/CPMD funding
2	FF	HOA, CPVFD	- Map, evaluate and improve secondary roads to provide better access routes, turnaround areas and operating sites for FD vehicles	CPVFD/RBE Committee input HOA BoD approval HOA heavy equipment/operators
3	A	HOA, CPVFD	- Identify and map potential locations for additional secondary roads or emergency roads to provide alternate access and egress	CPVFD/Park Manager effort
4	A	HOA, CPVFD	- Establish helicopter landing sites in middle and lower park	HOA BoD approval HOA equipment /operators
5	A	AG	- Investigate/recommend alternatives to evacuation via road	AG effort
F	IE	AG, HOA, CPMD	Initiate a multi-media information engagement effort to inform and motivate residents regarding wildland fire hazards and protection measures	
1	IE		- Identify target audience and themes/subjects for messaging and explore options for preferred media to deliver information	AG effort Marketing advice
2	IE		- Prepare and package information for delivery	AG effort
3	IE		- Plan and schedule ongoing information campaign	AG effort HOA comms
G	FF	CPVFD	Formalize individual mutual aid agreements with other local fire departments	CPVFD effort

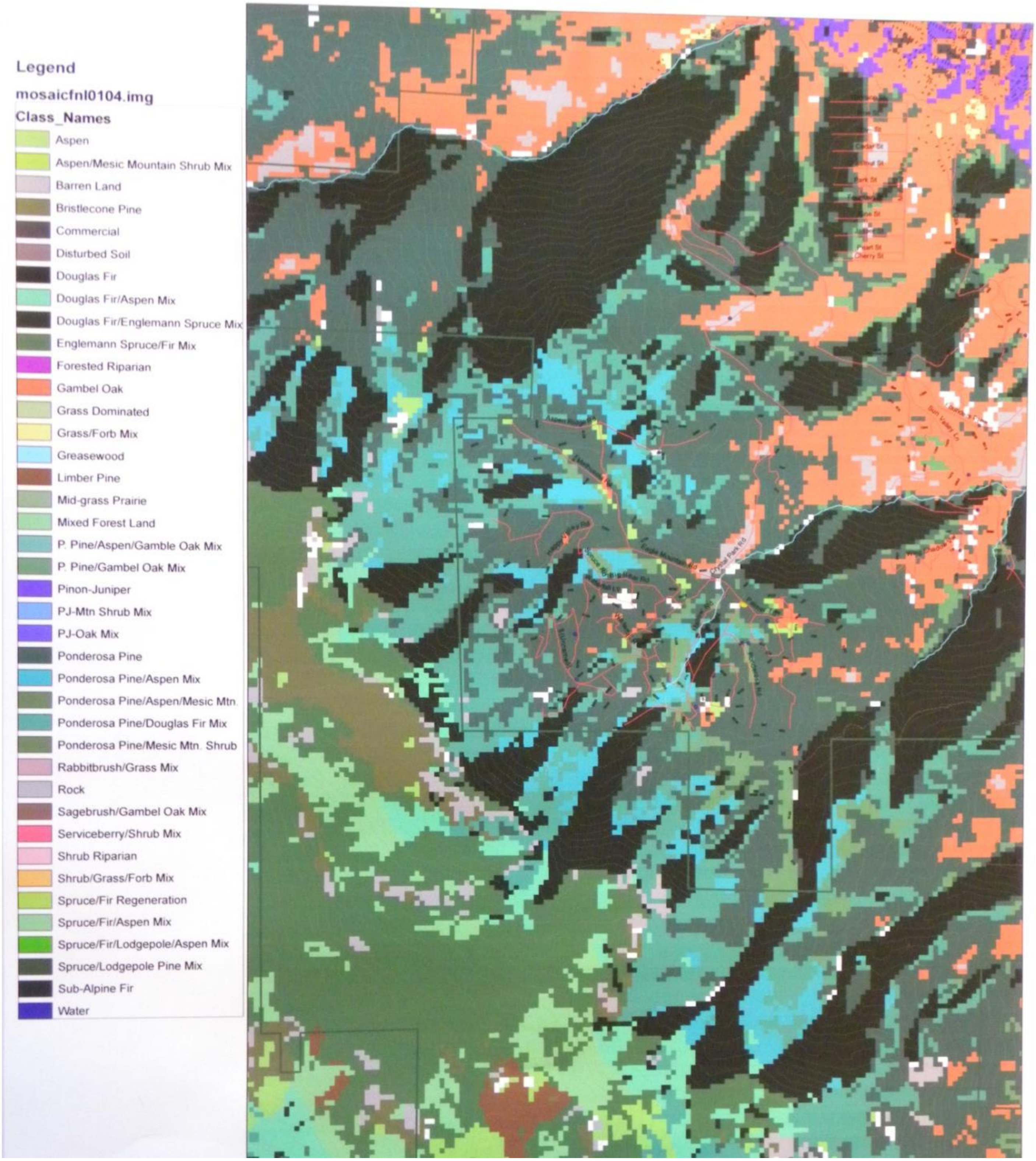
#	LOE	LEAD	PROJECT DESCRIPTION	RESOURCES OR ACTIONS REQUIRED
H	EW	HOA	Improve Early Warning and Communications Capability within Crystal Park	
1	EW	HOA	- Establish system to alert CPVFD to lightning strikes within Crystal Park and the surrounding area	Funding through HOA/grant
2	IE, EW	HOA	- Encourage residents or provide incentive for residents to install monitored or self-reporting in-home fire detection systems	HOA support Homeowner action/funding
3	EW	HOA	- Improve capability of HOA and CPVFD to communicate alerts and instructions to residents	
4	IE, EW	HOA	- Encourage residents or provide incentive for residents to install in-home cellular phone signal booster	HOA support Homeowner action/funding
5	EW	HOA	- Consider low-power FM or streaming audio broadcasts	Additional research HOA BoD approval /funding
6	EW, FF	HOA	- Evaluate the feasibility of adding remote controlled zoom cameras which all CP members could view (but which only the CPVFD could control remotely), positioned at the highest observation points in the Park to allow the fire department to monitor in high fire danger times and utilize to spot and monitor fires, smoke, lightning strikes, etc.	Additional research HOA BoD approval /funding

Appendix B – Maps

Tab 1: Boundary Map



Tab 2: Vegetation Map



Appendix C – Fire Threat / Firefighting

Tab 1: Wildland Fire Behavior

Fire has sometimes been described as displaying many of the behaviors seen in a living organism, in that it breathes, consumes, grows and reproduces. The term "fire behavior", while not addressing those specific activities, encompasses many other aspects of fire activity including intensity, direction of travel, rate of spread and more. In explaining basic fire behavior and specifically wildland fire behavior, the traditional models used are the "fire triangle" and the "wildland fire behavior triangle."

Fire Triangles

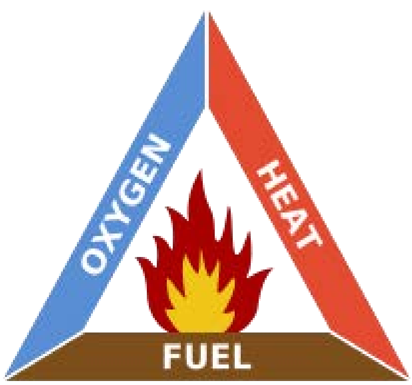


Figure C-1-1

Figure C-1-2

Fire is a chemical chain reaction needing fuel, heat and oxygen to sustain itself. (Figure 1.) With organic fuels, as in the wildland setting, fire or combustion is a two stage process: pyrolysis and ignition. Application of heat to organic fuels which results in chemical decomposition of the fuel is known as pyrolysis. The chemical reactions of pyrolysis yield, among other products, combustible organic vapors and charcoal. If exposed to high enough temperatures (heat) and sufficient air (oxygen), these combustible gases and charcoal (fuel) will ignite.

At temperatures of about 400^{o} – 600^{o} F and higher, the chemical reactions can generate additional heat which may allow the pyrolysis to become self-sustaining. The fire can continue to burn as long as all three of the key elements in the triangle remain in proximity. Removing any one of the three elements will extinguish the fire. An obvious but important point to emphasize is the fact that fire cannot sustain itself independent of a fuel source. Fire does not spread as a wave of flame, but rather as a series of ignitions. Heat must be transmitted from one bit of fuel to the next. Consequently, interrupting the continuity of fuels is an important factor in breaking the fire triangle.

Wildland fire behavior is shaped by its physical environment, which consists of ever-changing combinations of three major components: fuels, topography and weather. (Figure 2.). Each of these components can vary greatly with changes in time and place. Understanding how each component influences fire behavior can provide some insight into how complex the analysis and prediction of fire behavior can be.

Fuels

In a wildland-urban setting, there are two basic categories of fuels, vegetative and structural. Vegetative fuels consist of living and dead plants. Structural or non-vegetative fuels include such things as houses, ancillary buildings, fences, and firewood piles. Regardless of which general category a fuel falls into, a fire's behavior is influenced by a variety of common characteristics. The *amount, size* and *shape, compactness, continuity, arrangement, moisture content* and *chemical content* are seven characteristics of fuels, among others, that affect wildland fire behavior.

- As a general rule, the more fuel available to a fire, the more fire and heat is produced.
- The size of fuels influences the rate of spread and the duration of burning: smaller/lighter fuels ignite more easily and burn faster; larger/heavier fuels ignite more slowly and burn longer. Larger fuels may produce longer flame lengths and more heat. Shape is a factor, in that fuels with a higher surface-area-to-mass ratio will tend to heat and ignite more quickly. Small diameter fuels, especially grasses and forbs, dry more quickly than larger diameter fuels.
- With sufficient oxygen available, fuels that are more dense or compact can result in more intense fire, or conversely, may burn more slowly if their compactness reduces the air supply.
- Continuity of fuels influences the rate, manner and direction of spread as well as the intensity. Fuels that are continuous, or unbroken, allow fire to advance unimpeded from one bit of fuel to the next.
- Vertical arrangement can alter the basic character of a wildfire. Vertically continuous fuels can allow a manageable surface fire to travel upward through ladder fuels to become an uncontrollable crown fire.
- Moisture content of both live and dead fuels is a major factor in determining the fuel's combustibility or ignitability. Fuels with high moisture content will heat

more slowly and therefore tolerate longer exposure to heat before reaching their ignition temperature.

- A fuel's chemical components, such as plant oils or resins, can increase its flammability.

Fuel characteristics may vary over time or as the fire spreads to a location with a different fuel type, but such changes would normally be expected to occur relatively slowly. With regard to fire behavior, fuel can be considered a relatively stable factor, but the wide variations in fuel characteristics can contribute to wide variations in fire behavior from one time or place to the next.

Topography

Of the three basic components affecting wildfire, the most unchanging is topography. Stated simply, topography is the lay of the land, the physical landscape over which the wildfire burns. Some of the many topographical factors influencing fire behavior are *slope, elevation, aspect, barriers* and *wind-channeling terrain features*.

- Slope is significant with regard to fire behavior because heat rises, and therefore, heat from a fire will pre-heat and pre-dry uphill fuels. Consequently, fire will spread much more rapidly uphill into fuels which are heated closer to their ignition point. If fuels and winds are constant, a fire's rate of spread will increase as the slope increases. The steeper the slope, the faster the fire climbs.
- Elevation indirectly affects fire behavior by influencing climate, which affects temperatures, precipitation and ultimately fuel availability.
- Aspect refers to the compass direction a slope is facing. Depending upon their aspect, slopes receive varying amounts of sunshine, precipitation and wind, which again affects fuel characteristics.
- Barriers are either natural or manmade obstructions which inhibit or prevent the spread of fire. These are typically areas which are clear of any combustible fuel, such as roads, bodies of water, or previously burned areas.
- Wind channeling terrain features include ridges, canyons, chimneys, saddles, etc. Such features can block winds, create eddies, increase wind speed by funneling, and may create generally unpredictable wind conditions.

Even though topography is the most unchanging component of the fire behavior triangle, a fire's behavior can change dramatically and rapidly as it moves over variable terrain.

Recognizing the dramatic effect topography can have on fire behavior is critical in developing a plan to minimize wildfire risks.

Weather

Weather, unlike the two other components of the fire behavior triangle, is very dynamic, subject to continuous and often rapid changes. Because of this volatility, weather is the "wild card" and can result in the most extreme and often the most unexpected changes in fire behavior. Many aspects of weather play a part, but the major weather factors influencing fire behavior are *winds, temperature* and *humidity*.

- Wind can be the dominant factor influencing fire behavior. Wind carries oxygen to the fire. It also transfers heat from the fire to adjacent fuels, resulting in drying and pre-heating, bringing fresh fuel closer to its ignition point. In this way, wind is often credited with "driving" the fire, giving it speed and direction.
- High air temperatures will add heat to fuels through convection, again bringing the fuels closer to their ignition point. Radiant heat from sunlight also contributes greatly to increasing fuel temperatures, particularly on south and southwest facing slopes.
- Humidity influences fire behavior by adding or removing moisture from fuels. Low relative humidity (RH) dries fuels and, higher RH results in higher fuel moisture. The RH level has its greatest effect on dead fuels. It also affects live fuels, but to a lesser degree because of the active moisture transport mechanisms in living plants.

Weather is the most active and variable of the fire behavior components and its influence on fire can result from a wide range of events, from transient thunderstorms to long-term drought. The bottom line: the hotter, drier and windier the weather, the greater the potential for extreme fire behavior and rapid fire spread.

Fuels, topography and weather form extremely complex interrelationships which can result in varying and frequently unpredictable wildland fire behavior. Topography is what it is, constant and unchanging. Weather is anything but constant, often unpredictable and totally uncontrollable. Fuels, though relatively stable and unchanging, can be altered.

Of the three factors that determine wildland fire behavior, only fuels can be managed to reduce the spread and intensity of a wildland fire.

Speaking very broadly, there are two principal kinds of wildfire, surface fire and crown fire, although a single wildfire may likely contain variations and combinations of both.

A surface fire burns the needles, leaves, grass, small shrubs and other small biomass within a foot to a few feet of the ground and moves on. A fire line which breaks the horizontal continuity of surface fuels <u>may</u> be sufficient to stop an advancing surface fire.

In the presence of ladder fuels; meaning vegetation that is vertically continuous from the surface fuels to the crowns of large trees; surface fires may climb into the aerial fuels of the tree tops. The surface-to-crown ignition of individual trees or small clusters of trees is known as torching and is considered a form of extreme fire behavior. If larger groups of trees or entire stands ignite from tree top to tree top, this is an even more extreme form of fire behavior known as crowning. Elimination of ladder fuels and thinning to increase the distance between the crowns <u>may</u> reduce torching and crowning.

A crown fire burns both surface and aerial fuels, from the ground through the tops of the trees. Crown fires do not consume all of the fuels where they burn; rather, a crown fire quickly burns the needles or leaves and small twigs and limbs on the surface and throughout the crown of the trees. Because of the green fuels and the often discontinuous nature of the canopy, wind is usually needed to sustain a crown fire. Once burning vigorously, a crown fire can create its own wind—the strong upward convection of the heated air can draw in cooler air from surrounding areas, thus creating a wind that feeds the fire. The strong upward convection can also lift firebrands and send them soaring ahead of the fire, creating spot fires and accelerating the spread of the wildfire. Thus, crown fires that produce firebrands/spotting are difficult, if not impossible, to control.

Fire lines, natural or man-made areas that are free of flammable material, are frequently ineffective in combating extreme fire behavior such as torching and crowning. If the size of the area burning and the winds are not too great, lines created by water or fire retardant dropped from helicopters or air tankers can sometimes "knock down" a crown fire, returning the fire to the surface fuels. Fuel reduction zones, areas where aerial fuels have been thinned and/or ladder fuels removed, have also proven to be effective at returning a crown fire to the ground, but do little or nothing to reduce the threat from airborne embers. Often crown fires burn until they run out of fuel, the wind dies or precipitation extinguishes the flames.

Tab 2: How wildfire burns homes

An understanding of how wildfires ignite homes forms the basis for explaining home destruction during WUI fire disasters and can ultimately lead to a better understanding of how to protect homes from wildfire.

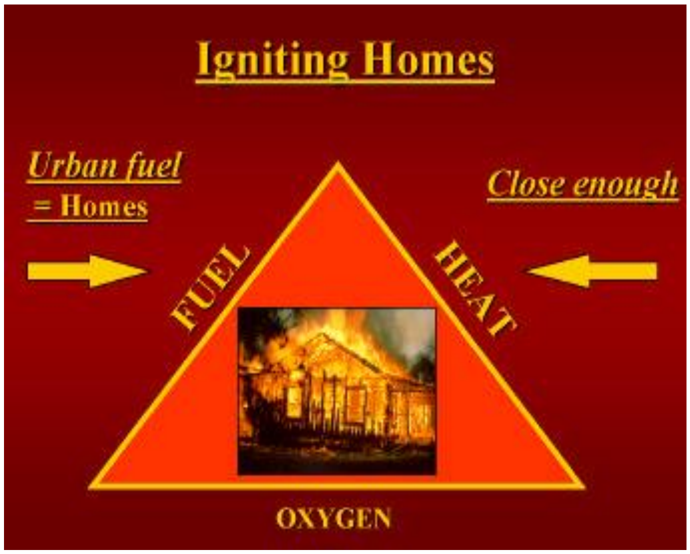


Figure C-2-1. Homes ignite and burn during wildfires when the requirements for combustion, a sufficiency of fuel, heat, and oxygen are sustained at one or more places on a home. The amount of heat transfer depends upon the fire's intensity, its distance from the home, and the duration (time) of the exposure.

WUI fire destruction occurs when the wildfire spreads from wildland fuels to residential fuels. For this spread to occur, the wildfire must close enough to transmit sufficient heat to ignite the flammable parts of a home. (Figure 1.) Given that fuel (homes) and oxygen are present, the key to home ignition becomes the transfer of heat to the home. There are three basic ways that heat can be transferred: radiation, convection, and conduction.

In a wildfire, as with any other fire, light and heat radiate out from the fire in all directions as energy waves. The intensity of radiant heat waves diminishes over distance, so the closer an object or structure is to a fire, the more radiant heat it receives. Given an intense enough wildfire, close enough to a house, for a long enough time, the house can ignite without coming in direct contact with flames or embers. Even if the exterior of the house is able to resist ignition, radiant heat may melt vinyl siding and window frames, break non-tempered windows and possibly even beam through windows to ignite flammable materials inside the house.

Convection is the transfer of heat through contact with heated air or other gases. If burning fuels are in close enough proximity to unburned fuels, the heated gases (flames) may contact the unburned fuels, and if the intensity and duration of contact are sufficient, the fuels will ignite. This type of ignition through direct flame impingement relies on the unburned fuels being close enough for the flames to make contact. Wildland fuels growing close to a flammable part of a structure is one situation that would make such direct flame contact possible.

Conduction is the direct transfer of heat between solid objects. Wood is generally a poor conductor, but in some situations it can carry heat. In the wildland-urban setting this type of heat transfer could result from a burning tree falling on a roof, but a much more common means of heat transmission is firebrands. Firebrands are burning embers blown by winds or carried aloft by the heat column of a fire. The embers lifted by heat currents can then be transported by prevailing winds, and they may not be controlled by fire lines or fuel breaks. Instead, they can easily fly long distances over fire control lines, as much as several hundred yards, carrying heat with them. If live firebrands land on flammable material such as a roof, a deck, patio furniture, or in vegetation growing near a structure, they can continue their slow burn, transmitting heat into that flammable material until it ignites.

Demonstrations of these principles of heat transfer and home ignition occur all too frequently along the Colorado Front Range. The 2002 Hayman Fire was Colorado's most devastating wildland-urban interface disaster until the 2010 Fourmile Canyon Fire in Boulder County. Fourmile Canyon was quickly surpassed by the 2012 High Park Fire and the Waldo Canyon Fire. At this time, the 2012 fires have not been thoroughly investigated, but reports from case studies of the earlier disasters have revealed important information about the conditions that may lead to homes being destroyed.

The Hayman fire burned 138,000 acres and 132 homes in 20 days. Surprisingly, 662 homes within the perimeter of the fire were not destroyed. Many of the homes that survived did so without intervention by firefighters. USDA Forest Service scientists Jack Cohen and Rick Stratton reported on the causes of home destruction in the "Hayman Fire Case Study". The study's objective was to determine if there were common factors among the surviving homes that might be helpful in preventing loss of homes in future wildfires. They found that trees torching or intense crown fires within 30 feet of a structure destroyed 70 homes. If a house was destroyed, but the surrounding trees did not burn, they assumed that surface fires or firebrands ignited it. They concluded that the remaining 62 of the 132 homes (47%) destroyed in the Hayman Fire were ignited by surface fires or firebrands.

This same team's report from their more recent study of the Fourmile Canyon Fire points out how research indicates that given extreme burning conditions, a home's characteristics and its immediate surroundings principally determine the home ignition potential. Consequently, home ignition commonly occurs over small distances - several dozen feet or less. This area is called the home ignition zone (HIZ). During extreme burning conditions, the flames from burning objects more than 100 feet from a home (outside the HIZ) do not directly ignite the home's combustible materials. Fire spreading into the HIZ, whether as a crown fire, surface fire or firebrands, must be closer than 100 feet and/or contact flammable parts of a home before ignition occurs.

A common perception of wildfire destruction is an intense wave of fire, such as a crown fire, sweeping away forests and homes. Conversely, low intensity surface fires may be seen as posing little or no threat. Previous fire investigations, reinforced by data from the Fourmile Canyon Fire, strongly suggest that neither of these perceptions is totally correct. Cohen and Stratton found that 83 percent (139/168) of the Fourmile Canyon Fire home destruction was not directly caused by the intense wildfire. Based on evidence such as unburned trees surrounding totally burned homes, they concluded that those 139 homes were more probably lost to surface fires creeping up to a flammable part of the house or directly ignited by firebrands from a distant, burning tree canopy.

Cohen and Stratton determined that home destruction was related more to a house and its immediate, site-specific surroundings than to the context of the larger fires. If the vegetation in the HIZ allowed high intensity fires to burn near the house or low intensity fires to come into direct contact, the home did not survive. If the vegetation kept high intensity fire at some distance and permitted only low intensity fires not in direct contact with the structure, the homes had a good probability of surviving. Flammability of roofs, decks, siding materials, and other house construction features raised or lowered the risk of flames igniting homes.

Fire resistant building practices and maintaining a fire resistant HIZ

are the main factors contributing to a home's survivability.

Tab 3: Wildland firefighting strategies and effectiveness

In response to any emergency, decisions must be made regarding the best use of the manpower, equipment and other resources available. In a wildland-urban setting where people and property are at risk, the priorities on a wildland fire are:

1. Protecting the lives of the public and of firefighters.
2. Suppressing the fire, while
3. Protecting property and other values.

To some, these priorities which place fire suppression ahead of protecting property may seem somewhat at odds with the CWPP priorities stated previously: lives first, property second, and all other third. The distinction lies in the fact that once a fire is burning, suppressing the fire, if possible and as soon as possible, is the best, most effective way to protect the most property. Depending on fire conditions and the availability of resources, firefighters will often be specifically assigned to defend homes and property, but the offensive strategy of attacking and suppressing the fire whenever possible is preferred.

Offensive strategies involve direct attack on the flaming front and flanks of the fire using ground crews with hand tools (hand crews), engines and hoses, heavy equipment, and even aerial water drops. Extreme fire behavior may make direct attack ineffective or dangerous for firefighters, and in such cases defensive strategies such as indirect attack and structure protection may be used. Indirect attack involves creating barriers or fire control lines some distance ahead of the flame front, essentially working ahead of the fire to establish containment at a place more accessible and advantageous to firefighters. Structure protection involves assigning engines and firefighters to defend one or more homes/buildings.

An important consideration when employing structure protection is the number of structures threatened versus the number and type of firefighting resources available. In cases where resources are insufficient to protect all of the structures threatened, firefighters will rely on structure triage to set priorities, by triaging (sorting) structures into one of the categories listed below, based on the level of threat and their ability to protect or defend those structures. The ultimate goal is to protect as many homes as possible with the limited firefighting forces available. Decisions will be made as to when and where the available forces should be deployed to be most effective – to save the most houses. This strategy of structure triage may necessarily sacrifice some less defensible homes in order to save more homes.

TRIAGE CATEGORIES

Defensible — prep and hold:

- Determining factor: Safety zone present
- Size-up: Structure has some tactical challenges
- Tactics: Firefighters needed on-site to implement structure protection tactics during firefront contact.

Defensible — standalone:

- Determining factor: Safety zone present
- Size-up: Structure has very few tactical challenges
- Tactics: Firefighters may not need to be directly assigned to protect structure because it is not likely to ignite during initial firefront contact. Patrol following passage of the firefront will be needed to protect the structure.

Non-defensible — prep and leave

- Determining factor: No safety zone present
- Size-up: Structure has some tactical challenges
- Tactics: Firefighters are not able to commit to stay and protect the structure. If time allows, rapid mitigation measures may be performed. Remember, pre-incident preparation is the responsibility of the homeowner. Patrol following passage of the firefront will be needed to protect the structure.

Non-defensible — rescue drive-by

- Determining factor: No safety zone present
- Size-up: Structure has significant tactical challenges
- Tactics: Firefighters are not able to commit to stay and protect structure. If time allows, ensure people are not present in the threatened structure. Patrol following passage of the firefront will be needed to protect the structure.

Decisions regarding firefighting strategies and tactics in the wildland setting will be determined by a number of factors, including *firefighter safety*, *fire intensity*, the *type of fuels* involved, *topography*, and the number and type of *firefighting resources* available.

- Firefighters must have safe access to approach and attack a fire, and must maintain clear, safe escape routes to pre-established safety zones. Lack of one or more of these safety considerations will necessitate a change in strategy/tactics.

- Extreme fire intensity can make it impossible for humans to even approach a fire, much less attack and control it. As a rule, hand crews cannot directly attack a fire with flame lengths greater than 4 feet. Direct attack on the front (head) of the fire with engines, heavy equipment and aerial drops can be effective with flame lengths up to only about 8 feet. With 8 to 11 foot flame lengths, there are likely to be problems with the fire torching, crowning and spotting, and any efforts to control the head of the fire will probably be ineffective. For flame lengths exceeding 11 feet, crowning, spotting and major fire runs are probable and control efforts at the head are ineffective.

- Fuels are a factor in decisions because they affect the fire's intensity and duration. Hand crews and other ground forces that could successfully combat fire burning in grass or brush may be overmatched by fire in heavy timber. During structure triage, homes that are most at risk because of flammable construction materials or surrounding wildland fuels may be categorized as non-defensible.

- Topographical conditions can not only influence fire behavior, but features such as extreme slopes or lack of roads can deny hand crews, engines and heavy equipment direct access to the fire, leaving aerial attack as the only offensive option. In difficult terrain, firefighters on the ground will often be forced to rely on defensive strategies.

- The number of firefighters, engines, aerial tankers and other resources must be sufficient to safely carry out the planned strategy, or the strategy must change to match the capabilities of the resources available.

Major fire events frequently occur during periods of weather and with terrain and fuel conditions that promote extreme fire behavior and a rapid rate of spread. In the first few hours of a major fire, the fire suppression response is often limited to the agencies within the community affected and its local surroundings. With extreme fire activity, the strategies of the initial firefighting response will likely be defensive in nature, relying heavily on aerial attack and primarily concerned with protecting public safety and the welfare of the firefighters. In such situations, the fire often gains a significant head start on the responders and in effect may burn beyond the control of firefighters for several hours or days.

This scenario was played out with disastrous effects in the 2010 Fourmile Canyon Fire near Boulder, where extreme burning conditions overwhelmed the initial wildfire suppression efforts. The data from the report of that fire shows that there were 474 homes lying within the area that burned, and during the 7 days before the fire was contained, a total of 168 of those homes (35%) were destroyed. Significantly, because the fire grew and spread rapidly while the early firefighters were still arriving on the scene, 157 of the 168 homes lost (93%) were destroyed within the first 12 hours.

The report concludes that even with idealized assumptions regarding their capabilities, the total firefighting resources available by the end of those first 12 hours (25 engines and 200 personnel) would have been insufficient to protect the 157 homes that burned, much less the total 474 that were potentially threatened. In the following excerpt from their report, the investigators noted that the ineffectiveness of the initial firefighting efforts on the Fourmile Canyon Fire was not uncommon for major fire events.

"This scenario of overwhelmed wildfire suppression and structure protection capabilities is comparable to the findings of previously examined home destruction associated with extreme burning conditions. With most residents evacuated and firefighters unable to protect most homes, any home with a sustained ignition resulted in total destruction. However, the total destruction of homes is not indicative of high intensity, massive flame fronts engulfing a destroyed home. Rather, all homes with any sustained ignition freely burned to total destruction due to a lack of available people to extinguish initial ignitions."

Even during later stages, several hours or days into a firefighting effort, abrupt changes in a fire's behavior (usually weather driven) can still overwhelm all of the suppression capabilities on hand. Sudden erratic winds, such as outflow from a thunderstorm, can cause a fire which seems to be well on its way to be contained and controlled to flare up and jump containment lines. Until a fire is extinguished, there is always a possibility that it will flare up, escape containment and regain the upper hand over firefighters. Even the best efforts of the most capable firefighters cannot control a fire when nature takes charge.

Appendix D – Wildland Fuels Treatment / Forest Management

Tab 1: Fuels treatment goals, strategies, methods and effects

Of the three factors that determine wildland fire behavior - fuels, weather and topography - only fuels can be readily managed to reduce the intensity and spread of a wildland fire. Wildland fuel treatment, also referred to as fuels reduction or fuels modification, is the alteration of wildland vegetation to reduce the likelihood or minimize the effects of major wildland fires. Fuels treatment for wildfire hazard reduction will not eliminate the chance of wildfire but, if properly managed, can create landscapes in which fire can occur without devastating consequences.

The most appropriate fuel treatment methods vary with forest type and the lay of the land - there is no such thing as a ‘‘one size fits all’’ fuel treatment design. Topography and accessibility may restrict treatment options. In part because of terrain and also because of the myriad combinations of surface, ladder and canopy fuels, fuel treatment projects require at least some degree of site-specific analyses.

Goals

Forests cannot be fire-proofed. Wildland fuel treatment will not prevent wildland fires. The overall goal of wildland fuel treatment is to create an environment in which fires may burn without disastrous effects on people, property and forests. Specific fuel treatment goals will vary with *land use*, *current conditions*, and the *ecology* of the site.

- Wildland-urban residential developments obviously require some different fuel treatment objectives than totally undeveloped wildlands, specifically the protection of residents and their homes.
- In the absence of previous fire activity and effective growth management, the current overgrown conditions of many forests will dictate different approaches than those that would otherwise be required for a well-managed forest.
- Although the ecology of a wildland-urban area is not always a major consideration in planning fuels treatment objectives, the health of the forest along with other ecological concerns can be factored into plans, even if only as a by-product of hazard reduction

Strategies

Fuel treatment projects involve strategic decisions about timing and placement of fuel treatments to accomplish as much as possible with finite resources. Decisions regarding fuel treatment objectives, which will in turn provide the focus for future plans and actions, should be based on previously determined priorities. Two of the most commonly employed strategies to protect people and property can be generally referred to as defensible spaces and fuel breaks.

Defensible space and the often related terms of survivable space and home ignition zone are all concerned with the area immediately surrounding a home or other structure. Defensible space implies that wildland and other fuels around a home have been reduced to the point that the home can be successfully defended from wildfire. Survivable space suggests that the fuel hazards have been reduced even further so that the home can likely withstand a wildfire even if no one is there to defend it. The home ignition zone refers to the space in which fuels exposed to wildfire may pose a risk to a home. The strategy behind all three of these terms involves reducing the amount of fuels in proximity to the home, so that an advancing wildfire cannot burn hot enough, long enough or close enough to ignite the home. A primary goal of thinning would be to reduce structure ignitions by minimizing ignition sources around homes. While large scale fuel treatments separate from structures have proven to be largely ineffective in reducing the risk of home destruction during extreme fire conditions, reducing fuel hazards in the immediate vicinity of the home have proven very effective.

Another strategy may be thinning to enhance fire suppression efforts by creating fuel breaks or fuel reduction zones. A great deal of debate has gone into arguing the merits of fuel breaks and other spatially contrived fuel treatment configurations. Fuel breaks are usually constructed by thinning relatively large, linear areas along roads or ridge tops. These areas of reduced fuels are intended to aid in suppression efforts by reducing the ultimate fire intensity and providing relatively safer areas to access the fire and establish control lines. Based on studies conducted following major fires, their effectiveness in consistently accomplishing these goals is yet unproven, although they have proven effective in certain situations. Fuel breaks have been successful in causing crown fires to drop to the ground and in reducing the intensity of surface fires, but can be easily defeated by wind driven fires and spotting. A fuel break is meant to be defensible line, not a stand-alone defensive barrier, and should not be relied upon to stop a wildfire.

Fuel breaks are not the same as fire breaks. Fire breaks, or fire lines, are fuel-free, linear barriers such as paved roads or dozer lines scraped down to mineral soil so there is nothing for the fire to burn. Their purpose is to stop the progress of a fire. Fire breaks are sometimes built at the beginning of each fire season and then require maintenance throughout the season to keep fuels from growing back. They are more often built as an immediate response to a fire, for example, a dozer or hand crew cutting a line ahead of an advancing fire.

Methods and effects

The methods of carrying out fuel reduction strategies are many and varied, and there is no single one-size-fits-all scheme for reducing wildland fuel hazards. There are four basic types of fuels treatments for fire management: *mechanical, prescribed fire, fire use*, and *other*.

- Mechanical treatments are those projects involving the use of anything motorized such as chainsaws, dozers, and/or chippers.
- Prescribed fire treatments are those projects which involve igniting a fire under very restricted and conditional criteria in effort to protect, maintain, or restore resources or conditions.
- Wildland fire use treatments involve projects which utilize natural ignitions and manage these fires appropriately and to our benefit.
- Other types of treatments include grazing, seeding and the use of chemicals.

Choosing the method(s) to be used will necessarily be based on *practicality*, *effectiveness* and *costs*.

First, the type of treatment selected must be suited to the area to be treated. Topography and accessibility will restrict treatment options. There may be few areas where the use of heavy equipment would be possible or cost effective. Prescribed fire and wildland fire use are not appropriate for previously untreated wildland-urban residential areas where escaped fire can have disastrous results. Some of the less common methods mentioned above, such as grazing and chemical use, generally have limited applications in specific settings or fuel types, but could be considered in some situations.

Next, the method must achieve the desired effect. In many, if not most situations, a combination or adaptation of a variety of methods may be required to obtain the results wanted. For example, combining mechanical thinning of surface/ladder fuels and selective reduction of the canopy, followed by removal of timber and chipping of slash can provide significantly better results than any single method. If mechanical thinning does not treat surface fuels or deal with the slash created, it can actually increase the fuel hazard in the treated area. Similarly, reducing canopy cover can increase surface growth over time, eliminating any short-term benefit that might have been achieved.

Often the decision regarding which fuels treatment method to use will be based largely on costs, either in dollars to be spent or in the time and effort to be expended by volunteers. An important consideration when looking at costs is the impact or results achieved for the dollars or hours invested. Relatively easy work over a large area may cost considerably less per acre or per hour, however, more difficult, more expensive work may do much more to protect higher priority values. Spending limited resources to get the “low-hanging fruit” may not be the wisest investment. The true value of the work should be determined by the results, the degree to which it reduces risks and adds protection, rather than simply the cost per acre.

Mechanical thinning is a common means of reducing fire hazard. Tree removal can play an important role in treating fuels, especially removal of small understory trees that can provide a ladder into the forest canopy, but is subject to site specific limitations. Thinning is not an appropriate option in some forest types and in some geographic locations.

Guidelines for treating wildland fuels with thinning involve four principles: reduce surface fuels, increase the height to the canopy, decrease crown density, and retain big trees of fire resistant species. Exactly how thinning alters biomass fuels depends on the approach used and on what is done with the biomass left on the site. There are three basic approaches to thinning.

- Low thinning, or thinning from below, removes the smallest trees, those with the poorest form and other ladder fuels.
- Crown thinning, or thinning from above, removes the larger trees to open the canopy and stimulate growth of the remaining trees.
- Selection thinning, removes the least desirable trees for the future stand, commonly the less desirable species and trees with poorer form.

Thinning for fire hazard reduction, specifically to reduce the potential for crown fire, should concentrate in general on the smaller understory trees to reduce vertical continuity between surface fuels and the forest canopy. In many cases the overstory can be left largely intact, in effect creating *shaded fuel breaks*, although in some cases it may be desirable to reduce the horizontal continuity of the canopy as well by thinning some bigger trees. Thinning to reduce crown fire potential requires careful evaluation of the tradeoffs in treatment effects on potential surface fire behavior.

Thinning may potentially result in increased surface fire behavior, for several reasons. First, thinning reduces the moderating effects of the canopy on windspeed, so surface windspeed will increase. It also results in increased solar radiation on the forest floor, causing drier surface fuels. It may also cause an increase in flammable grassy and shrub fuels over time, due to the increased sunlight and reduced tree competition.

Thinning large trees alone does not typically constitute an effective fuel treatment, but instead must be combined with treatment of surface fuels. Unless thinning also includes removal of cut fuels and treatment of other surface fuels, it can actually increase surface fuel loads due to the added slash created by the harvest activity. Thinning ideally needs to be followed by removal of the newly created surface fuels by chipping, prescribed fire or pile burning. When chipping or burning is not feasible, slash should be lopped and scattered.

In some areas and certain fuel types, another option for reducing hazardous fuels is prescribed fire. Prescribed fire, also referred to as prescribed burning or by some as controlled burning, is any fire ignited to meet specific objectives. Use of prescribed fire is widely accepted as a primary tool for reducing hazardous fuels in appropriate settings and under appropriate conditions. Where possible, the use of prescribed fire is often preferred over other fuel reduction methods because it is generally cheaper and yields ecological benefits that cannot be achieved by other means.

Prescribed fire is typically used to remove surface fuels such as grass, limb litter and underbrush from beneath stands of trees, usually in relatively open or undeveloped areas. In some instances it may also be effective in raising canopies by burning or singeing the lower limbs on the larger trees. It is not useful in previously unmanaged, untreated areas with significant ladder fuels which would carry the fire into the canopy. The presence of such ladder fuels, other unfavorable fuel and/or terrain conditions as well as the presence of closely spaced residential or commercial properties could make the use of prescribed fire unsafe or impractical.

Use of prescribed fire requires a sound understanding of fire behavior and technical expertise in the application of fire. To be effective and safe, prescribed fires must be carefully planned and executed under the right conditions. A written, approved plan, or prescription, must exist, and must meet applicable federal and state requirements.

Wildland fire use, allowing fires ignited by nature to burn in wildland areas, has become more accepted in recent years as a natural means of reducing fuel loads. While potentially beneficial to a wildland ecosystem, allowing even a low-intensity fire to burn within a previously untreated wildland-urban setting would run contrary to the primary WUI objectives of protecting lives and defending property. In the WUI, the risks of fire use, prescribed or otherwise, are more than most residents or firefighters would be willing to accept, and are unwarranted when other methods can be used more safely.

In comparison, thinning has several advantages over prescribed burning and wildland fire use for reducing fuels. First, it is more controlled; which fuels are cut and which trees are left can be selected, and the operation can be halted at any time. Another advantage is that low thinning can emphasize eliminating ladder fuels, which is of major concern in reducing the risk of crown fires. A third advantage of thinning is that any of the three approaches; high, low or selective; will reduce crown density to some degree.

Tab 2: Silviculture and Wildfire Mitigation

Foresters manage trees not as individuals but in groups called stands. A stand of trees is defined as a group of trees that are similar with respect to age, species composition and other characteristics. Each stand is different from the ones nearby, and each landowner may have different objectives in addition to wildfire mitigation.

Thus, the information that follows is intended to be a general and highly simplified summary of the basic concepts of wildfire mitigation. It is only intended to give the reader an idea of how foresters approach the process of prescribing treatments for fire mitigation. When planning private fire hazard mitigation, an initial consultation with a forester is recommended. Specific prescriptions for any forest stand are best developed when the existing conditions of the stand and the landowner's specific objectives are known.

Although foresters may use many characteristics of trees to categorize them, the most common--and useful when discussing fire mitigation--is the tree's tolerance to shade. Shade tolerance means the ability of a tree to germinate and grow in the shade of other trees. Species of trees vary in their tolerance to shade, but they can be grouped by those that require sunlight for germination and those that require shade.

Shade Intolerant Trees

Shade intolerant trees are those that require full sunlight to sprout and grow to maturity. Shade intolerant trees are those that first colonize a site after a disturbance, such as wildfire, removes the existing trees. For this reason, ecologists call these pioneer species. Aspen, the most shade intolerant of local species, will send up new sprouts within days after a fire destroys the old trees. Shade intolerant trees common to this area include aspen, ponderosa pine, lodgepole pine, Gambel oak, and piñon and juniper.

Figure D-1 The ponderosa sections in this photo illustrate how tree diameter is not a reliable indicator of age. The center section is 100 years old; section 2 is 99; section 3 is 101; section 4 is 90; section 5 is 85; section 6 is 130; section 7 is 81. (Sculpture by Bill Wallace. Photo by Bill Buckman, courtesy of the Black Forest Slash & Mulch Program)

It follows that if the trees in a particular area grow in following a disturbance, all the trees in a stand will be of roughly the same age. As the trees compete for sunlight, water and nutrients, the most vigorous become the dominant trees in the new stand. The dominant tree soon outgrows its siblings, yet the weak trees remain in the understory stunted and overtopped. Thus in shade intolerant stands, small trees are not young trees, but merely suppressed.

Following are some important species of shade intolerant trees with respect to fire mitigation:

Ponderosa pine: Of all the species of trees in the local area, ponderosa is the best adapted to survive a low intensity wildfire. First, the thick bark of the tree acts as insulation from the heat of the fire. Second, as the upper branches shade the lower branches, the low branches die, and in time, are broken off. Thus there are fewer low hanging branches to act as ladder fuels. Fires that burn in the grass and litter under a mature ponderosa rarely harm the tree.

Aspen: As noted earlier, aspen are the most shade intolerant of local trees. Unlike the ponderosa, aspen bark is thin and the tops of the trees are killed by even the coolest fire. The root system however is insulated from the fire's heat by the ground, and when the tree tops die, the roots respond by vigorously resprouting.

As a deciduous tree, aspen will not carry a fire in the tree crowns, thus fires drop to the ground in aspen stands. For this reason aspen are desirable trees to retain in fuel breaks and defensible spaces. Furthermore, aspen are desirable wildlife trees, and many stands are becoming shaded out by conifers due to years of fire suppression.

Since wildfire mitigation practices almost always require thinning, many landowners assume that aspen should be thinned as well, but they should not. Thinning aspen is rarely recommended since the falling trees invariably wound the remaining trees. The bark on aspen is so thin that any wound will expose the tree to many different fungal diseases that are eventually fatal. Fire mitigation in aspen should be limited to removal of dead trees if care is taken to avoid wounding live trees, cleaning up down dead wood, and removing conifer regeneration from the aspen understory.

Lodgepole pine: Lodgepole tend to grow at higher elevations than ponderosa, and unlike ponderosa they are not well adapted to survive frequent low severity fires. Instead, they are prone to infrequent stand replacing crown fires. Lodgepole resprout after a fire by virtue of their closed or serotinous cones. Serotinous cone scales are "glued" shut by sap, and the heat of the passing fire melts the sap causing the cones to pop open. Seeds fall on the bare ground free of competition from other plants. As the seeds sprout, a new dense stand of lodgepole—"doghair" (slang for thicker than the hair on a dog's back)—develops.

The dense nature of lodgepole stands has important implications when attempting to mitigate wildfire hazard. The density of the stand protects the trees from the wind, and they do not become firmly rooted. If one attempts to thin lodgepole heavily the remaining trees will often blow down. Lodgepole should be thinned lightly or patch cut to avoid blow down.

Gambel (scrub) oak: "Scrub" oak may not be a tree, but it is a common and often dangerous fuel type. Fire mitigation usually consists of creating openings and linear pathways to break up the continuous stands. Openings in oak should be a minimum of two-and-one-half times the height of the adjoining oak clumps.

When cut, oak tends to resprout vigorously, and it is often difficult to maintain fuel breaks. Continued mowing of fuel breaks cut in oak is often necessary to keep the sprouts down. Resprouting can be greatly reduced if the cut stumps are treated with a herbicide such as Garlon IV or Roundup within an hour after the stump is cut.

It is also helpful to thin the lower branches and sprouts within remaining clumps of oak to reduce ladder fuels. Such thinning will slightly reduce resprouting, but it should not be considered as a substitute for separating oak clumps with adequate space.

Scrub oak can also be a dangerous ladder fuel when growing underneath or adjacent to conifer trees. As a rule of thumb, oak should be cut back at least twelve feet from the dripline of any conifers in fuel mitigation projects.

Piñon and juniper woodlands: There are extensive areas of piñon juniper woodlands in the foothills of El Paso County mostly on Fort Carson and in the Southwestern 115 Fire Protection District where the trees can be quite dense and are often interspersed with thickets of Gambel oak. This combination can result in severe fire hazards. Juniper can be a particularly volatile tree because the plant has high concentrations of oil in the scales.

Fire mitigation in piñon juniper woodlands is typical for shade intolerant trees. Space should be created around trees to prevent crown fires and ladder fuels, particularly oak should be removed as recommended above. Due to the volatile character of juniper, piñon should be favored as the "leave tree", but this should not imply that all junipers should be eliminated since they are valuable wildlife trees. Where juniper is selected as leave a tree, allow more space around the tree.

Shade Tolerant Trees

Shade tolerant trees are those that will sprout from seed and grow in the shade of the existing forest canopy. Shade tolerant trees are usually found on the cooler moister north facing slopes of hillsides and in moist drainages. In fact, most shade tolerant trees require shading for the seedlings to survive. A seedling in direct sunlight will often be burned by the sun. As a result stands of shade tolerant trees contain trees of many ages. The most common shade tolerant trees in the area are Colorado blue spruce, Engelmann spruce, Douglas-fir, and white fir.

Spruce: Colorado blue and Engelmann spruce are so similar that they may be considered together for discussion of fire mitigation. Colorado blue spruce is usually found in lower altitudes (below 9,000 ft) while Engelmann spruce is usually found above 9,000 feet. The ability of seedlings to survive in the shade of mature trees usually creates dense forests with a closed canopy above and thickets of ladder fuels below. The typical fire regime in spruce is an infrequent stand replacing crown fire.

Like lodgepole pine, spruces tend to be shallow rooted and excessive thinning of the upper canopy can result in wind throw in the remaining trees. Typically fire mitigation prescriptions for spruce require creating openings of one tenth acre or larger with clumped trees between the openings. Removal of small trees in the understory of the clumped trees reduces ladder fuel.

Douglas-fir: Typically Douglas-fir are found on cooler north facing slopes in lower elevations and mixed with spruce in higher elevations. It is in the lower elevation ponderosa pine forests where Douglas-fir has become the most serious concern for wildfire mitigation. After a century of fire suppression in lower elevation ponderosa pine stands the canopy has closed, shading the forest floor. As a result, Douglas-fir has invaded the understory of the ponderosa stands creating dense thickets of ladder fuels.

Douglas-fir are firmly rooted trees and can be thinned much the same as ponderosa pine. In lower elevation ponderosa stands most Douglas-fir should be eliminated, especially the ladder fuels. There is an important exception to this general rule where the ponderosa are infected with dwarf mistletoe. In such situations the landowner may choose to favor the Douglas-fir since they are immune to the ponderosa pine dwarf mistletoe. In such cases, special attention should be given to providing adequate separation between the crowns of larger trees and pruning the lower branches from the Douglas-fir to reduce ladder fuels.

Where Douglas-fir is intermixed with less wind firm spruce, they can be favored to maintain forest cover. It is still important to prune the trees to remove ladder fuels.

Thinning and Fuel Reduction

Foresters use many methods of thinning depending on the specific objectives of the landowner. Fuel break thinning is most often accomplished by a process called thinning from below. Trees are usually removed or remain based on their height in the canopy.

Figure D-2. Thinning from below on the Black Forest School Section. These trees were first thinned in about 1980, and dense regeneration was thinned again in 2008.

For simplicity, trees can be divided in three levels in the forest canopy. The largest trees at the highest level of the canopy are called dominants. These are usually the most vigorous since they have the largest root systems, most leaf area and receive the most sunlight. Next are the co-dominant or intermediate trees. These trees occupy the middle level of the canopy, but tend to be crowded and of smaller diameter. They are less vigorous with smaller root systems and fewer leaves as the result of crowding by the dominant trees. At the lowest level of the forest canopy are the overtopped trees. These are completely shaded by the dominant and co-dominant trees.

As noted earlier, it is a common misconception in shade intolerant stands that the diameter of a tree is an indicator of its age. Often the co-dominant and overtopped trees are as old as or older than the dominant trees. In pure shade intolerant stands young trees are usually found in openings in the canopy, and can be recognized by having a diameter proportionate to the tree height, and a conical shape. If there are truly young trees in the stand it is desirable to leave some to increase diversity. Thickets of young trees should be thinned to give adequate growing space.

Thinning from below removes all of the overtopped and most of the co-dominant trees. It is essential when thinning for fuel breaks to remove ladder fuels and create enough openings in the forest canopy to reduce the crown fire risk. Thinning from below is desirable in fuel reduction projects because it 1) leaves the most vigorous trees on the site, 2) creates openings in the forest canopy by removing the less vigorous co-dominants, and 3) eliminates ladder fuels by removing the overtopped trees, shrubs, and pruning lower limbs of remaining trees.

Generalized Prescriptions for Wildfire Hazard Mitigation

In a broad sense there are two generalized categories of mitigation. First is survivable (similar to defensible) space thinning around structures to increase the chance that the structure will survive a wildfire. Second is fuel break thinning away from structures to reduce severe fire behavior and give firefighters a safer place to work and possibly halt an approaching wildfire. Both approaches require thinning of the canopy and removal of ladder fuels. As noted in the previous section, the approach will vary depending of the forest conditions existing on the area in question.

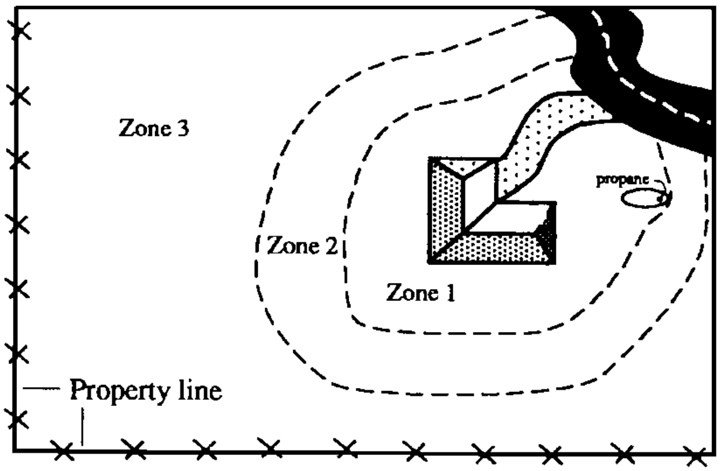


Figure D-3 Diagram of survivable space showing the three thinning zones.

Protecting Homes with Survivable Space

Thinning around homes is different than thinning for fuel breaks. Thinning for survivable space is designed to protect structures from the heat of wildfires. Survivable space includes both thinning around structures to reduce the heat from burning vegetation and reducing flammability of the structures to protect them from wind borne embers. Further information about increasing the survivability of structures is found on the CSFS website at: http://csfs.colostate.edu/pages/pub-csfs2.html

Survivable space is defined as an area around a structure where existing vegetation is modified to slow the rate and intensity of an advancing wildfire. This includes selective removal of trees around structures in two or three concentric management zones. Fuels are reduced according to prescriptions for each zone.

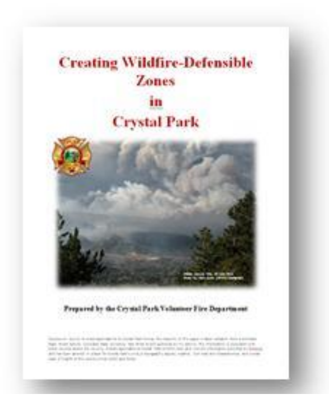


Figure D-4. Available at http://www.crystalparkvfd.org/

Zone one: This is the closest zone to a structure, and extends 15-30 feet from the outer most edge of a structure including any decks. The management goal is to reduce or eliminate most large trees or shrubs within this zone so that they cannot produce intense flames and heat capable of igniting the structure. A few tall trees may be left in zone one if the lowest branches are pruned so that they are well above a fire resistant roof. It is best to limit this to one or two trees near a structure. Treat such trees as part of the structure and create 15-30 feet of space outside the tree.

Zone two: The width of zone two depends on the slope around the house. If the average slope angle is less than 5%, zone two extends out 55 feet from zone one (70 feet total distance around the house). If the slope is more than 5%, zone two extends 85 feet from zone one (100 feet total) on the downhill side of the house. The distances on the other house sides are 55 feet.

The main fuels reduction guideline for zone two is to thin the trees to an average spacing of 10-feet crown separation. All ladder fuels under trees should be removed. The branches of dominant trees should be pruned to a height of 8 feet above ground, but small trees should have at least two-thirds of the green needles remaining.

Zone two should extend along both sides of driveways for a width of 50 feet on each side of the drive. This is important to allow safe access and egress for emergency vehicles. Adequate clearance should be maintained to allow access to large structural fire trucks. Twelve feet of horizontal clearance and 13 feet of vertical clearance should be maintained. At the end of driveways, adequate room for a large fire engine to turn around should be maintained. Firefighters must be able to escape quickly if conditions suddenly deteriorate.

Zone three: The guideline for zone three is to thin the forest primarily to improve forest health. Spacing is less critical in this area but some spaces should be made in the canopy. A useful rule of thumb is that a tree should receive sunlight from all four sides.

There is a publication available titled *Landowner Guide to Thinning* that is an excellent reference. The booklet is no longer in print, but is still available on the CSFS Website at http://csfs.colostate.edu/pdfs/landowner_g4thin_scr.pdf.

One comment should be made about the publication's recommendation that trees should be thinned to an average tree spacing based on the "D+7 Rule". After reading the booklet, many landowners feel that this arbitrary spacing should be the primary objective when thinning. The spacing rule should be considered a guideline but not the objective of a thinning project. In fact, the primary objective is always to leave the healthiest trees. It should not be to achieve a predetermined spacing.

Thinning for Fuel Breaks

Fuel Break thinning is most analogous to zone two of survivable space except that rather than being centered on a structure, fuel breaks are linear. Because winds and preheating from flames tend to push fires uphill, ridge tops (as opposed to midslope fuel breaks) are superior locations. Many fuel breaks are centered on roads. It is desirable to place fuel breaks along roads to provide safer evacuation routes from communities during wildfires, and the access provides firefighters a safer and more convenient place to attack an approaching fire.

On flat terrain, a fuel break should have a minimum width of 300 feet. Wider fuel breaks are always superior, and where they are located on slopes, width should be increased. Where fuel breaks are located on slopes, the spacing between tree crowns should also be increased. Refer to the CSFS publication *Fuel Break Guidelines for Forested Subdivisions and Communities* available from the Woodland Park District or on the web at: http://csfs.colostate.edu/pdfs/fuelbreak_guidellines.pdf

One objective of any mitigation project should be to enhance the diversity of forest stands. Bitter experience has shown that when all trees are the same species and the same age, catastrophic losses to insects or disease are sure to follow. Most insects or diseases are specific to certain species of tree and certain ages. Thus diverse forest stands are less prone to complete mortality from one cause. If a forest stand consists of one species attempt to leave trees of different ages, or thin in such a way that regeneration of new trees is promoted. A forester can recommend methods of thinning that reduce fire hazard and increase forest diversity.

When thinning for fuel breaks it is not necessary, or even desirable, to remove all dead trees or pick up all dead wood from the forest floor. Some standing dead trees, or snags, should remain as habitat for wildlife. The most desirable snags are trees larger than ten inches in diameter that are widely spaced. Avoid leaving more than three snags per acre. Do not leave dead trees in zones one and two of survivable space or where they might fall across roads or power lines.

Likewise, some down wood is desirable. Large concentrations of down woody material should be removed, but isolated down logs in varying degrees of decay can remain as cover and habitat for small mammals.

While it is wise to rake up pine needles from zone one of a defensible space, it is not necessary to so elsewhere. Needles on the forest floor act as mulch retaining moisture in the soil, reduce erosion, and add organic matter to the soil as they decay. If regeneration of new trees is an objective, however, it is desirable to expose some bare soil since this will promote seed germination and establishment.

Slash Treatments

Slash treatments will always be needed to clean up the residue from any forest thinning treatments. Untreated slash will only increase the fire hazard—possibly undoing all the good of thinning. It can also attract undesirable insects to the area—primarily ips beetles and turpentine beetles. Slash treatment may be the most labor intensive, and, thus expensive, part of any fuel mitigation project.

Lop and Scatter: This treatment consists of using saws or equipment to cut the slash into smaller pieces so that the height of the remaining slash is reduced, usually less than 12 inches high by 24 inches long. It may be the only practical treatment in areas where chippers are unavailable, prohibitively expensive, or in inaccessible locations. It is usually the lowest cost treatment since no special equipment, other than a chainsaw, is required.

The treated slash is left to decompose, and until it breaks down it will be unsightly. Over the course of several winters, snow pack pushes the slash down and it decomposes. Decomposition usually requires three to five years or longer if larger material was present. It also creates an extremely flammable fuel bed until it decomposes, which can be easily ignited, and burns with high intensities. It should not be used adjacent to high values, such as homes, or areas prone to regular fire occurrence.

Lopped and scattered slash can also lead to problems with Ips or turpentine beetles. The beetles may lay eggs in green slash and the brood may emerge to attack living trees. This problem can be alleviated by doing any forest restoration treatments requiring this method in the fall and winter when the beetles are not active and by cutting slash into small pieces that dry out quickly.

Chipping: Chipping is the grinding up of the slash into small pieces, usually less than a few inches in diameter. Material can be chipped and left, or removed for off-site disposal or as a product.

It requires mechanized equipment to perform the chipping. The slash must be brought to the chipper, unless it is an expensive mobile chipping piece of equipment. Either way, it can quickly become a very expensive operation.

Chipping is a common method of slash disposal in the defensible zones around structures. Chips do not significantly contribute to fire hazard around structures since they produce low intensity fire behavior. Large piles of chips should be avoided however, as they could smolder for a significant amount of time. Chips should be spread along the ground to a depth of less than four inches.

Chipping is an effective means of treating wood infested with bark beetles since the insects will not survive in the small bits of wood. Green slash that is promptly chipped will not harbor infestations of ips, turpentine, or other bark beetles. Chips also can pull nitrogen out of the soil, reducing the productivity of the ground.

Community Chipping Projects: Many communities have found that an effective way to promote mitigation is to sponsor a community chipping program. They have discovered that landowners are quite willing to undertake the effort of thinning trees if there is a simple low cost way to remove the slash. Community chipping usually consists of one of two approaches.

First is the community slash site where landowners may drop of the slash at a designated area. The slash is then ground and given away as mulch or used in some sort of reclamation activity. Most sites are open on designated days and manned by volunteers from the sponsoring community. Some slash sights that are not gated and are unmanned have reported some problems with illegal dumping, although this seems to be a rare occurrence. Rather than collection sites other communities have paid for roll off dumpsters to be placed at certain locations for collection of slash.

The second method is the drive by chipping program. The community contracts with a tree service or mitigation contractor to bring a chipper to the community on a certain day. Residents with slash to dispose of may drag it to the curb where the contractor will chip it on site. Commonly the chips are blown back onto the property. Usually an official from the homeowner's association or mitigation committee coordinates the program, and records the location of slash piles for the contractor.

Trampling, Crushing, or Roller Chopping*:* This is using heavy equipment, usually a dozer, to run over the slash, breaking it down in both size and height. It can be done with just the tracks or by also pulling a heavy, water filled drum with cutting blades welded on it.

It is very effective and can also crush and break up heavy fuels such as down logs. However, the slash must dry, usually for several seasons, to make this treatment truly effective. There is an increased fire hazard in the interim.

There is an additional benefit to crushing or trampling. The material is not only broken down, but also driven into the soil. This can add nutrients to the soil faster, create small pockets in the soil surface for holding water, and decrease the potential for erosion.

Pile Burning: Any form of open burning requires a permit. The sheriff in each county is by law the county fire marshal, but often the authority to issue burn permits is delegated to the local fire protection district. Anyone contemplating pile burning should check with the sheriff's office in the early planning stage to determine the proper procedure to obtain a burn permit. Burning must be done only under the conditions stipulated in the permit. In some counties where air quality is a problem, private land burning, is also regulated through the State Department of Public Health and Environment, and requires a smoke permit. The open burning page of the DOPHE website for the department is: http://www.cdphe.state.co.us/ap/openburnfaq.html

Piles can be constructed with equipment or by hand. Piling with heavy equipment should only be done with a brush rake and not a regular blade. Piling with a regular blade will include significant amounts of dirt, which will make the pile harder to burn, create more smoldering and smoke, and will hold heat longer which adds to the risk of an escape at a later date.

For most landowners the slash is piled by hand and burned when conditions are safe—usually several inches of snow on the ground that will persist for a couple days. This will depend on what type of material is contained in the pile. Material greater than five inches will take longer to burn and will hold heat for more time. Piles burn best when they are relatively compact, contain material less than one inch in diameter, and the height is greater than the diameter. This arrangement promotes hotter burning and less smoke.

It is important that burn piles should not be located directly adjacent to or under the canopy of trees or other flammable material. Separation should be greater on the downwind side. It is easy to scorch living trees from the heat of the burning pile, even in winter. Avoid making burn piles on top of stumps. Stumps will smolder for extended periods of time.

Often piles must sit through the summer in order to dry, or piles from one season may be left over the next summer if proper burning conditions do not occur during the winter. In each case the dry woodpiles will sit through a burning season with the risk of ignition.

The fire should be monitored during the day and for several days thereafter. The center of a pile usually burns completely, but often wood around the edges does not. To ensure that the slash at the edge of each pile burns it is necessary to "chunk in" the piles periodically. This means that as the fire at the middle of the pile burns down to a low flame, wood from the edges should be thrown into the center to insure complete burning of all slash.

The burned slash pile must be monitored and may need to be cooled below the point of combustion, a process called "mopping up." This is especially important on south and west slopes where the snow melts off quickly and may be followed by dry windy weather.

For several years after a pile is burnt, an unsightly black ring remains where the heat of the fire scorched the soil. Many landowners find these unpleasant to look at. They may also present an opportunity for noxious weed to colonize the bare soil. Breaking up the burned soil with a rake and reseeding with native plants is recommended.

Maintenance

Survivable space, fuel break thinning, or any type of forest management, does not end when the initial project is finished. Continual maintenance is an essential part of any forest management program. Even in well managed forests trees will die, storms and wind will damage trees, and new trees will germinate.

Trees should be inspected every spring for any sign of damage from winter or spring snows or wind. Prune any broken branches if they are not too high in the tree, and trees bent by heavy winter snows should be removed. Check for any signs of insect activity or disease.

Late October is the best time to inspect trees for attack by mountain pine beetles. Beetles have finished attacking trees at this time, and there is adequate time to cut and treat the tree before the adult beetles fly the next July.

At five years, check the canopy closure, especially in zones one and two. Remove any trees necessary to maintain openings in the canopy. Do any additional pruning or removal of trees and shrubs to eliminate ladder fuels.

After ten years, dense thickets of young trees (regeneration) may have become established, and these will need to be thinned. Not all regeneration should be cut since trees of various ages are important for forest diversity. Young trees in openings with adequate room to grow should remain. Regeneration that is likely to become ladder fuel or crowded by other trees should be cut. Depending on their objectives, landowners may want to consider removing some of the larger trees to make room for the younger ones.

Tab 3: Insect and Disease Conditions

Literally thousands of insect and diseases are present in forested areas. Fortunately, like the common cold, most do no serious or lasting damage. But when in poor health, trees, like humans, are more prone to infection from other causes; the concept of preventive medicine applies to forests, as well. Maintaining forests in good health will prevent problems in the future. For the most part, forest insect and disease issues are similar across the region.

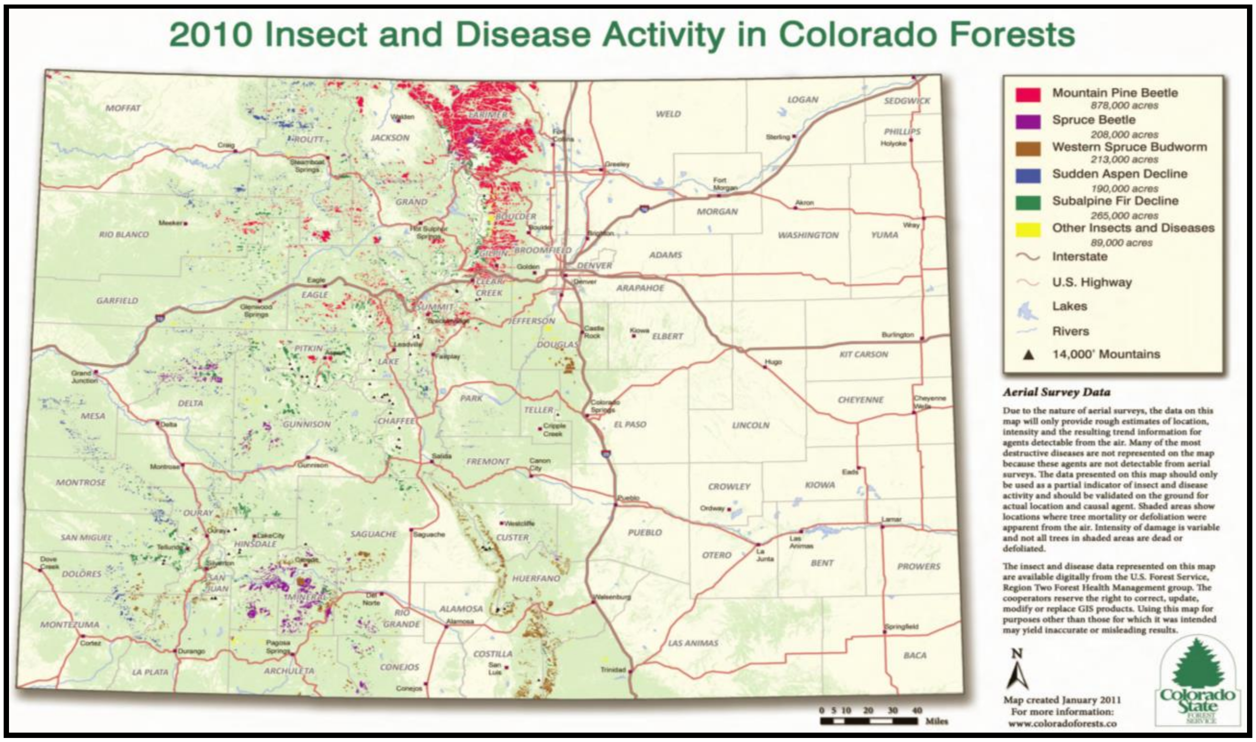


Figure D-5. Aerial detection of insect and disease conditions from the 2010 flight. Courtesy of Colorado State Forest Service

Every summer, insect and disease specialists from the USDA Forest Service and Colorado State Forest Service (CSFS) survey Colorado's forests from the air to monitor insect and disease outbreaks. These flights are an excellent means of finding new areas of insect and disease activity and monitoring trends in existing outbreaks. Maps of the previous year's findings are published in January and can be found on the CSFS website at http://csfs.colostate.edu/pages/common-insects.html.This link also contains more detailed information on the insect and disease issues presented here.

The lack of large scale insect and disease activity within the area should not be inferred to mean no insect or disease activity. All the insects and diseases that are shown on the above map are doubtless active within adjoining areas, but at low levels not detectible from the air.

Residents should not be complacent. Particularly in view of the current drought, forest trees are stressed and vulnerable to insect and disease attack. The unnaturally dense forest conditions that cause the potential for hazardous fire also create the potential for cyclical insect and disease outbreaks. Trees weakened by overcrowding and severe competition for water and sunlight are susceptible to invasion by insects and disease. When planning wildfire hazard mitigation projects, it is important to address current insect or disease issues and prevent those that are likely to become a problem. Following is information on some of the common forest insect and disease problems that have been identified in the area.

Dwarf Mistletoe

Dwarf mistletoe is a parasitic plant that robs moisture and nutrients from the host tree. Over many years, it causes the tree to decline in vigor and eventually may cause death. More commonly, the tree declines to the point where bark beetles attack and kill it.

Three common species of dwarf mistletoe are found in the region, each named after its principle host – ponderosa pine, lodgepole pine and Douglas-fir. Locally, ponderosa and lodgepole varieties grow on any pine species, but Douglas-fir dwarf mistletoe is exclusive to Douglas-fir trees. Spruce, true firs and deciduous trees are immune to all three species of dwarf mistletoe.

The most obvious symptom of dwarf mistletoe infection is the dense, distorted growth of the branches, called witch's brooms because they appear to be twisted or tied in knots. The shoots of ponderosa and lodgepole dwarf mistletoe are visible on the branch as thick fingerlike growths extending out of the branch or trunk. The shoots of ponderosa and lodgepole dwarf mistletoe are long and obvious to casual observation, but Douglas-fir dwarf mistletoe shoots are shorter than the needles and are not easy to see.

Mistletoe shoots are only reproductive structures with no photosynthetic function. Removing the shoots from a branch does not control dwarf mistletoe, except to temporarily halt seed production. Structures called sinkers, (analogous to roots in plants) embedded in the wood cause the damage, and the mistletoe plant continues to absorb the host tree's water and nutrients. Shoots that are removed grow back in two or three years.

During the growing season, dwarf mistletoe shoots develop berries containing a seed. In August, the berries fill with water and explode, shooting the seed as far as 40 feet. Most seeds strike branches of the host tree and do not travel the full 40 feet, so the expansion of dwarf mistletoe pockets averages two feet per year. When the seed strikes a branch, it germinates and the sinkers penetrate the bark into the tree's conductive tissues. The growing mistletoe begins to steal the tree's food and water. The first visible symptom of infection is swelling in the branch at the site of the growing mistletoe plant, but nubs of the emerging shoots won't be visible for three years and a shoot won't bear its first seeds until seven years after. As seeds spread, all susceptible trees in the vicinity may become infected; it is extremely rare to find an isolated infected tree in the forest.

The tendency of mistletoe to infect all trees in a stand makes eradication difficult. No effective chemical treatment exists for mistletoe, and the only way to kill the parasite is to kill the host. In stands where only the susceptible species of tree exists, total eradication of the mistletoe would require a clear-cut, which is unacceptable to most landowners.

Fortunately, mistletoe kills trees slowly, so it is not necessary to eradicate the parasite. The disease can be controlled by a program of thinning to increase tree vigor. Pruning the more heavily infected branches also helps, even if not all the mistletoe is eliminated. The final step in the process is to replant with non-susceptible species so that new trees will grow before the mistletoe kills the remaining trees.

Figure D-6. A ponderosa pine with advanced dwarf mistletoe infection. Note the heavy contorted "witch's brooms" in the lower branches. After long periods of infection, the needles at the top of the tree become sparse and shorter. Colorado State Forest Service photo by Dave Root.

The spread of mistletoe can be halted by a minimum 40-foot buffer zone between infected and non-infected trees. In this situation, cut 20 feet into non-infected trees to remove any mistletoe that is not yet visible; cut the remaining 20 feet into the infected stand. Non- infected trees outside the buffer should be checked each spring for mistletoe and any infected branches should be immediately pruned before seeds develop.

In forest stands with mixed tree species, it may be possible to eliminate all mistletoe by retaining only non-susceptible trees if they are in good health. For example, in a mixed stand of ponderosa and Douglas-fir, if the ponderosa are infected, leave only Douglas-fir. Aspen are always desirable trees in situations where fire mitigation and mistletoe control are objectives, as aspen are not prone to crown fires and are immune to all species of dwarf mistletoe.

Dwarf mistletoe treatment is a complicated process that depends on the site conditions and the landowner's tolerance for cutting trees. In most cases, a combination of treatment methods will best suit the landowner's objectives. Consultation with a qualified forester is recommended to develop an effective and acceptable treatment plan.

Western Spruce Budworm

The western spruce budworm (WSBW), a defoliating insect of Douglas-fir and spruce, is a growing threat in some areas. Depending on the intensity of defoliation, budworm may damage or kill the host tree.

Figure D-7 WSBW larva feeding on the needles of Douglas-fir. Note the typical webbing in the bottom of the photo. **(Colorado State Forest Service photo by David Leatherman.)**

A severe outbreak of WSBW in the late 1980s damaged or killed large areas of Douglas-fir throughout the region. Trees with dead branch tips or those with forked or dead tops are legacies of the previous epidemic. Many of the dead Douglas-fir were first weakened by budworm and then killed by Douglas-fir beetles. (See the section on Douglas-fir beetle, below.)

The grayish, mottled adult moths are active in July and August when females lay eggs on the underside of needles. Eggs hatch within days and the larvae migrate to bark scales where they overwinter. The following spring, larvae invade the new buds and feed on the emerging needles. Webbing around the new growth is an obvious sign of budworm activity and if heavy defoliation continues for three to five years, the tree will die. If shorter-term defoliation occurs, the branch tips or the entire top of the tree could die.

Natural predators or severe winter weather helps control budworm populations, which keeps them at non-threatening levels. Spraying with *Bacillus thuringensis* may be useful to protect high value trees, but is not practical on a large scale.

Mountain pine beetle Unlike the Western Slope, mountain pine beetle (MPB) is at normal levels in the area. The beetles have crossed the Continental Divide in northern Park County and northern Larimer County, and activity currently is confined mostly to higher altitude lodgepole pine. It presently is not known if or when the beetles will reach into the lower-elevation ponderosa forests, but where they have reached ponderosa, heavy mortality has occurred.

Adult beetles fly from midsummer through the first frost, although the vast majority fly between mid-July through the middle of September. Females seek a large, weak tree in which to mate and lay eggs. Vigorous trees generate enough pitch to prevent the female from burrowing through the bark, and this attempt by the tree to prevent entry creates the pitch tubes symptomatic of beetle attack. Pitch tubes are **not** a particularly reliable indicator of a successful attack. If pitch tubes are seen, check for reddish boring dust (fine sawdust) at the base of the tree and in the bark crevices. Boring dust is a more reliable indicator of successful attack.

Once a female penetrates the bark, she hollows out a circular mating chamber between the bark and the wood, releasing a pheromone (scent) to attract a mate. The pheromone also attracts additional females to the tree and the tree is attacked en masse. After mating, the female burrows up the trunk between the bark and wood laying eggs. She inoculates the tree with spores of bluestain fungus, which provides food for the larvae. The fungus clogs the tissues that conduct water throughout the tree, leading to death within a few weeks.

Figure D-8. Mountain pine beetle galleries under the bark. The maternal beetle burrowed straight up the tree, creating the darker central gallery. Larval beetles feed horizontally, creating the smaller galleries. A larva is in the upper right and pupae in the lower left. Note the bluestain in the wood. (Colorado State Forest Service photo by David Leatherman.)

Eggs hatch within a few days. The developing larvae feed horizontally from the maternal gallery over winter. The vertical maternal gallery and horizontal larval galleries are characteristic of the mountain pine beetle. The feeding larvae spread the bluestain fungus horizontally through the tree, and it becomes visible in the wood around February. The presence of bluestain is absolute confirmation that beetles have successfully attacked a tree.

Woodpeckers feed on the larvae through the fall and winter. The holes made by the woodpeckers are a visual clue to an infested tree. Untrained observers often are confused by the holes woodpeckers make when they feed on beetle larvae and sapsuckers feed on the sap. Woodpecker feeding is characterized by random holes about one-half inch in diameter that make it appear as though the tree was peppered with a shotgun. Sapsuckers, on the other hand, make a small hole about one-eighth inch in diameter, and the holes are in straight lines or a grid pattern. Sapsuckers do not indicate the presence of beetles in the tree.

Although the tree is dead within a few weeks of successful attack, needles remain green until the following spring. Within the space of a few weeks, in late May or early June the tree will turn straw-yellow and then reddish-brown. Once beetles invade a tree, nothing can be done to save it; the tree must be cut and disposed of in a way that will kill the beetles. No insecticide is available to kill beetles under the bark; thus, some sort of mechanical treatment is necessary. Any wood greater than four inches in diameter may harbor beetles and must be treated.

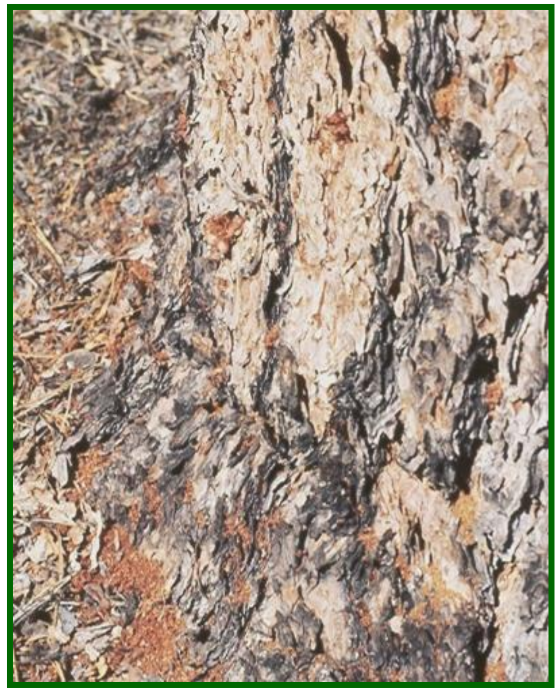


Figure D-9. Boring dust on a ponderosa pine after bark beetle attack. The reddish brown sawdust at the base of the tree and in the bark crevasses is a strong indication of successful beetle attack. Colorado State Forest Service photo by David Leatherman.

Following are treatment options for beetle-infested trees:

- Cut the tree and move all wood greater than four inches in diameter to a designated mountain pine beetle-safe site – usually an area at least one mile away from the nearest pine tree.
- Move all wood to a landfill or bury it under at least eight inches of dirt.
- Completely debark any wood that is larger than four inches in diameter.
- Chip the tree. Many tree services have chippers capable of chipping large diameter trees. The beetles are killed when the wood is chipped.
- Cover wood with at least six-mil clear plastic. This method, known as solar treatment, warms the wood to lethal temperatures and increases moisture, encouraging mold growth in the logs, which kills the beetles. Treat the wood properly for successful control. Cut into firewood lengths and stack no more than two logs high. Be sure there are no exposed stubs or sharp edges that might tear the plastic. Trench around the pile and, if possible, wet down the pile to encourage mold growth. Cover the pile with plastic, push the edges of the plastic into the trenches, and seal the edges with dirt. Check periodically to be sure the plastic has not torn. If torn, it can be repaired with duct tape.

It is best to check for infested trees in October of each year – remember that infested trees, although dead, are still green at this time. Pitch tubes and boring dust will be the most obvious clues. If infested trees are located early, there is adequate time to treat them.

While no insecticide effectively treats infested trees, spraying with insecticides such as carbaryl or permethrine prevents attack. Preventive sprays will not kill beetles under the bark. Spray trees between May 1st and July 1st each year for maximum effectiveness. It is not practical to spray every tree on a large tract of land, so choosing which trees to spray depends on the landowner's budget and the value of individual trees to the landowner. It is advisable to solicit bids from several different spray companies, as prices can vary widely. It also is wise to request and check references.

Thinning forests for increased health and vigor by far is the best preventive measure for mountain pine beetle. Because trees require several years to respond to thinning, it is best done before beetles reach epidemic levels. Follow thinning guidelines for wildfire mitigation to reduce susceptibility to MPB.

Ips (engraver) Beetles

Ips beetles, relatives of the mountain pine beetle, usually attack trees less than four inches in diameter and, in such circumstances, may be useful in thinning dense stands of young trees. Thus, it usually is not considered as threatening as its larger cousin. Ips will attack larger trees if they are severely weakened by disease (most often dwarf mistletoe), or are damaged by construction, lightning strikes or in horse corrals where soil compaction injures the roots. Like the mountain pine beetle, ips burrow beneath the bark and inoculate the tree with bluestain fungus, often following mountain pine beetles into larger trees.

The differences between mountain pine beetle and ips are significant to anyone implementing a forest management program. In contrast to MPB, which produce one generation per year, ips may produce up to four. Ips become active in spring when the weather exceeds 50 degrees F, developing from egg to adult within eight weeks. They continue to attack trees until the first fall frosts. For this reason, preventive spraying should be done with permethrine or carbaryl in April and repeated in July. When spraying preventively for ips, it is important to spray the branches, as well as the trunk.

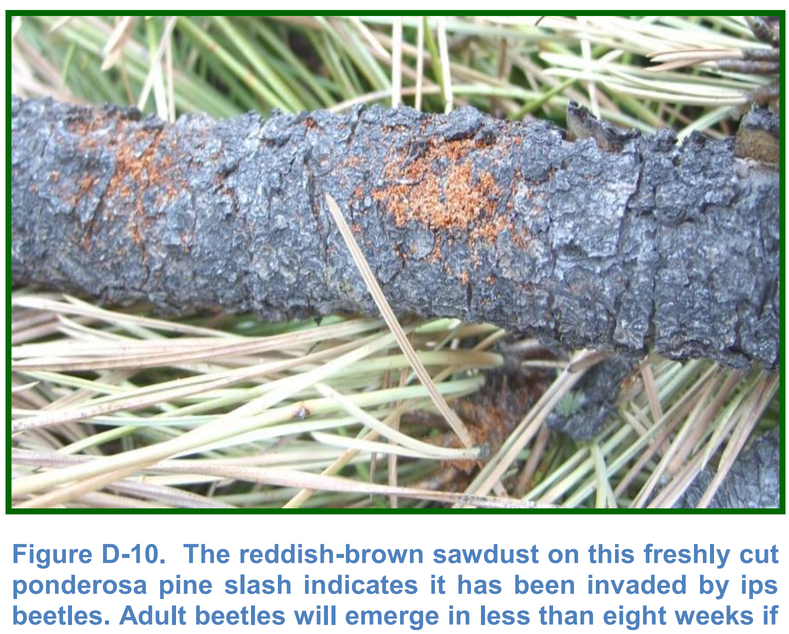


Figure D-10. The reddish-brown sawdust on this freshly cut ponderosa pine slash indicates it has been invaded by ips beetles. Adult beetles will emerge in less than eight weeks if the slash is not properly treated. Colorado State Forest Service photo by Dave Root.

Ips attack causes no pitch tubes to form on live trees, so the only visual clue is boring dust or woodpecker holes in the trunk. Smaller trees quickly turn reddish-brown, but when they attack larger trees, ips often infest only the upper portion of the tree. The first symptom is browning of the top, but subsequent generations emerge and continue down the tree.

Ips will infest green slash and downed logs from forest management projects. If slash is not promptly treated, ips will emerge to attack living trees; treat slash within four to six weeks after cutting. If weather conditions permit, thinning trees in winter when ips are dormant will prevent problems with beetles in slash. However, slash cut after March 1 may still be green enough to attract ips when the weather warms.

Chipping slash will kill ips beetles. Lopping and scattering slash into lengths less than 24 inches promotes rapid drying and prevents infestation. Slash cut late in fall that is subsequently infested can be treated or piled and burned over the winter, but untreated slash left over the winter will produce live broods the following April. Due to their short lifecycle, solar treatment of ips-infested logs is ineffective. Bucking larger diameter logs and promptly splitting them into firewood accelerates the drying process and usually is effective in preventing ips infestations.

Many high value trees have been lost as a result of the common, and ultimately costly, practice of stacking firewood against green trees. Ips beetles will burrow out of infested firewood directly into standing trees.

Douglas-fir Beetle

Douglas-fir beetles also are present in the area, but are not killing large numbers of trees. If the current western spruce budworm defoliation seriously harms trees in the area, this will change. Some similarities exist between Douglas-fir beetle and MPB, but there are important differences that require different treatment strategies for infested trees.

Both species burrow under the bark to lay eggs and both carry blue stain fungus that kills the tree within a few weeks of infestation. Each beetle prefers dense stands with large diameter, low vigor trees; thus, thinning Douglas-fir for wildfire mitigation also reduces susceptibility to beetles.

Adult Douglas-fir beetles emerge in mid-June, and a few adults may overwinter in trees and emerge as early as April. There are no insecticides available for treatment of beetle infested trees. Infested trees should be treated prior to April of each year to prevent emergence of overwintering adults. Effective treatments are whole tree chipping, debarking of all wood greater than four inches in diameter, transportation to a safe site or landfill, and burying under eight inches of dirt. Solar treatments should begin in the fall, preferably early fall.

Preventative spraying is an option for high value trees. Permethrine or carbaryl are effective as Douglas-fir beetle preventatives, but, because of the earlier emergence of overwintering adults, spraying should be done in April. Preventative sprays are not an effective treatment for infested wood.

Unlike MPB-infested trees, Douglas-fir trees do not form pitch tubes when attacked, so there may not be an obvious visual indication of infestation. Some Douglas-fir bleed sap when attacked, resulting in rivulets of sap on the trunk; however, this does not occur in all infested trees. Trees should be checked carefully for boring dust in early October. Later in the year, woodpecker holes may provide a visual clue that trees are infested.

Figure D-11. Pitch streamers on the bark of a beetle-infested Douglas-fir. Not all infested trees will exhibit pitch. Trees should be checked for boring dust in the early fall. Colorado State Forest Service photo by Dave Root.

Trees partially defoliated by western spruce budworm are particularly susceptible to attack by Douglas-fir beetles. Injury, overcrowding or any conditions that adversely affect the vigor of the tree will make it more susceptible. Managing the forest for open, vigorous stands of Douglas-fir is the best prevention.

Aspen Diseases

Many diseases affect aspen trees – far more than can be covered in the scope of a Community Wildfire Protection Plan. The common thread among aspen diseases is that landowners can do little about any of them. Treatments are always costly and usually ineffective.

A rather cynical forester once described aspen this way: “New aspen sprout from the roots. The tree grows. A deer rubs his antlers on the bark, and a fungus invades the wound. The tree dies. New sprouts come up from the roots.”

The quote reflects aspen’s role as a short-lived species that colonizes a site after fire or other disturbances remove existing conifers. Sun-loving aspen do not grow well in the shade. After a fire kills the existing trees, aspen roots re-sprout vigorously in the full sunlight. As aspen shade the site, shade-tolerant conifers sprout in the aspen understory. Eventually, the conifers will over-top and shade out the aspen; thus, disturbance – usually fire – is necessary to maintain pure aspen stands.

Aspen are prized by most landowners and, as noted earlier, are valuable trees for fuel breaks and wildlife. Diseased aspen are a serious concern for most residents. The most logical way to consider aspen diseases within the scope of this plan is to divide them into diseases of the stem and diseases of the leaves.

Most fungal diseases of aspen stems are the result of wounds to the bark. The thin bark is easily wounded; when it is, several species of fungi may invade the tree. If the tree is healthy, it will tolerate the fungus for many years, but unhealthy trees usually will succumb within a short time. As noted earlier, little can be done to treat an aspen invaded by fungus. The tree will die and re-sprout. It is impossible to prevent deer and elk from wounding aspen, but it is possible to prevent human wounding of the tree. Avoid any practice that will injure the bark. Managing the forest to give aspen adequate sunlight will improve their vigor and tolerance to disease.

Fungal diseases of the leaves are a concern to landowners, but they rarely cause any real harm. Several fungi attack aspen leaves and usually are recognized by yellow or brown spots on the leaves. Leaf diseases are more common in wet years, as humid conditions are favorable for the fungi. Treatment is not necessary, but raking up dead leaves to reduce the number of fungal spores may reduce the infection of new leaves. If the following year is drier, there will be less fungus. The CSFS website at http://csfs.colostate.edu/pages/forest-types-aspen.html has detailed information about the many insect and disease problems of aspen.

A new phenomenon observed in recent years is "sudden aspen decline," and several areas of this decline have been noted. Aspen stands that appear to be healthy undergo rapid dieback and decline. A lack of re-sprouting after the older aspen die is the most disconcerting aspect of sudden aspen decline.

The causes of sudden aspen decline are not completely understood and are a subject of debate among researchers studying the phenomenon. The stress of the recent drought followed by invasion of insects and disease are cited by most researchers as likely causes. Lack of aspen regeneration due to fire suppression also has been cited as a contributing cause by some scholars. Low elevation, open aspen stands on south and west facing slopes are most often affected. Tree age does not appear to be a factor.

Given the uncertain cause of sudden aspen decline, the best method of prevention also is unclear. Encouraging regeneration of aspen clones by clear cutting or burning while they are healthy seems to hold the most promise. Because sudden aspen decline is a landscape level phenomenon, landowners with small lots may not be able to address the problem. Currently, the best option is to manage for healthy aspen stands.

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GLOSSARY

Aerial fuels: Standing and supported live and dead combustibles not in direct contact with the ground and consisting mainly of foliage, twigs, branches, stems, cones, bark, and vines: typically used in reference to the crowns of trees.

Chimney: A topographical feature such as a narrow drainage on a hillside or the upper end of a box canyon that could channel wind, smoke or flames up the slope; acting as a fireplace chimney would to draw smoke and heat upward.

Crown fire / Crowning: A form of extreme wildland fire behavior consisting of fire that advances from top to top of trees or shrubs more or less independent of a surface fire. Crown fires are sometimes classed as running or dependent to distinguish the degree of independence from the surface fire.

Defensible space: A term typically used to describe the area around a structure/home indicating that fuels in the area have been reduced or modified to the point that the area/structure may be safely and successfully protected from a wildland fire. (Also see *Survivable space* and *Home Ignition Zone*.)

Escape route: A preplanned and understood route firefighters take to retreat from an unsafe or fire-threatened area and move to a safety zone or other low-risk area**.**

Extreme fire behavior: A level of fire behavior that ordinarily precludes firefighting methods involving direct attack on the fire. One or more of the following is usually involved: high rate of spread, prolific crowning and/or spotting, presence of fire whirls, strong convection column. Predictability is difficult because such fires often exercise some degree of influence on their environment and behave erratically, sometimes dangerously.

Firebrands: Flaming or glowing fuels lofted into the air during intense burning by strong upward convection currents. Also referred to as airborne embers.

Fire front / Flame front: The part of a fire within which continuous flaming combustion is taking place. Unless otherwise specified, the fire front is assumed to be the leading edge of the fire perimeter.

Fire break: A natural or constructed fuel-free barrier used to stop or check fires that may occur, or to provide a control line from which to work.

Firewise: A National Fire Protection Association's (NFPA) program encouraging local solutions for wildfire safety by involving homeowners, community leaders, planners, developers, firefighters, and others in the effort to protect people and property from wildfire risks.

Fuel break: A linear area in which wildland fuels have been reduced or modified to reduce fire intensity and provide better access for firefighters to approach and control a fire (not necessarily a fuel-free area).

Fuel reduction zone: An area similar to a fuel break but not necessarily linear, in which fuels have been reduced or modified to reduce the likelihood of ignition and/or to reduce fire intensity thereby lessening potential damage and resistance to control.

Home Ignition Zone (HIZ): An area including the home and its immediate surroundings within which burning fuels could potentially ignite the structure; usually considered to be an area extending out roughly 100 feet from the home. The HIZ is often used to describe the area in which fuel modification measures should be taken to protect the home.

Ladder fuels: Fuels which provide vertical continuity from lower to higher levels of wildland fuels, thereby allowing fire to carry from surface fuels into the crowns of trees or shrubs with relative ease. They help initiate and assure the continuation of crowning.

Lines of Effort: Tasks sets or sets of actions that are linked or coordinated with other task sets to accomplish a larger mission or reach a desired end state. Lines of effort allow leaders and decision makers to direct a variety of separate actions toward a unified result.

National Fire Protection Association (NFPA): A private, non-profit organization dedicated to reducing fire hazards and improving fire service.

Ready, Set, Go (RSG): A program, managed by the International Association of Fire Chiefs (IAFC), seeking to develop and improve the dialogue between fire departments and residents. The program helps fire departments teach individuals who live in high-risk wildfire areas how to best prepare themselves and their properties against fire threats.

Saddle: A depression, dip or pass in a ridgeline; significant in wildland firefighting because winds may be funneled through a saddle, causing an increase in wind speed.

Safety zone: An area essentially cleared of flammable materials, used by firefighters to escape unsafe or threatening fire conditions. Safety zones are greatly enlarged areas in which firefighters can distance themselves from threatening fire behavior without having to take extraordinary measure to shield themselves from fire/heat.

Shaded fuel break: A fuel break built in a timbered area where the trees within the break are thinned and limbed up to reduce crown fire potential, yet retain enough crown canopy to provide shade, thereby making a less favorable microclimate for surface fires.

Spot Fire / Spotting: Fires ignited beyond control lines or outside the perimeter of a fire by firebrands landing on/among flammable material. Spot fires/spotting are a form of extreme fire behavior typically resulting from high wind conditions.

Structure protection: A defensive strategy in wildland firefighting in which firefighters are assigned to evaluate, prepare and, when possible, defend structures/homes that may be threatened by a wildfire.

Structure triage: Evaluating and sorting structures/homes into categories based on their relative likelihood of surviving a wildland fire threat (*defensibility*). Triage decisions are based multiple factors and conditions occurring during an actual fire - weather, fire behavior, home ignition potential, defensible space, presence of escape routes, and availability of firefighting resources, among others - with the goal of doing the most good with the resources available.

Surface fuels: Fuels lying on or near the surface of the ground, consisting of leaf and needle litter, dead branch material, downed logs, bark, tree cones, and low-lying live vegetation.

Survivable space: A term typically used to describe the area around a structure/home indicating that fuels in the area have been reduced to the point that there is little or no serious fire threat to the structure; the structure has a high probability of surviving a wildland fire without anyone on scene providing active protection.

Torching: The burning of the foliage of a single tree or a small group of trees, from the bottom up. Sometimes, also called candling. Torching is an extreme form of fire behavior, similar to but less extreme than crowning in that crowning affects larger numbers, even entire stands of trees.

Wildland-Urban Interface or Wildland-Urban Intermix (WUI): The line, area, or zone where structures and other human development meet or intermingle with undeveloped wildland or vegetative fuels. Although ***Interface*** is the more general, more commonly used term; it technically refers specifically to the area where development and wildlands meet. ***Intermix*** indicates the presence of wildland vegetation/fuels intermingled throughout the developed area.