Durango West Metropolitan District # 1
Community Wildfire Protection Plan

November 2009

Aerial Image of Durango West One Subdivision, La Plata County, Colorado: Courtesy, Google Earth

Prepared for:
Durango West One Firewise Committee
Durango West Metropolitan District #1
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Community Wildfire Protection Plan: Durango West #1

Approval

The Durango District of the **Colorado State Forest Service** has reviewed this Community Wildfire Protection Plan and approves its content and certifies that it meets or exceeds CSFS Community Wildfire Protection Plan minimum standards.

D. Kent Grant, District Forester — Date 11/5/09

The following entities have received a copy of this Community Wildfire Protection Plan and agree with and support its content and recommendations.

Durango West Metro District #1 — Date 11/5/09

Durango Fire and Rescue Authority — Date 11/17/09

La Plata County Office of Emergency Management — Date Nov/0 09

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1. INTRODUCTION

Community Wildfire Protection Plans are authorized by the Healthy Forests Restoration Act (HFRA) of 2003. HFRA places renewed emphasis on local community wildfire protection and response planning by extending a variety of benefits to communities with a wildfire protection plan in place. Among the benefits are the abilities to participate in establishment of fuels treatment priorities for both federal and non-federal lands surrounding communities, establishment of a local definition and boundary for the Wildland-Urban Interface (WUI), and enhanced opportunities for cost-sharing of community-based fuels treatments.

The Board of Durango West Metropolitan District #1, covering the Durango West One subdivision (DW1), has recognized that the subdivision is at risk from wildfires moving into or originating within the subdivision. A local effort to educate homeowners and assist them in completing fuels mitigation work on their properties has been underway for several years. Development of a Community Wildfire Protection Plan (CWPP) for the subdivision is the next step in that effort.

2. BACKGROUND

A. Location

This CWPP covers the Durango West One subdivision and its defined WUI. Durango West One is approximately 8 miles west of the city limits of Durango, Colorado in La Plata County, on the south side of US Highway 160 (Location Map, Appendix A). The subdivision was initially platted in 1970. Mean elevation of the subdivision is 7500 feet.

B. Local Fire History

No wildfires larger than one acre have occurred in the immediate vicinity of the subdivision within the past 20 years. One to five small wildfires occur in the area annually. Most are single-tree lightning strikes or person-caused brushfires in relatively light fuels and are controlled in a matter of a few hours. Large wildfires have occurred in La Plata County in similar fuel types over the past twenty years, however. The most notable are the 2002 Missionary Ridge and Valley Fires which burned 70,662 acres and 83 structures.

C. Recent Wildfire Preparedness Activities

Metro District

1. Established Neighborhood Firewise Ambassador Committee in early 2007.

2. Performed mitigation work on five acres of Metro District common property in 2008. The area mitigated was in a high-traffic portion of the subdivision and was signed as a mitigation demonstration project.

3. Sponsored Fall Clean-up Days in 2007 and 2008 which stressed mitigation work around residences and a Community Fire Prevention Day in 2008. The 2008 Fall Clean-up Day was in partnership with the Firewise Council of Southwest Colorado, the Southwest Conservation Corps and Fire Ready.

4. Participated in county-wide Red Zone study in 2007. Study has been made available to all residents.

5. Included Firewise educational information in monthly billing statements to residents and in DW1 quarterly newsletter.

6. Secured $20,000 in grants for mitigation work on Metro District common property for 2009.

7. Developed and completed emergency evacuation survey for Durango West One. Results have been compiled for use by La Plata County Emergency Services.

Property Owners

1. Twenty property owners completed mitigation work on their residences as part of the April 2008 Community Fire Prevention Day.

2. Several property owners are continuing mitigation and maintenance work (e.g., hazard tree and shrub removal, branch pruning, needle removal from roofs and gutters, etc.).

3. PLAN AREA

A. Boundaries

The CWPP covers the WUI area developed collaboratively with the Durango West One Firewise Committee, subdivision residents, the Colorado State Forest Service and the San Juan Public Lands Center, responsible for managing the National Forest and Bureau of Land Management Public Lands in the area. The WUI boundaries are from Sheep Springs Gulch at the northeastern edge of Durango West Two subdivision south to US Highway 160, then south along South Lakeside Drive to County Road 125, then west to State Highway 140, north along Highway 140 to its intersection with US Highway 160; then east to Sheep Springs Gulch along the northern boundary of Durango West Two subdivision. Total WUI area is 5.1 square miles and is shown on the WUI Map in Appendix A.

B. Private Land Characteristics

The private lands within the WUI boundary consist of three subdivisions, Durango West One, Durango West Two and portions of Lake Durango, as well as over 100 parcels outside the subdivisions. Parcel sizes range from approximately 0.1 acre in Durango West One to over 500 acres. Many of the private parcels have residences or other structures on them. All three subdivisions and the private tracts are forested with ponderosa pine (*Pinus ponderosa*), Douglas-fir (*Psuedotsuga* menziezii) and montane shrubs dominated by gambel oak (*Quercus gambelii*). Some residents have completed wildfire fuels mitigation around their homes, but many have not.

C. Public Land Characteristics

Public lands in the WUI are limited to the Durango West Metro District #1 (11 acres) and Durango West Metro District #2 (76.5 acres) ownership and road Rights-of-Way. The Ute Mountain Ute Tribe owns two parcels of non-Reservation land totaling 1688 acres within the WUI area. The tribal lands are not open to the general public. The Colorado State Forest Service has assisted the tribe in fuels mitigation work on parts of the properties in the past several years.

D. Fire Protection

Structural and wildland fire protection is provided by the Durango Fire and Rescue Authority. A volunteer-staffed fire station is located on the east side of the subdivision. Both structural and wildland fire engines are resources available through the Authority. Other wildland fire resources are available through Durango Interagency Dispatch Center. Wildland fire resources include engines and crews from the US Forest Service, Bureau of Land Management, Colorado State Forest Service, Bureau of Indian Affairs and the Southern Ute and Ute Mountain Ute Tribes. An air tanker base is located at Durango - La Plata Regional Airport. The Counties, Federal land management agencies, Colorado State Forest Service and Fire Protection Districts in Southwest Colorado operate under a Consolidated County Annual Operating Plan (AOP) for wildfire protection

4. POLICIES

A. Federal

The Durango West One CWPP has been developed in response to the Healthy Forests Restoration Act of 2003 (HFRA). This legislation established unprecedented incentives for communities to develop comprehensive wildfire

protection plans in a collaborative, inclusive process. Furthermore, this legislation directs the Departments of Interior and Agriculture to address local community priorities in fuel reduction treatments, on both federal and non-federal lands.

The HFRA emphasizes the need for federal agencies to collaborate with communities in developing hazardous fuel reduction projects and places priority on treatment areas identified by communities themselves through development of a Community Wildfire Protection Plan (CWPP). Priority areas include the wildland-urban interface (WUI), municipal watersheds, areas impacted by windthrow or insect or disease epidemics, and critical wildlife habitat that would be negatively impacted by a catastrophic wildfire. In compliance with Title 1 of the HFRA, the CWPP requires agreement among local government, local fire departments, and the state agency responsible for forest management i.e., the Colorado State Forest Service. The CWPP must also be developed in consultation with interested parties and the applicable federal agency managing the land surrounding the at-risk communities.

B. Consolidated County Annual Operating Plan

The Counties, Federal land management agencies, Colorado State Forest Service and Fire Protection Districts in Southwest Colorado operate under a Consolidated County Annual Operating Plan (AOP) for wildfire protection. This plan provides for mutual aid to assist with the management of wildfire incidents in southwest Colorado. The plan for mutual aid provides significantly enhanced initial and extended attack capabilities through the rapid convening of fire protection resources for managing a wildfire. The Consolidated County AOP outlines standard operating procedures and the level of participation and available resources of each party under the plan.

C. USFS and BLM Land and Resource Management Plan/ Fire Management Plan

The San Juan National Forest and San Juan Resource Area Land and Resource Management Plan and associated Fire Management Plan describe the role of fire in the native ecosystems in southwest Colorado. These plans outline the strategies that the USFS and BLM will utilize to manage wildland fire and fuels on these federal lands in southwest Colorado. The San Juan National Forest and San Juan Resource Area Fire Management Plan (2007) specifically describes objectives and strategies to manage fire and fuels on federal lands near communities within the wildland-urban interface.

D. La Plata County CWPP

The Durango West One CWPP tiers to the La Plata County CWPP approved in 2006. This plan is consistent with the goals and strategies described within the La

Plata County CWPP and provides further strategic and tactical direction specific to wildfire protection and mitigation for the Durango West One community.

E. Subdivision Covenants

The subdivision covenants filed with La Plata County on September 30, 1977 and amended October 31, 1991 limited tree removal to that needed to construct a dwelling and associated outbuildings on a lot. New covenants were filed March 15, 2000 which encourage homeowners to thin trees on lots, remove leaf litter from roofs and gutters, prune branches in close proximity to chimneys, maintain irrigated greenbelts or xeriscapes around their homes and otherwise develop and keep defensible space around their homes.

5. PLANNING PROCESS AND PARTNERS

A. Process

The Durango West One Firewise Committee has met at least quarterly since late 2007 (minutes on file at the Metro District offices). Resident education events were held in April and October 2008. A public CWPP input-gathering workshop was held in May 2009 with 12 attendees from the subdivision plus representatives from the Colorado State Forest Service and the San Juan Public Lands Center.

The Firewise Committee has received process and planning input from Craig Goodell , Fuels Mitigation and Education Specialist for the San Juan Public Lands Center; Kent Grant, Colorado State Forest Service Durango District Forester; Bob Dettman and Deputy Chief Allen Clay, Durango Fire and Rescue Authority: Butch Knowlton, La Plata County Emergency Management; Pam Wilson, Firewise Council of Southwest Colorado: Sam Burns, Ft Lewis College Office of Community Services; Robert Wolf, subdivision developer and adjoining landowner; and Bruce Short, Short Forestry, LLC, forest and fire management consultant.

The Planning Core Group solicited input from the subdivision residents through periodic mailings, a quarterly newsletter and community information and education events in conjunction with neighborhood clean-up days. Firewise Committee meetings were publicized and the public invited. A public CWPP information-gathering workshop was held in May 2009 to solicit public input for the Plan. A draft CWPP document was developed and circulated among federal, state and local agencies as well as other interested individuals and stakeholders for comment prior to finalization of the CWPP.

The members of the Core Planning Group are:
Jules Masterjohn, DW1 Firewise Ambassador, Chair
Robert Maple, DW1 Firewise Ambassador
Kathy Phelps, Durango West Metropolitan District #1
Greg Simpson, DW1 Firewise Ambassador

Roxanne Woodman, DW1 Firewise Ambassador
Nick Laistch, DW1 Firewise Ambassador
Shan Wells, DW1 Firewise Ambassador

B. Desired Future Condition

The Desired Future Condition (DFC) for Durango West One has been developed through the collaborative CWPP process. The DFC is:

Durango West One is a desirable, semi-rural forested community safe from catastrophic wildfire moving into or through the community. Homes are not vulnerable to wildfire by the use of fire-resistant construction methods and landscaping. Natural fuels are maintained at levels which would support only low intensity surface fires characteristic of the native forest ecosystem.

6. RESOURCE ASSESSMENT AND TRENDS

A. Community

Durango West One is a 55 acre subdivision with 256 homes. The subdivision is essentially built-out, with some older mobile and modular homes now being replaced with "stick-built" homes. Lot size is small, so houses are close together. Population of the subdivision is 650.

The subdivision consists of single-family residences except for the Metropolitan District Office on Hollyhock Trail, the Durango Fire and Rescue Authority (DFRA) Station #9 on Woodcrest Drive, the Metropolitan District water treatment facility on Lazy Pine Drive, and the Metropolitan District water supply tanks just west of the subdivision. The Metropolitan District owns 11 acres of common property across the subdivision as well. Much of the common property contains the utility delivery infrastructure and is often used by the residents as extensions of their yards.

The road system serving the subdivision is paved with 25 foot-wide streets. Vehicles are often parked curb-side, so maneuvering room for large fire apparatus can be limited. Many streets end in cul-de-sacs. Public access to the subdivision is a single entrance from Highway 160. Acceleration/deceleration lanes are provided on the highway. An alternate access to Highway 160 exists from Woodcrest Drive in the southeast corner of the subdivision, but it is a dirt "2-track" and no legal emergency exit status has been established.

Durango West One is located in a ponderosa pine/gambel oak forest vegetation type. A characteristic of the 55 acre subdivision is the retention of the native trees and shrubs during construction of the residences. In the nearly 40 years since the establishment of the subdivision, other trees and shrubs have been planted in close proximity to the houses. The subdivision is bounded on the north by US Highway

160 and Durango West Two, a larger but somewhat less dense subdivision, and on the east by Lake Durango, a subdivision with 10 to 20 acre lots. The areas on the south and west consist of larger tracts of 40 acres or more with few structures. The overall context is semi-rural with generally unmanaged ponderosa pine/gambel oak vegetation. The community could expand to the west, since the tract immediately west of the subdivision is large enough to subdivide within La Plata County regulations and is owned by the subdivision developer. There are no known plans to expand at this time, however.

There are no permanent water bodies or perennial streams within the subdivision. Lake Durango is located approximately one-half mile southeast in an adjoining subdivision. An unnamed intermittent tributary of Coal Gulch runs along the southern boundary of the subdivision.

The wildlife present in the area includes all the species expected in the lower montane areas of the central Rocky Mountains. Mule deer (*Odocoileus hemionus*), elk (*Cervus elaphus*), black bear (*Ursus americanus*), cougar (*Felis concolor*), coyote (*Canis latrans*), porcupine (*Erethizon dorsatum*), skunk (*Spilogale spp*), and Abert's squirrel (*Sciurus aberti*) are some of the mammalian species. Merriam's turkey (*Meleagris gallopavo merriami*), common raven(*Corvus corax*), golden eagle (*Aquila chrysaetos*), red-tailed and sharp-shinned hawks (*Buteo jamaicensis* and *Accipiter striatus*), horned owl (*Bubo virginianus*), mountain and western bluebirds (*Sialia currucoides* and *S. Mexicana*), American robin (*Turdus migratorius*) and various other songbirds are some of the avian species. No US Fish and Wildlife Service listed "Threatened" or "Endangered" species are known to inhabit the subdivision, however bald eagles (*Haliaeetus leucocephalus*) have been known to nest around Lake Durango.

Slopes ranges from essentially level (0-5%) in the eastern portion of the subdivision to approximately 10% in the western portion. Average grade from east to west is +8%. Slope position is on the back slope of the hillside rising from east to west. Slope shape is slightly convex. Aspect is east southeast.

Annual precipitation for the area is approximately 18 inches, with the majority falling as snow from October to April. June and September are relatively dry, with a summer "monsoon" in July and August. Early monsoonal storms are often characterized by dry thunderstorms with lightning and strong, variable outflow winds. The largest wildfires in the past 20 years in La Plata County have occurred from early June into mid July.

B. Fuels and Fire Hazard

Fuels

The subdivision sits in an 80 to 120 year old "second growth" ponderosa pine/gambel oak vegetation type. Tree density is double or triple "normal" levels

in this vegetation type, with tree group densities of 300 trees per acre or more. Tree crowns often touch and crown bases are often less than 5 feet off the ground. "Ladder" fuels are common with gambel oak and planted shrubs occurring directly under the tree crowns. Crown fire potential is high even for low to moderate intensity fires. Pre-settlement fire frequency for the ponderosa pine/gambel oak vegetation type in southwest Colorado was 2 to 20 years and the fires were generally low intensity. Lightning potential is low to moderate based on past lightning-caused wildfires in the subdivision WUI area. Human-caused wildfire potential is considered to be moderate, based on the fuel availability and density of the subdivision.

Fire suppression over the last 75 years or more has produced fuel conditions that are higher than considered "normal" for the ponderosa pine/gambel oak vegetation type. "Ladder" fuels and thick litter layers are continuous over much of the area within and surrounding the subdivision. Development of the subdivision itself has produced structural fuels in close proximity to the heavier than normal natural fuels. The risk of crown fire has increased and the risk of loss of structures in a fire event is higher. The subdivision is located within the "Red Zone" designated by the Colorado State Forest Service as having "High" risk of loss of structures in a wildfire. The La Plata County Fire Risk map completed as a part of the County CWPP process rates the area containing Durango West One as "Higher" risk.

Natural fuels and fuel continuity would be expected to continue to increase if not treated.

Structural Vulnerability

Structural ignitability is varied across the subdivision. Structures range from aluminum-sided mobile homes to masonite and vinyl siding on wood framed houses to logs to combination wood or masonite siding with brick or stone fascias. Roofing is dominated by asphalt shingles, with metal a secondary material. As homeowners replace older roofing, metal is becoming more popular. Many houses have attached wood decks and porch structures. Trees are often within 5 feet of the residence and pine needle buildup on roofs is common. Many houses have junipers planted next to them as landscaping or for ground cover. Native gambel oak is common on the lots and in the common space. Bark or wood chips are common as landscaping materials or as mulches in planting beds next to houses. Privacy fences are usually wood construction. Due to the close juxtaposition of heavy natural fuels and relatively flammable structural fuels, any structural fire occurring within the subdivision in the summer and fall has a high probability of turning into a wildfire. This situation also means that a wildfire moving into the subdivision currently has a high probability of causing structure loss.

Access to the fronts of the residences is generally good, but streets are relatively narrow for large urban fire apparatus. Access to the rear of residences is generally poor. Most houses have very small driveways and parking areas.

Street width is moderately good (25 feet) and the streets are paved, but vehicles parked along the streets may limit accessibility for large urban fire apparatus. Cul-de-sac turnarounds are generally insufficient for large fire trucks due to vehicles parked along the curbsides.

Reduction in mobile homes is expected to continue as they age and are replaced with "stick-built" or manufactured housing. New construction materials are generally more fire-resistant compared to the older types of materials common across the subdivision, so the newer homes may be somewhat more fire-resistant. Approximately 20 of the 256 residences in the subdivision have completed wildfire mitigation work on their lots.

C. Values At Risk

Socio/Economic

The forested ambiance of the subdivision is valued by its residents. House pets are common. Durango West One is a relatively lower cost subdivision close to Durango, so the location is prized by its residents. Many residents have detached garages or sheds in addition to their homes. Outdoor gazebos and hot tubs are also present.

Ecological

The setting of Durango West One is forested, so loss of the trees from wildfire would have a significant impact to the ambiance of the community, even if any structures lost were rebuilt. No threatened or endangered species are known to inhabit the subdivision itself, but rare plants may occur within the WUI area.

Southwest Colorado is noted for its good air quality. Wildfire would negatively affect the air quality of the area during a fire.

Wildfire can adversely affect soil quality, reducing water permeability, increasing bulk density and removing organic matter. The soils in the subdivision are silt and clay loams with low to moderate erodibility and moderate to good fertility.

The water originating from the watershed containing the subdivision flows into Lightner Creek and then into the Animas River upstream from the Animas-La Plata pumping station. Introduction of soot and sediment due to a wildfire within the watershed would compromise water quality in the Animas and the new Lake Nighthorse Reservoir.

Ecosystem health for the WUI is fair to moderate. Lack of frequent fire has increased the size of the oak component, lowered crown base height in the

ponderosa pine and increased needle and leaf litter depths. Some forest management has occurred on the Ute Mountain Ute tribal ownerships and in some of the tracts bordering Durango West One, but the forested stands are overstocked across the WUI in general.

D. Protection Capability

The subdivision is served by Station #9 of the Durango Fire and Rescue Authority (DFRA), located on Woodcrest Drive. The Station is staffed by nine volunteer firefighters, all of whom have National Wildfire Coordinating Group (NWCG) wildland firefighting qualifications. DFRA has three stations staffed 24/7, two of which are within 10 miles of the subdivision. An additional Type 6 brush engine is staffed from May through October by the Authority. Station #8 at Rafter J Estates subdivision has eight volunteer firefighters, a Type 1 engine, a Type 6 brush engine and water tender. The Fort Lewis Mesa FPD is also available under the mutual aid agreement with DFRA. Training of all DFRA firefighting staff, including volunteers, is conducted by the Authority.

There are 19 fire hydrants across the subdivision. Water storage capacity is 300,000 gallons in two tanks. Situations requiring use of multiple hydrants my result in low water pressures or lack of water at some hydrants (personal communication with DFRA Deputy Chief Allen Clay).

Wildland fires occurring on private lands are generally managed for full suppression. Wildfires on National Forest and BLM-managed public lands in La Plata County are managed with policies which may involve full suppression, point suppression, confinement or containment strategies. The state and the tribes generally manage with suppression or containment strategies.

An Evacuation Survey has been conducted within the subdivision with the responses given to La Plata County Emergency Management. The survey included contact information from the respondents. A community information database been created and it is updated continually for changes in property ownership. Evacuation routes are shown on the Evacuation Route Map in Appendix A. Evacuation actions are the responsibility of the La Plata County Sheriff's Office and the La Plata County Office of Emergency Management.

7. MITIGATION ACTION PLAN

A. Education and Community Outreach

The audience for the Mitigation Action Plan includes the residents of Durango West One, landowners immediately surrounding the subdivision that can benefit from mitigation activities on their properties and within the subdivision; government agencies planning complementary mitigation treatments and/or

supplying grants or matching funds to perform mitigation; and emergency responders.

Planned outreach methods include:

- Educational information included with Metro District billings
- Sponsored community fuels mitigation activities
- Educational community workshops
- Quarterly Firewise Newsletter mailed to all residents
- Identified individualized mitigation needs mailed to all residents with methods to cost-effectively accomplish those actions (including cost-sharing and grants).

B. Policy

Authority for managing vegetation on Metro District property comes from Title 32 of the State of Colorado regulations governing Special Metropolitan Districts. La Plata County also has a regulation regarding driveway size for new construction permits issued in the County but it has not been enforced. Additional authorities for defensible space and driveway alignment and width for fire apparatus access have been proposed but have not been enacted at this time.

The Metropolitan District will work to procure legal evacuation route status for the dirt "two-track" road access to Highway 160 from Woodcrest Road **(2009)**.

C. Fuel Mitigation Treatments

Durango West One has 20% of the land base of the subdivision in common space owned by the Metro District. Most of the common space has native trees and shrubs in a similar condition to that on the privately owned lots. The Metro District has approved and is moving forward with fuels mitigation on the common property. The primary strategy is to remove ladder fuels, reduce built-up litter and thin overstocked clumps of trees to improve general forest health. The second strategy is to demonstrate the types of fuels mitigation needed to the residents and surrounding landowners. A third strategy is to provide cost-sharing and grant opportunities to the residents and other landowners.

Metropolitan District #1
The Metro District projects for 2009 and future years by priority are:

1. Create a shaded fuelbreak on Metro District property between Westridge Road and the "triangle" at the intersection of Trail Wood and Forest Ridge Drives. Area treated is approximately 3.5 acres. Treatment RX is to reduce stand densities to 40 – 60 square feet of basal area, remove ladder fuels under pines

and reduce continuity of surface fuels. Biomass would be disposed by removing material over 3" diameter to a site for firewood for the community and chipping material less than 3" and scattering on-site. Project costs are estimated at $1500 per acre for a total cost of $5,250 **(2009)**.

1. Develop a formal subdivision Evacuation Plan in consultation with DFRA, La Plata County Office of Emergency Management and the subdivision residents. Project cost is estimated at $5,000 **(2009-2010)**.

2. Procure a "brush-hog" type of implement that can be used for maintaining mitigation treatments on Metro District properties. Cost of the implement is estimated at $15,000 **(2010)**.

3. Develop and maintain the Metro District ownership within the subdivision as shaded fuelbreaks **(2011-2015).**

Subdivision Homeowners

1. Assist homeowners with individual defensible space creation and fuel mitigation by providing information, education and advice on effective mitigation techniques **(on-going).**

2. Explore grant and cost-sharing opportunities for homeowners with CSFS, DFRA, La Plata County and other governmental bodies **(2010)**.

Adjoining Ownerships

1. Create 200 foot-wide shaded fuelbreak along the west edge of the subdivision on the Robert Wolff property. Area treated is approximately 13 acres. Treatment RX is to reduce stand densities to 40 - 60 square feet of basal area, remove ladder fuels under pines, and reduce continuity of surface fuels. Biomass would be disposed by removing material over 3" diameter to a site for firewood for the community and chipping material less than 3" and scattering on-site. Project costs are estimated at $1500 per acre for a total cost of $19,500. The project is dependent on agreement by the landowner **(2009)**.

2. The Durango West One Firewise Committee will encourage Robert Wolff, owner of the remaining undeveloped property within the subdivision, to perform mitigation work including tree thinning and oakbrush reduction on his property **(2010-2011)**.

3. The Firewise Committee will encourage the Lake Durango and Durango West Two subdivisions to develop their own CWPP's and perform fuels mitigation within their subdivisions **(2010-2011)**.

8. MONITORING AND EVALUATION

Multiple stakeholders are involved with monitoring and evaluation of outreach, education and mitigation efforts within the Durango West One subdivision and it's WUI.

A. Monitoring
The monitoring actions and the responsible stakeholders are:

1. Quarterly Firewise Committee Newsletters and semi-annual community work days.
2. Annual Report to the Community, Firewise Council of SW Colorado , Colorado State Forest Service from the Firewise Committee and the Metro District.
3. Annual monitoring of mitigation status by the Firewise Committee.
4. Bi-annual monitoring of mitigation status by the Durango Fire and Rescue Authority and the Colorado State Forest Service.

B. Evaluation
Evaluation Actions and the responsible stakeholder are as follows:
1. The Firewise Committee Annual Report will list "Lessons Learned" from projects and activities over the preceding year.
2. Measure progress by degree of accomplishment of mitigation benchmarks stated above annually. Firewise Committee and Metro District update benchmarks as accomplished.
3. Metro District review CWPP annually by December 31. Colorado State Forest Service, Firewise Council of SW Colorado and Durango Fire and Rescue Authority review CWPP and update as needed or not less than every five years.

9. GLOSSARY

acre: an area of land containing 43,560 square feet. A square acre would be about 209 feet by 209 feet. A circular acre would have a radius of 117.75 feet.

basal area: the cross-sectional area of a single stem, including the bark, measured at breast height (4.5 feet above the ground) For example, the basal area of a tree 14 inches in diameter at breast height is about 1 square foot. Basal area = 0.005454 times diameter squared. (b) of an acre of forest: the sum of basal areas of the individual trees on the area. For example, a well stocked pine stand might contain 80 to 120 square feet of basal area per acre.

canopy: the foliage formed by the crowns of trees in a stand.

defensible space: an area around a structure where fuels and vegetation are treated, cleared or reduced to slow the spread of wildfire towards the structure

diameter at breast height (dbh): the diameter of a stem of a tree at 4 ½ feet above the ground

dominant: One of four crown classes recognized on the basis of relative position and condition of the stand. Specifically, trees with crowns extending above the general level of the crown cover, receiving full light from above and partly from the side; larger than the average trees in the stand, and with crowns well-developed but possibly somewhat crowded on the sides.

downed fuels: the accumulated woody and vegetative material on the forest floor from leaf/needle fall, natural pruning and breakage that serves as fuel for wildfire.

ecosystem: A functional unit consisting of all the living organisms (plants, animals, microbes) in a given area, and all the non-living physical and chemical factors of their environment, linked together through nutrient cycling and energy flow. An ecosystem can be of any size a log, pond, field, forest, or the earth's biosphere but it always functions as a whole unit. Ecosystems are commonly described according to the major type of vegetation; for example, forest ecosystem, old-growth ecosystem, or range ecosystem.

fuel loading: the oven-dry weight of fuel per unit area

fuelbreak: A strategically located strip or block of land (of varying width) depending on fuel and terrain, in which fuel density is reduced, thus improving fire control opportunities. The stand is thinned and remaining trees are pruned to remove ladder fuels. Most brush, heavy ground fuels, snags and dead trees are removed and an open park-like appearance established.

ladder fuels: combustible material that provides vertical continuity between vegetation strata and allow fire to climb into the crowns of trees or shrubs with relative ease.

litter: the surface layer of a forest floor that is not in an advanced stage of decomposition, usually consisting of freshly fallen leaves, needles, twigs, stems, bark, and fruits

lop and scatter: a hand method of removing the up-ward branches from tips of felled tress to keep slash low to the ground, to increase rate of decomposition, lower fire hazard, or as a pre-treatment prior to burning.

natural regeneration: trees or an age class of trees growing from natural seeding or natural vegetative reproduction (suckering, layering or sprouting).

pioneer species: a plant capable of invading new bare sites, e.g., newly exposed soil, and persisting there or colonizing them until supplanted by successional species.

pure stand: a stand composed principally of one species, conventionally at least 80 percent based on numbers, basal areas, or volumes

sapling: a usually young tree larger than a seedling but smaller than a pole.

second-growth forest: a relatively young forest that has been regenerated naturally or artificially after some drastic interference such as extensive cutting, wildfire, insect or disease attack, or blowdown

seedling: (a) a tree, usually less than 2 inches in DBH, which has grown from a seed (in contrast to a sprout). (b) a nursery grown tree which has not been lifted and replanted in the nursery (see transplant)

silviculture: the art, science, and practice of establishing, tending, and reproducing forest stands of desired characteristics. It is based on knowledge of species characteristics and environmental requirements

snag: a standing, generally unmerchantable dead tree from which the leaves and most of the branches have fallen

stand: a contiguous group of trees sufficiently uniform in age-class distribution, composition, and structure, and growing on a site of sufficiently uniform quality, to be a distinguishable unit

thinning: a cultural treatment made to reduce stand density of trees primarily to improve growth, enhance forest health, or recover potential mortality

uneven-aged forest: a stand with trees of three or more distinct age classes, either intimately mixed or in small groups.

Wildland-Urban Interface: The geographical meeting point of two diverse systems - wildland and structures. In the WUI, structures and vegetation are sufficiently close so that a wildland fire could spread to structures or a structure fire could ignite vegetation.

APPENDICES

A. Maps

1. **Location**
2. **WUI Area**
3. **Evacuation Routes**
4. **Fire Hydrant Locations**

B. Creating Wildfire-Defensible Zones (CSFS Publication 6.302, C. F. Dennis)

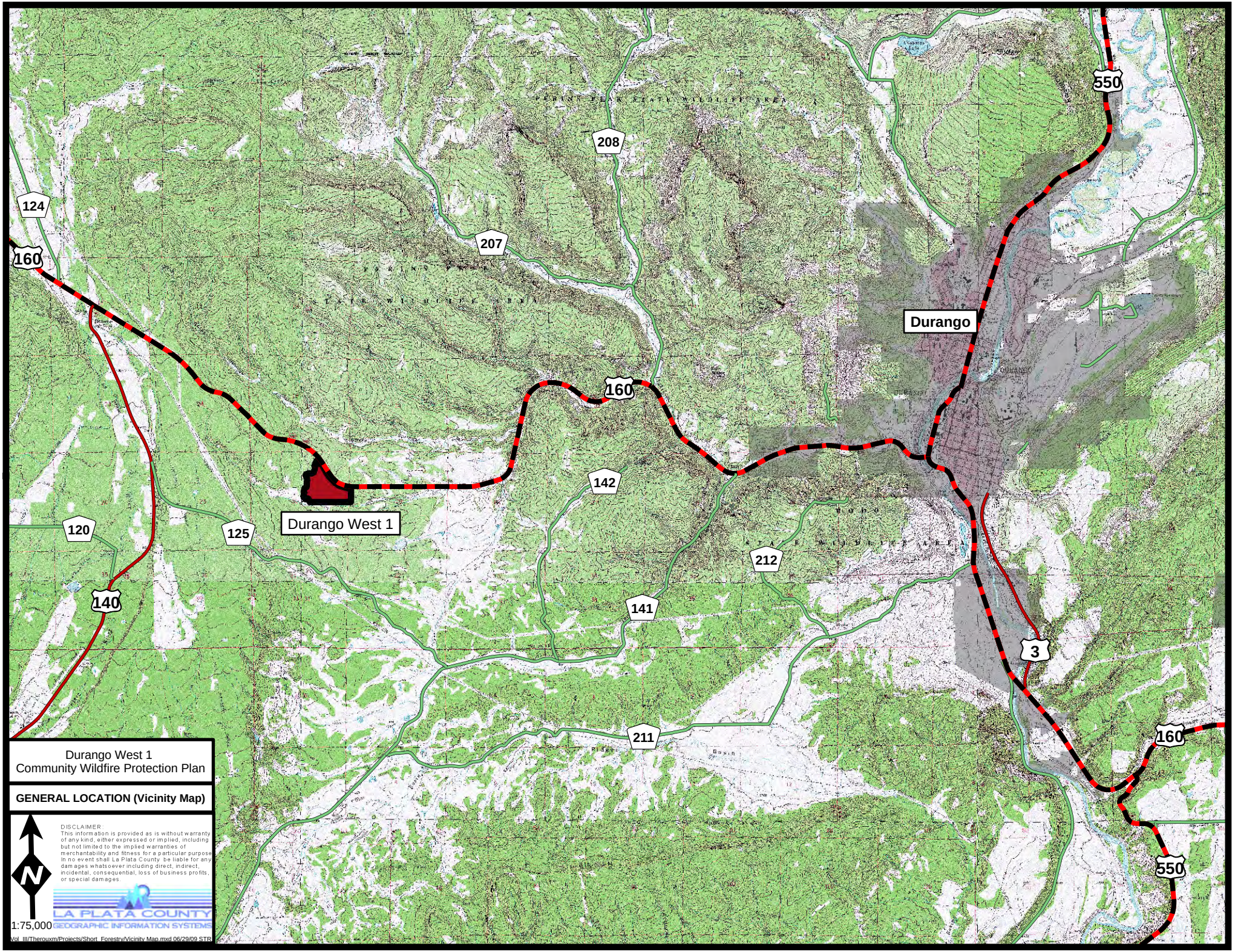
C. Fuelbreak Guidelines for Forested Subdivisions and Communities (C. F. Dennis)

D. Firewise Construction: Design and Materials (P. Slack)

E. Photos

Appendix A

Maps



Durango West 1
Community Wildfire Protection Plan

GENERAL LOCATION (Vicinity Map)

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LA PLATA COUNTY
GEOGRAPHIC INFORMATION SYSTEMS

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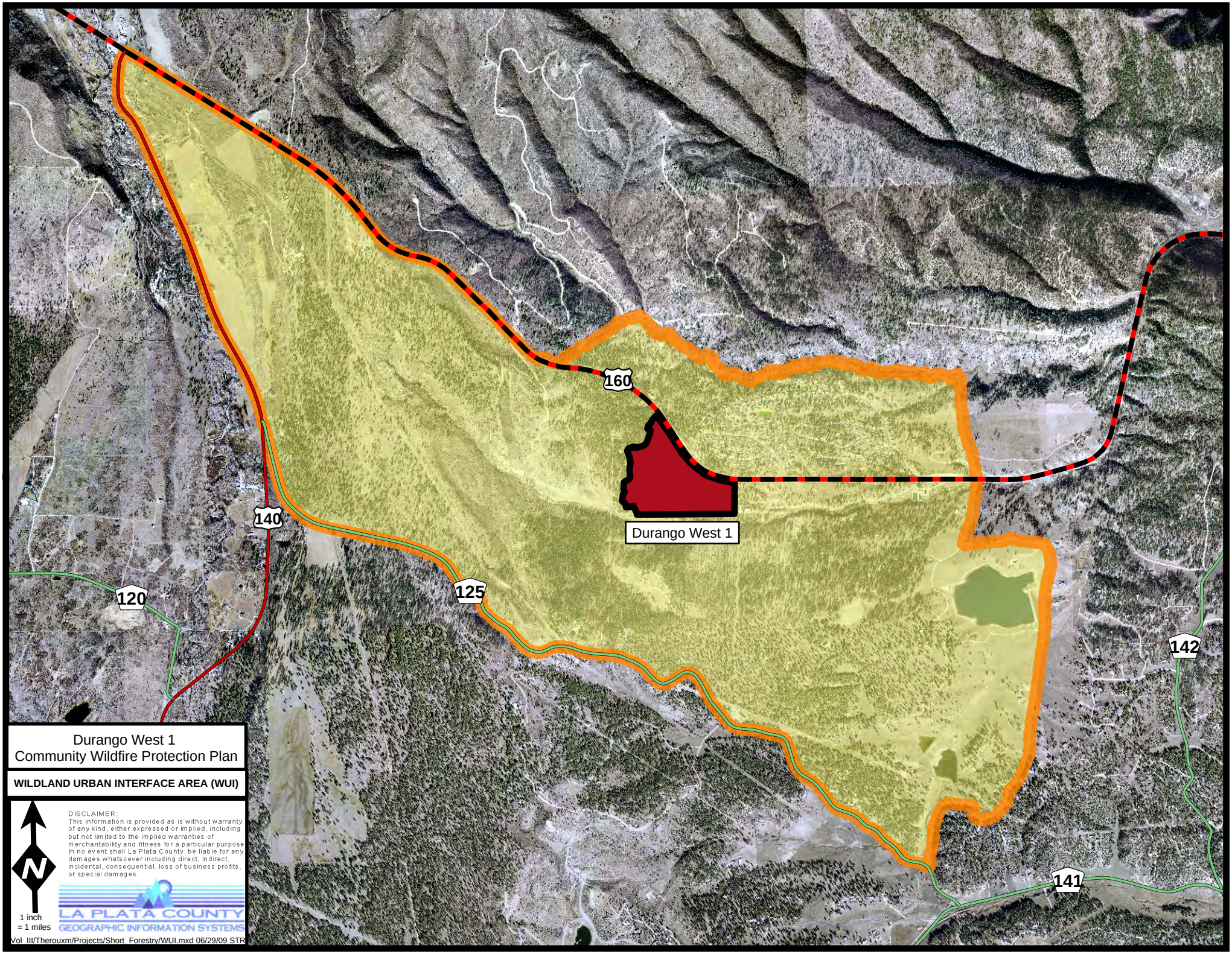

Durango West 1
Community Wildfire Protection Plan

WILDLAND URBAN INTERFACE AREA (WUI)

N

1 inch
= 1 miles

LA PLATA COUNTY
GEOGRAPHIC INFORMATION SYSTEMS

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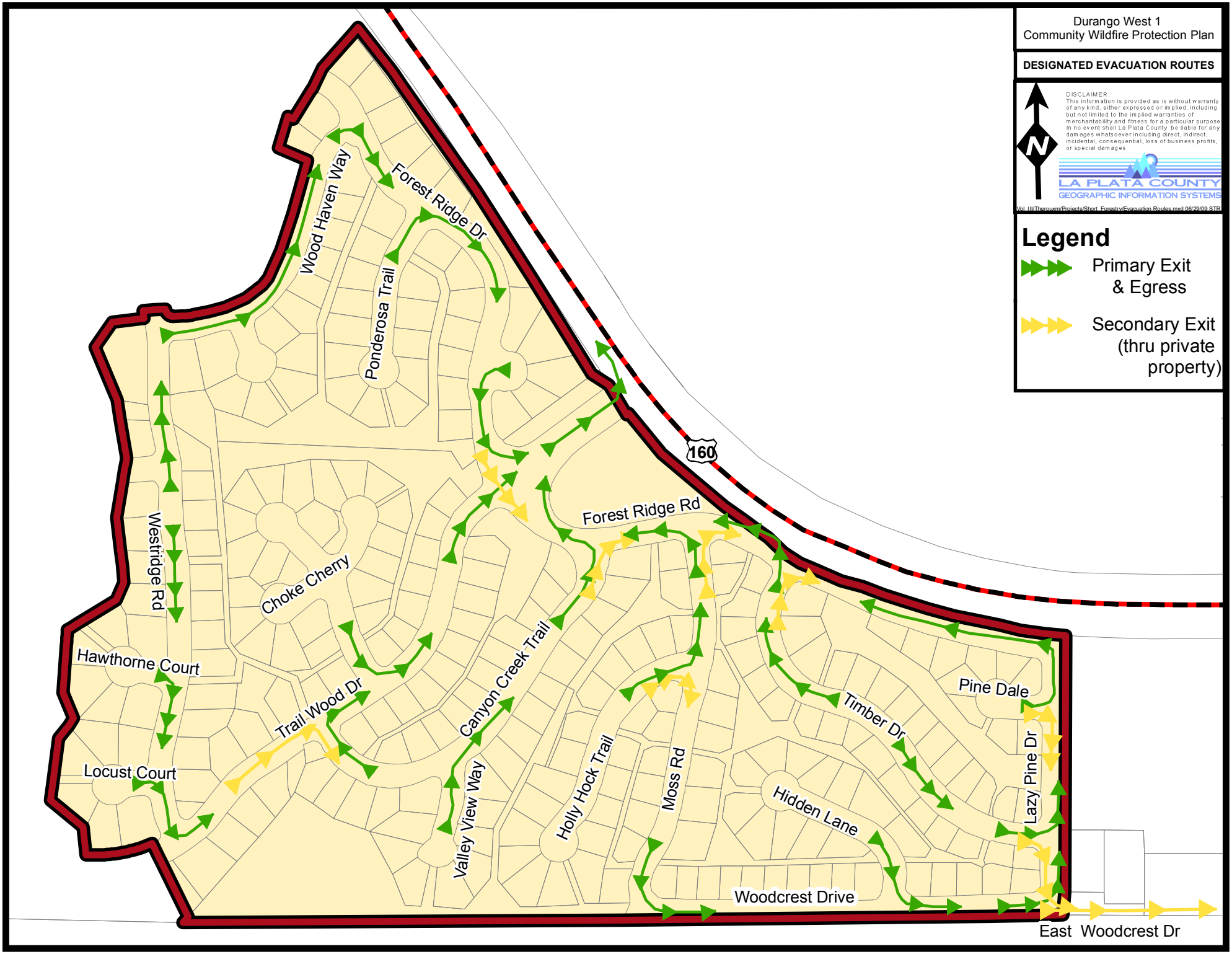
Durango West 1
Community Wildfire Protection Plan
DESIGNATED EVACUATION ROUTES
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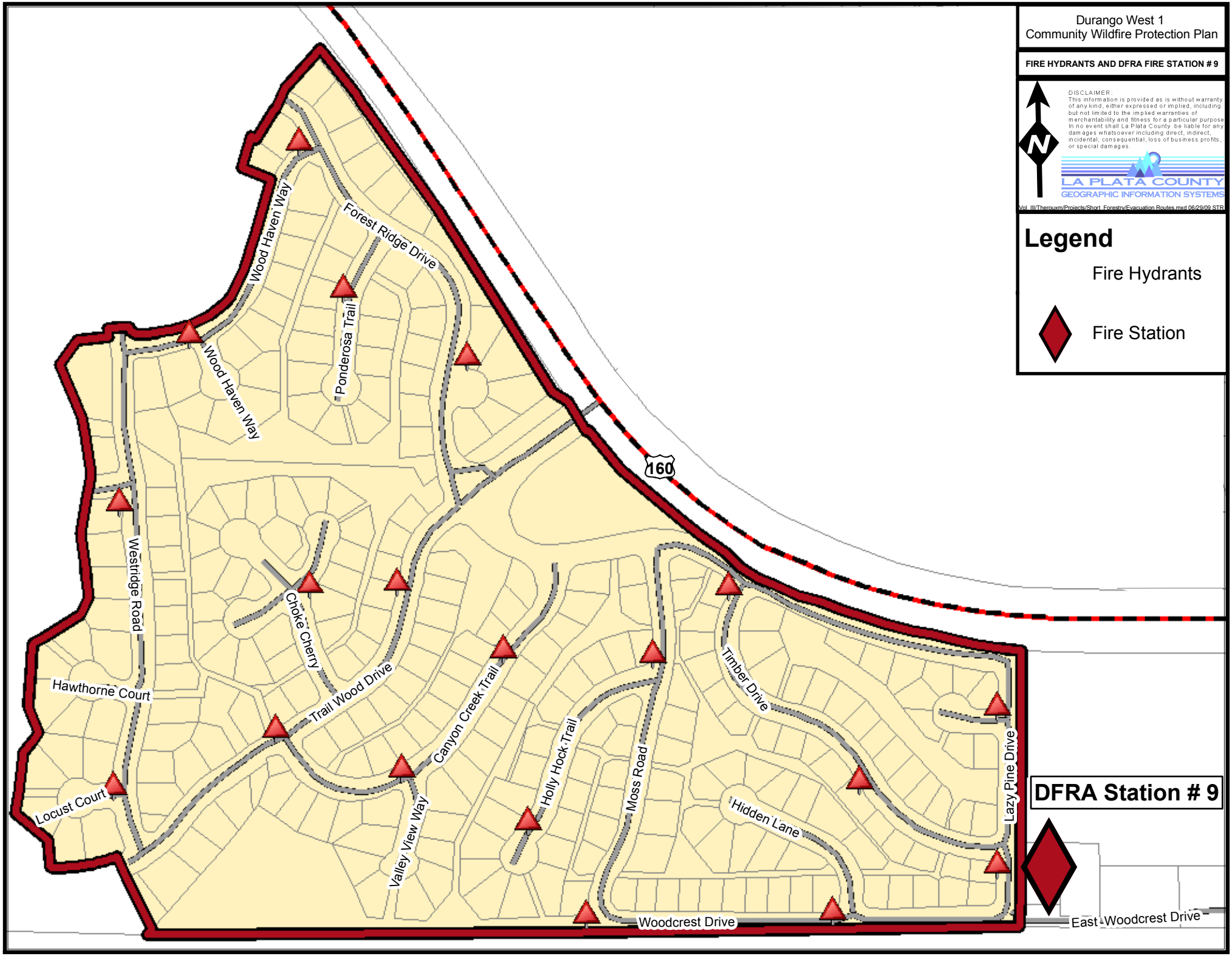
N
LA PLATA COUNTY
GEOGRAPHIC INFORMATION SYSTEMS
Legend
Primary Exit & Egress
Secondary Exit (thru private property)
160
Wood Haven Way
Forest Ridge Dr
Ponderosa Trail
Forest Ridge Rd
Westridge Rd
Choke Cherry
Hawthorne Court
Trail Wood Dr
Canyon Creek Trail
Locust Court
Valley View Way
Holly Hock Trail
Moss Rd
Timber Dr
Pine Dale
Lazy Pine Dr
Hidden Lane
Woodcrest Drive
East Woodcrest Dr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FIRE HYDRANTS AND DFRA FIRE STATION # 9
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LA PLATA COUNTY
GEOGRAPHIC INFORMATION SYSTEMS
Legend
Fire Hydrants
Fire Station
DFRA Station # 9
160
Wood Haven Way
Forest Ridge Drive
Ponderosa Trail
Wood Haven Way
Westridge Road
Choke Cherry
Hawthorne Court
Trail Wood Drive
Canyon Creek Trail
Holly Hock Trail
Moss Road
Timber Drive
Lazy Pine Drive
Hidden Lane
Locust Court
Valley View Way
Woodcrest Drive
East Woodcrest Drive

Appendix B

Creating Wildfire-Defensible Zones

FORESTRY

Creating Wildfire-Defensible Zones no. 6.302

by F.C. Dennis [1]

Quick Facts...

Wildfire will find the weakest links in the defense measures you have taken on your property.

The primary determinants of a home's ability to survive wildfire are its roofing material and the quality of the "defensible space" surrounding it.

Even small steps to protect your home and property will make them more able to withstand fire.

Consider these measures for all areas of your property, not just the immediate vicinity of the house.

Fire is capricious. It can find the weak link in your home's fire protection scheme and gain the upper hand because of a small, overlooked or seemingly inconsequential factor. While you may not be able to accomplish all measures below (and there are no guarantees), each will increase your home's, and possibly your family's, safety and survival during a wildfire.

Start with the easiest and least expensive actions. Begin your work closest to your house and move outward. Keep working on the more difficult items until you have completed your entire project.

Defensible Space

Two factors have emerged as the primary determinants of a home's ability to survive wildfire. These are the home's roofing material and the quality of the "defensible space" surrounding it.

Use fire-resistive materials (Class C or better rating), not wood or shake shingles, to roof homes in or near forests and grasslands. When your roof needs significant repairs or replacement, do so with a fire-resistant roofing material. Check with your county building department. Some counties now restrict wood roofs or require specific classifications of roofing material.

Defensible space is an area around a structure where fuels and vegetation are treated, cleared or reduced to slow the spread of wildfire towards the structure. It also reduces the chance of a structure fire moving from the building to the surrounding forest. Defensible space provides *room for firefighters to do their jobs.* Your house is more likely to withstand a wildfire if grasses, brush, trees and other common forest fuels are managed to reduce a fire's intensity.

The measure of fuel hazard refers to its continuity, both horizontal (across the ground) and vertical (from the ground up into the vegetation crown). Fuels with a high degree of both vertical and horizontal continuity are the most hazardous, particularly when they occur on slopes. Heavier fuels (brush and trees) are more hazardous (i.e. produce a more intense fire) than light fuels such as grass.

Mitigation of wildfire hazards focuses on breaking up the continuity of horizontal and vertical fuels. Additional distance between fuels is required on slopes.

Creating an effective defensible space involves developing a series of management zones in which different treatment techniques are used. See Figure 1 for a general view of the relationships among these management zones. Develop defensible space around each building on your property. Include detached garages, storage buildings, barns and other structures in your plan.

The actual design and development of your defensible space depends on several factors: size and shape of buildings, materials used in their construction, the slope of the ground on which the structures are built, surrounding topography,

Colorado State University Cooperative Extension

Putting Knowledge to Work

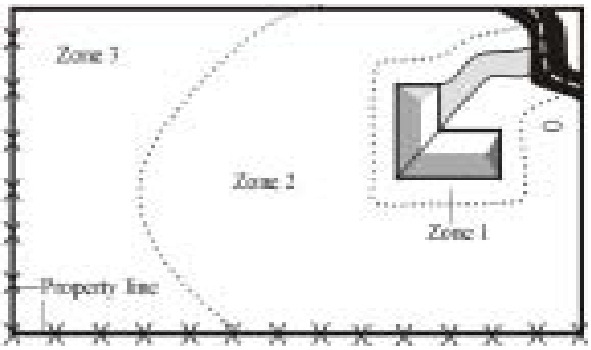


Figure 1: Forested property showing the three fire-defensible zones around a home or other structure.

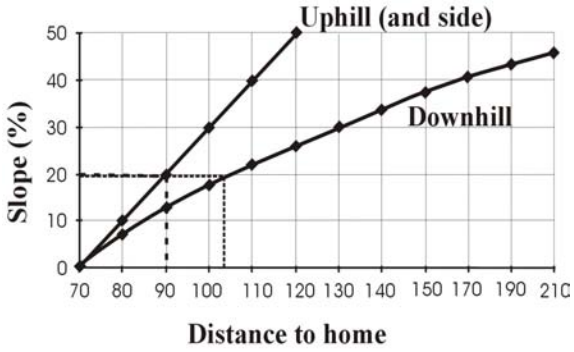


Figure 2: This chart indicates the *minimum recommended* dimensions for defensible space from the home to the outer edge of Zone 2. For example, if your home is situated on a 20 percent slope, the minimum defensible space dimensions would be 90 feet uphill and to the sides of the home and 104 feet downhill from the home.

and sizes and types of vegetation on your property. These factors all affect your design. You may want to request additional guidance from your local Colorado State Forest Service (CSFS) forester or fire department. (See the Special Recommendations section of this fact sheet for shrubs, lodgepole pine, Engelmann spruce, and aspen.)

Defensible Space Management Zones

Zone 1 is the area of maximum modification and treatment. It consists of an area of 15 feet around the structure in which all flammable vegetation is removed. This 15 feet is measured from the outside edge of the home's eaves and any attached structures, such as decks.

Zone 2 is an area of fuel reduction. It is a transitional area between Zones 1 and 3. The size of Zone 2 depends on the slope of the ground where the structure is built. Typically, the defensible space should extend *at least* 75 to 125 feet from the structure. See Figure 2 for the appropriate distance for your home's defensible space. Within this zone, the continuity and arrangement of vegetation is modified. Remove stressed, diseased, dead or dying trees and shrubs. Thin and prune the remaining larger trees and shrubs. Be sure to extend thinning along either side of your driveway all the way to your main access road. These actions help eliminate the continuous fuel surrounding a structure while enhancing homesite safety and the aesthetics of the property.

Zone 3 is an area of traditional forest management and is of no particular size. It extends from the edge of your defensible space to your property boundaries.

Prescriptions

Zone 1

The size of Zone 1 is 15 feet, measured from the edges of the structure. Within this zone, several specific treatments are recommended.

Plant nothing within 3 to 5 feet of the structure, particularly if the building is sided with wood, logs or other flammable materials. Decorative rock, for example, creates an attractive, easily maintained, nonflammable ground cover.

If the house has noncombustible siding, widely spaced foundation plantings of low growing shrubs or other "fire wise" plants are acceptable. Do not plant directly beneath windows or next to foundation vents. Be sure there are no areas of continuous grass adjacent to plantings in this area.

Frequently prune and maintain plants in this zone to ensure vigorous growth and a low growth habit. Remove dead branches, stems and leaves.

Do not store firewood or other combustible materials in this area. Enclose or screen decks with metal screening. Extend the gravel coverage under the decks. Do not use areas under decks for storage.

Ideally, remove all trees from Zone 1 to reduce fire hazards. If you do keep a tree, consider it part of the structure and extend the distance of the entire defensible space accordingly. Isolate the tree from any other surrounding trees. Prune it to at least 10 feet above the ground. Remove any branches that interfere with the roof or are within 10 feet of the chimney. Remove all "ladder fuels" from beneath the tree. Ladder fuels are vegetation with vertical continuity that allows fire to burn from ground level up into the branches and crowns of trees. Ladder fuels are potentially very hazardous but are easy to mitigate. No ladder fuels can be allowed under tree canopies. In all other areas, prune all branches of shrubs or trees up to a height of 10 feet above ground (or 1/2 the height, whichever is the least).

Zone 2

Zone 2 is an area of fuel reduction designed to reduce the intensity of any fire approaching your home. Follow these recommended management steps.

Thin trees and large shrubs so there is at least 10 feet between crowns. Crown separation is measured from the furthest branch of one tree to the nearest branch on the next tree (Figure 3). On steep slopes, allow more space between tree crowns. (See Figure 4 for *minimum recommended* spacing for trees on steep slopes.) Remove all ladder fuels from under these remaining trees. Carefully prune trees to a height of at least 10 feet.

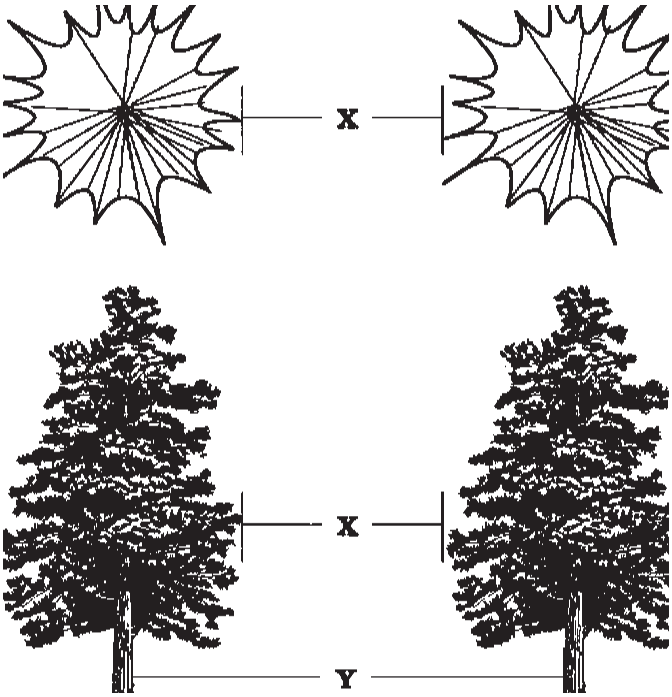


Figure 3: X = crown spacing; Y = stem spacing. Do not measure between stems for crown — measure between the edges of tree crowns.

Small clumps of 2 to 3 trees may be occasionally left in Zone 2. Leave more space between the crowns of these clumps and surrounding trees.

Because Zone 2 forms an aesthetic buffer and provides a transition between zones, it is necessary to blend the requirements for Zones 1 and 3. Thin the portions of Zone 3 adjacent to Zone 2 more heavily than the outer portions.

Isolated shrubs may remain, provided they are not under tree crowns. Prune and maintain these plants periodically to maintain vigorous growth. Remove dead stems from trees and shrubs annually. Where shrubs are the primary fuel in Zone 2, refer to the Special Recommendations section of this fact sheet.

Limit the number of dead trees (snags) retained in this area. Wildlife needs only one or two snags per acre. Be sure any snags left for wildlife cannot fall onto the house or block access roads or driveways.

Mow grasses (or remove them with a weed trimmer) as needed through the growing season to keep them low, a maximum of 6 to 8 inches. This is extremely critical in the fall when grasses dry out and cure or in the spring after the snow is gone but before the plants green up.

Stack firewood and woodpiles uphill or on the same elevation as the structure but at least 30 feet away. Clear and keep away flammable vegetation within 10 feet of these woodpiles. Do not stack wood against your house or on or under your deck, even in winter. Many homes have burned from a woodpile that ignited as the fire passed. Wildfires can burn at almost any time in Colorado.

Locate propane tanks at least 30 feet from any structures, preferably on the same elevation as the house. You don't want the LP container below your house — if it ignites, the fire would tend to burn uphill. On the other hand, if the tank is above your house and it develops a leak, LP gas will flow downhill into your home. Clear and keep away flammable vegetation within 10 feet of these tanks. Do not screen propane tanks with shrubs or vegetation.

Dispose of slash (limbs, branches and other woody debris) from your trees and shrubs through chipping or by piling and burning. Contact your local CSFS office or county sheriff's office for information about burning slash piles. If neither of these alternatives is possible, lop and scatter slash by cutting it into very small pieces and distributing it over the ground. Avoid heavy accumulations

% slope	Tree Crown Spacing	Brush and Shrub Clump Spacing
0 -10 %	10´	2 1/2 x shrub height
11 - 20%	15´	3 x shrub height
21 - 40%	20´	4 x shrub height
> 40%	30´	6 x shrub height

Figure 4: Minimum tree crown and shrub clump spacing.

Tree Diameter (in inches)	Average Stem Spacing Between Trees (in feet)
3	10
4	11
5	12
6	13
7	14
8	15
9	16
10	17
11	19
12	21
13	23
14	24
15	26
16	28
17	29
18	31
19	33
20	35
21	36
22	38
23	40
24	42

Figure 5: Minimum tree spacing for Zone 3.

of slash. Lay it close to the ground to speed decomposition. If desired, no more than two or three small, widely spaced brush piles may be left for wildlife purposes. Locate these towards the outer portions of your defensible space.

Zone 3

This zone is of no specified size. It extends from the edge of your defensible space to your property lines. A gradual transition into this zone from defensible space standards to other management objectives you may have is suggested. Typical management objectives for areas surrounding homesites or subdivisions are: provide optimum recreational opportunities; enhance aesthetics; maintain tree health and vigor; provide barriers for wind, noise, dust and visual intrusions; support limited production of firewood, fence posts and other forest commodities; or grow Christmas trees or trees for transplanting.

Specific requirements will be dictated by your objectives for your land and the kinds of trees present. See Figure 5 for the *minimum* suggested spacing between "leave" trees. Forest management in Zone 3 is an opportunity for you to increase the health and growth rate of the forest in this zone. Keep in mind that root competition for available moisture limits tree growth and ultimately the health of the forest.

A high canopy forest reduces the chance of a surface fire climbing into the tops of the trees and might be a priority for you if this zone slopes steeply. The healthiest forest is one that has multiple ages, sizes, and species of trees where adequate growing room is maintained over time. Remember to consider the hazards of ladder fuels. Multiple sizes and ages of trees might increase the fire hazard from Zone 3 into Zone 2, particularly on steep slopes.

A greater number of wildlife trees can remain in Zone 3. Make sure that dead trees pose no threat to power lines or fire access roads.

While pruning generally is not necessary in Zone 3, it may be a good idea from the standpoint of personal safety to prune trees along trails and fire access roads. Or, if you prefer the aesthetics of a well-manicured forest, you might prune the entire area. In any case, pruning helps reduce ladder fuels within the tree stand, thus enhancing wildfire safety.

Mowing is not necessary in Zone 3.

Any approved method of slash treatment is acceptable for this zone, including piling and burning, chipping or lop-and-scatter.

Special Recommendations

Tree spacing guidelines do not apply to *mature* stands of aspen trees where the recommendations for ladder fuels have been complied with. In areas of aspen regeneration and young trees, the spacing guidelines should be followed.

Brush and shrubs

Brush and shrubs are woody plants, smaller than trees, often formed by a number of vertical or semi-upright branches arising close to the ground. Brush is smaller than shrubs and can be either woody or herbaceous vegetation.

On nearly level ground, minimum spacing recommendations between clumps of brush and/or shrubs is 2 1/2 times the height of the vegetation. Maximum diameter of clumps should be 2 times the height of the vegetation. As with tree crown spacing, all measurements are made from the edges of vegetation crowns (Figure 3).

For example: For shrubs 6 feet high, spacing between shrub clumps should be 15 feet or more apart (measured from the edges of the crowns of vegetation clumps). The diameter of shrub clumps should not exceed 12 feet (measured from the edges of the crowns). Branches should be pruned to a height of 3 feet.

Grasses

Keep dead, dry or curing grasses mowed to less than 6 inches. Defensible space size where grass is the predominant fuel can be reduced (Figure 5) when applying this practice.

Windthrow

In Colorado, certain locations and tree species, including lodgepole pine and Engelmann spruce, are especially susceptible to damage and uprooting by high winds (windthrow). If you see evidence of this problem in or near your forest, or have these tree species, consider the following adjustments to the defensible space guidelines. It is highly recommended that you contact a professional forester to help design your defensible space.

Adjustments: If your trees or homesite are susceptible to windthrow and the trees have never been thinned, use a stem spacing of diameter plus five instead of the guides listed in the Zone 3 section. Over time (every 3 to 5 years) *gradually* remove additional trees. The time between cutting cycles allows trees to "firm up" by expanding their root systems. Continue this periodic thinning until the desired spacing is reached.

Also consider leaving small clumps of trees and creating small openings on their lee side (opposite of the predominant wind direction). Again, a professional forester can help you design the best situation for your specific homesite and tree species. Remember, with species such as lodgepole pine and Engelmann spruce, the likelihood of a wildfire running through the tree tops or crowns (crowning) is closely related to the overabundance of fuels on the forest floor. Be sure to remove downed logs, branches and *excess* brush and needle buildup.

Maintaining Your Defensible Space

Your home is located in a forest that is dynamic, always changing. Trees and shrubs continue to grow, plants die or are damaged, new plants begin to grow, and plants drop their leaves and needles. Like other parts of your home, defensible space requires maintenance. Use the following checklist each year to determine if additional work or maintenance is necessary.

% slope	D-space size (uphill, downhill, sidehill)
0 - 20 %	30'
21 - 40%	50'
> 40%	70'

Figure 6: Minimum defensible space size for grass fuels.

Defensible Space and FireWise Annual Checklist

- □ Trees and shrubs are properly thinned and pruned within the defensible space. Slash from the thinning is disposed of.
- □ Roof and gutters are clear of debris.
- □ Branches overhanging the roof and chimney are removed.
- □ Chimney screens are in place and in good condition.
- □ Grass and weeds are mowed to a low height.
- □ An outdoor water supply is available, complete with a hose and nozzle that can reach all parts of the house.
- □ Fire extinguishers are checked and in working condition.
- □ The driveway is wide enough. The clearance of trees and branches is adequate for fire and emergency equipment. (Check with your local fire department.)
- □ Road signs and your name and house number are posted and easily visible.
- □ There is an easily accessible tool storage area with rakes, hoes, axes and shovels for use in case of fire.
- □ You have practiced family fire drills and your fire evacuation plan.
- □ Your escape routes, meeting points and other details are known and understood by all family members.
- □ Attic, roof, eaves and foundation vents are screened and in good condition.

Stilt foundations and decks are enclosed, screened or walled up.

□ Trash and debris accumulations are removed from the defensible space.

□ A checklist for fire safety needs inside the home also has been completed. This is available from your local fire department.

References

Colorado State Forest Service, Colorado State University, Fort Collins, CO 80523-5060; (970) 491-6303:

- *FireWise Construction — Design and Materials*
- Home Fire Protection in the Wildland Urban Interface
- Wildfire Protection in the Wildland Urban Interface
- *Landowner Guide to Thinning*

Colorado State University Cooperative Extension, 115 General Services Bldg., Fort Collins, CO 80523-4061; (970) 491-6198; E-mail: resourcecenter@ucm.colostate.edu:

- 6.303, *Fire-Resistant Landscaping*
- 6.304, *Forest Home Fire Safety*
- 6.305, *FireWise Plant Materials*
- 6.306, *Grass Seed Mixes to Reduce Wildfire Hazard*
- 7.205, *Pruning Evergreens*
- 7.206, *Pruning Shrubs*
- 7.207, *Pruning Deciduous Trees*

FIREWISE Community Fire Prevention Partnership ©1999 CSFS

FIREWISE is a multi-agency program that encourages the development of defensible space and the prevention of catastrophic wildfire.

Colorado State FOREST SERVICE

This fact sheet was produced in cooperation with the Colorado State Forest Service.

[1]*Wildfire Hazard Mitigation Coordinator, Colorado State Forest Service.*

Appendix C

Fuelbreak Guidelines for Forested Subdivisions and Communities

Fuelbreak Guidelines for Forested Subdivisions & Communities

By

Frank C. Dennis

Colorado State Forest Service

Knowledge to Go Places

This publication was developed for use by foresters, planners, developers, homeowners' associations and others. Implementation of these measures cannot *guarantee* safety from all wildfires, but will greatly increase the probability of containing them at more manageable levels.

Inadequate fire planning can result in loss of life or property and costly suppression activities.

Colorado's forested lands are experiencing severe impacts from continuing population increases and peoples' desire to escape urban pressures. Subdivisions and developments are opening new areas for homesite construction at an alarming rate, especially along the Front Range and around recreational areas such as Dillon, Vail, and Steamboat Springs.

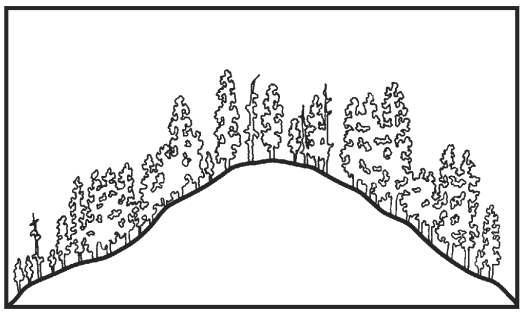
But with development inevitably comes a higher risk of wildfire as well as an ever-increasing potential for loss of life and property. Methods of fire suppression, pre-suppression needs, and homeowner and fire crew safety must all be considered in the planning and review of new developments as well as for the "retrofitting" of existing, older subdivisions.

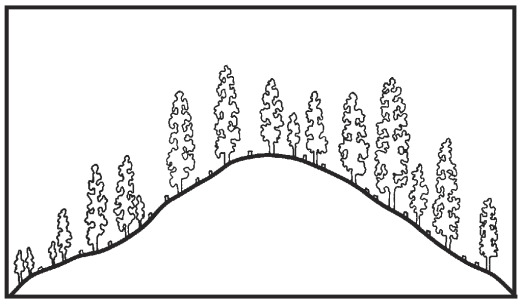
Fuelbreaks should be considered in fire management planning for subdivisions and developments; however, the following are guidelines **only**. They should be customized to local areas by professional foresters experienced in Rocky Mountain wildfire behavior and suppression tactics.

Fuelbreak vs Firebreak

Although the term fuelbreak is widely used in Colorado, it is often confused with firebreak. The two are entirely separate, and aesthetically different, forms of forest fuel modification and treatment.

• A firebreak is strip of land, 20 to 30 feet wide (or more), in which all vegetation is removed down to bare, mineral soil each year prior to fire season.





Above, cross section of mixed conifer stand before fuelbreak modification. Below, after modification.

• A fuelbreak (or shaded fuelbreak) is an easily accessible strip of land of varying width (depending on fuel and terrain), in which fuel density is reduced, thus improving fire control opportunities. The stand is thinned, and remaining trees are pruned to remove ladder fuels. Brush, heavy ground fuels, snags, and dead trees are disposed of and an open, park-like appearance is established.

The following is a discussion of the uses, limitations, and specifications of fuelbreaks in wildfire control and fuels management.

Fuelbreak Limitations

Fuelbreaks provide quick access for wildfire suppression. Control activities can be conducted more safely due to low fuel volumes. Strategically located, they break up large, continuous tracts of dense timber, thus limiting uncontrolled spread of wildfire.

Fuelbreaks can aid firefighters greatly by slowing fire spread under normal burning conditions. However, under extreme conditions, even the best fuelbreaks stand little chance of arresting a large

Before and after photos of a forest stand thinned to reduce fuel loads.

fire, regardless of firefighting efforts. Such fires, in a phenomenon called "spotting," can drop firebrands 1/8-mile or more ahead of the main fire, causing very rapid fire spread. These types of large fires may continue until there is a major change in weather conditions, topography, or fuel type.

It is critical to understand: A fuelbreak is the line of defense. The area (including any homes and developments) between it and the fire may remain vulnerable.

In spite of these somewhat gloomy limitations, fuelbreaks have proven themselves effective in Colorado. During the 1980 Crystal Lakes Subdivision Fire near Fort Collins, crown fires were stopped in areas with fuelbreak thinnings, while other areas of dense lodgepole pine burned completely. A fire at O'Fallon Park in Jefferson County was successfully stopped and controlled at a fuelbreak. The Buffalo Creek Fire in Jefferson County (1996) and the High Meadow Fire in Park and Jefferson Counties (2000) slowed dramatically wherever intense forest thinnings had been completed. During the 2002 Hayman Fire, Denver Water's entire complex of offices, shops and caretakers' homes at Cheesman Reservoir were saved by a fuelbreak with no firefighting intervention by a fuelbreak.

Burned area near Cheesman Reservoir as a result of the Hayman Fire. Note the unburned green trees in the middle right of the photo, a treated fuelbreak.

The Need For A Fuelbreak

Several factors determine the need for fuelbreaks in forested subdivisions, including: (1) potential problem indicators; (2) wildfire hazard areas; (3) slope; (4) topography; (5) crowning potential; and (6) ignition sources.

Potential Problem Indicator

The table below explains potential problem indicators for various hazards and characteristics common to Colorado's forest types. All major forest types, except aspen, indicate a high potential for wildfire hazard.

Fuel Type	Characteristics			Hazards			
	Aesthetics	Wildlife	Soil	**Wildfire**	Avalanche	Flood	Climate
Aspen	2	3	3	**2**	4	3	2
Douglas-fir	2	2	3	**5**	2	2	3
Greasewood-Saltbrush	4	2	2	**2**	1	3	3
Limber-Bristlecone Pine	3	2	4	**3**	4	2	5
Lodgepole Pine	2	2	3	**5**	4	2	4
Meadow	5	4	4	**2**	3	4	3
Mixed Conifer	2	1	1	**5**	3	1	3
Mountain Grassland	5	3	4	**3**	3	2	4
Mountain Shrub	3	5	4	**4**	2	2	3
Piñon-Juniper	2	3	4	**4**	2	3	2
Ponderosa Pine	2	3	1	**5**	2	2	3
Sagebrush	4	4	3	**3**	3	2	3
Spruce-Fir	2	3	3	**4**	5	**3**	4

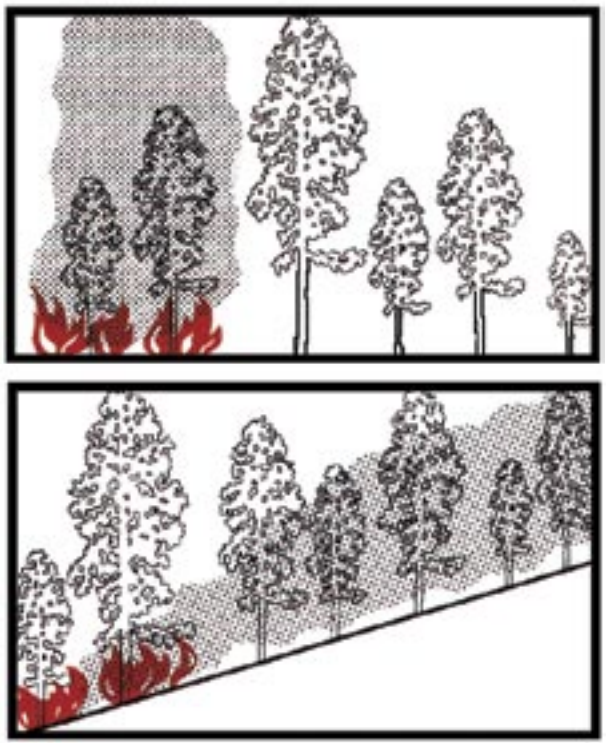
Legend: 5 – Problem may be crucial; 4 – Problem very likely;
3 – Exercise caution; 2 – Problem usually limited;
1 – No rating possible

Wildfire Hazard Maps

The Colorado State Forest Service (CSFS), numerous counties and some National Forests have completed wildfire hazard mapping for many areas within Colorado, particularly along the Front Range. These maps typically consider areas with 30 percent or greater slope; hazardous fuel types; and hazardous topographic features such as fire chimneys. Wildfire Hazard Ratings may be depicted in several ways. Whatever system is used, areas rated moderate or higher should be considered for fuel modification work.

Slope

Rate of fire spread increases as the slope of the land increases. Fuels are preheated by the rising smoke column or they may even come into contact with the flames themselves.



Fire effects, flat vs steep terrain. Note preheating of fuels on steep ground from passage of smoke column.

At 30 percent slope, rate of fire spread doubles compared to rates at level ground, drastically reducing firefighting effectiveness. **Areas near 30 percent or greater slopes are critical and must be reviewed carefully.**

Topography

Certain topographic features influence fire spread and should be evaluated. Included are fire chimneys, saddles, and V-shaped canyons. They are usually recognized by reviewing standard U.S.G.S. quad maps.

• Chimneys are densely vegetated drainages on slopes greater than 30 percent. Wind, as well as air pre-heated by a fire, tends to funnel up these drainages, rapidly spreading fire upslope.

• Saddles are low points along a main ridge or between two high points. Like chimneys, they also funnel winds to create a natural fire path during a fire's uphill run. Saddles act as corridors to spread fire into adjacent valleys or drainages.

Chimney.

Saddle.

• Narrow, V-shaped valleys or canyons can ignite easily due to heat radiating from one side to the other. For example, a fire burning on one side of a narrow valley dries and preheats fuels on the opposite side until the fire "flashes over." The natural effect of slope on fire then takes over and fire spreads rapidly up drainage and uphill along both sides of the valley.

Flashover in V-shaped valley.

Crowning Potential

An on-site visit is required to accurately assess crowning potential. A key, below, helps determine this rating. Fuel modification is usually unnecessary if an area has a rating of 3 or less.

Crowning Potential Key

	Rating
A. Foliage present, trees living or dead — B	
B. Foliage living — C	
C. Leaves deciduous or, if evergreen, usually soft, pliant, and moist; never oily, waxy, or resinous.	0
CC. Leaves evergreen, not as above — D	
D. Foliage resinous, waxy, or oily — E	
E. Foliage dense — F	
F. Ladder fuels plentiful — G	
G. Crown closure > 75 percent	9
GG. Crown closure < 75 percent	7
FF. Ladder fuels sparse or absent — H	
H. Crown closure > 75 percent	7
HH. Crown closure < 75 percent	5
EE. Foliage open — I	
I. Ladder fuel plentiful	4
II. Ladder fuel sparse or absent	2
DD. Foliage not resinous, waxy, or oily — J	
J. Foliage dense — K	
K. Ladder fuels plentiful — L	
L. Crown closure > 75 percent	7
LL. Crown closure < 75 percent	4
KK. Ladder fuels sparse or absent — M	
M. Crown closure > 75 percent	5
MM. Crown closure < 75 percent	3
JJ. Foliage open — N	
N. Ladder fuels plentiful	3
NN. Ladder fuels sparse or absent	1
BB. Foliage dead	0

The majority of dead trees within the fuelbreak should be removed. Occasionally, large, dead trees (14 inches or larger in diameter at 4 1/2 feet above ground level) may be retained as wildlife trees. If retained, all ladder fuels must be cleared from around the tree's trunk.

Ignition Sources

Possible ignition sources, which may threaten planned or existing developments, must be investigated thoroughly. Included are other developments and homes, major roads, recreation sites, railroads, and other possible sources. These might be distant from the proposed development, yet still able to channel fire into the area due to slope, continuous fuels, or other topographic features.

Fuelbreak Locations

In fire suppression, an effective fire line is connected, or "anchored," to natural or artificial fire barriers. Such anchor points might be rivers, creeks, large rock outcrops, wet meadows, or a less flammable timber type such as aspen. Similarly, properly designed and constructed fuelbreaks take advantage of these same barriers to eliminate "fuel bridges." (Fire often escapes control because of fuel bridges that carry the fire across control lines.)

Since fuelbreaks should normally provide quick, safer access to defensive positions, they are necessarily linked with road systems. Connected with county-specified roads within subdivisions, they provide good access and defensive positions for firefighting equipment and support vehicles. Cut-and fill slopes of roads are an integral part of a fuelbreak as they add to the effective width of modified fuels.

Fuelbreaks without an associated road system, such as those located along strategic ridge lines, are still useful in fire suppression. Here, they are often strengthened and held using aerial retardant drops until fire crews can walk in or be ferried in by helicopter.

Preferably, fuelbreaks are located along ridge tops to help arrest fires at the end of their runs. However, due to homesite locations and resource values, they can also be effective when established at the base of slopes. Mid-slope fuelbreaks are least desirable, but under certain circumstances and with modifications, these too, may be valuable.

Fuelbreaks are located so that the area under management is broken into small, manageable units. Thus, when a wildfire reaches modified fuels, defensive action is more easily taken, helping to keep the fire small. For example, a plan for a subdivision might recommend that fuelbreaks break up continuous forest fuels into units of 10 acres or less. This is an excellent plan, especially if defensible space thinnings are completed around homes and structures, and thinning for forest management and forest health are combined with the fuelbreak.

When located along ridge tops, continuous length as well as width are critical elements. Extensive long-range planning is essential in positioning these types of fuelbreaks.

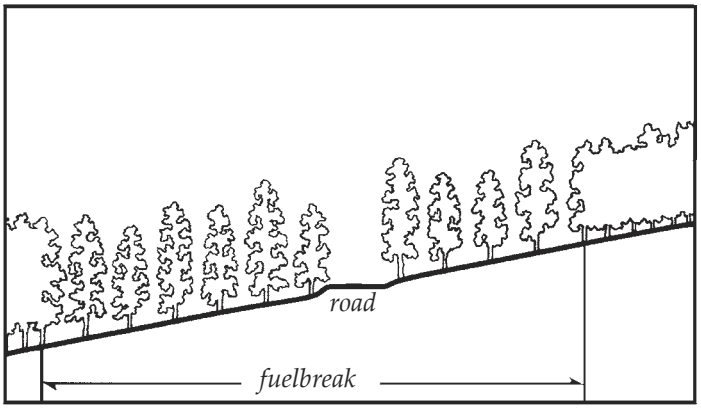
Aesthetics

Improperly planned fuelbreaks can adversely impact an area's aesthetic qualities. Careful construction is necessary when combining mid-slope fuelbreaks with roads involving excessive cut-and-fill.

These photos, far- and near- views of the same site, illustrate that forest can be thinned without impacting aesthetics.

Care must also be taken in areas that are not thinned throughout for fuel hazard reduction. In such cases the fuelbreak visually sticks out like a "sore thumb" due to contrasting thinned and unthinned portions of the forest. (Especially noticeable are those portions of the fuelbreak above road cuts).

These guidelines are designed to minimize aesthetic impacts. However, some situations may require extensive thinning and, thus, result in a major visual change to an area. Additional thinning beyond the fuelbreak may be necessary to create an irregular edge and to "feather," or blend, the fuelbreak thinning into the unthinned portions of the forest. Any thinning beyond the fuelbreak improves its effectiveness and is highly recommended.



Cross-section of a typical fuelbreak built in conjunction with a road.

Constructing the Fuelbreak

Fuelbreak Width and Slope Adjustments

Note: Since road systems are so important to fuelbreak construction, the following measurements are from the toe of the fill for downslope distances, and above the edge of the cut for uphill distances.

The minimum recommended fuelbreak width is approximately 300 feet for level ground. Since fire activity intensifies as slope increases, the overall fuelbreak width must also increase. However, to minimize aesthetic impacts and to maximize fire crew safety, the majority of the increases should be made at the bottom of the fuelbreak, below the road cut.

Widths are also increased when severe topographic conditions are encountered. Guidelines for fuelbreak widths on slopes are given below:

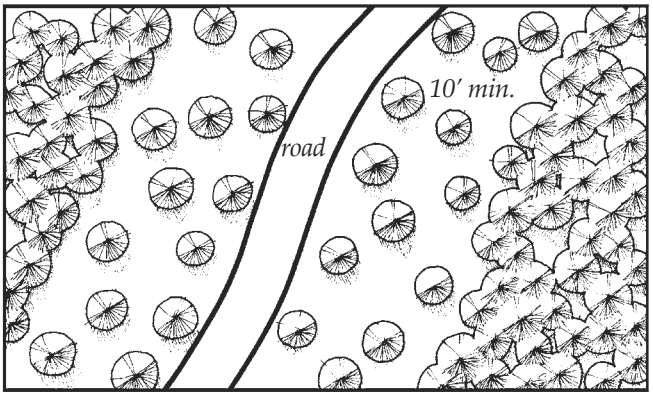
Fuelbreak Width/Slope

Percent Slope (%)	Minimum Uphill Distance (ft)	Minimum Downhill Distance (ft)	Total Width of Modified fuels (ft)*
0	150	150	300
10	140	165	303
20	130	180	310
30	120	195	315
40	110	210	320
50	100	225	325
60	100	240	340

*As slope increases, total distance for cut-and-fill for road construction rapidly increases, improving fuelbreak effective width.

Stand Densities

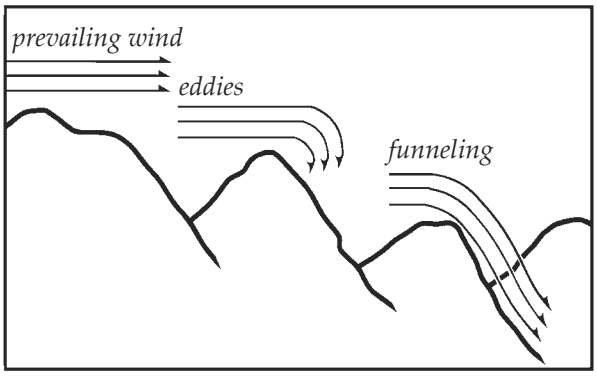
Crown separation is a more critical factor for fuelbreaks than a fixed tree density level. A *minimum* 10-foot spacing between the edges of tree crowns is recommended on level ground. As slope increases, crown spacing should also increase. However, small, isolated groups of trees may be retained for visual diversity. Increase crown spacing around any groups of trees left for aesthetic reasons and to reduce fire intensities and torching potential.



Plan view of fuelbreak showing minimum distance between tree crowns.

In technical terms, a fuelbreak thinning is classified as a heavy "sanitation and improvement cut, from below." Within fuelbreaks, trees that are suppressed, diseased, deformed, damaged, or of low vigor are removed along with all ladder fuels. Remaining trees are the largest, healthiest, most wind-firm trees from the dominant and co-dominant species of the stand.

Because such a thinning is quite heavy for an initial entry into a stand, prevailing winds, eddy effects, and wind funneling must be carefully evaluated to minimize the possibility of windthrow. It may be necessary to develop the fuelbreak over several years to allow the timber stand to "firm-up" — this especially applies to lodgepole pine and Engelmann spruce stands.



Topography affects wind behavior – an important consideration during fuelbreak construction.

Area-wide forest thinnings are recommended for any subdivisions. Such thinning is not as severe as a fuelbreak thinning, but generally should be completed to fuelbreak specifications along the roads (as outlined on page 6.) In addition, "defensible space thinnings" are highly recommended around all structures (see CSU Coop. Extension Fact sheet 6.302, *Creating Wildfire-Defensible Zones*).

Debris Removal

Limbs and branches left from thinning (slash) can add significant volumes of fuel to the forest floor, especially in lodgepole pine, mixed-conifer, or spruce/fir timber types. These materials can accumulate and serve as ladder fuels, or can become "jackpots," increasing the difficulty of defending the fuelbreak during a wildfire. **Slash decomposes very slowly in Colorado and proper disposal is essential.** Proper treatment reduces fire hazard, improves access for humans and livestock, encourages establishment of grasses and other vegetation, and improves aesthetics.

Three treatment methods are commonly used. These are lopping-and-scattering, piling and burning, and chipping. Mulching of small trees and slash using equipment similar to Hydro-axes or Timbcos equipped with mulching heads are becoming a popular method of treatment. Size, amount, and location of slash dictates the method used, in addition to cost and the final desired appearance. The method chosen will also depend on how soon an effective fuelbreak is needed prior to construction in new developments.

Lop and scatter: slash should be no deeper than 12'' above ground surface.

Chipping is the most desirable, but also the most expensive method of slash disposal.

Piled slash can be burned but only during certain conditions, such as after a snowfall.

Fuelbreak Maintenance

Following initial thinning, trees continue to grow (usually at a faster rate). The increased light on the forest floor encourages heavy grass and brush growth where, in many cases, where little grew before. The site disturbance and exposed mineral soil created during fuelbreak development is a perfect seed bed for new trees that, in turn, create new ladder fuels. Thus, in the absence of maintenance, fuelbreak effectiveness will decrease over time.

Fuelbreak maintenance is essential. Ingrowth, shown above, will minimize the effectiveness of this fuelbreak within a few years.

Fuelbreak maintenance problems are most often the result of time and neglect. Misplaced records, lack of follow-up and funding, and apathy caused by a lack of fire events are some of the major obstacles. In addition, the responsibility for fuelbreak maintenance projects is often unclear. For example, control of a fuelbreak completed by a developer passes to a homeowner's association, usually with limited funds and authority to maintain fuelbreaks.

If fuelbreak maintenance is not planned and completed as scheduled, consider carefully whether the fuelbreak should be constructed. An un-maintained fuelbreak may lead to a false sense of security among residents and fire suppression personnel.

Conclusion

An image of well-designed communities for Colorado includes:

• Forested subdivisions where the total forest cover is well-managed through carefully planned, designed, and maintained thinnings. This contributes to reduced wildfire hazards and a much healthier forest — one that is more resistant to insects and disease.

• A system of roads and driveways with their associated fuelbreaks that break up the continuity of the forest cover and fuels. These help keep fires small, while also providing safer locations from which to mount fire suppression activities. In addition to allowing fire personnel in, they will allow residents to evacuate if necessary.

• Individual homes that all have defensible space around them, making them much easier to defend and protect from wildfire, while also protecting the surrounding forest from structure fires.

Creation of such communities is entirely feasible if recognition of the fire risks, a spirit of cooperation, an attitude of shared responsibility, and the political will exists.

Colorado's mountains comprise diverse slopes, fuel types, aspects, and topographic features. This variety makes it impossible to develop general fuelbreak prescriptions for all locations. ***The previous recommendations are guidelines only.*** *A professional forester with fire suppression expertise should be consulted to "customize" fuelbreaks for particular areas.*

Appendix D

Firewise Construction: Design and Materials

Firewise Construction

Design and Materials

FIREWISE ©1999
Community Fire Prevention Partnership

Colorado State Forest Service

Federal Emergency Management Agency

Firewise Construction

Design and Materials

Peter Slack

First edition printing, 1999
Revised printing, 2000

To obtain copies of this publication contact the
Colorado State Forest Service at
970-491-6303 or online at csfs.colostate.edu

About the Author

Peter Slack of Boulder, Colorado was a practicing architect for 26 years, until his untimely death in June 2000. Peter's practice included many homes and other buildings in the Interface. His design emphasized the integration of fire-resistive elements with other important design principles such as proper site development for limited impact, low energy and water consumption, and the use of appropriate, resource conserving materials.

Peter was a firefighter and a officer in a high-risk mountain fire district for 19 years. He specifically worked with wildland fire suppression and mitigation issues for much of that time. After fighting Boulder County's two major interface fires, Black Tiger, 1988 and Olde Stage, 1990, Peter participated in Boulder County's WHIMS Program (Wildfire Hazard Identification and Mitigation System). FEMA funded the WHIMS program as a result of those fires. This publication is developed from a lecture on firewise construction that Peter presented for several years.

Acknowledgements

This publication combines Peter's professional knowledge as an architect and builder in the Interface with his experience as a firefighter for 19 years. Added to his experiences is the wealth of information and experience so generously given by the firefighting community. Most of all, it was their assistance in learning to visualize fire in its environment and around our buildings that facilitated the creation of these illustrations.

The following people contributed to this pamphlet by providing a wealth of information.

Dr. Claire Hay, consultant, Wildfire Interface Group

Mark Mulinex, Wildland Fire Coordinator, City of Boulder Fire Dept.
Mike Tombolato, chief, Cherryvale Fire Protection District

The many members of the Boulder County WHIMS program, who over many years have developed, to this date, one of the most comprehensive and systematic approaches to understanding the hazards of wildland fire to homes in the Interface.

The following people helped make this publication possible. They were responsible for choosing the author and providing additional technical details and editing:

Frank C. Dennis, Colorado State Forest Service

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Gillans Engineering, Colorado, editing, second printing

Jill Croft Slack, editing and support

Table of Contents

1. Introduction

This publication provides homeowners and builders in the Wildland Urban Interface with design and building techniques that can offer more protection from wildland or forest fires. The Federal Emergency Management Agency (FEMA), the Colorado State Forest Service and the Colorado Office of Emergency Management funded this project.

What is the Urban Wildland Interface?

The Urban Wildland Interface, or Interface, is any area where man-made buildings are built close to or within natural terrain and flammable vegetation, where high potential for wildland fires exists.

During the past few decades, population growth in the Interface has increased. Subdivisions and other high-density developments have created a situation where a wildland fire can involve more buildings than any amount of fire equipment can possibly protect.

Fire suppression and increased fuels

The past 100 years of wildland fire and suppression has created more vegetation for fuel.

As population in the Interface has increased, so too has the difficulty of protecting that population from wildland fires. When fires occur in the Interface, we put them out to prevent the destruction of homes. This creates a problem because forests have historically depended on fire to maintain good health. Fire thins trees and brush and eliminates dead material. By suppressing fires to protect our homes and population, we have interfered with this natural process. Since natural fires are now infrequent, vegetation density has increased, which provides more fuel for fires. When fires do occur, the denser vegetation burns with more intensity, and the fire is more destructive and dangerous.

How can we protect our buildings?

This publication offers a two-part approach to the problem:

1. Build more fire-resistive structures and
2. Reduce the hazards of forest fuels.

If we consider the specific needs of Interface structures, we can combine design elements and construction materials to build more fire-resistive structures. Our goal is to create buildings that can either resist fire on their own, or at least make it easier for firefighters to protect structures safely.

We recognize that building a fireproof structure, as we do in an urban setting, can be prohibitively expensive. This publication discusses how to consider a combination of cost effective strategies that increase the probability of a building surviving a wildland fire.

Combustible house with no defensible space

Solutions to problems in the Interface depend on a two-part approach: Make our buildings more fire resistive and manage the surrounding wildlands. If we leave the surrounding wildland in its current state, we need to build structures that are nearly fireproof. Fireproof structures are far too expensive to build. Conversely, trying to provide a defensible space large enough for a typical, combustible structure may not be practical or desirable. Choosing the best combination of these two strategies for a particular site requires a basic understanding of wildland fire behavior.

Another goal of this publication is to give the homeowner and builder a better understanding of how buildings in the Interface ignite during a wildland fire. With this information they can make better choices when considering building techniques and materials.

When reading this publication keep in mind that fire is only one of many considerations during building construction. We are not suggesting that any one technique is absolutely necessary, or that you cannot use alternate materials or design elements. Rather, we want to show you how an awareness of the unique issues facing Interface buildings can direct you toward a more comprehensive solution in the design process. Some design elements and materials may help mitigate fire hazards; and some may not. It is possible, however, to compensate for less appropriate fire protection choices and meet design goals.

Fire intensity and duration related to the fire resistance of a house

How fire resistive should a house be? The answer to this question depends on the fire intensity, (how hot the fire burns), and the fire duration, (how long the fire will last a your site). If the fire hazard is low to moderate, only a few precautions may be needed. If the fire hazard is high or very high, most, or all, of the strategies we describe may be needed.

In Colorado, generally any area surrounded by natural vegetation faces some hazard due to wildland fires. In mountainous regions between elevations of 5,000 and 10,000 feet, hazard is increased due to topography and increased vegetation density. The next section discusses this in more detail.

Evaluating fire hazards

A good way to determine the specific hazard rating at a site is to look at a fire hazard map or study located at the county building or land use department. The Colorado State Forest Service or your local fire protection district may also have information. If this information is not immediately available, use this short evaluation to determine a site's hazard level.

Note: We refer to this hazard rating throughout this publication with respect to design and material elements in building design.

This short evaluation is based on the Wildland Home Fire Risk Meter developed by the National Wildfire Coordinating Group (www.nwcg.com).

Slope	**Score**
Level:	0
0° - 10°	1
10° - 20°	2
20° - 30°	3
30°+	4

Vegetation	
water, bare rock, irrigated lawn	0
grass, shrub, less than 2 feet tall, no trees	1
grass, shrub, less than 4 feet widely dispersed trees	2
dense young shrubs, no dead wood or trees	2
many trees, touching, some grass and brush	3
dense shrubs with some trees	3
thick, tall grass	3
dense evergreen trees with grass and shrubs	4
dense mature shrub with dead branches	4

After selecting the appropriate slope and vegetation scores, add them together to determine the hazard rating.

Scores	**Hazard Rating**
0	0
1 - 2	low
3 - 4	medium
5 - 6	high
7 - 8	very high

2. Fire Behavior: Fuels, Topography and Weather

Wildland fires and the nature of burning structures

Wildland fires have been studied in great detail to help predict fire behavior. Anticipating the intensity, duration and movement of a wildland fire is very important for both firefighter safety, and as the basis of tactical decisions made during the suppression of a fire.

Understanding fire behavior, especially its intensity and duration at a building site, will help homeowners and builders decide how fire-resistive a house needs to be.

Three factors affect wildland fire behavior:

1. **The fuel for the fire.** The type, continuity and density of the surrounding vegetation provides fuel to keep the fire burning.

2. **The topography of the site.** The steepness of slopes and other land features affects the fire behavior.

3. **The weather.** Wind and humidity affect each fire.

Vegetation is the fuel for wildland fires

The type and density of a specific plant determines how it will burn. Not all vegatation burns the same way. Some vegetation almost never burns; others burn at different times of the year; and some can burn almost anytime.

Deciduous trees and bushes: Trees such as aspen, cottonwood and mountain ash; bushes such as mountain maple and dwarf lilac usually burn only during severe droughts.

Bushes, such as the Gambel oak, serviceberry and sage, can burn either in the fall when leaves have changed or dropped, or when there is an extended dry period.

Evergreen trees with resinous sap: Pines, spruce and firs can burn any time of year. They usually burn during extended dry weather or high wind events.

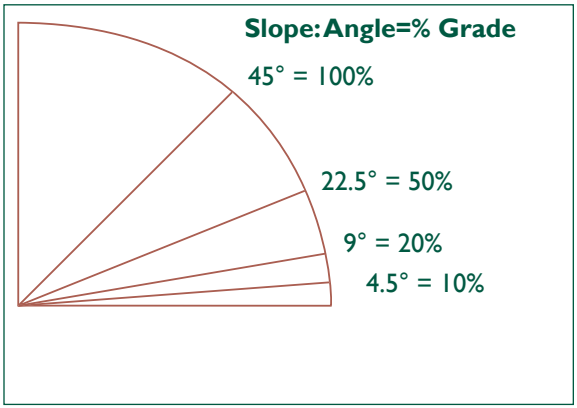
Evergreen bushes: Cedar and juniper can also burn any time of year when conditions are dry.

Grasses. Grasses can burn any time of the year and only need a short dry period before they are receptive to fire. Grass is fire resistive only when it is very green or a good snow cover exists.

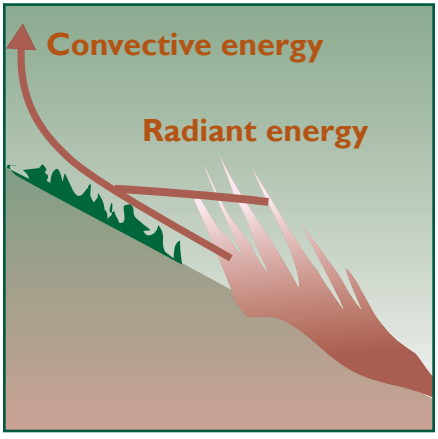
Fire duration and fuel

Fire duration is how long a fire will burn at a particular site. The type of fuel and its density determines a fire's duration. For example, grass is a light fuel. It will burn in less than five minutes and produce relatively less heat than heavier fuels would produce. Medium fuels, such as brush, burn five to 10 minutes with more heat. Large trees are considered heavy fuels because they burn from 10 minutes to over an hour with the most heat.

Understanding this is very important to determine how long a house must



Slope chart



Convective and radiant energy from a fire

resist a fire. Different building materials can resist fire for different time periods.

Fire behavior and slope

Slope is the angle of the ground relative to the horizon. It is commonly measured in either degrees or as a percent. Slope topography shows the steepness of the slope and the shape of the land.

The steeper the slope, the more quickly a fire moves and the hotter it burns. For example, ***a fire will spread twice as fast on a 30 percent slope than it will on level ground.***

This means that a house located on a steep slope needs more fire resistance.

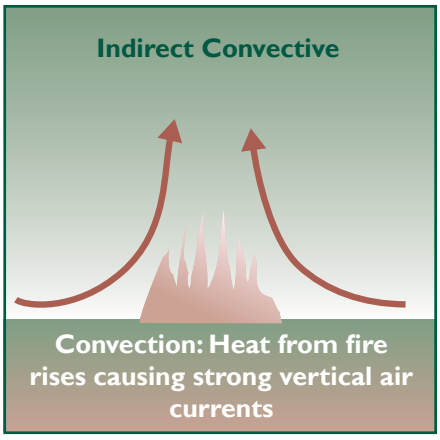
Fire behavior, ignition of fuels: mechanisms of heat transfer

As a fire burns, it releases hot gas and air from the combustion of burning vegetation or buildings. These gases move up the slope, drying and preheating any vegetation in the fire's path. The fire also releases large amounts of radiant energy, like that of the sun, which also heats and dries the fuels. Once flames make contact with these plants, they ignite more easily. This in turn speeds up the rate at which the fire moves and increases its intensity. Look more closely at the mechanisms of fire and how fire ignites a building by studying three categories of heat transfer:

1. indirect convective heating and lifting
2. indirect radiant
3. direct contact or impingement.

Convective lifting

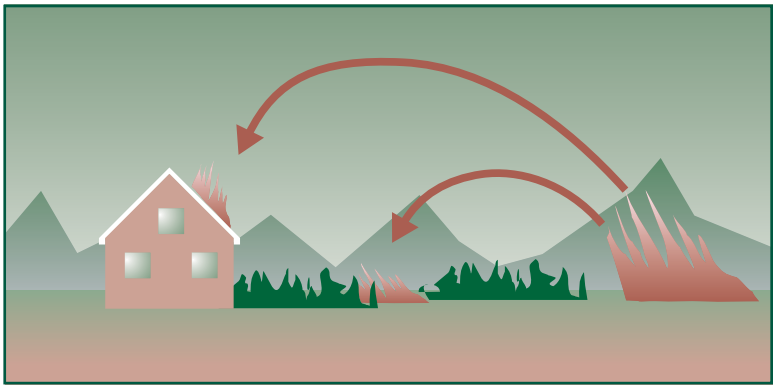
Fire produces hot gases that rise and carry partially burned substances and smoke into the atmosphere. During a wildland fire this atmospheric effect can be very strong, even causing its own wind as cooler air rushes in to replace the rising hot air.



Convective lifting

Convective vertical air currents can also lift burning materials or embers, called firebrands, and carry them horizontally for long distances from the fire.

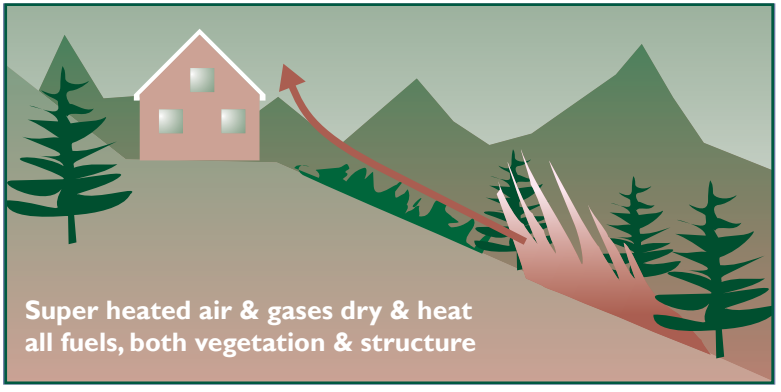
Once out of the rising air currents, firebrands fall back to the ground and onto horizontal surfaces such as combustible roofs, decks and dry vegetation around a house. This effect, called spotting, can be very widespread. Firebrands often travel hundreds or even thousands of feet in front of the actual fire.

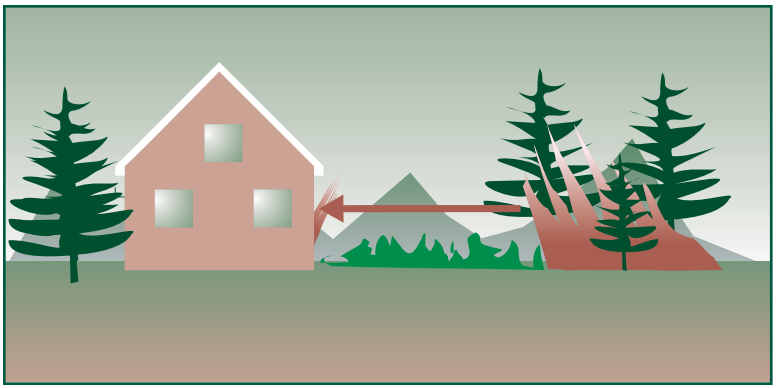


Firebrands, transported by convective lifting, create spot fires

Indirect: Convective Heating

The same hot air and gasses that dry and preheat vegetation do the same thing to a building, making any combustible materials ready to ignite once the fire gets closer.



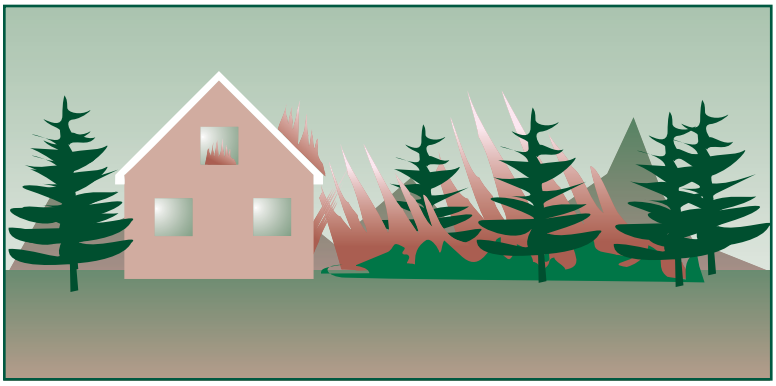


Radiant heating

Indirect: radiant heating

Buildings can be preheated, even ignite and burn, from the transfer of heat by radiant energy from the fire. This is similar to sunlight heating objects, but fire heats only in the infrared portion of the light spectrum. Radiant heat transfers on a straight line of sight and can be reduced by barriers.

Vertical surfaces, such as siding, can ignite from this effect well before fire actually reaches the building. Large heavy fuels, once ignited, burn with high temperatures that amplify radiant energy, creating more potential for ignition through heat transfer.



Fire directly impinging on a house

Direct contact or impingement

Continuous and abundant fuels like those found in unmanaged vegetation areas provide a direct path for a fire to contact a building. Creating defensible space and fuel breaks around a building is specifically intended to reduce this effect.

Weather

Weather is a major factor affecting fire behavior and is, of course, highly variable in terms of time, intensity and location. During extended periods of low moisture, the possibility of wildfire increases. Weather can also increase and intensify fire behavior when there is low humidity and high winds.

Colorado's fire season is highly variable. Typically, winter and spring have few wildfires; summer and fall have more wildfires. However the period between winter and spring, after the snow has melted but the vegetation has not yet greened, is often a period of high fire occurrence.

Colorado typically has 50 to 100 days a year of critical fire weather when severe wildfires are possible. More "fire days" occur at lower elevations while fewer "fire days" occur at higher elevations.

3. Building Site Location

Topography and vegetation: fire behavior and intensity

The location of a structure will influence the intensity and duration of the fire to which it is exposed. As discussed in the fire behavior section, we know at any location how intense a fire will be; how long it will be there; and how fast it will travel, based on the surrounding topography and vegetation.

When choosing a site location or determining the level of fire resistance a building requires, the builder or homeowner should be aware of how the local vegetation and topographic variations affect fire behavior.

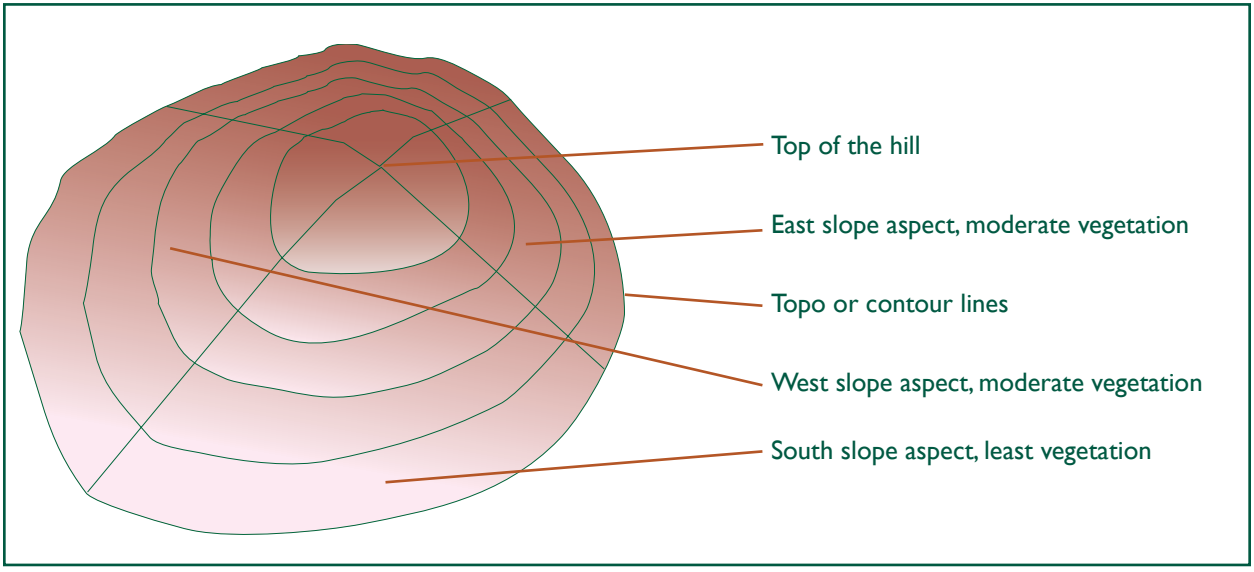
Aspect

Aspect is the direction that a site's slope faces. Vegetation varies widely between the extremes of south facing and north facing slopes.

South slopes tend to have the least vegetation in an area because they quickly dry out and have less available moisture for plants. Since there is less fuel on south facing slopes, fire burns with less intensity than on other slopes with more fuel.

East and west slopes generally have more vegetation than south slopes. They are more prone to drying out in the summer when the sun is high in the sky. Fire potential increases on these slopes during the summer season.

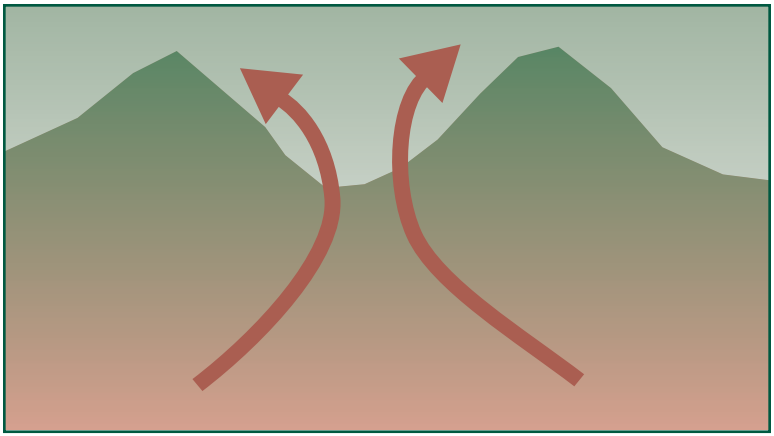
North slopes typically have the most dense vegetation because there is more water available for plants. The higher moisture content of the vegetation on north slopes means that fires occur there less frequently. However, when fires do occur, they burn with more intensity because there is more fuel.



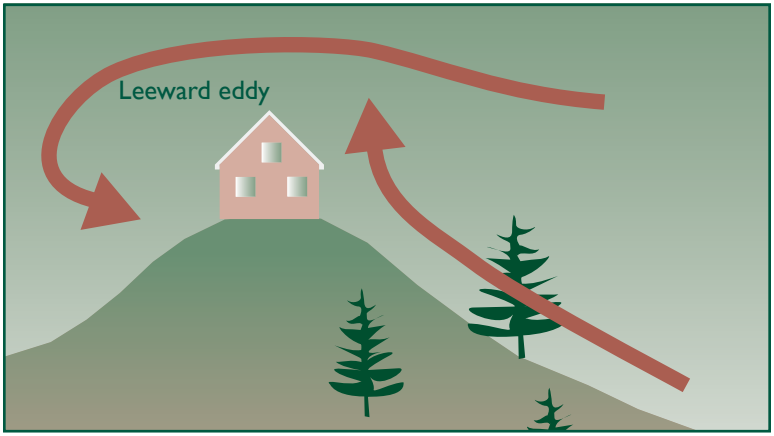
Aspect of slope

Dangerous topographic features: areas of more intense fire behavior

Variations of topographic features such as valleys, ridges, canyons and saddles can be dangerous areas that further intensify or attract a fire.



Saddle, low area on a ridge



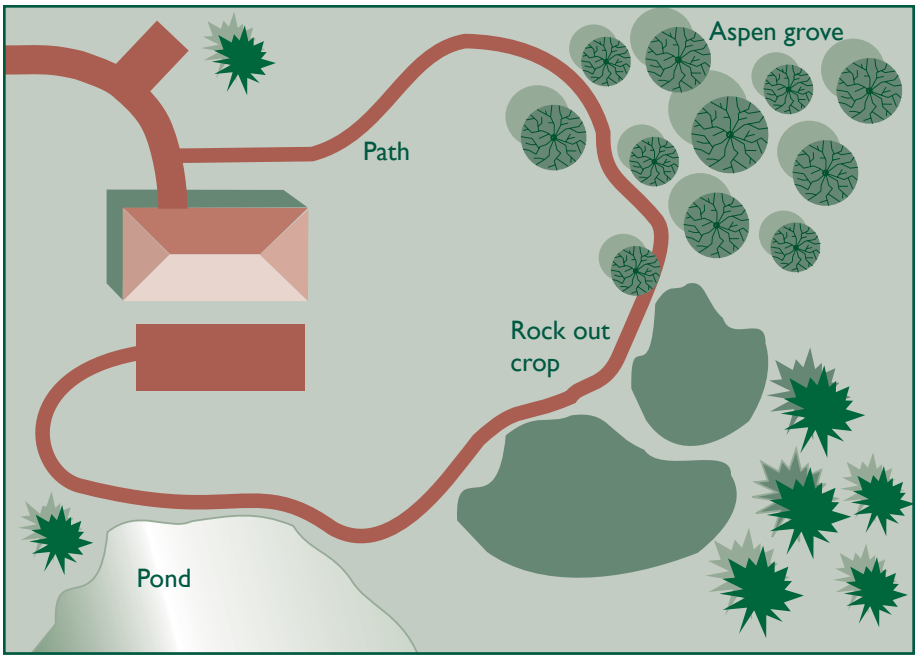
Ridge with wind exposure

A **valley,** as a concave form, tends to collect and concentrate winds. This means that a wildland fire's intensity increases as it moves through a valley. If the valley is narrow with steep sides, such as a **canyon,** this effect is more pronounced.

When a valley crosses a ridge it creates a **saddle** between the higher parts of that ridge. Like a valley, saddles will channel, intensify and speed up a fire. These areas tend to be built upon because they offer some shelter and often flat areas. It is important to recognize that saddles are natural fire paths where fire will travel first, and with more intensity.

Ridges experience more wind primarily because they are elevated above the surrounding land. When a fire moves up a slope toward a ridge, it gathers speed and intensity.

As the wind crosses a ridge it usually has a leeward eddy where the wind rolls around and comes up the leeward side, exposing both sides of the structure to wind and fire. There are usually no areas on ridges to provide protection from the fire.



Site: House located relative to natural features that buffer against fire

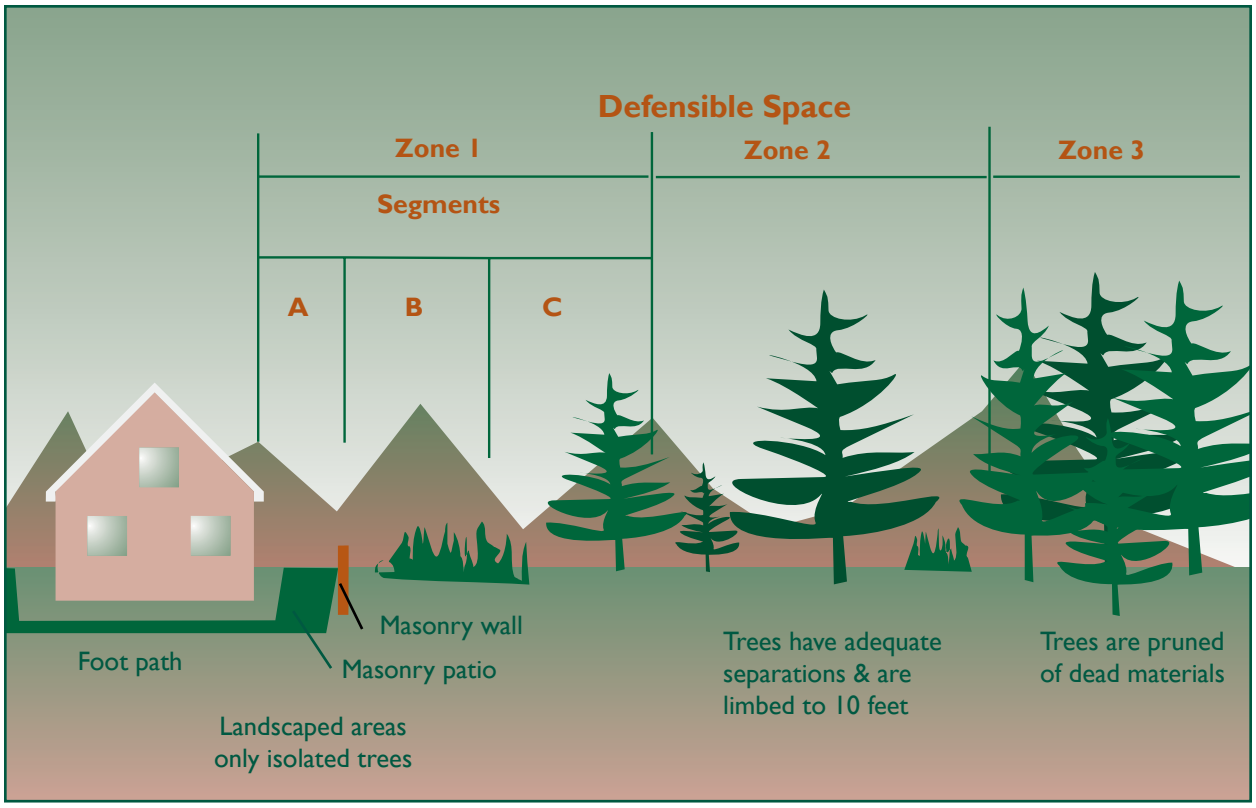
Natural barriers and buffer zones

Some physical features will reduce fire behavior and can be used to slow, reduce or deflect a fire. Some examples of these beneficial barriers are natural rock outcroppings, wetlands, streams, lakes and deciduous tree stands, (aspen, cottonwood, etc). Take advantage of these features by placing a building so that the natural barrier is between the building and the anticipated path of a fire.

How this affects building location and design decisions

On large parcels of land consider these physical features when choosing the final location of a building. Many other factors such as privacy, views, access and aesthetic values will also effect site location decisions. Fire is just one of these factors. Whether or not fire is the primary consideration will depend on how high the fire hazard is in the area.

On smaller parcels there may be only one suitable building location. The site's physical features will determine the probable fire intensity and dictate what combination of site modifications and fire-resistive construction is necessary to prevent the building from igniting.



Defensible space

Site design and modifications to the forest: developing a defensible space

After evaluating the fire hazard rating of a site, develop a plan to manage the surrounding forest and defensible space. This is the first part of a our two-part stategy to build a fire-resistive structure. **Defensible space** is the area around a building that has been significantly modified to reduce a wildfire's intensity just enough to prevent the fire from igniting the house. The defensible space will also allow firefighters to more safely defend the house. It can also help prevent a house fire from spreading to surrounding vegetation.

A diagram of the features at a building site would show that moving away from the building out into the wildland, the features gradually shift from man-made to more natural elements. We divide this gradation into zones. Developing a defensible space plan requires an inventory of the existing site features and analysis of how hazardous they are. Man-made elements are landscaping features such as masonry walls, patios, footpaths and driveways. These features create barriers and buffer zones.

The area next to the building (Zone 1-A) should contain primarily noncombustible surfaces. Any planting in this zone should be only deciduous, well-trimmed and irrigated. Ground covers should be flowerbeds and cut grass.

Moving away from the building, the next area (Zone 1-B) can have more

landscaping and less man-made surfaces. Vegetation should still be deciduous trees, bushes and grass can be native, but they must be kept trimmed to fewer than 6 inches tall.

Moving farther away from the building to (Zone 1-C) the landscaping should change from introduced deciduous plants to natural vegetation, including evergreens. These trees or bushes should be far apart and well maintained by trimming.

In Zone 2 the landscape is entirely natural vegetation that is intensely managed or modified. Trim dead material from natural vegetation closest to the buildings. Prune all limbs to 10 feet above the ground. Thin trees so that a minimum of 10 feet separates the tree crowns.

Moving vegetation farther away from the building into Zone 3, the forest management gradually becomes less intensive and subtler. Tree limbs need to be pruned only 4 to 5 feet above the ground. Tree crowns can be closer together.

Remember, the more intensive and wide-ranging modifications you make in the defensible space, the less the need for fire-resistive materials and building design. Conversely, fewer modifications to the surrounding wildland increase the need to use fire-resistive materials and design for the building. These two strategies work together to achieve the goal of building a firewise structure that does not burn when wildfires occur.

4. Building Design

So far we have discussed elementary fire behavior and how to manage the wildlands surrounding an Interface building. The second part of our approach to building fire-resistive structures is learning about appropriate design and material choices.

Simple vs. complex forms

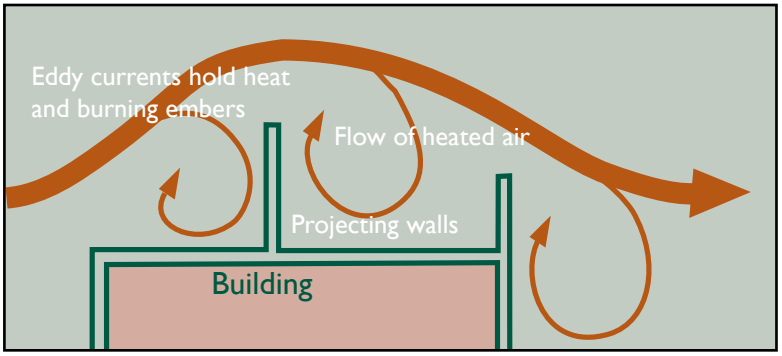
Simple building forms have less surface area relative to the volume of the building. Complex building forms have much more surface area relative to volume. Simple building forms are less expensive to build, more energy efficient and easier to protect from wildland fires. There is simply less exterior surface to protect.

Complex forms not only increase the surface area of the structure, but also create shapes that trap the fire's heat. These areas are called heat traps. Transitions between vertical surfaces and horizontal surfaces, inside corners between two walls or abrupt intersections of different solid planes form pockets where wind velocity drops and eddies form.

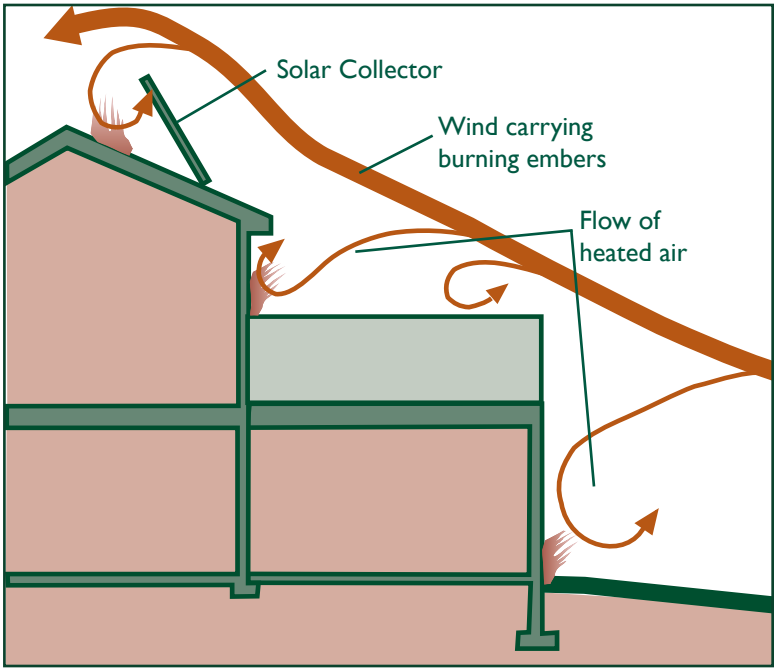
Parapet walls, solar collectors, roofs intersecting walls, roof valleys and decks are examples of heat traps. These forms cannot be avoided, and their locations require much more attention to fire-resistive materials.

When wind speed decreases burning embers falls most often at the locations described above.

Roofs are very susceptible to firebrands in a wind driven fire.



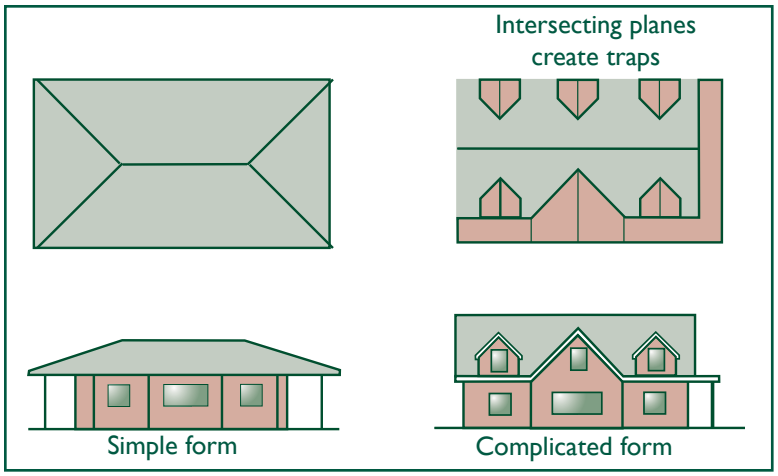
Heat traps around walls



Heat traps around roofs

A simple root form such as a hip or straight gable is best. Complicated roofs with intersecting planes and

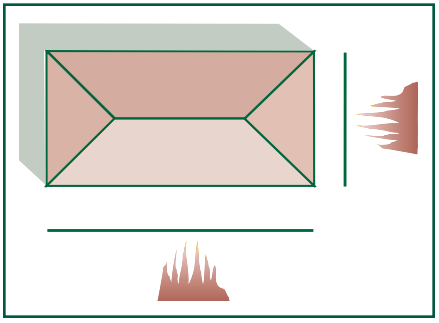
valleys form dead air pockets and eddy currents. The use of complicated forms further highlights the importance of a truly fire-resistive roof.



Roof forms

Aspect ratio

Aspect ratio is the ratio between the east-west axis and the north-south axis. In Colorado's climate it is generally better to have a structure that is longer on the east-west axis than the north-south axis. Such a structure has a more favorable energy relationship with the



climate and can gain the benefits of the sun's passive solar heat.

With regard to fire, if a house presents its widest exterior in the direction from which a fire is likely to come, it will be more vulnerable. More fire-resistive materials and components are needed on the side that faces the oncoming fire. On a flat site the direction of a fire is somewhat unpredictable, but it will generally be determined by the predominant winds and fuel.

The probable fire path is more easily predicted on sloping sites. Fire can be expected to approach up the slope. On east and west facing slopes, placing the building on the longer east-west axis works well for both energy and fire considerations. The building presents its widest side to the winter sun and its narrowest side to the

fire path.

Remember, a building can contradict these principles. In that case the building will require more fire-resistive building materials and components when simple forms and optimum aspect ratios cannot be used.

Vents, eaves, soffits and decks

Building a fire-resistive house can be compared to building a watertight roof. One little hole in the roof allows water to leak in, and it doesn't matter how well the job was done on the rest of the roof, it failed and damage occurred.

Small building elements like soffits and vents can be the weak link in a fire. An otherwise fire-resistive house is damaged or destroyed because fire found a way in through these areas.

Vents

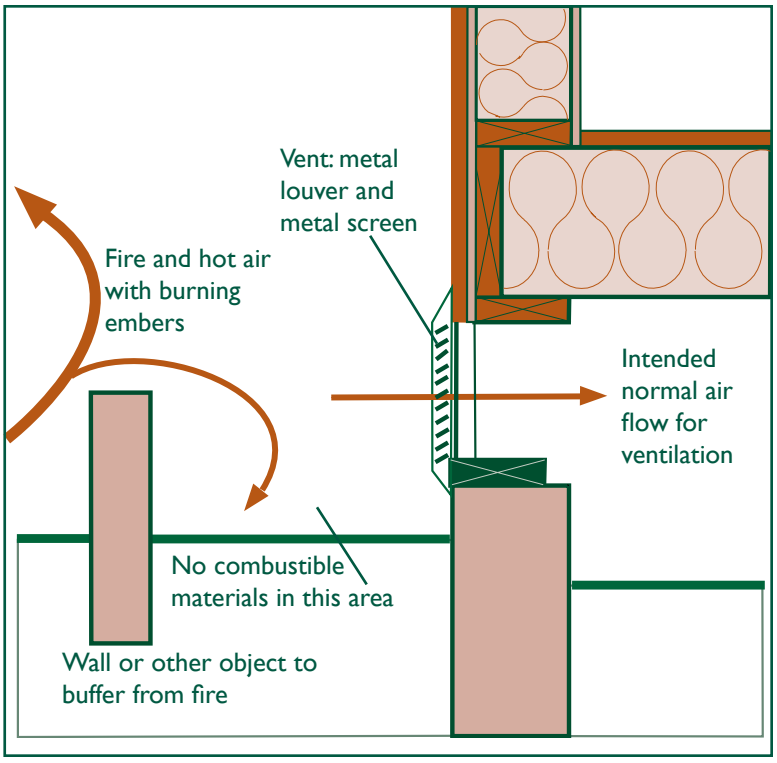
Vents are required by the building code to prevent accumulation of water vapor.

All crawl spaces under wood floors are required to have ventilation. One square foot of vent is required for

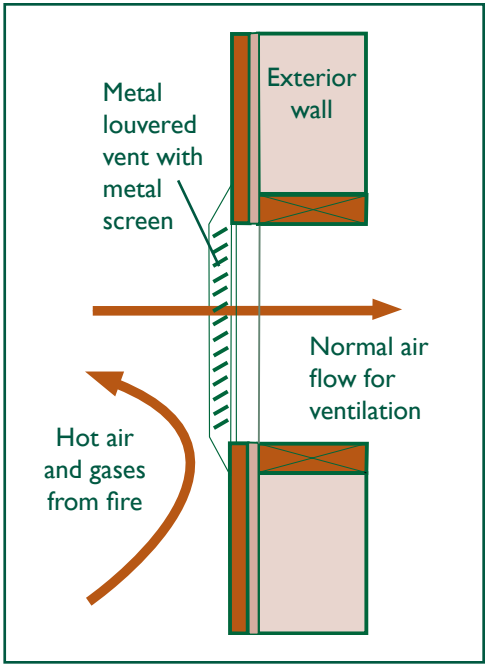
every 150 square feet of floor area. Since these vents are typically located near the ground, care should be taken to not have any combustible vegetation immediately next to them.

Vents located on the downhill side of the house should have landscaping elements like stone patios or walls that block the direct path of the fire. Building codes typically allow alternatives to traditional vents. In some cases louvered vents are permitted. These can be closed when moisture is not a problem. (Fire season is usually the dry season.) Mechanical ventilation with intakes and exhaust located away from the ground or other vulnerable locations can also be used.

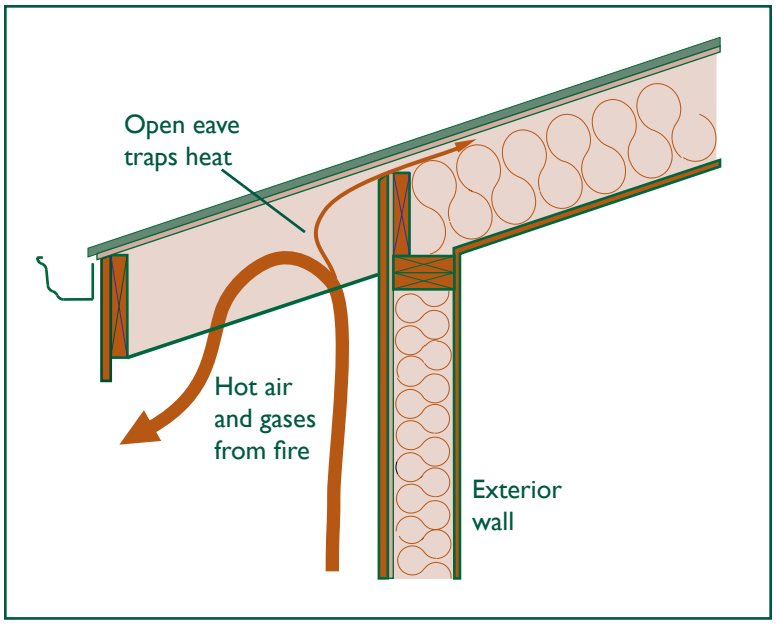
All attic spaces and roof cavities are required to have ventilation. One square foot of vent is required for every 300 square feet. of roof. (See eaves and soffits on page 18.) In both cases the vents should be made of metal with wire screen material that has 1/4 inch or smaller openings.



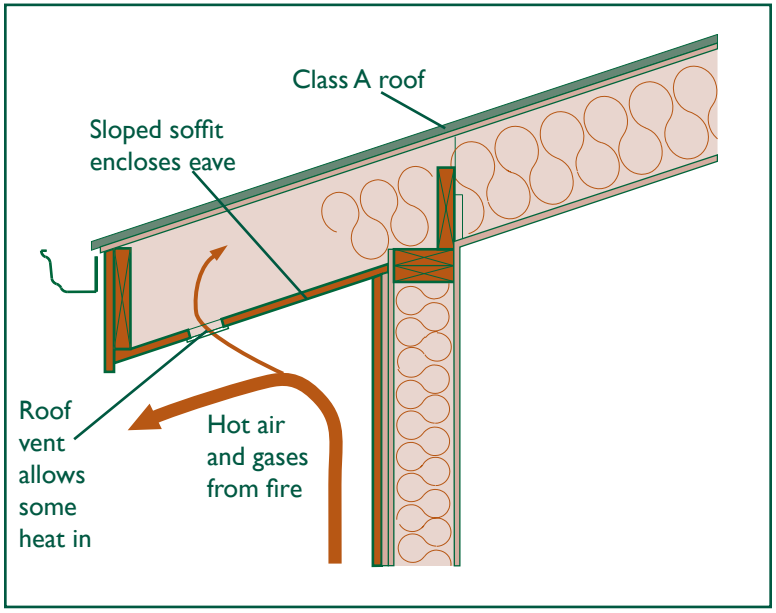
Crawl space ventilation



Attic Vent



Open eave with no soffit



Open eave with soffit

Eaves and soffits

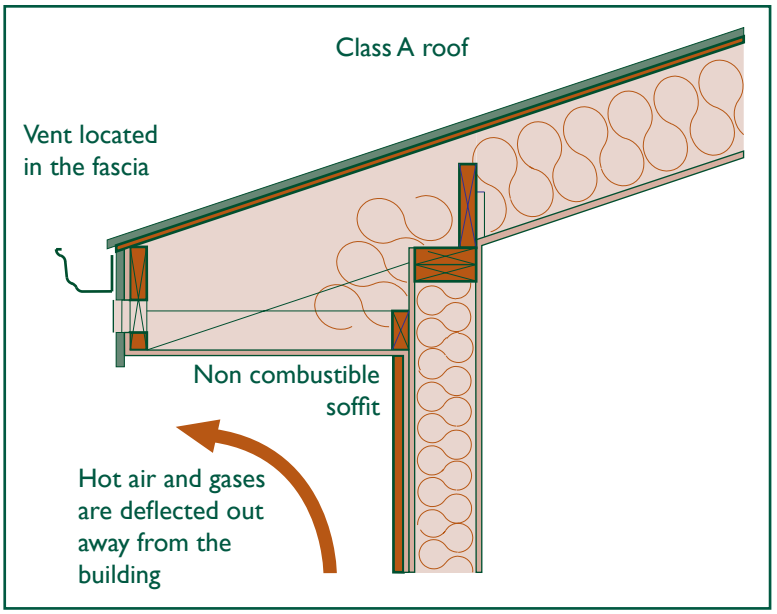
The extension of the roof beyond the exterior wall is the eave. This architectural form is particularly prone to ignition. As fire approaches the building, the exterior wall deflects the hot air and gasses up into the eave. If the exterior wall is combustible this effect is amplified.

The solution is to cover the eave with a soffit. If the soffit is applied directly to the rafter eave, it forms a sloping soffit. This still makes a pocket that can trap fire.

A better detail is to form a flat soffit that allows the building to more readily deflect fire outward.

The soffit material should be at least 3/4 inch plywood in low fire hazard areas, noncombustible in moderate and high areas, and one-hour rated material in very high hazard areas.

Vents for roof ventilation are often found in the soffit. **Placing vents in these locations creates a perfect path for fire to enter the roof structure.** If the vent must be in this location it is better to place it farther from the wall and closer to the fascia. The vent can also be placed in the fascia or near the lower edge of the roof.

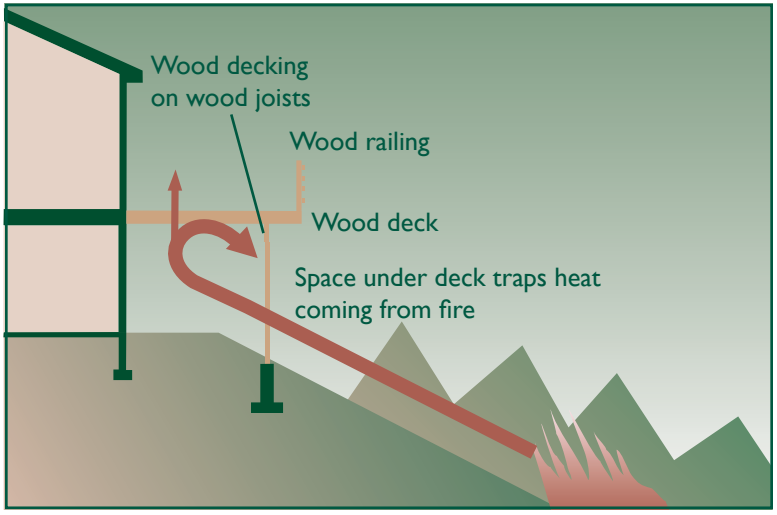


Fully enclosed soffit with isolated vent

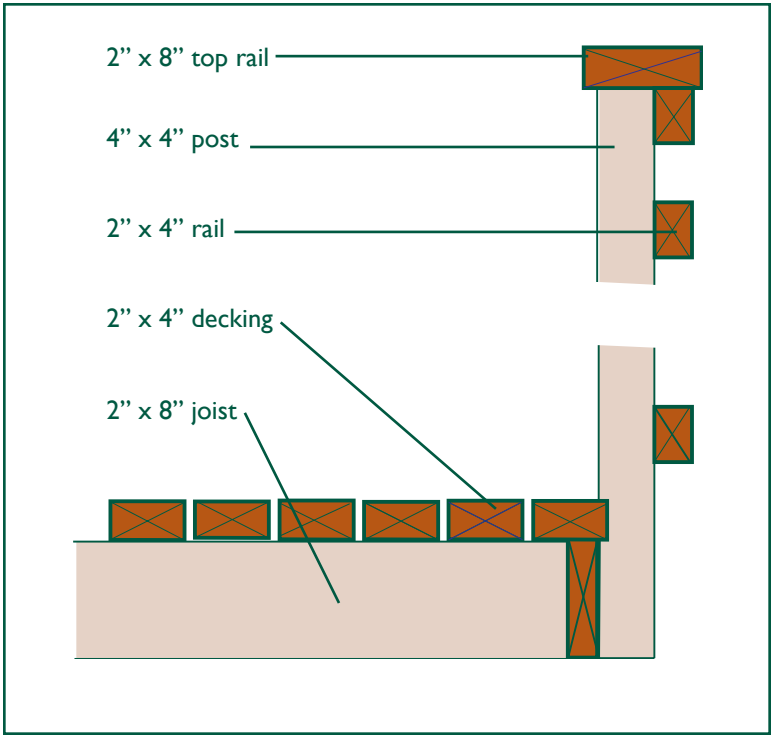
Decks

Decks are a very popular and well-used part of the house, especially in mountainous terrain. Because they provide elevation above the terrain and surrounding vegetation, they offer a better view. They also supply flat areas for walking on otherwise sloping terrain.

The problem is that most decks are highly combustible structures. They are the ultimate heat traps. Their shape traps hot gasses from an approaching fire. Decks often face downhill towards a fire's most likely approach up a slope.



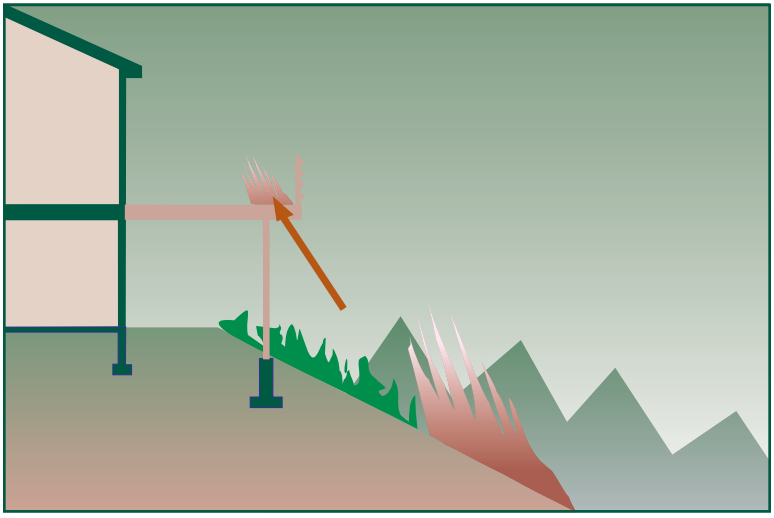
Conventional deck in a fire



Conventional deck construction detail

Decks are built perfectly to burn, almost as easily as wood stacked in a fireplace. All the components of a deck; joists, decking and railings, are made of only 2 inch thick wood with a high surface-to-volume ratios.

When fire approaches, the wood quickly dries out and heats up. lignition can occur very easily when either the radiant energy from the fire gets hot enough or a burning ember lands on it.

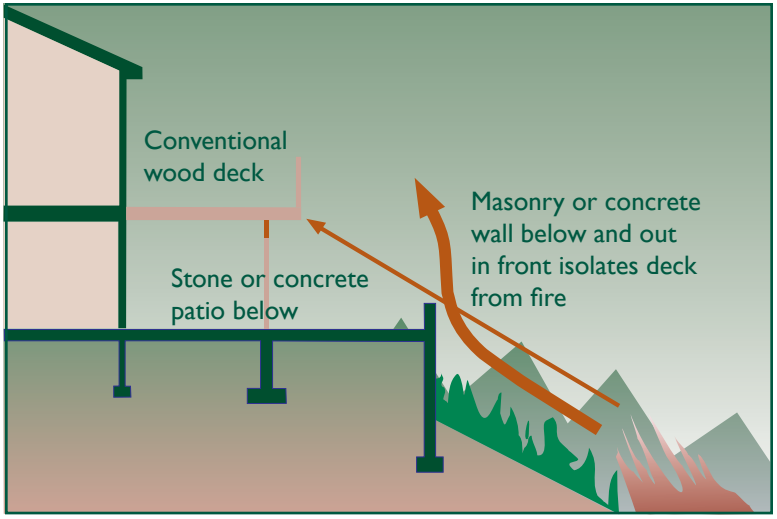


Ignition of decks

Conventional wood decks are so combustible that when wildland fire approaches, the deck often ignites before the fire gets to the house. Sometimes unburned vegetation exists between the house and the fire, demonstrating that the deck was more flammable than the vegatation.

Isolate the deck from the fire with a patio and a wall

In low and moderate fire areas, it may be sufficient to isolate the deck from the fuels and fire by building a noncombustible patio and wall below it. The patio will assure that no combustible materials are below the deck. The wall will act as a shield, deflecting both the radiant and convective energy of the fire.

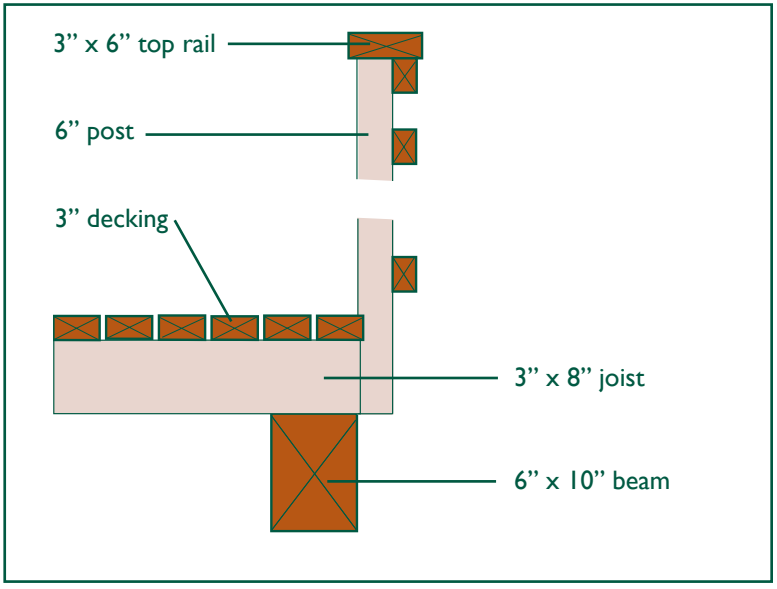


Deck with a patio and a wall below

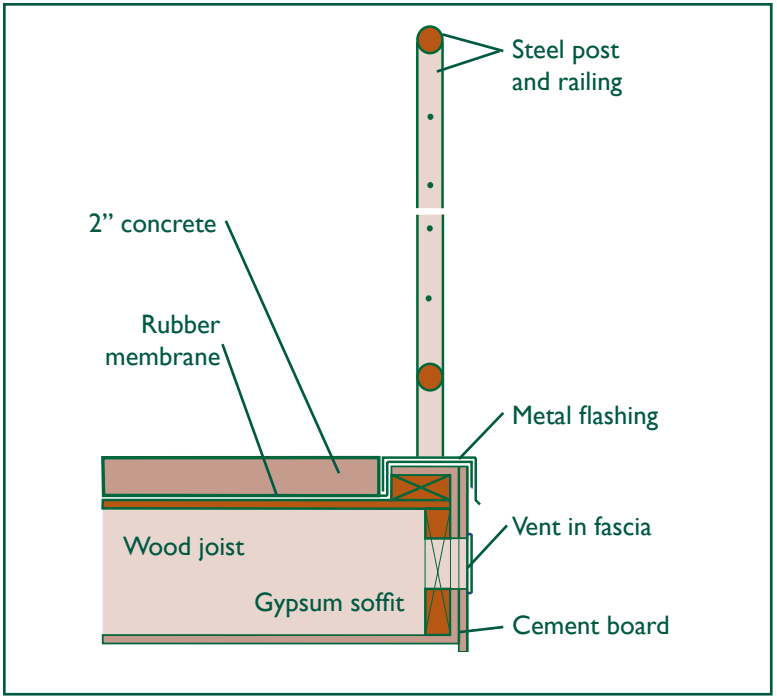
Heavy timber construction

In moderate hazard areas the use of heavy timber construction is acceptable. Like log siding, heavy timber is combustible but so thick that it burns very slowly.

Minimum thickness for a heavy timber deck is 6 inches for the posts and structural members and 3 inches for the decking and rails. This type of construction can be used with a patio below for additional protection.



Heavy timber deck



Fire-resistive deck construction detail

Fire-resistive deck construction

In the highest fire hazard areas, consider noncombustible surfaces and fire-resistive building materials for a deck. Wood frame construction is permitted, but change the surface to noncombustible or one-hour rated materials

To build this type of surface, place a waterproof membrane over the top of the deck. This allows the use of fire-resistive soffit materials, which cannot tolerate moisture. The most common materials are cement fiber panels or metal (noncombustible), or gypsum (noncombustible and one-hour rated).

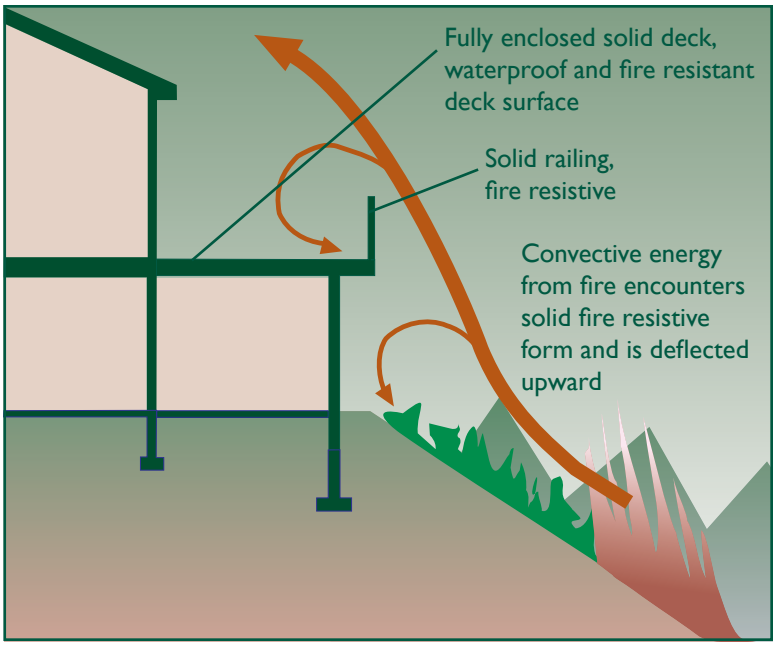
Cover the membrane with decking. One suggestion is plastic wood which has low combustibility; it will burn but only very slowly. Better yet, use 1 to 2 inches of concrete or stone. This surface is fire-proof and protects the deck from air-born firebrands. However, this covering requires that the structure be strengthened to support the additional weight.

Posts and railings can be economically built from steel. Wood posts near the ground can have stone, brick, or noncombustible coverings. A popular baluster design is steel wire, but this is expensive. Steel pipe, usually 1 to 2 inches in diameter, is very economical and easy to work with. Square steel shapes can look like traditional wood railings.

Fully enclosed decks

The best design is to convert the deck to a solid form by fully enclosing it. This completely eliminates the heat trap. This form also complies with the new Urban/Wildland Interface code (1997).

In the photo above, the deck is over the garage. It has a metal railing with heavy timber posts and concrete deck.



Fully enclosed solid deck

5. Building Materials and Components

Ratings

When discussing building materials and components we make frequent references to ratings. Through testing various national organizations provide ratings or evaluations for the fire resistivity of materials or building assemblies. A building assembly is a combination of materials forming a component of a building such as a roof or wall. The ratings are in the following categories:

Combustible or noncombustible

Classes: A (best), B, and C

Time: 20 minute, one-hour, two-hour and four-hour

The organizations that provide these ratings are: the International Conference of Building Officials (ICBO) through its publication, the Uniform Building Code (UBC); Also a founding member of the International Code Council (ICC) through its publication the International Building Code (IBC); The American Society for Testing and Materials (ASTM); the Underwriters Laboratory (UL); and the National Fire Protection Association (NFPA).

The difference between a non-combustible material and a rated material or assembly is the surface resistance to ignition versus the protection afforded the building behind it. A good example of a non-combustible material is metal roofing and siding. Metal is non-combustible, but an excellent conductor of heat. If the fire remains present long enough, the heat will be conducted through the metal and ignite the material behind it. An example of a fire-rated assembly is wood siding applied over gypsum sheathing. This assembly is rated as one hour. The surface can ignite, but the building is protected from the fire for one hour. **The importance of this is the difference between intensity of fire and duration of fire as described in the fire behavior section.**

Most ratings are for commercial buildings in urban settings, but some apply to residential structures. For example, the wall between a garage and a house must be rated as one-hour fire resistive. The door between the garage and the house must have a "C label" rated for 20 minutes with an automatic closer.

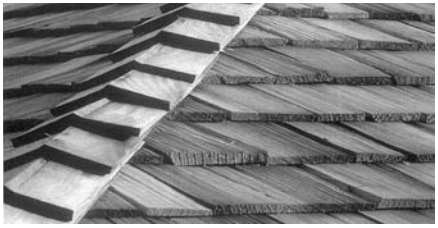
Material ratings for the wildland fire environment have been directly addressed by the I.C.B.O, through a subsidiary, the International Fire Code Institute, Fire Service Division and its publication, the Urban Wildland Interface Code and N.F.P.A. Standard 299. These publications also address other issues covered in this publication such as access, utilities and water supplies for fire suppression. Much of what is contained in this publication is based on or refers to these publications.

Roofing

Roofing is one of the most important ways to protect a house from wildland fire. As shown earlier, when wildland fires become more intense, the lofted firebrands become a significant cause of the fire spread. Since most roofing has a rough surface and numerous cracks, it can trap wind blown embers and firebrands. In all major Interface fires, houses thousands of feet from the fire have been observed with burning roofs.

Wood shakes and shingles

Simply put, wood shakes and shingles are made perfectly to burn. They are almost like kindling. They are thin, 1/2 to 1 inch thick, with a very rough surface and many cracks. When a wood roof burns it also lofts burning embers, contributing to the spread of fire. Another important characteristic of wood roofs is that they dry out in Colorado's dry climate.



A cedar roof can be modified to be fire-resistive. Pressure treatment with chemicals can change wood shingles to a class B or C roof. Chemically treated cedar roofs built with a gypsum underlayment can have a class A assembly rating. However, many doubt that the testing conditions for these shingles matched Colorado 's climate of low humidity, high winds, elevated ultraviolet radiation and extreme temperature variations.

The use of wood shakes in the Colorado region is diminishing, not because of the fire risk they pose, but because of the unavailability of insurance coverage for damage due to hail and high winds. Cost wise, hail losses in Colorado are 10 times greater than fire losses.

Asphalt shingles

Asphalt shingles are probably the most economical way to roof a building, especially in terms of dollars spent per years of guaranteed life. Conventional mineral reinforced asphalt shingles have been around for more than 60 years. They are normally guaranteed for 10 to 20 years, and usually have a class C rating.

Mineral reinforced shingles have gradually been replaced by fiberglass reinforced asphalt shingles. These offer guarantees of 20 to 40 years and are a class A material. They are available in many colors and textures and can even imitate wood or slate shingles.

Metal: sheet and shingles

Metal roofing has always been available in sheet form in many colors. It usually has standing seams or ribs. The most common metal roof is galvanized steel with factory-applied paint (usually a two-part epoxy type, not too different from automobile paint).

Metal roofing is also available as an imitation wood shingle. This product is made by stamping a texture and shape on the metal and then applying the appropriate color. This imitation is so good that at a distance of 100 feet or more it is difficult to tell the difference between it and a wood shingle.

The advantage of metal roofing, both flat and stamped shingle, is that it is non-combustible, durable and very lightweight. It requires a gypsum underlayment in order to have a class A assembly rating, but that is only necessary in high or very high fire hazard situations. Guarantees start at 20 years and go to 50 years.

In addition to galvanized steel with paint, metal roofing is also available in aluminum with paint, stainless steel and copper. These tend to be more expensive but also last longer.

Fiber–cement shingles

These shingles are made of cement and fiberglass, or cement and wood. Like the metal shingle, they are made to imitate a wood shingle's texture, shape and color. The cement in these products is altered with polymers to make it less brittle. These products are also noncombustible but require an underlayment for a class A assembly rating.

Membrane roofs

These materials include both rubber and hot applied, bituminous saturated mineral felt for flat roofs. These materials are marginally combustible but are most often used with other covering systems like concrete. It can be applied over a gypsum underlayment for a class A assembly rating. Guarantees are only in the 10 to 20 year range, but these products can be considered permanent when covered with concrete.

Concrete shingles and tile, slate shingles, clay tile

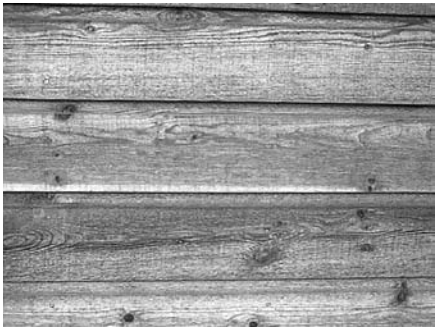
These products provide the best fire-resistive roof, but they are expensive. They are 1 inch thick, heavy (10 pounds per square foot), non-combustible, class A rated and usually come with 50 year guarantees. Concrete shingles are manufactured to look like wood shingles. When having a tile roof installed, pay careful attention to the closure of the round openings of the tiles at the edge of the roof.

Exterior walls: siding

The exterior walls of a building are most affected by radiant energy from the fire and, if there is not enough defensible space provided, by the direct impingement of the fire.

Wood panels and boards

Wood panels and boards are the most common and economical forms of siding, but they are readily combustible. This siding is usually not very thick, 1/2 inch to 3/4 inch, and will burn through to the structure behind it in less than 10 minutes. A one-hour rating can be achieved by adding gypsum sheathing behind the siding. However, this addition is of limited value because the building can still ignite, and the fire can spread to other parts of the building such as the eaves above the exterior wall or the windows.



Fiber cement panels, boards and shingles

These products are non-combustible, but they may not be rated and may need gypsum sheathing to achieve a one-hour rating. These materials are very economical and cost just a little more than wood products. When these products are applied with the gypsum sheathing they offer the most economical way to side a house that will resist almost all fire hazard conditions. These materials are virtually permanent on a vertical surface and come with a 50 year guarantee, but they need to be painted. Some can even take a stain with satisfactory results. These products are available with textures molded to imitate wood grain.

Metal: galvanized steel,

aluminum, boards, panels and shingles

Like their counterparts in roofing, these products are available in either flat sheets with seams, a stamped board or shingle that imitates a wood product. They are factory painted with two-part epoxy paint and usually have a 50 year guarantee. Unlike the fiber cement product, the paint on this product is a part of the guarantee; thus, it is an almost permanent, no-maintenance material. It is non- combustible, but like other metal products needs a gypsum sheathing to achieve a one-hour rating.

"Real" Stucco

Real stucco, as base material, is 3/4 inch to 1 inch thick cement and gypsum. The stucco is applied in two or three coats with metal mesh reinforcing. The color is integrated into the final coat and thus lasts a very long time. Guarantees are 10 to 20 years. It is both a non-combustible and one-hour rated material, which makes it a very good material for high hazard areas. Real stucco tends to be expensive and is also prone to cracking if not applied absolutely correctly.

Synthetic stucco, exterior

insulating finish system (EIFS)

This product is a 1/8 inch thick acrylic cement finish on fiberglass mesh. This is applied to the tap surface 1 to 2 inches of expanded polystyrene (EPS). The color, like real stucco, is in the cement coat and thus lasts a long time. This is the preferred way to do stucco because it takes less labor and is therefore cheaper. The foam insulation isolates the stucco finish from the building, which virtually eliminates cracking.

The surface is noncombustible and has no rating by itself. This product is interesting in a fire because it significantly delays a fire due to the insulation quality of the rigid foam and the fact that the system does not ignite; it actually fails and falls away. In moderate to high fire hazard situations this product will work well. It can, like other products, obtain a one-hour rating with gypsum sheathing, which should be used in a very high fire hazard area.

Heavy timber or log construction

This wood product has a minimum thickness of 6 inches for frame members and exterior siding, and 3 inches for decking and steps. Heavy timber is recognized by building codes as a separate fire-resistive category.

Even though heavy timber is combustible, the low surface-to- volume ratio causes it to burn very slowly. This makes it very appropriate for medium and high fire risk situations.

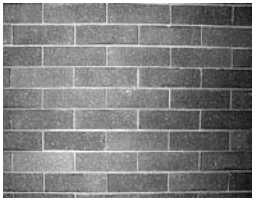
Concrete synthetic stone

These products are cast concrete with integral color forming the texture and shape of the stone being imitated. They are modular shapes that have consistent dimensions with flat backs, keeping labor costs down.

Synthetic stone is reinforced with fiberglass and steel mesh, making it very resistant to cracking. It is fully non-noncombustible and is usually rated as a one-hour material.

Brick, stone and block

These materials are both permanent and fireproof. Ratings are usually two hours. These are the best products to use in regard to fire resistivity but are the most expensive.



Windows and Glass

Windows are one of the weakest parts of a building with regard to fire. They usually fail before the building ignites, providing a direct path for the fire to reach the building interior.

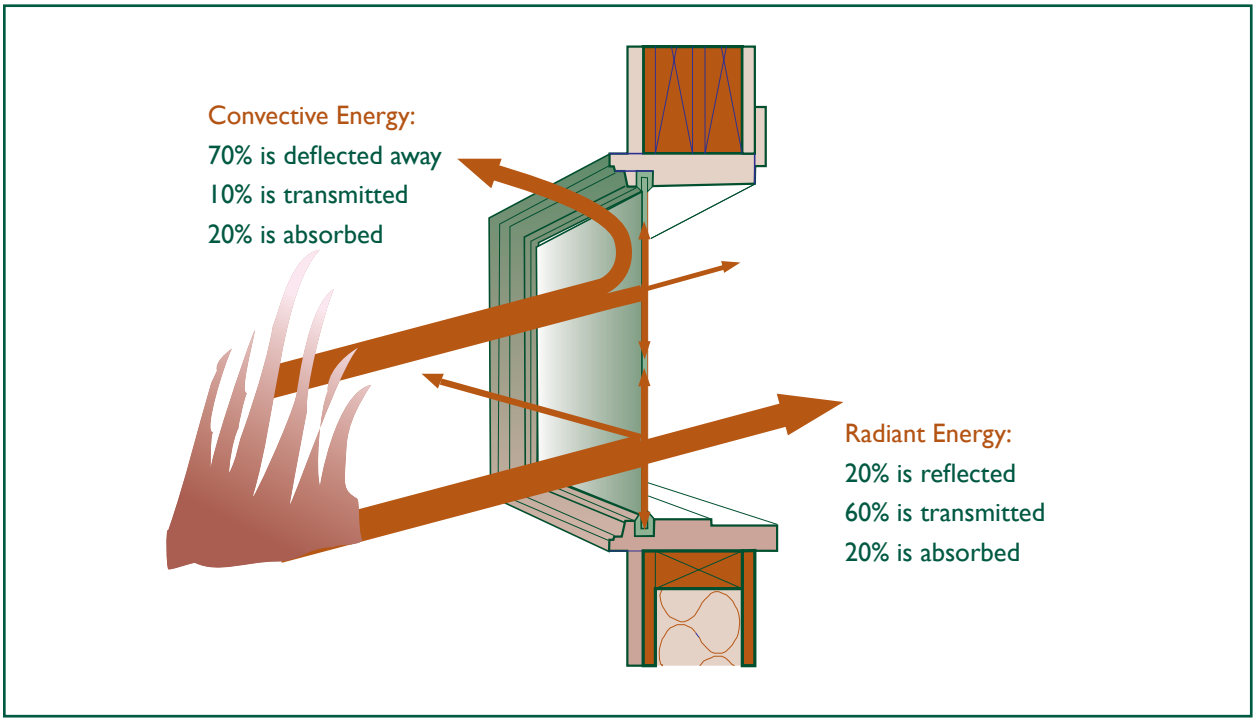
Glass failure

Glass provides only a partial barrier to fire and only for a short time. It fractures in the presence of heat. In the case of a wildland fire, this will happen in about five minutes. Glass deflects most of the convective energy, but not the radiant energy of the fire.

Convective energy is hot air and gasses. About 70 percent of the heat is deflected by window glass; about 20 percent of the heat is absorbed; and 10 percent of the heat is transmitted to the interior of the building.

Radiant energy from a fire is infrared light energy, like the energy we experience from the sun. Most radiant energy from a fire, 60 percent, is transmitted through the glass to the interior of the building; about 20 percent is reflected; and about 20 percent is absorbed by the window glass.

Both the radiant and convective energy heats the glass, but the perimeter of the glass is covered and protected by a sash. This causes a differential heating and stressing of the glass, which causes it to crack.



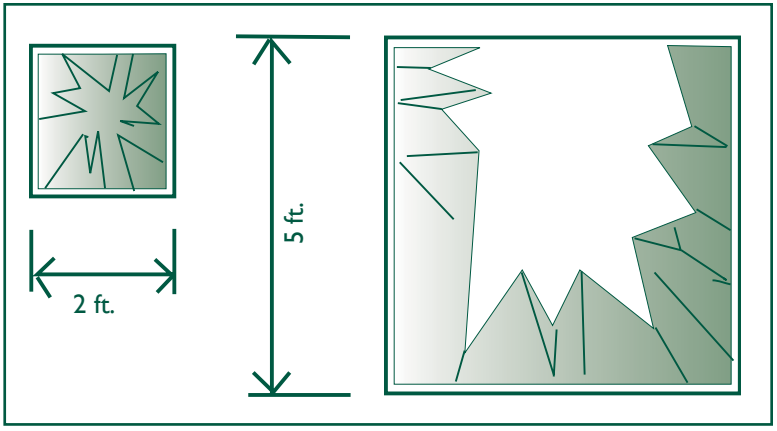
Energy transmission, convential glass

Large and small windows

Even if the glass does fracture, the hot gasses (convective energy) from the fire and the fire itself cannot enter the building if the glass stays in place. Only the radiant energy heat can get through. Eventually, even with the glass in place, combustible materials behind the window may ignite. (See Low E glass).

Small windows, less than 2 feet wide or tall on a side, will keep fractured glass in place. The size of glass held in place by the sash is relatively small with little weight.

Large windows (more than 2 feet wide or tall on a side) cannot keep the fractured glass in place. The size and weight of glass in relationship to the length of sash is too great.



Small and large windows

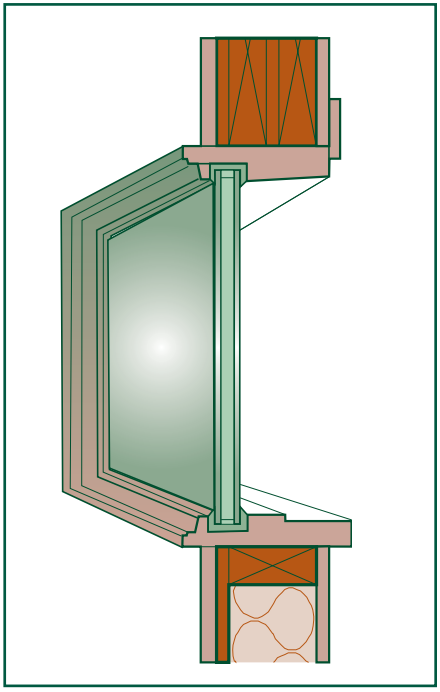
Thermopane or double glazed windows

Because of current energy codes, most glass today is double glazed or Thermopane. Double-glazed windows last about twice as long as a single pane, or about 10 minutes.

The same processes of convective and radiant energy affect the front pane of glass. As long as the front pane is in place, the second pane is partially protected. When the front pane fails and falls away, the process continues on the second pane until it fails and falls away.

As shown earlier in the fire behavior section, the duration of a fire at a site is dependent on the slope and the fuels. It can be as short as 5 minutes in the case of a grass fire.

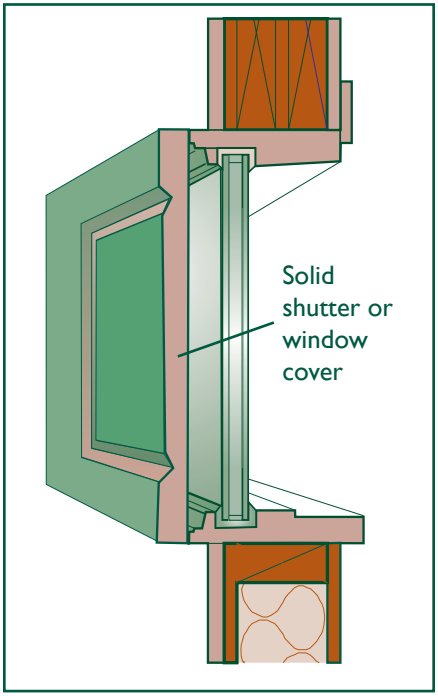
If the duration of the fire is any longer than 10 minutes due to significant fuel supply around the house or preheating, additional protection will be necessary to prevent glass failure and fire entering the house.



Thermopane window

Exterior window covers, shutters and screens

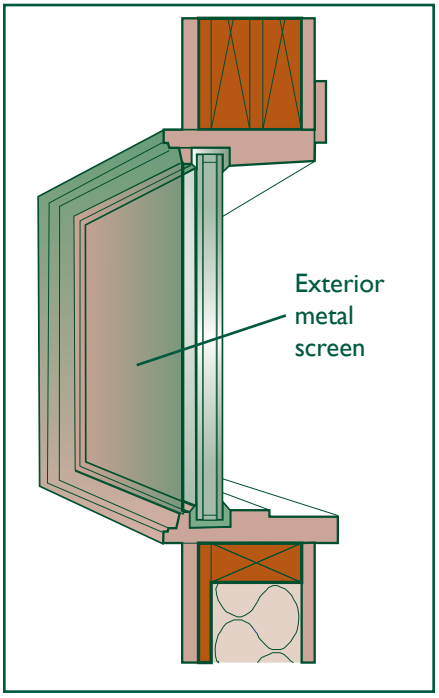
Only an additional 10 to 20 minutes of protection is necessary for a window to survive most fires. Exterior window covers, such as in-place shutters, can add this time. Shutters originated in New England as protection from storms when the wind would break the glass. They are now readily available in the Southeast for hurricane protection.



Wood shutters are the most common and economical, but they will ignite within five minutes. However, as shown in the fire behavior section, if the wildland fire duration is short enough, an additional five minutes of protection may be all that is needed. Also, even though fire departments may use foam to protect structures, it will not stick to glass. Therefore, shutters may still be advisable.

Metal shutters are better. They will protect the window long enough to last through the fire event and will not ignite.

The disadvantage of shutters is that they are not completely passive, that is, they require intervention on the part of the homeowner or the fire department to work.



Permanently placed exterior metal screens eliminate the deployment problem. Exterior screens are not going to protect the window as much as a solid cover, but as mentioned before, only five to 10 minutes of additional protection may be needed. Screens also provide a surface to which foam can adhere. These screens cannot be used with outward acting windows, like casement or awning windows, but they can be used with horizontal sliding and double hung windows.

Tempered glass

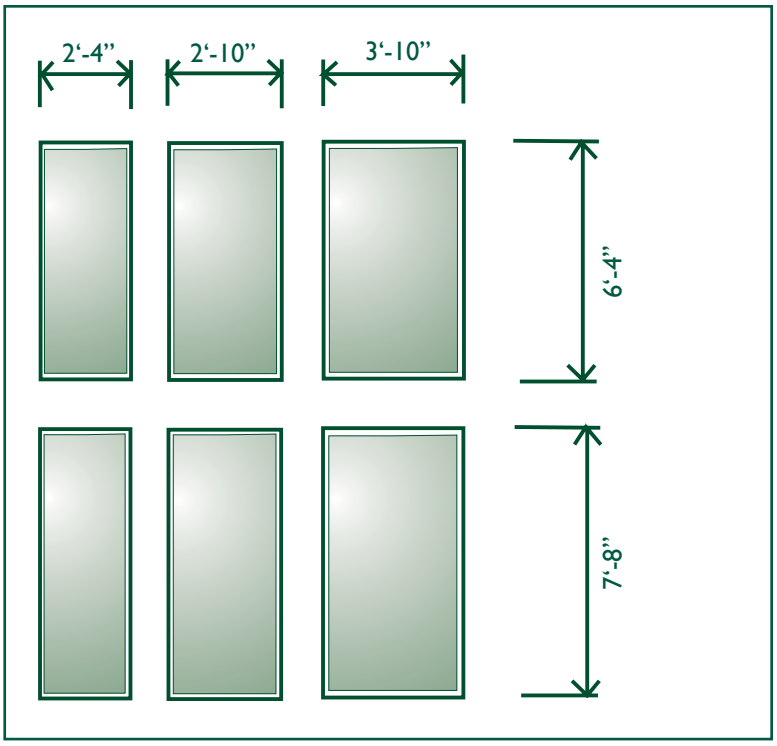
Tempered glass is both resistant to high impact and high heat. Most of us are familiar with it. Building codes require that tempered glass be used in patio doors and all areas subject to human impact. It is also the glass used in front of fireplaces. Tempered glass will stay in place and intact throughout the wildland fire event.

A problem with tempered glass is cost. Windows with tempered glass typically cost 50 percent more than regular glass. There are strategies around this, and costs are coming down.

Patio door replacement units are, as they infer, used to replace glass in patio doors. These units are mass produced and stocked by virtually every glass business. As a result they are very economical. In fact they are less expensive than conventional glass. They come in six sizes, as shown at right, and typically can be used as a picture unit, or combined to make a window wall or solar structure.

Using patio door replacement units provides a lot of tempered glass at a very economical price.

A few brands of windows are marketed as replacement windows in existing mid-rise urban buildings where the use of tempered glass is required. As a result, the additional cost for these brands of tempered glass is only 25 percent more than standard glass. Your local window supplier can suggest appropriate manufacturers.



Patio door replacement unit sizes

Low E glass

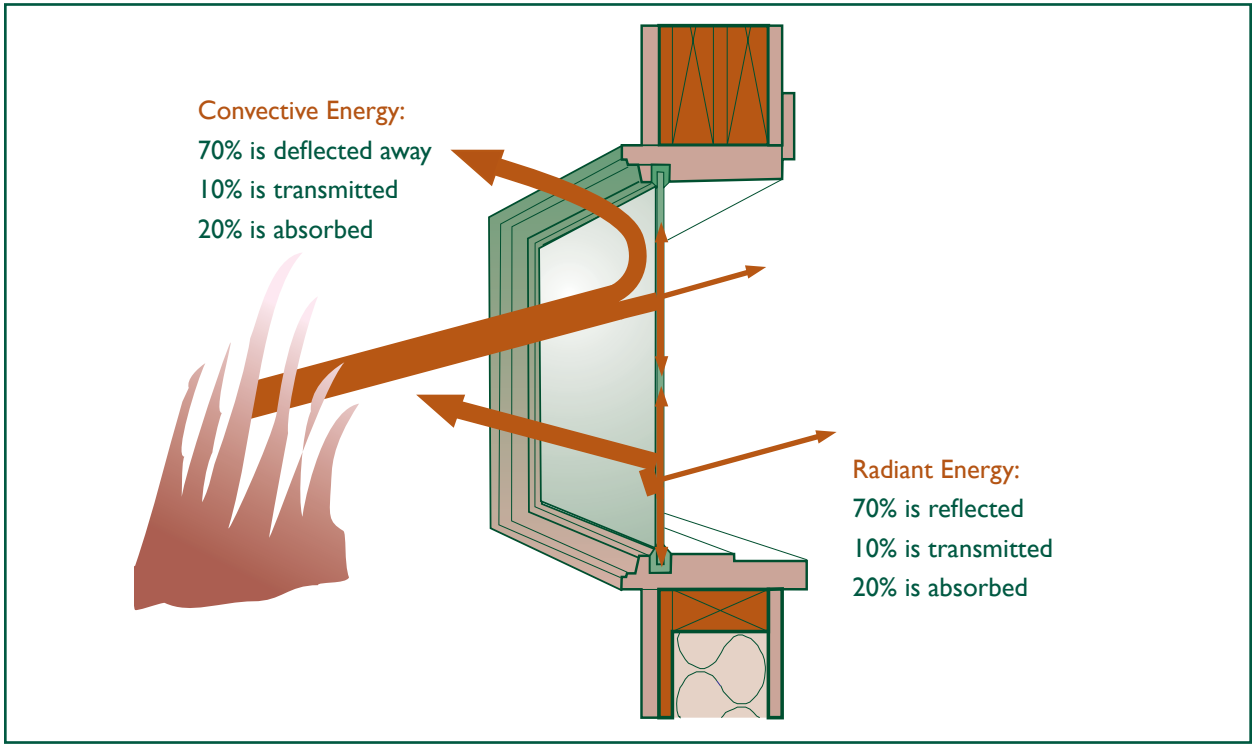
Low E stands for low emissitivity. This is an ultra thin, several microns thick, metallic coating on glass that appears white or reflective to infrared and ultraviolet light. It is used in windows for energy efficiency because it holds more heat in during the winter and keep more heat out during the summer. It also protects fabrics from fading and wood from yellowing.

This glazing option is widely used in windows today and only costs about 10 percent more than standard double glazed units.

The advantage of this glass in a wildland fire is that it stops the radiant energy transfer to combustible materials behind the glass such as drapes, wood furniture and walls.

The combination of Low E and tempered glass features for windows provides the best possible solution for windows in a wildland fire. The glass will stay intact throughout the fire event and will transfer less radiant energy to combustibles in the structure.

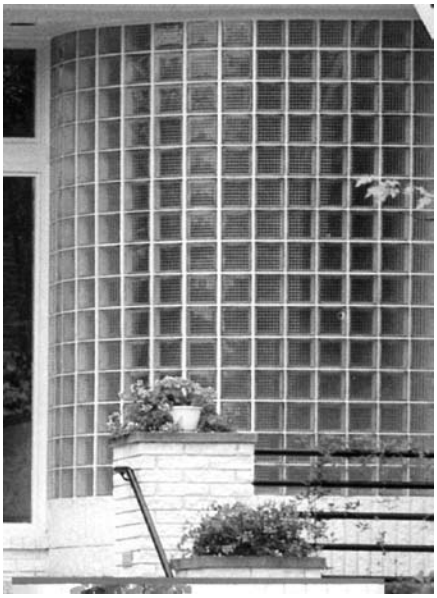
It should be noted that the use of tempered and Low E glass is a recommendation based on observations in the field. Actual laboratory studies in a wildland fire setting need to be conducted to give these types of glass specific quantitative values.



Energy transmission, Low E glass

Glass block

Glass block is the most fire- resistive glass available. It has the highest available rating of 90 minutes. It has an excellent appearance but provides a poor view. It does not have the Low E option.



A good use may be in a situation where only day lighting is needed, a view is not a factor and the orientation of the window may be toward a very high fire hazard.

Frames and sashes

Windows with improved glass technology will only work as long as the glass remains in place. The glass is held in place by the frame, so the frame needs to withstand the fire.

Wood frames will burn. Since they have a high surface-to-volume ratio they will readily ignite and burn freely. They are not a good choice.

Vinyl frames seldom ignite, and if they do, the combustion rate is very slow. It does not contribute to the combustion of the house. The problem is that vinyl frames melt and structurally fail, allowing the glass to fall away. They are not a good choice either.

Aluminum clad wood frames delay the ignition of the wood frame. They do not completely protect the window because the aluminum conducts the heat to the wood. This delay is enough in most wildland fires.

All aluminum frames are even better. Since there are no combustible materials, they remain fully intact during a fire. These frames are now available with a thermal break, a plastic spine that connects the interior frame to the exterior frame.

Doors

Wood doors

Residential buildings typically use wood doors with glass inserts. The same fire issues related to window glass apply to glass in doors. An unrated wood door is typically 1 1/2 to 2 inches thick. It can readily ignite and burn through in only 10 minutes, which is much faster than the rest of the structure will burn.

Wood doors are available with a class C, 20 minute rating. These doors are typically used between the garage and the house. They are a good solution in moderate fire hazard situations. In very high fire hazard situations, they may not resist burning for the fire duration and will allow other exterior building components to ignite.

Metal doors, steel and aluminum

Metal doors are non-combustible and available with 20 minute, 45 minute and one and one half-hour ratings, which makes them the most appropriate solution for very high hazard situations. Glass sizes are restricted in these doors. The surfaces are available with embossing to simulate wood grain and raised panel designs.

Just as in energy conservation, a good fire-resistive door requires adequate weatherstripping so that the seal prevents hot gasses or burning embers from entering the building.

6. Summary

A major wildfire can be an overwhelming event to experience. It can be huge, blotting out the sun and creating its own winds. It can throw flames and burning embers everywhere. Wildfire is a natural part of our environment that we can either respect or fear. If we make adjustments and modifications to our homes and the sites they occupy, then we can live confidently with fire. Each Interface resident must understand the basic characteristics of wildland fire and how it puts their property and lives at risk. Then the actions they take by building appropriate structures and properly caring for their Interface environment can significantly reduce the fire hazard.

A comparison is often made between fire and water. Fire, like water, tries to find a way into our homes. It does not matter how fire-resistive some parts of a structure are if weak points let a fire in. An awareness of how each building component is affected by fire will enable the owner, architect or builder to eliminate those weak points.

And finally, each of us needs to understand that, when we suppress wildland fires we must enhance our forest management policy to reduce fire fuels. When fires do occur they will be more manageable and less destructive to both the forest and our buildings.

References and additional information

The following is a partial list of publications and/or organizations can provide more information on this topic.

California's I-Zone

Rodney Slaughter, editor.

Available from the CFESTES bookstore in the California State Fire Marshal's Office, 1131 S St., Sacramento, California 95814.

Ph: 916-445-8200

Brushfire Prone Areas: Siting and Design of Residential Buildings

Construction of Buildings in BushfireProne Areas

Queensland Department of Local Government and Planning

P.O. Box 187, Brisbane Albert Street Qld 4002, Australia

Ph: 07-3237-1703, Fax: 07-3235-4071

The Urban Wildland Interface Code

The International Fire Code Institute, International Conference of Building Officials

5360 Workman Mill Road, Whittier, California 90601-2298

Ph: 562-699-0541

NFPA 299 Standard for Protection of Life and Property from Wildfire

National Fire Protection Association, (NFPA) 11 Tracy Drive, Avon, Massachusetts 02322

Ph. 800-344-3555

www.firewise.org

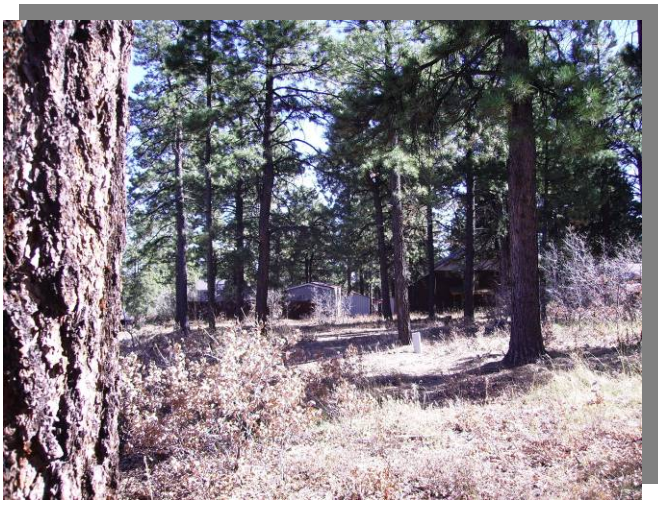
a web site maintained by NFPA covers much of what is in this pamphlet.

Appendix E

Photos

Structure with Lack of Defensible Space

Recommended Thinning Area on Wolff Property



Common Space Area Previously Mitigated

Recommended Common Space Mitigation Area

Recommended Alternate Evacuation Route