Lessons Learned from Waldo Canyon

FIRE ADAPTED COMMUNITIES
MITIGATION ASSESSMENT TEAM FINDINGS

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The Nature Conservancy
U.S. Department of the Interior
National Association of State Foresters
National Volunteer Fire Council
U.S. Fire Administration
National Wildfire Coordinating Working Group–Wildland Urban Interface Mitigation Committee

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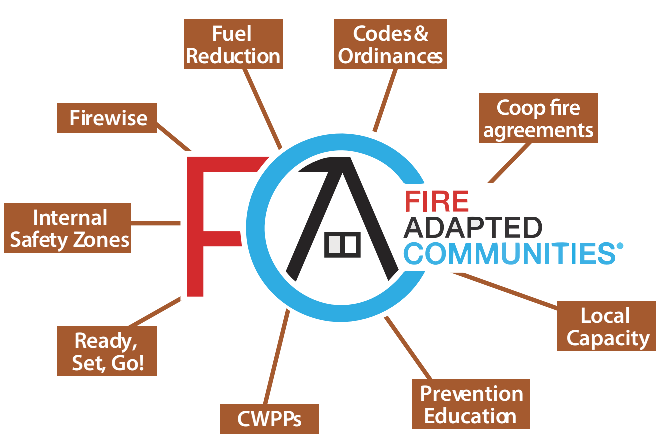
Introduction & Background

The Waldo Canyon Fire started the afternoon of June 23, 2012 near Colorado Springs, Colorado. The fire threatened the Cedar Heights community in the early hours of June 24, however no homes were lost. Two days later, the fire entered the Mountain Shadows neighborhood, where 346 homes were eventually destroyed on June 26.

Considered the worst fire in Colorado state history, Waldo Canyon forced more than 30,000 people to evacuate, scorched 18,247 acres, killed two residents, and took firefighters 18 days to fully contain. The fire burned through brush, mountain shrub, grass, and trees including oak, Pinyon-juniper, ponderosa pine, Douglas-fir, spruce and limber pine. In addition to disrupting thousands of lives and destroying hundreds of properties, the wildfire left the scarred landscapes vulnerable to flooding and/or debris slides that will pose long-term problems.

The Waldo Canyon fire presented the first opportunity for partners in the national Fire Adapted Communities (FAC) Coalition to collectively assess the performance of mitigation practices in Colorado Springs in a post-fire environment and to compare the results to the mitigation strategy recommended by the Fire Adapted Communities program. The assessment was conducted from July 18-20, 2012, by a FAC Wildfire Mitigation Assessment Team, which included two sets of researchers: structural assessment and forestry experts and social science and public education experts, accompanied by staff from the Colorado Springs Division of the Fire Marshal and the State of Colorado. The structural assessment team surveyed 40 homes that were damaged, undamaged and destroyed during the fire, toured fuels management projects, and examined a variety of mitigation initiatives including creation of defensible space, Wildland Urban Interface (WUI) Codes and Ordinances, wildfire preparedness information and awareness efforts. The team of social science and public education experts talked with local officials, homeowners and community leaders and also toured the above-mentioned areas. The FAC Mitigation Assessment Team included representatives from the USDA Forest Service, Insurance Institute for Business & Home Safety (IBHS), International Association of Fire Chiefs, National Fire Protection Association (NFPA) and The Nature Conservancy.



OVERVIEW OF FIRE ADAPTED COMMUNITIES STRATEGY

The USDA Forest Service developed the Fire Adapted Communities program in 2009. It is based on the Quadrennial Fire Review's recommendation that creating fire adapted communities is the best alternative to escalating wildfire in the Wildland Urban Interface. The strategy promotes multi-jurisdictional use of a suite of mitigation tools focused on helping communities live successfully with wildfire through mitigation and preparation, rather than depending upon suppression and protection resources that are not always available.

PRIMARY ELEMENTS OF A FIRE ADAPTED COMMUNITY:

1. An informed and active community that shares responsibility for mitigation practices.
2. A collaboratively developed and implemented Community Wildfire Protection Plan (CWPP).
3. Structures hardened to fire and including adequate defensible space practices; advocated by Firewise Communities, IBHS and others.
4. Local response organizations with the capability to help the community prepare and can respond to wildfire; advocated by Ready, Set, Go!
5. Local response organizations with up-to- date agreements with others who play a role in mitigation and response.
6. WUI Codes, Standards or Ordinances, where appropriate, which guide development
7. A visible wildfire reduction prevention program that educates the public about the importance of a communitywide approach and the role of individual homeowners.
8. Adequate fuels treatments conducted in and near the community, including development and maintenance of a fuels buffer or firebreak around the community.
9. Established and well-known evacuation procedures and routes.

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OVERVIEW OF COLORADO SPRINGS MITIGATION

Colorado Springs metro area has about 650,000 people living in an area roughly 195 square miles. About 24 percent of the metro area's population resides in the 28,000 acres of WUI, which runs from the Air Force Academy south to Cheyenne Mountain Air Force Station. Much of the WUI is in forested/vegetated foothills on alluvial fans along narrow drainages and ridgelines with slopes up to 45 percent. Average annual precipitation is about 17 inches and summer temperatures can reach 100 degrees.

Colorado Springs Wildfire Mitigation Section has an annual budget of about $300,000 and two full-time employees. Additional grant funding for mitigation projects is often sought through public and private sources. See Appendix A for a brief overview of the mitigation measures Colorado Springs Fire Department has put into place since creating the Wildfire Mitigation Section in 1993.

Community Education and Outreach

The Colorado Springs Fire Department Wildfire Mitigation Section developed a strong community education effort early in the process and has built on its success. Outreach included development of the "Sharing the Responsibility" campaign, active engagement with residents and homeowners' associations, community and neighborhood meetings, development of homeowner guides, education about evacuation, on-site risk assessments and consultations, online resources, brochures and other educational tools. The effort has evolved into a community lecture series that discusses wildfire risk mitigation, wildfire behavior and forest health and arbor care. The community also has a Wildfire Mitigation Season kick-off each spring to alert residents of the need for action prior to the official start of wildfire season.

A series of stakeholders meetings began in 2000 and a Core Advisory Group was formed. Grants from the U.S. Forest Service and the U. S. Fire Administration Assistance to Firefighters propelled the program in 2001 with the production of wildfire risk materials, including a video for public access cable channel. Voters approved the Public Safety Sales Tax, which helped fund the mitigation program.

The Colorado Springs Firewise program, patterned after the national Firewise Communities Program, became part of homeowner mitigation and outreach messaging in 2001. A Firewise Program Coordinator was hired and began a series of community Firewise meetings to discuss risk, mitigation, and evacuation. In 2002 Colorado Springs launched an interactive Firewise website which combined mitigation messages aimed at the homeowner and each property's hazard rating which encouraged a sense of community competition among neighbors.

It should be noted that the Colorado Springs Wildfire Mitigation Firewise program is substantially different from the national Firewise program in regards to scope, regulation and size. With 36,485 addresses and 28,800 acres identified in the Colorado Springs WUI, the fire department is actively engaged with 87 neighborhoods by providing:

- a wildfire risk assessment down to the lot level through aerial photographs and windshield drive-by methods;
- development review process that involves progressive code requirements for new construction and rebuilding post-fire;
- education and outreach to homeowners and neighborhood organizations;
- a fuels mitigation program that addresses neighborhood chipping; residential properties and adjacent common areas and open spaces;
- champion recognition;
- grant funding and administration;
- fire danger monitoring, and
- oversight of a self-regulating process that is performed by the citizens in partnership with the fire department to "Share the Responsibility" without an enforcement posture.

The Mitigation Assessment Team found that regular, consistent and open communication with targeted neighborhoods about services offered by the fire department and the need for individual responsibility on the part of homeowners helped the community understand both the need for and how to implement mitigation work. The Colorado Springs Firewise effort is the core of the education and outreach effort. Colorado Springs Fire Department made residents partners in the process by sharing risk information and helping them conduct mitigation efforts. It also identified Firewise Champions in WUI neighborhoods and

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recognized them during both state Wildfire Awareness Weeks and official city-sponsored Firewise Weeks. Many more Firewise Communities were created by promoting champions each year and highlighting the successes of individuals and their neighborhoods.

Codes and Ordinances

Colorado Spring passed its first wildfire-related ordinance in 1993 and has since continued to work with the city council and with local developers and residents to address WUI issues through regulation. The office of the Fire Marshall provides free Hazard Risk Assessments for developments planned in the WUI. The review includes vegetation and landscape design as well as building components. All building permits must be processed through city offices.

The city's fire code is based on the International Fire Code and defines the WUI and at-risk areas. The code does not allow new construction with wood shake roofs; pre-existing cedar shake roofs are "grandfathered" in until homeowners replace roofs due to routine maintenance, at which time roof replacement cannot be with wood shakes. Additionally, the code now restricts development on slopes in the WUI, requires a Class "A" roof for all residential occupancies, [has requirements for other exterior-use materials] and fuels management measures such as creating defensible space, and many other measures intended to reduce wildfire risk.

The Mitigation Assessment Team found that Colorado Springs existing ordinances had been effective in reducing risk. See additional information in the section, "Assessment Findings Reinforce Need for Mitigation." Replacement of 55,000 cedar shake roofs over the last six years had a significant impact on ember starts as did use of fire resistant materials, home design and placement, and landscaping. Mitigation measures, building siting or location, fuels reductions, and building materials all were addressed. The Waldo Canyon Fire was responsible for igniting homes in close proximity to the blaze and igniting combustible building materials on or near other homes that ultimately resulted in the homes being damaged or destroyed.

As a result of post fire inspection the Colorado Springs Fire Marshal's office worked closely with the city council, the local builders associations, and residents to amend the city's fire code to provide more guidance on exterior-use materials, soffit screening size, and other factors intended to reduce risk. The effort to amend the ordinance was successful. The full text of the amended ordinance is available at ***http://www.springsgov.com/SIB/files/Ordinanace_No__12-111[1](2).pdf.***

Community Wildfire Protection Plan (CWPP)

Colorado Springs Community Wildfire Protection Plan (CWPP) is an active one that is implemented and is updated on a regular basis, the last time in 2011. Partners in the plan include Colorado Springs Utilities, Cheyenne Mountain Zoo, University of Colorado, USDA Forest Service, the City of Colorado Springs, Palmer Land Trust, Colorado State Forest Service, Colorado State Parks, El Paso County, Coalition for the Upper South Platte, U.S. Air Force Academy, Mount St. Francis, the Development Review Enterprise, and a host of residents representing homeowners associations.

The 48-page plan addresses a wide array of pertinent issues affecting wildfire impact on Colorado Springs and has served as the community's guide to mitigation and preparedness. The goals of the plan are to reduce risk to residents, firefighters, property, infrastructure and natural resources by educating residents about minimizing risk by reducing natural hazardous fuels around and adjacent to buildings and infrastructure, improving structural characteristics around new and existing construction through ordinances, development reviews, and individual consultations and to manage common areas and open spaces wild respecting natural characteristics and protecting habitat.

The plan calls for a minimum of 10 feet of clearance around structures and 30 feet of mitigated vegetation. Adjacent areas and open spaces calls for reduced stand density, removal of ladder fuels, separation between oak clumps by at least 10 feet, a minimum of two snags per acre for wildlife habitat, and a thinned understory in mixed conifer and mature pine.

The Colorado Springs Fire Department Wildfire Mitigation Section used the Wildfire Hazard Risk Assessment (WHINFOE) tool to determine risk ratings from low to extreme. Nearly 36,000 homes were identified as at-risk in the interface in 63 neighborhoods. Property owners can access their risk ratings on line at any time and compare

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them to those of their neighbors, thus using peer pressure to encourage mitigation. The risk information is updated as property owners make modifications or upgrades. A full update of the hazard risk map is done every 10 years; view the information at ***http://csfd.springsgov.com.***

The Mitigation Assessment Team found that the CWPP was a living document that resulted from a wide collaborative effort, including many stakeholders at the federal, state, and local level, as well as residents and homeowner associations. This broad-based support and collaboration provided credibility to the CWPP as a community-developed and accepted document. The community was invested through participation and better understood the issues involved, which fostered support for the plan's implementation, according to local officials and community leads. The CWPP outlines the community's wildfire risk issues and ways to address or mitigate them. In fact, the document goes into detail to describe mitigation practices and programs. The document is updated regularly and serves as the action plan for mitigation and risk reduction. Download the CWPP at: ***http://www.springsgov.com/units/fire/wildfire/COS_CWPP_2011.pdf.***

The Stewardship Program Agreements and Fuels Management

The Wildfire Mitigation Section gets fuels management work done through stewardship agreements with private and public property owners. Those agreements, which outline fire department and property owner responsibility and liability, are signed and in place before any mitigation work is undertaken.

Colorado Springs fuels management projects are anticipated to result in a savings of $12 to $24 for every $1 invested in mitigation. The Wildfire Mitigation Section treats nearly 1,000 acres annually through maintenance, prescribed burning, volunteer projects and neighborhood chipping. The fire department also works on cross-boundary projects with the USDA Forest Service, Air Force Academy, El Paso County, and Colorado Springs Utilities.

Colorado Springs conducts about 900 acres of fuel treatments annually. Roughly 300 acres are treated in parks, open spaces and common areas and 600 acres are treated on private property through the neighborhood chipping program. Treatments cost $800 to $2,500 per acre and can have multiple objectives. Aesthetics are important to nearby residents. City licensing requirements limit the pool of contractors, while city ordinances limit types of treatments. The city does not currently conduct broadcast burning.

In general, continuous fuel layers are broken up into clumps; small trees are thinned out and ladder fuels are removed. The hope is, these treatments will moderate the behavior of any wildfires and allow firefighters to extinguish fires before they damage structures.

More than 60 City neighborhoods/ homeowner associations participate annually in the CSFD community chipping program, which is funded by the Public Safety Sales Tax. This keeps a two-person crew busy eight months out of the year. Homeowners qualify for chipping by having a free wildfire risk assessment at their home or by attending a CSFD Wildfire Mitigation Meeting. If stacked according to CSFD guidelines, woody material is removed free of charge during a designated week. Mitigation efforts are not enforced.

Treatments also are conducted in residential common areas, parks and open spaces where the city has fire suppression responsibilities. Priority is given to forested areas adjacent to neighborhoods with high fire risk. Project area limitations include economic and contracting feasibility and ownership. The city has a seasonal five-person fuel mitigation crew and also hires contractors through an RFP process to conduct mitigation projects. Vegetation is not physically removed from treatment areas; rather, it is cut, chipped and spread across the ground to a depth of no more than 4 inches. The goal is to re-treat areas every two to four years depending upon regeneration.

Specific treatment prescriptions are based on the vegetation types and condition and terrain. In areas dominated by Gambel oak and similar shrubby species, hazard mitigation objectives focus on breaking up fuel continuity. According to Jester et al,[1] "spacing requirements between clumps of brush and/or shrubs are 2½ times the height of the vegetation. The maximum diameter of clumps is 2 times the height of the vegetation." In mixed conifer and ponderosa pine stands, thinning from below treatments are the norm. Mature trees are retained and the more flammable understory trees are cut, as are limbs that serve as ladder fuels.

[1] *N. Jester, K. Rogers, and F.C. Dennis (2012). "Gambel Oak Management," Natural Resources Series, No. 6.311. Colorado State University Extension, 115 General Services Building, Fort Collins, CO.*

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The Mitigation Assessment Team found the most significant fuel treatment "story" played out at Solitude Park on June 24. The area known as Solitude Park lies above the neighborhood of Cedar Heights and covers approximately 300 acres. It is located between the residential neighborhoods and the national forest. Fuel treatments were conducted in 2010 across approximately 300 acres of the area. Vegetation types in the treated areas are primarily Gambel oak shrubland, ponderosa pine woodland, mixed conifer forest, and pinyon-juniper woodland. The treatments were funded by the city through a FEMA grant and carried out primarily by contractors as described in the above section.

In places where there had been a continuous layer of dry, shrubby fuels (decadent Gambel oak), the treatment broke the layer into clumps (Figure 1).

Figure 1: Solitude Park parcel dominated by Gambel oak, where the results of the fuel treatment by breaking up a continuous layer of shrubby fuels, are still obvious. The Waldo Canyon Fire spread to this treated area. It was extinguished before it spread to homes. Source: USDA Forest Service.

When the wildfire approached on June 24, this alteration of the fuel structure allowed firefighters to anchor in a safe zone and create a dozer line, which was instrumental in fighting the fire there and protecting the Cedar Heights community adjacent to the treatment area. It was also easier for firefighters to address spot fires in areas where the fuels were discontinuous (Figure 2). Water and retardant drops near the fuels treatment reinforced its effectiveness. Ultimately no homes were lost in the Cedar Heights neighborhood which is adjacent to the treatment area, partially due to the fuels treatment, firefighters anchored in the safe zone that put out spot fires, and changes in fire behavior.

Figure 2: The wildfire stopped or was extinguished in the middle of this treated area. Source: USDA Forest Service.

OVERVIEW OF HOME ASSESSMENT SURVEYS AND LOCATIONS

Following are the detailed findings of the FAC Wildfire Mitigation Assessment Team surveys regarding structural perofrmance, with particular emphasis on construction details that can increase the vulnerability of homes to wildfire exposures. It is intended to highlight the importance of choosing the right types of building materials and following proper installation and maintenance practices for properties located in wildfire-prone areas.

Home and buildings that were damaged and destroyed were located in the area to the west of Centennial Boulevard and to the north of N. 30th Street. The homes and other buildings in this area were represented on a preliminary damage assessment survey map published July 2, 2012 by the Colorado Springs Division of the Fire Marshal, shown in Figure 3, and included approximately 1,525 buildings. Of these, 346 were destroyed and 38 were damaged; all were located on streets accessed by Flying W Ranch Road.

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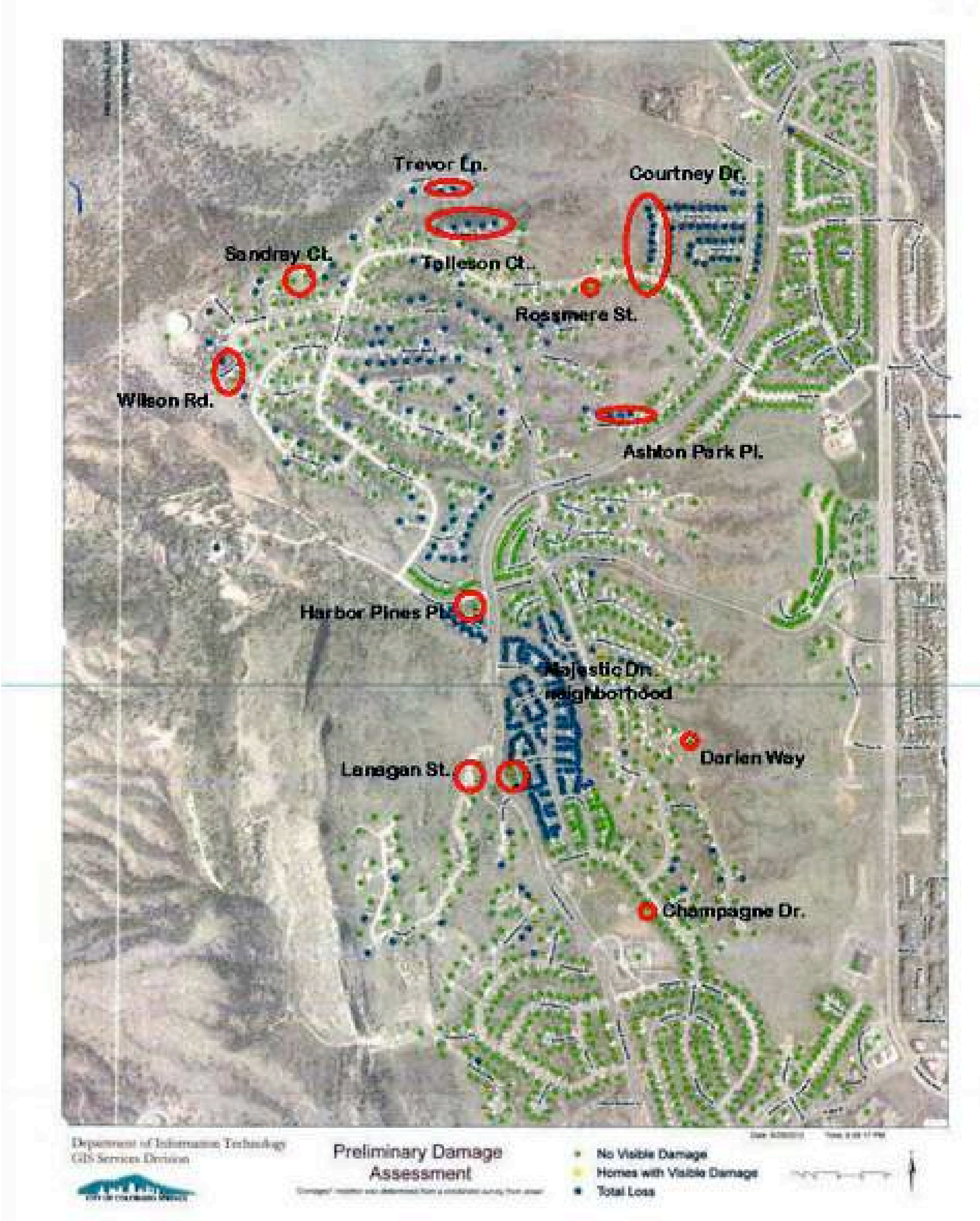

Figure 3: The red circles indicate areas in the Mountain Shadows neighborhood where home assessments were conducted. Source: Colorado Springs Division of the Fire Marshal and IBHS.

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Forty homes were included in the FAC Wildfire Mitigation Assessment Team survey; 38 were located in the Mountain Shadows neighborhood and two were located in the Cedar Heights neighborhood. All homes within the nominal fire perimeter were not examined.

The relative location of the Mountain Shadows and Cedar Heights neighborhoods are shown in Figure 4. Of the 38 homes included in the survey from the Mountain Shadows neighborhood, 26 homes were destroyed, 10 homes were damaged, and two homes were not damaged. The areas within the Mountain Shadows neighborhood where assessments were conducted are shown in Figure 3. The damage assessment survey form used for the home assessments is shown in Appendix A. This form was based on the NIST/USDA FS WUI-1 Damage Assessment Report form, but was modified for use in this survey. Some general observations about the role of landscape vegetation and landscaping during the fire are in Appendix B.

Home Assessment Focus

When conducting the field inspections, the FAC Wildfire Mitigation Assessment Team examined the types of building materials and construction techniques used in damaged and undamaged homes and looked for vulnerabilities that could be responsible for damage to homes and buildings. For destroyed homes, the team surveyed debris for evidence of the type of building materials used and examined landscaping vegetation and features to determine whether and how the fire might have reached and ignited the houses. As with prior post-wildfire field investigations, there was evidence of several types of possible ignition scenarios, including wildfire-to-building and house-to-house fire spread. Wildfire-to-building fire spread could occur from wind-blown embers or the flaming front or flank of the fire. By its very nature, wildfire is a fast-moving natural hazard that leaves little time for preparation when a fire is threatening. This fact, combined with the potential for multiple causes of ignition that can result in wildfire damage, further reinforces the need for a communitywide approach to wildfire mitigation to complement the role of individual responsibility among homeowners.

Approximately 90 percent of homes ignited by the Waldo Canyon Fire were completely destroyed. Of those that were damaged, firefighter intervention was the likely reason the house was saved. This pattern is similar to other wildfires where a large number of homes were destroyed and few are damaged, as indicated by many prior post-fire surveys. This report provides examples of situations where firefighter intervention was reported, and confirmed by Colorado Springs Fire Marshal's personnel, and examples where intervention did not likely occur.

How Homes Ignite during Wildfires

Wildland fire-to-building ignition resulting in damage or loss during wildfires occurs if the fire can burn directly to the building; directly or indirectly from wind-blown embers (also known as firebrands) or from exposure to embers generated by the burning wildland vegetation. An example of loss due to indirect exposure is ember ignition

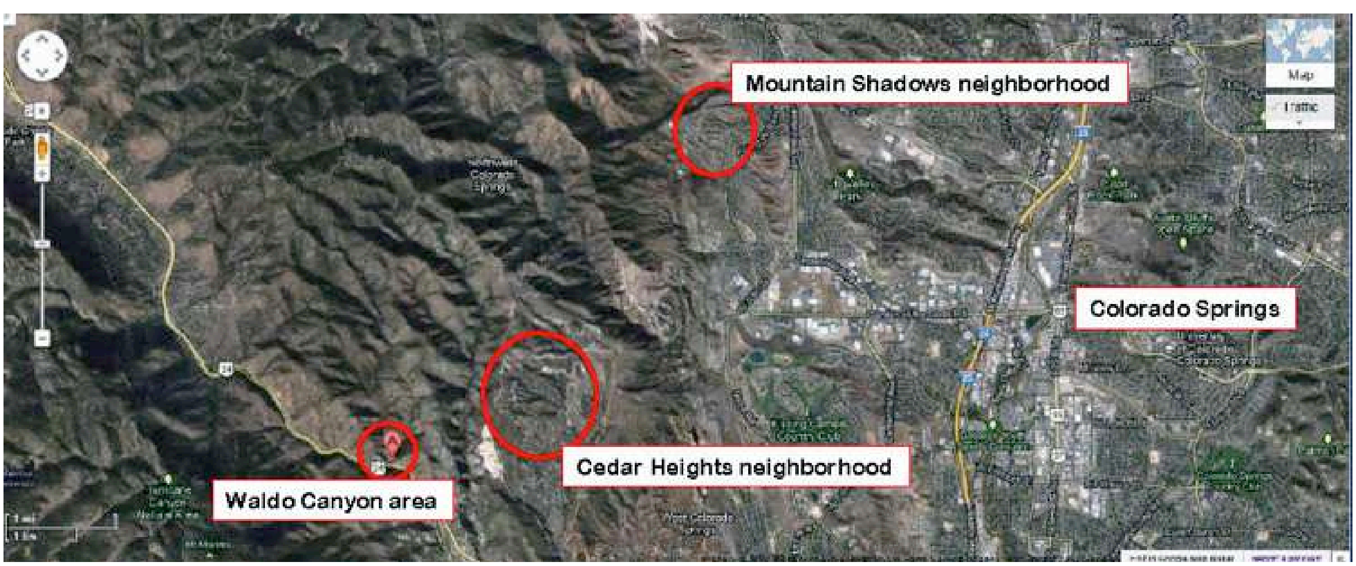

Figure 4: Relative locations of the Cedar Heights and Mountain Shadows neighborhoods in Colorado Springs. Source: Google Maps.

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of vegetation or other combustible materials located near the building resulting in subsequent ignition of a building component from a radiant and/or direct flame contact exposure. Depending on the extent and duration of a radiant heat exposure, pre-heating or ignition of a material can occur, or the glass in a window or door can break. An example of loss due to direct ember exposure would be ember entry through a vent or open window with subsequent ignition of combustible materials inside the building. Direct ignition by embers also can occur through ember accumulation on combustible materials, such as a wood shake roof or combustible decking or immediately adjacent to combustible materials, such as siding.

Once homes and other buildings ignite and burn, they also become a source of embers and threaten other homes and buildings – this report will not distinguish between vegetation and buildings as the sources of embers. Once an initial wildland fire-to-building ignition has occurred, depending upon building-to-building spacing and other topography features, additional building ignitions can occur via building-to-building fire spread. It was reported that during the 2007 Witch Creek Fire, building-to-building fire spread was more likely if between-building spacing was less than 15 feet[2]. The role of proximity between houses also was present in Waldo Canyon, where many of the destroyed houses were spaced 12 feet to 20 feet apart.

In the report on the 2007 Witch Creek Fire, Maranghides and Mell[3] described three categories for building ignition: 1) uninterrupted vegetative or ember ignition, 2) vegetation fire or ember ignition and 3) ember ignition. As indicated in this report, ignition by uninterrupted vegetative fire spread would be limited to buildings located on the perimeter of a community of neighborhood since roads would provide a fuel break that would preclude vegetative fire spread. Ember ignition is included in category one because, without an eyewitness account, it would be difficult to exclude the possibility of direct ember ignition, even in cases where there is an uninterrupted vegetative path between an oncoming wildfire and a building. Loss from direct or indirect ember exposure would be included in categories two and three, with direct exposure in category three being determined either by the lack of near-building vegetation or the lack of damage to near-building vegetation.

Examples of building-to-building fire spread and the three categories of wildland fire-to-building fire spread described by Maranghides and Mell were observed during the FAC Wildfire Home Assessment Team's on-site surveys. Examples of these wildfire risks are described in the following sections, along with mitigation strategies that could minimize property damage associated with the various risks.

[2]*Insurance Institute for Business & Home Safety (2008). Megafires: The Case for Mitigation. IBHS field investigation: Witch Creek Wildfire, San Diego, CA, Insurance Institute for Business & Home Safety, Tampa, FL.*

[3]*Maranghides, Alexander and William Mell (2009). A Case Study of a Community Affected by the Witch and Guejito Fires, NIST Technical Note 1635. National Institute of Standards and Technology, Gaithersburg, MD.*

Observed Wildfire Risks and Mitigation Strategies

MOUNTAIN SHADOWS

Most of the homes in Mountain Shadows that were included in this survey were single-family detached houses, with the exception of one townhome/duplex. All of the survey homes had basements with windows and window-wells. A combination of materials, including wood-lined, stone, and metal-lined window-well retaining walls were observed. On newer homes or homes, where the window-well retaining wall had been replaced, stone or metal-lined window wells were present. Wood-lined enclosures consisted of 4 x 4 (or greater dimension) vertical support members and nominal 2x horizontal planking. The accumulation of vegetative debris in windows wells was common. In general, the fire consumed wood-lined enclosures on homes that were destroyed, but it was not clear if they were a cause of ignition or whether they were ignited by the burning home.

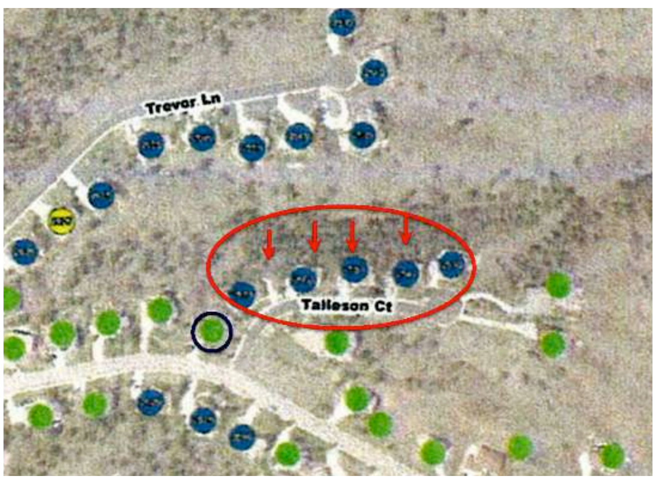

Figure 5: Five homes on Talleson Court were destroyed (red circled). These homes were located at the top of a slope and each had overhanging decks. One home suffered minor damage (blue circled).

Wildfire-to-Home: Uninterrupted Vegetative or Ember

Area Focus: Talleson Court

Although some perimeter homes were included in the assessment survey, none provided clear evidence of uninterrupted vegetation fire spread from the main body of the wildfire. The destroyed homes on Talleson Court represented an example of wildfire-to-home spread, with embers first igniting a wooded area within the community with a subsequent direct flame contact exposure to the home (Figure 5). These homes were located at the top of a steep slope (> 30%) and were rated as being in an "extreme" hazard zone by the Colorado Springs Division of the Fire Marshal.

RISK: WOODED SLOPE

Each home had a deck overhanging the slope. Figure 6 shows a view from the top of slope where the deck was located, looking down slope. The spot fire in the wooded area crowned and separation from homes to the trees was insufficient to avoid a direct flame contact to the overhanging decks. Fire then spread from the deck to the interior of the homes. An interview with a homeowner, who was present during the site visit and whose house was destroyed told members of the assessment team that the house had a lower and upper deck, and that one deck was constructed using wood, while the other deck was built using a wood-plastic composite decking product.

Figure 6: View down slope from a Talleson Court home. Note the lack of needle vegetation on the trees, indicating the fire crowned in these trees. Source: IBHS.

MITIGATION STRATEGIES

Mitigation strategies for this threat would include thinning trees and removing ladder fuels. Building a cross-slope retaining wall using noncombustible materials down-slope from the homes could also be an effective strategy for shorter brush-type vegetation[4]. However, this would not work in a wooded area with taller trees since a crown fire would burn over top a typical retaining wall. This mitigation strategy is an example of where a communitywide effort would produce the most effective results.

[4]NFPA (2008). *NFPA 1144, Standard for Reducing Structure Ignition Hazards from Wildland Fire (Appendix A).* National Fire Protection Association, Quincy, MA.

Observed Wildfire Risks and Mitigation Strategies

RISK: WINDOWS

Figure 7 depicts a home that suffered minor damage from radiant heat. This home was located approximately 30 feet from the home that was destroyed. Damage consisted of deformed vinyl frames in two windows and cracked outer glass panes in the same windows. A near-home pine tree showed signs of needle scorch. No damage was observed on the stucco-type exterior cladding. In this case, because of the limited damage to the vinyl frame windows, and because the damage was caused by the radiant heat exposure from the adjacent home, human intervention wasn't likely. Because the glass in the windows did not completely fail (i.e., the outer glass pane remained intact and the frame did not ignite), ember entry into the home did not occur.

It should be noted that, with the exception of the pine tree located near the home and a small bush in the interior corner, the defensible space on this side of the house was good (Figure 7). A noncombustible gravel product was used within 10 feet of the house. Any ember deposition and accumulation would have been on this material.

MITIGATION STRATEGIES

Mitigation strategies for this threat would include installing multi-pane windows that incorporate tempered glass. Studies have shown that the glass is the most vulnerable component of window in terms of complete failure. When glass breaks, it creates openings large enough for fire or embers to enter the home. Tempered glass is several times stronger than annealed glass (the type of glass most commonly used in windows) and therefore will require a radiant heat exposure that is higher than that required to break annealed glass. Because of this difference, tempered glass is recommended for use in these applications.

As already noted, the vinyl window frames deformed when subjected to the radiant heat exposure from the adjacent destroyed homes. To avoid these aesthetic types of damage, shutters or other coverings that could be deployed when wildfire threatens could be used. Use of shutters or coverings, and minimally multi-pane tempered glass windows, should be used in neighborhoods with close home-to-home spacing.

Wildfire-to-Home: Uninterrupted Vegetative or Ember with Subsequent Home-to-Home Fire Spread

In wildfires where large numbers of homes are destroyed, it is common for a significant number of home ignitions to result from home-to-home fire spread, with the wildfire becoming an urban fire. Close home-to-home spacing is an important component for this kind of fire. Topography and weather (wind) will also contribute to fire spread during these events. An example of this wildfire-to-urban fire scenario is the October 1991 Oakland-Berkeley Hills Tunnel Fire. The Tunnel Fire destroyed more than 3,600 homes while burning more than 1,500 acres. Similarly, during the Waldo Canyon Fire, a large number of homes were destroyed as a result of home-to-home fire spread after a smaller number of wildland fire-to-home ignitions occurred.

Figure 7: This damaged Talleson Court home was approximately 30 feet from a destroyed home. Two windows were damaged (one is circled in red; another window of the same size is located to the left of the one shown). The tall pine tree had lower branches removed and noncombustible gravel was used within approximately 10 feet from the house. Note the scorch on the destroyed home side of the pine tree and small tree in the foreground. Source: IBHS.

Observed Wildfire Risks and Mitigation Strategies

Area Focus: Majestic Drive

Aerial photographs of the Majestic Drive area before and after the fire are shown in Figures 8 and 9 As shown in Figure 8, the fire burned down to Flying W Ranch Road, burning the vegetation on the west side of the road (left-hand side in Figure 8). Flying W Ranch Road is a major thoroughfare through the community and is approximately the width of a four-lane road: it consists of two lanes with a center common turning lane and wide, paved shoulders. Because of the width of Flying W Ranch Road, the homes in this area ignited either from direct or indirect ember exposure or home-to-home spread. Although it was not determined which of the homes in the Majestic Drive area were ignited by embers and which were specifically ignited through home-to-home fire spread, because of the relatively close between-home spacing, it is probable that many of the 135 homes destroyed in this area were the result of home-to-home fire spread.

Figure 8: Majestic Drive area of the Mountain Shadows neighborhood prior to the Waldo Canyon Fire. Source: Google Maps.

Figure 9: Majestic Drive area of the Mountain Shadows neighborhood after the Waldo Canyon Fire. Source: Colorado Springs Division of the Fire Marshal.

RISK: HOME-TO-HOME SPACING

The homes in included in the assessment from this area were on Hot Springs Court. Between-home spacing for these homes was between 12 and 20 feet, representative of the other homes in the Majestic Drive area. Four homes were inspected in this area: two that were destroyed and two that were damaged (Figure 10). The homes had a Class A (asphalt composition shingle) roof covering and wood composite (hardboard) siding. The homes that were damaged had soffited (and vented) eaves. Decks on these homes used both solid wood (non-fire retardant treated) and wood-plastic composite deck boards. Both of these products are combustible. Neither qualifies as being an ignition-resistant material, which requires passing a longer-duration (30 minutes versus 10 minutes) version of the test used to evaluate the flame spread rating of a material. This test and designation applies to materials used as siding, decking and trim. Only a few commercially available materials qualify as an ignition-resistant material–the most common being wood products treated with an exterior-rated pressure impregnated fire retardant chemical formulation.

MITIGATION STRATEGIES

Maranghides and Johnsson[5] reported that by using a one-hour, fire-rated wall construction, the spread of fire from one building to another located 6 feet away could be slowed down compared to a building clad with combustible materials that did not include the underlying materials (such as a fire-rated gypsum wallboard product) to provide the fire-rating. Since fire-resistance is measure of fire penetration through the wall assembly, and does not evaluate flame spread up the wall, or ignition resistance, a one-hour fire-rated wall would not be the complete answer to hardening a building, but it could help in situations where there is close home-to-home spacing.

[5] *Maranghides, Alexander and Erik L. Johnsson (2008). Residential Structure Separation Fire Experiments, National Institute of Standards and Technology, Gaithersburg, MD.*

Observed Wildfire Risks and Mitigation Strategies

Mitigation strategies for this threat would also include installing multi-pane windows that incorporate tempered glass. Studies have shown that the glass is the most vulnerable component of window in terms of complete failure. When glass breaks, it creates openings large enough for fire or embers to enter the home. Shutters or other coverings that would be deployed when wildfire threatens could also be used. Shutters and coverings are typically active devices, meaning that a resident must be present to deploy or install. There are advantages to passive devices since they are always enabled.

Figure 11: The distance between the destroyed home on the left and the damaged home on the right was approximately 16 feet. Source: IBHS.

Figure 12: Embers ignited a firewood pile located next to the garage of this home. The direct flame contact exposure from the burning firewood ignited the composite wood (hardboard) siding product. Source: IBHS.

Figure 10: Majestic Drive area of the Mountain Shadows neighborhood showing destroyed (blue), damaged (yellow) and undamaged (green) homes, as shown in the preliminary damage assessment survey map. An undamaged home in the middle identified by an arrow was not included in this field assessment. Source: Colorado Springs Division of the Fire Marshal.

Ignition of the destroyed home at 2551 Hot Springs Court, shown as the upper most home in the red circled area in Figure 10, was either from the adjacent destroyed home located 16 foot away or through direct ember ignition. Defensible space was very good; rock mulch surrounded the home and the balance of the property consisted of irrigated lawn. The wood "half wine-barrel" planters were either largely undamaged, or burned on the house-facing side, indicating exposure from the burning house.

RISK: NEAR-HOME COMBUSTIBLES

The distance from the destroyed home to the adjacent damaged home included in this survey was also approximately 16 feet (Figure 11). Damage to this home occurred on two sides: the side facing the adjacent destroyed home at 2551 Hot Springs Court and the opposite side, facing the non-damaged home (green dot within red circle in Figure 10). Damage to the side facing the destroyed home was relatively minor – one window in the window-well was damaged. Damage to the opposite (garage) side was more extensive, and was caused by the ember ignition of a fire wood pile immediately adjacent to the wood siding. The wood siding was ignited by the flames from the burning fire wood pile and the fire ultimately entered the garage (Figure 12). Firefighter intervention was reported at this home, and there is clear evidence that intervention occurred with wood from fire wood pile being kicked away from the building.

Observed Wildfire Risks and Mitigation Strategies

MITIGATION STRATEGIES

Ignition of the firewood pile by wind-blown embers points to the importance of creating and maintaining a noncombustible zone, or at minimum a low combustible zone, within five feet of a home or building. Firewood piles, lumber and other combustible materials, bark and rubber ground mulch products, and woody vegetation should not be stored, planted or used in this area. The goal is to create a "near-home" zone that minimizes the opportunity for a direct flame contact exposure to the side of the house or to the underside of the deck.

The relatively minor damage to the side of the home shown in Figure 11 is unusual given the close between home spacing. The lack of charring or scorch on the siding and shrubs (not shown in Figure 11) indicated that the destroyed house largely burned within the interior and then collapsed before involving most of the exterior. This would imply minimal window area on the sides facing the damaged home. A portion of the unconsumed wood-framed wall was standing on the side of the destroyed home facing the damaged home. The terrain at this location was relatively flat which could also help minimize exposure to the adjacent home[6].

Damage to the remaining non-destroyed home on this court consisted of bubbling paint on window and other trim boards and a deformed vinyl window frame (Figure 13). The distance to the destroyed home was approximately 20 feet.

Figure 13: Radiant heat from the burning home, which was destroyed and was located 20 feet from this damaged home, was sufficient to cause paint on the wood trim to bubble (circled blue) and thinner components on the vinyl window frame to deform (circled red). Source: IBHS.

Area Focus: Courtney Drive

RISK: HOME-TO-HOME FIRE SPREAD

The perimeter homes located on the west side of the road (left side in the figure) shown in Figure 14 were included in the assessment. Evidence observed at the site indicated the likely wildland fire-to-home ignition occurred at 2340 Courtney Drive (Figure 14). This was likely due to the initial ignition of a detached storage shed and fire that subsequently spread to the home. Six additional homes were destroyed through home-to-home fire spread. The between-home spacing was consistently between 12 and 17 feet, which is consistent with the findings from prior post-fire field investigations, indicating the vulnerability of closely spaced homes to this type of home-to-home fire spread. All the homes were located on a moderate upslope between 10% and 20%, with the home at 2340 Courtney Drive being located at the bottom of the slope (Figure 15).

The defensible space around the destroyed homes was adequate. Observations during the site visit showed that burned and scorched vegetation and other combustibles were from radiant heat and / or fire spread out from the burning homes rather than the wildfire (Figures 16 and 17).

Figure 14: Homes on Courtney Drive that were destroyed by home-to-home spread after an initial wildfire-to-home ignition (indicated with red arrow). One home at the top of slope (red circled) suffered minor damage. The home to the east (right) of the wildfire-to-home, shown as a non-damaged green dot in this figure (blue circled), also had minor damage. Source: IBHS.

[6]Interpretation of this event includes input resulting from personal communication with Dr. Jack Cohen, USDA Forest Service, Missoula, MT.

Observed Wildfire Risks and Mitigation Strategies

Figure 15: A composite figure showing destroyed Courtney Drive homes, as viewed from upslope and down slope different perspectives. Source: IBHS.

Figure 16: Composite figure of backyards of two destroyed homes on Courtney Drive; photos taken from the home site location. Damage to vegetation and other combustible components was from burning home, not wildfire. Source: IBHS.

Figure 17: Damage to the play structure slide resulting from radiant heat exposure from the burning Courtney Drive home. Deformation of plastic components (slide and roof) was observed. Scorch or charring of wood structural support members was not observed. Source: IBHS.

Figure 18: A composite figure of two damaged homes on the west side of Courtney Dr. The up-slope home is above and the down-slope home below. The charred combustible siding in the up-slope home is not visible in this figure. The damaged components in the down-slope home are circled. Source: IBHS.

Observed Wildfire Risks and Mitigation Strategies

MITIGATION STRATEGIES

The mitigation strategies here are the same as those recommended by Maranghides and Johnsson referenced in the Majestic Drive section of this report.

The Courtney Drive homes included in this survey suffered from radiant heat damage to the siding, windows and/or the edge of the roof (Figure 18). The combustible siding on the upslope home was charred (the damaged home shown in the upper photograph in Figure 18). This home was approximately 25 feet away from the adjacent destroyed home, and was off-set from the other homes on this side of the street. Damage to the down-slope home (bottom in Figure 18) was limited to deformation of the vinyl frame in one window, similar deformation of part of a satellite dish and evidence of the flow of heated asphaltic compound in the asphalt composition roof covering; the combustible component of this Class A fire-rated roof covering. As was the case with the damaged home on Talleson Court, because the damage resulted from a radiant heat exposure, firefighter intervention did not likely occur.

WILDFIRE-TO-HOME: EMBER IGNITION

Embers, either via direct or indirect means, have been identified as the major cause of building ignitions during wildfires. It is difficult to quantify wildfire ember exposure of a component in terms of the mass or number of embers that land during a wildfire. Several examples of ember accumulation on or adjacent to materials will be discussed in this section. In most cases the accumulation of embers resulted in ignition.

RISK: EMBER ACCUMULATION AT THE BASE OF EXTERIOR WALLS

Low ground-to-siding clearance is commonly observed in construction. This condition was observed on many homes that were included in the assessment. When wood or wood-based siding is used, the building code requires a six-inch earth-to-wood clearance. This means the concrete foundation must extend 6 inches above the ground before the first course of wood siding is applied. This requirement is included in the code to minimize degradation to the siding (e.g., fungal decay or subterranean termite damage). Construction assemblies where clearance is low may be vulnerable to the accumulation of embers at the base of the wall. Ember accumulation at the base of a wall in Mountain Shadows home resulted in ignition of the wall assembly. Construction details that could be vulnerable to ember accumulation were observed on a Cedar Heights home. These conditions will be discussed in the following section.

Area Focus: Lanagan Street

The exterior siding on the garage of a Lanagan Street home (the location of this street is shown in Figure 3) consisted of an exterior insulation finishing system (EIFS) assembly (Figure 19). In this case, the EIFS assembly consisted of a thin noncombustible stucco-like outer layer, an underlying foam insulation board, oriented strand board sheathing, and wood framing. There was a (metal) weep screed at the base of the wall to allow for drainage of water that gets behind the outer-most siding layer. As seen in Figure 19, combustible components in the middle and right-hand columns ignited. The apparent cause was from an accumulation of embers at the base of the EIFS wall. The bottom of the weep screed is perforated to allow for water to exit the wall assembly. These perforations also allowed for easier access of the accumulating embers at the base of the wall to the combustible components in the wall assembly (Figure 20). The combustible materials included the foam insulation, wood-based sheathing, building paper or house wrap and wood framing.

Observed Wildfire Risks and Mitigation Strategies

Figure 19: Photographs of the left, middle and right side columns of the two-car garage at a home on Lanagan Street. Note the low clearance between the concrete driveway and the EIFS system, as shown in the left-hand side column. The metal weep screed is visible at the base of the middle column. Source: IBHS.

Figure 20: The components of this EIFS system include a noncombustible stucco outer coating, and inner layers of combustible foam insulation, wood-based sheathing, and wood framing. Source: IBHS.

CEDAR HEIGHTS

While the Waldo Canyon Fire threatened the Cedar Heights community no homes were lost. This is a community of single-family detached homes that are more widely spaced than those in Mountain Shadows. The Mitigation Assessment Team found significant fuel treatment actions in Solitude Park, which is located above the neighborhood and covers approximately 300 acres, significantly assisted firefighters in their quest to save homes in this community. However, there was evidence of potentially vulnerable conditions around homes in Cedar Heights, which may not have performed as well if weather conditions had changed.

Area Focus: Outer Vista Point Road

One home on Outer Vista Point Road in the Cedar Heights neighborhood was included in the assessment survey. This home exhibited two different low clearance conditions that would make this home vulnerable to the accumulation of embers at or near the base of the wall. The front of this home is shown in Figure 21; the wall assembly at this location included a noncombustible fiber-cement shingle product and a wood-based sheathing product that was exposed at the bottom of the wall. Bark mulch was used at this location. The vulnerability of this location is exacerbated as a result of the bark mulch which can be ignited by

Observed Wildfire Risks and Mitigation Strategies

embers during a wildfire. If the mulch ignited, the resulting fire could spread to the exterior wall. This assembly shows one way that the protection offered by a noncombustible cladding product can be by-passed, since the underside of the wall assembly (and the wood-based sheathing) would be exposed to a direct flame contact exposure. If the sheathing ignites, the fire could spread into the wall cavity and then into the living space of the home. Flame height would depend on the type and depth of the mulch product, but given this condition, earth-to-siding clearing would have to be greater than that needed to avoid damage if accumulation were occurring on a noncombustible surface, such as the driveway at the Lanagan Street home.

Figure 21: The siding on this home was a noncombustible fiber-cement shingle product (upper photo). The assembly at the base of the wall, showing combustible wood-based sheathing, is shown in the lower photo. Source: IBHS.

A noncombustible rock mulch product was used on the back side of this home (Figure 22), along with a fiber-cement shingle product. As was the case of the Lanagan Street home, the ground-to-siding clearance for this home was minimal and accumulation of embers at the base of the wall could result in the ignition of the underlying wood-based sheathing. In this case, the foam insulation was not included in the assembly.

MITIGATION STRATEGIES

In each of the construction conditions discussed in this section, increasing the ground-to-siding clearance would result in a less vulnerable assembly. Mitigation strategies for the Lanagan Street home would include increasing the height of the concrete foundation to increase the distance between the driveway and the beginning of the EIFS cladding system. Use of a six-inch driveway-to-EIFS clearance would correspond to the already code-required earth-to-wood clearance for wood-based siding products. A six-inch clearance may or may not be the optimal separation to avoid ember accumulation-related damage via smoldering and / or flaming combustion, but based on these observations, it would be the preferred option to the observed much lower earth-(or ground)-to-siding clearances.

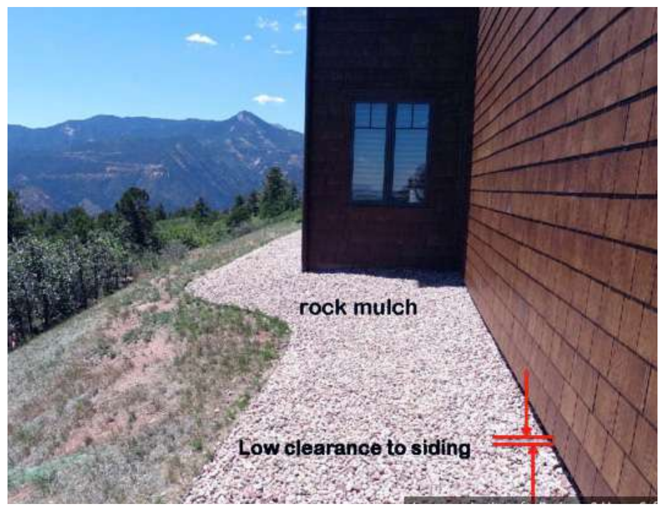

Figure 22: The back side of the home on Outer Vista Point Road. Noncombustible rock mulch and fiber-cement shingle siding products were used. The low clearance may allow for the underlying wood-based sheathing product to be vulnerable to ember accumulation at the base of the wall. Source: IBHS.

For the condition at the front of the Outback Vista Point Road home, where combustible mulch was used near the home, the best option would be to use noncombustible siding and noncombustible mulch products to reduce the vulnerability of the home to a wind-blown ember exposure.

Detailing using noncombustible materials, such as an a concrete foundation wall, should generally be used at the intersection between horizontal and vertical surfaces where one or both of the materials are combustible or where the assembly incorporates an exposed combustible component, would reduce the vulnerability of these

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assemblies. In some situations, such as a deck to wall intersection, metal flashing could be used. The metal flashing detail could be more easily incorporated into a mitigation strategy for an existing home.

These findings are in agreement with those of Barrow. In his report about the 1944 Beaumaris Fire (Australia), Barrow stated his observations "… showed that the resistance to fire is determined more by the details of construction than by the materials used in the walls."[7] Hardening the building using appropriate details can be as important as hardening with materials alone (e.g., using noncombustible materials) since poor detailing can result in a given wildfire exposure by-passing the protection offered by the exterior material.

RISK: ROOF VULNERABILITY TO EMBERS

A similar vulnerability can also occur on complex roofs, as shown in Figure 23. This detail was observed on a home in the Majestic Drive area, but is common on complex roof systems. The code required clearance between the roof and wood and wood-based siding is two-inches (less than that required for earth-to-wood siding). Ember ignition of vegetation debris in gutters and on the roof at roof-to-wall intersections has been demonstrated[8] as has the ignition of wood decking, without an accumulation of vegetative debris[9].

Figure 23: The roof-to-siding return on this complex roof consists of a composite wood (hardboard) siding product and a Class A fire-rated asphalt composition shingle roof covering. Even without vegetative debris at the roof-to-wall intersection, an accumulation of embers could result in ignition of the wood-based siding. Source: IBHS.

MITIGATION STRATEGIES

As mentioned with the EIFS cladding system, detailing using noncombustible materials, such as metal flashing, at the intersection between horizontal and vertical surfaces, where one or both of the materials are combustible or where the assembly incorporates an exposed combustible component, would reduce the vulnerability of these assemblies. The metal flashing detail could be more easily incorporated into a mitigation strategy for an existing home. If using a flashing detail, to avoid moisture-related degradation, the upper portion of the flashing should be tucked in behind (or into) the siding in such a way that rain water cannot get into the space between the flashing and the siding.

Area Focus: Rossmere Street and Champagne Drive

The vulnerability of (non fire-retardant treated) wood shake roofs has been documented. Removal of wood shake roofs and replacement with Class A fire-rated roof coverings has been a strong recommendation by the fire service and others involved in homeowner educational programs for a number of years. The roof represents a large relatively horizontal surface that can and will collect embers. Highly combustible roof coverings, such as wood-shake coverings, can be easily ignited. In many locations, including Colorado Springs, use of wood shake roofs in wildfire-prone areas is not allowed when a roof covering is replaced. Although many homeowners in the Colorado Springs have replaced their wood shake roofs in recent years, many homes still have this type of roof covering.

Figure 24: Location of the Rossmere Street and Champagne Drive homes (circled red) within the Mountain Shadows community. Source: IBHS.

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[7]Barrow, G.J. 1945. A Survey of Houses Affected in the Beaumaris Fire, January 14, 1944. Journal of the Council for Scientific and Industrial Research. 18
[8]Quarles, Stephen L (2012). Vulnerabilities of Buildings to Wildfire Exposure. http://www.extension.org/pages/63495/vulnerabilities-of-buildings-to-wildfire-exposures.
[9]Manzello, Samuel L. and Sayaka Suzuki. 2012. Exposing Wood Decking Assemblies to Continuous Wind-Driven Firebrand Showers. NIST Technical Note 1778. National Institute of Standards and Technology, Gaithersburg, MD. 20 pp.

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RISK: WOOD SHAKE ROOF

Two homes in the Mountain Shadows neighborhood, both located well-away from the perimeter of the community (Figure 24), had wood shake roofs that were ignited by wind-blown embers (Figure 25). The actions of firefighters saved each home, supporting findings from many other post-fire surveys and investigations of the benefit of intervention / suppression efforts in saving homes that have ignited. Fires in homes that are destroyed start out as relatively small fires and can be extinguished if discovered early. The Rossmere Street photo in Figure 25 shows three neighboring homes, with the middle one having the wood shake roof. The two adjacent homes have a Class A fire rated roof covering. These homes were not damaged. Given the proximity of the homes to each other, the ember exposure to each was likely similar, demonstrating the importance of replacing a wood shake roof covering.

Figure 25: Homes on Rossmere Street (upper) and Champagne Drive (lower), each had wood shake roof coverings that were ignited by wind-blown embers. Source: IBHS.

Figure 26: Combustible materials were present in the near-home zone of the Rossmere Street home. Embers are evident in the right-hand middle photo (embers circled in red). Source: IBHS.

Each of the two homes with wood shake roof coverings also had relatively poor defensible space in the near-home, 0-5 foot zone (Figures 26 and 27), and an ember exposure to near-home combustible materials was evident. The front of the Rossmere Street home had a design feature that,

Observed Wildfire Risks and Mitigation Strategies

coupled with the wood mulch on the ground, resulted in a vulnerability to the home (Figure 28). This condition is very similar to the previously discussed earth-to-wood condition observed at other homes in Mountain Shadows and Cedar Heights. Although an ember exposure occurred in this area at the front of the home, ignition of mulch was not evident. Although any of these could have resulted in ignition of the home indirectly, given a large enough ember exposure, the wood shake roof was the most vulnerable feature on these homes.

Figure 27: Combustible materials were present in the near-home zone of the Champagne Drive home. Source: IBHS.

Figure 28: The "bump out" design feature at the front of the Rossmere Street home would be been vulnerable, if the wood mulch had been ignited by the observed ember exposure. Given the low earth-to-wood clearance, flame spread to the bump out would have provided a flame contact exposure to the combustible underside feature. Source: IBHS.

MITIGATION STRATEGIES

Wood shake roofs should be replaced with Class A fire-rated roof coverings. Adequate defensible space in the three zones: 0-5 feet (the noncombustible zone), 5 feet- 30 feet and 30 feet-100 feet or to the property line, should be created and maintained along, with regular roof maintenance to keep gutters clear and the roof free of debris, particularly at intersections where debris can easily accumulate.

SUMMARY AND CONCLUSIONS

The Waldo Canyon Fire represented the first opportunity for the partners in the Fire Adapted Communities Coalition to study a community post-wildfire. The FAC Mitigation Assessment Team found that Colorado Springs' post-fire mitigation work closely mirrors recommendations of the Fire Adapted Community strategy in most aspects (see chart below).

The mitigation work conducted in the high risk areas of the community was credited with helping the fire department achieve an 82 percent save rate. According to estimates provided by the Colorado Springs Mitigation Section and FEMA, the cost benefit ratio for the mitigation efforts for the Cedar Heights neighborhood was 1/257; $300,000 was spent on mitigation work and $77,248,301 in losses were avoided. Combined cost benefit ratio was 1/ 517 for the three neighborhoods with the highest impacts. However, it should be noted that changes in fire weather behavior such as wind shifts could have resulted in significantly higher fire losses.

This field survey has confirmed findings of other post-fire surveys in terms of the basic mechanisms whereby buildings can ignite, particularly by exposure to wind-blown embers. Construction details were identified that can make buildings vulnerably to wildfire and solutions to mitigate these vulnerable features were offered. This survey confirmed that effective pre-fire mitigation efforts must be conducted at both the individual and community levels in order to create fire-adapted and fire-safe neighborhoods in wildfire-prone areas. Wildfires will continue to occur and homes and communities in wildfire prone areas must be prepared to resist the associated wildfire exposures.

By addressing the vulnerabilities identified in this report, coupled with mitigation strategies outlined, residents with existing properties can significantly reduce their risk of wildfire-related property losses. However, regular maintenance of properties located in wildland areas is also a

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critical component of this process. By incorporating mitigation strategies when rebuilding or repairing properties post-fire, communities will take an important step toward becoming more fire-adapted.

Major Findings of FAC Mitigation Assessment Team

BUILDING DESIGN AND MATERIALS IMPROVEMENTS AND MAINTENANCE COULD HAVE REDUCED LOSSES

- Ember ignition via ignition of combustible materials on, in or near the home was confirmed by the surveys. This reaffirms the serious risk posed by ember ignitions to properties during wildfires. This reinforces the importance of maintaining an effective defensible space and regularly removing debris from areas on and near the home.
- Home-to-home fire spread was again a major issue, as with prior post-fire field investigations. When it occurred, it was dependent on at least one wildland fire-to-home ignition and then home spacing and slope / terrain. Home-to-home fire spread was attributed to a relatively large number of home losses in this survey.
- Wildland fire-to-home ignition was influenced by location of home on slope and fuels treatment(s) or lack of on the slope leading to the home.
- A building can be hardened with noncombustible materials, for example, but it is also necessary to incorporate appropriate construction details, which will help ensure that the protections offered by those materials is not by-passed.
- Individual homeowners must take responsibility for fortifying their property against wildfire damage by taking appropriate measures to incorporate noncombustible building materials and construction details.

A COMMUNITY-WIDE APPROACH IS BEST

- Community leaders must recognize the value of community-wide collaboration, an essential component to home survival and creation of fire adapted communities.
- While creating ember resistance, defensible space, and ignition-resistant construction are key wildfire mitigation features,

FAC Elements Compared to Colorado Springs Mitigation	Yes	No	N/A
Engaged, active community	X		
Firewise defensible space, hardened structures	X		
Codes and Ordinances	X		
Wildfire Prevention, Fire Danger Monitoring	X		
Fuels Treatments	X		
Evacuation Routes	X		
CWPP	X		
Co-op Agreements			X
Local Capacity			X

Observed Wildfire Risks and Mitigation Strategies

equally important are mitigation efforts conducted neighborhood-by-neighborhood and community-by-community.

- A small dedicated/motivated organization or group can have a big impact.
- Homes located closer than 15 feet apart can be vulnerable if a neighboring home has not been well prepared and ignites.
- The community tax base is significantly impacted by the widespread damage and destruction of homes and businesses during wildfires. This has economic consequences for all residents.

FUELS REDUCTION IS IMPORTANT

- Hazardous fuels reduction should continue both around neighborhoods and in more remote areas containing flammable vegetation. Treatments should have explicit, specific objectives.
- While the Waldo Canyon Fire caused widespread damage, it also left behind a healthier landscape by reducing the amount of fuel for future fires. The FAC site visit underscored the importance of prescribed fire as a fuels reduction tool.

PARTNERS IN PREPAREDNESS CAN EQUAL SUCCESS

- The preparedness message is most effective when carried by a variety of partners. Public policymakers, officials and local community and business leaders should echo best practices provided by the Fire Adapted Communities Coalition to reinforce the need for wildfire mitigation efforts at every level.
- Partnerships are critical in building support and extending the area of influence for wildfire preparedness efforts.
- The Colorado Springs Mitigation Section integrated a variety of methods that mirrored, to a large extent, the Fire Adapted Communities effort and were able to accomplish significant mitigation, even with a relatively small staff and budget. This was the result of collaborative efforts with important partners.
- There is a need to create WUI messages that work for different neighborhoods, different audiences, and different contexts. This is particularly true for rural and urban communities. People may not identify with their risk if they don't see their neighborhood as being in the traditional WUI.
- Contractors and design professional, along with code/ordinance development bodies, have an important role to play in wildfire preparedness. By incorporating best practices to reduce wildfire vulnerabilities into building design and construction techniques and ordinances the risks to properties can be reduced.

APPENDIX A: THE HISTORY OF THE COLORADO SPRINGS WILDFIRE MITIGATION SECTION

1993: City ordinance passed regarding vegetation management, roadway width and sprinkler installation that applied to development after April 1993.

1994: Chief Manuel Navarro was hired and immediately acknowledged the need for a wildfire mitigation program, based on prior experience in California.

1999: A Tri-Data Study identified need to address wildfire risk in the community.

2000: Office of the Fire Marshal created a wildland risk manager position and began meetings with stakeholders toward formation of a Core Advisory Group. Risk model analysis began. Risk assessments conducted on 44,000 properties.

2001: Wildfire Mitigation Plan completed, including partnering with Colorado Springs Utilities.

- First grants received through USDA Forest Service and U. S. Fire Administration Assistance to Firefighters.
- Senior GIS analyst hired.
- Voters approved Public Safety Sales Tax to fund Wildland Risk Management Program.
- First wildfire risk materials created.
- Colorado Springs Firewise Program Coordinator hired to serve as liaison between homeowners and fire department.
- "Sharing the Responsibility" tagline created and public awareness education and outreach launched.
- Mandatory evacuation ordinance presented to the city council.

2002: Launch of interactive Colorado Springs Firewise website. Free onsite mitigation consultations for homeowners by mitigation specialists begin. Research begins on development of a cedar shake roofing ordinance. Class "A" Roofing Ordinance passed.

2003: Class "A" Roofing Ordinance takes effect on Jan. 1.

- Vegetation Management Coordinator hired. Neighborhood Stewardship Agreements begin.
- Collaboration with City Parks and Open Spaces begins.
- Mayor proclaims an annual Firewise Week.
- Outreach to Peak-to-Prairie Landscaping Symposium, Home Builders Association Home and Garden Show, Insurance Company Outreach with State Farm and California Casualty.
- Mitigation media campaign launched. First homeowners' association mitigation project completed with help of Eagle Scouts.

2004: Curbside Chipper Program begins. Neighborhood demonstration sites created. Third in a series of Colorado Springs Firewise videos produced for city's cable access channel.

2005: FEMA Pre-disaster Mitigation Grant received. First Colorado Springs Firewise Newsletter mailed to homeowners. 20 Firewise Champions from 14 neighborhoods recognized during Wildfire Awareness Week.

2006: FEMA Pre-disaster Mitigation Grant received by 28 new Firewise Champions. First Annual Patrick Niedringhaus Memorial Award presented to a homeowner; recipient embodies Niedringhaus' spirit, energy, and enthusiasm for preserving community and its natural beauty. Niedringhaus, who was killed in an avalanche in 2005, was the first Eagle Scout to complete a mitigation project with the Wildfire Mitigation Office.

2007: FEMA Pre-disaster Mitigation Grant received.

2008: 65 more Firewise Champions recognized. Eight Colorado Springs neighborhoods become NFPA Firewise Recognized Communities.

2009: FEMA Pre-disaster Mitigation grant received. Fuels crew established.

2010: Colorado re-brands Firewise for local application.

2011: Two new NFPA Firewise Communities recognized.

2012: Waldo Canyon Fire strikes destroying more than 300 homes and killing two people; 82 percent of impacted homes are saved due to response and previous mitigation work.

APPENDIX B: DAMAGE ASSESSMENT FORM

Colorado Springs - Waldo Canyon Fire - Damage Assessment Form

Day - (circle one)   Wednesday 7/18/2012   Thursday 7/19/2012   Friday 7/20/2012   Time: ___________

GPS Location:
____
____

Photograph Number(s): ____________________

Site Information -

____________ Street Number   ____________________ Street Name   __________ Unit No. (if applicable)

Parcel and Residence Information -

Reason for inadequate D-space:

Type of Parcel: Single Family □ Townhouse □ Apartment □

Slope: Low (Flat-10%) □ Moderate (11-30%) □ Steep (>30%) □

Extent of Damage: None □ Minor □ Destroyed □

Type of Ignition: Ember/0-5 □ Vegetation Ember/5-30 □ Ember/Building □ Wildfire □
Radiant Heat / Flames from Neighbor □

Topography / Location: Flat □ Bottom – Lower 1/3 □ 1/3 – top of slope □

Adequate Defensible Space: 0-5 ft. (including fencing) □ 5-30 ft. □ 30-100 ft. □

Proximity to Neighbor / Secondary Building(s): Front ___ Left ___ Back ___ Right ___
(*Relative to Front*)
D-space Comments:

Roof-type: Flat □ Sloped □ [Steep (>5:12) yes □ no □] Simple □ Complex □ Not Known □
Skylights: No □ [Yes □ Glass □ Plastic □]

Roof Material: Asphalt Comp □ Metal □ Tile-Flat □ Tile-Barrel □ Wood Shake □ Other / Unknown □
Bird Stop evident: yes □ no □ n/a □

Vents: Eave □ Gable End □ Through-roof □ [Ridge □ High Wind? yes □ no □ Not Known □]

Gutter: Vinyl □ Metal □
[Evidence of cover: yes□ no□] [Evidence of drip edge: yes□ no□]

Eave Type: Open □ Soffited □ Not Known □ Material: ________________

Deck: Solid Surface □ Combustible (Wood / W-P Composite) □
Enclosed: Horizontal □ Vertical □ n/a - Not Known □

Window Frame: Vinyl □ Other □ Glass: Single Pane □ Multi-pane □ Tempered □
Window Screen: Yes □ No □

Foundation: Slab on Grade □ [Raised Floor □ Vented? yes □ no □] Basement □
Earth-to-Siding: <6 inches □ > 6 inches □

Siding: Solid Wood □ Heavy Timber / Log □ Shingles □ Composite (HB/OSB) □ Vinyl □ Noncombustible □

APPENDIX B

APPENDIX C: OBSERVATIONS ON THE ROLE OF FUELS MANAGMENT AND LANDSCAPE VEGETATION AND FEATURES

WALDO CANYON: FUEL TREATMENT EFFECTIVENESS AND FIREWISE LANDSCAPING

Cedar Heights

Past fuel treatments, by mastication, in heavy, continuous, mature Gambel oak retained multi-season effectiveness for reducing wildfire spread. Two and three year old oak treatments did not carry fire. Oak leaves were scorched, but did not typically burn (Figure C1). Arboricultural explanation: Re-sprouted oak is connected to a well-developed root system necessary to support mature oak. Even during drought conditions, a large root system was supporting a much smaller, above-ground biomass. In effect, it retained characteristics of a Firewise plant.

Figure C1: Crown Fire (left), treated Gambel oak (right). Source: NFPA.

Mountain Shadows

Hardened landscape barriers such as noncombustible retaining walls, paths, and gravel borders were effective in stopping fire in lighter fuel types. Landscape ignitions, when isolated by gravel borders and other hardscaping features, did not spread to adjacent areas (Figure C2). These hardened areas were observed to be effective in preventing fire spread caused by ember ignitions of native fuels in adjacent open spaces.

Figure C2: Ember ignition in landscaping contained by rock border. Source: NFPA.

Pruning and thinning of ladder fuels in Gambel oak clumps as a Firewise practice by homeowners appeared to be effective in keeping fire on the ground, and reducing crown fire potential (Figure C3). Fire burned underneath the treated clumps and scorched the leaves, but generally did not crown (Figure C4). There are two explanations for this: 1) ladder fuels contribute significantly to the fuel loading, and crown fire potential of Gambel oak as a native fuel; and 2) cleaned out and thinned native oak clumps more closely meet the criteria for Firewise landscape plants: lean, clean and green.

Figure C3: Ember ignition and under-burn below treated Gambel oak. Source: NFPA.

APPENDIX C: OBSERVATIONS ON THE ROLE OF FUELS MANAGMENT AND LANDSCAPE VEGETATION AND FEATURES

Figure C4: Ember ignition with treated ladder fuels in oak and pines. Source: NFPA.

Figure C6: Torched Austrian pine in front of scorched deciduous shrubs below window. Source: NFPA.

Firewise landscape plants, primarily deciduous trees and shrubs, were scorched, but did not burn when exposed to heat from adjacent crowning fuels (Figure C5). Two examples were: crabapple trees planted in a row below a deck and retaining wall that were scorched, but did not carry fire to the deck and shrub plantings adjacent to structures that were scorched, but did not ignite even from crowning fuels that were located within 15-18 feet (Figure C6).

Figure C5: Scorched deciduous trees in foundation planting below deck. Source: NFPA.

Landscaping fencing contributed to fire spread from adjacent native areas to structures (Figure C7). Split rail and cedar privacy fencing both led fire to structures. In many instances, home loss was prevented by intervention of the fire services when resources were available to remove the fence connection to the structure. This observation re-enforces the message that ,"If it's connected to the house, it's part of the house."

Figure C7: A partially burned cedar privacy fence. Source: NFPA.

APPENDIX C: OBSERVATIONS ON THE ROLE OF FUELS MANAGMENT AND LANDSCAPE VEGETATION AND FEATURES

Summary of Firewise Landscape Observations

- Past fuel treatments by mastication in heavy, continuous, mature Gambel oak retained multi-season effectiveness for reducing wildfire spread. Two- and three-year-old oak treatments did not carry fire. Oak leaves were scorched, but did not typically burn.
- Hardened landscape barriers such as noncombustible retaining walls, paths and gravel borders were effective in stopping fire in lighter fuel types.
- Pruning and thinning of ladder fuels in Gambel oak clumps, as a Firewise practice by homeowners, appeared to be effective in keeping fire on the ground and reducing crown fire potential.
- Firewise landscape plants, primarily deciduous trees and shrubs, were scorched but did not burn when exposed to heat from adjacent crowning fuels.
- Landscaping fencing contributed to fire spread from adjacent native areas to structures. Split rail and cedar privacy fencing both led fire to structures.

APPENDIX D: CASE STUDIES

Case Studies

Information about the inspection of two undamaged homes in the Cedar Heights neighborhood and one undamaged home in Mountain Shadows neighborhood is provided here. The fire came close to the Cedar Heights neighborhood (Figure D1), but did not reach it. The Outer Vista Point Road home in this neighborhood would be considered a perimeter home and the Manor Rock Lane home was an interior home. The Darien Way home in the Mountain Shadows neighborhood was an interior home.

Figure D1: The fire came within about 500 feet of the neighborhood at the Outer Vista Point Road perimeter. Source: IBHS.

Outer Vista Point Road

The Outer Vista Point Road perimeter was directly across the street from the home that was inspected (Figure D2). The defensible space around the home is shown in Figures D3 – D6, with one figure showing the general condition on each side of the house. Defensible space was generally good, particularly on the two sides (left and rear) that used rock in the near-home zone. Bark mulch was used in the near-home zone in the front and right sides of the house. Bark mulch has been shown to be ignited by embers and therefore on these exposures any ember-ignited mulch would result in a flaming exposure to the side of the house. The fiber cement shingle siding is a noncombustible product, but the construction detailing of the wall-assembly exposes the wood-sheathing product (Figure D4 and 19). Given a direct flame contact exposure to the wall system, the sheathing would become the vulnerable component. This provides an example of a situation where the non-combustible "near-home" zone is critical even in situations where a noncombustible exterior siding product is used. This detail could also be vulnerable to an ember ignition of a sufficient quantity of dried debris on rock mulch (Figure D5).

Figure D2: The Outer Vista Point Road, located at the top of the Cedar Heights community. Source: IBHS.

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APPENDIX D: CASE STUDIES

Figure D3: These photographs depict the vegetation management (defensible space) in the area at the front of the house. The upper photograph is representative of the 5-to-30 foot zone and the lower photograph is representative of the 0-to-5 foot (near home) zone. Source: IBHS.

Figure D4: The upper left photograph depicts the vegetation management (defensible space) in the 0-to-5 foot zone on the left side of the house. The lower right photograph is a bottom-view of the wall construction consisting of oriented strand board sheathing under the fiber cement shingle siding product. Source: IBHS.

Figure D5: The upper left photograph depicts the vegetation management (defensible space) at the rear of the house. The lower right photograph shows an accumulation of dried vegetative debris in the corner, on top of the rock mulch. Source: IBHS.

APPENDIX D: CASE STUDIES

Figure D6: The upper photograph depicts the vegetation management (defensible space) in the 0-to-5 foot zone on the right side of the house. The lower photograph shows low earth-to-siding clearance. Source: IBHS.

Another vulnerability observed at this home was unscreened vents into a room at the rear of the home that contained gas appliances (Figure D7). Although 1/8-inch mesh screen will not prevent embers from passing through the vent and into the home, 1/8- inch mesh screen and finer, as allowed by the building code) will reduce the size and number and is a better choice compared to non-screened vents and ¼-inch mesh screening. Finer mesh screen will be more likely to become occluded with air-borne debris and so will require more maintenance to keep the screen clear so it can perform its moisture management function and also to supply make-up air for combustible appliances.

Although it is more commonly understood about the need to plug ("bird-stop") the ends of certain styles of roof coverings (e.g., clay-barrel tile and certain metal roof coverings), openings along the ridge and hip must also be plugged with a noncombustible material. As shown in Figure D8, this home had a flat tile roof. An opening at the end of the roof is not as likely with this style, but openings still occur at the hip and ridge.

Figure D7: These photographs show venting for the make-up air to a room containing gas appliances. Metal screening was missing from these vents, as seen in the lower photograph. Source: IBHS.

APPENDIX D: CASE STUDIES

Monitor Rock Lane

The other home that was inspected in the Cedar Heights neighborhood was located on Monitor Rock Lane (Figure D9). The defensible space for this home is shown in Figures D10–D15. As seen in these figures, the defensible space, particularly in the 0-5 foot "near-home" zone is inconsistent. The right and left sides of the home have good defensible space, with rock mulch in the near-home zone (Figures D12 and D15). Defensible space at the front (Figures D10 and D11) and some of the rear of the home (Figure D13 and D14) is poor.

Figure D8: Un-stopped/unblocked openings at the hips of the flat-tile roof. Source: IBHS.

Ignition of near-home vegetation increases the chance for flame contact exposure to the exterior wall (siding, windows and other components) and the under-eave area, including any under-eave vents. A noncombustible stucco-type cladding was used on this home, but in this case, the windows and under-eave areas would still be vulnerable. The same detail whereby the wood-based sheathing is exposed at the bottom of the wall was used on this home, making a nominally noncombustible wall vulnerable because of a combustible component in the wall assembly (Figure D14). This detail was also observed on the Outer Vista Point home (Figure D4). Note the open window in Figure D10. Although a wildfire was not threatening this home on the day of the site-visit, residents should remember that windows should be closed when a wildfire is threatening. In order for the defensible space of a home to be effective, it must be consistently implemented and maintained.

Figure D9: The Monitor Rock Lane home located in the Cedar Heights neighborhood. Source: IBHS.

APPENDIX D: CASE STUDIES

Figure D10: Near-home vegetation was prevalent at the front of this home. Note the open window in the lower photograph. Source: IBHS.

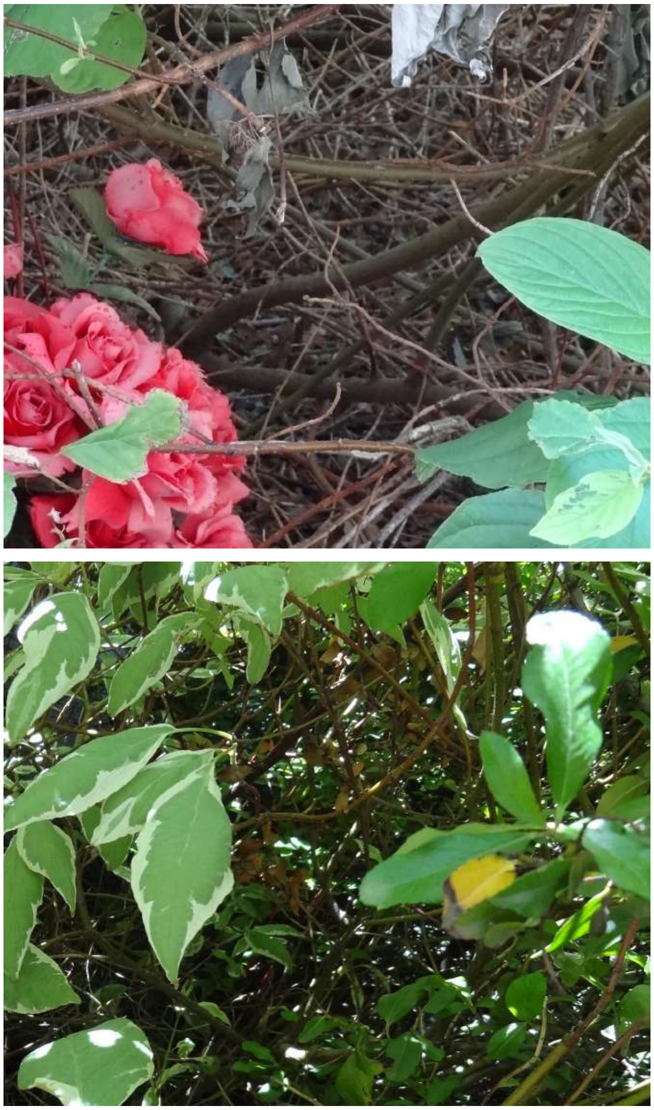

Figure D11: Near-home vegetation located at the front of the home. Note the fine fuels on the ground and in the vegetation. This fine fuel would facilitate ignition by wind-blown embers. Source: IBHS.

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Figure D12: The left side of the house had good defensible space, particularly in the 0-to-5 foot near-home zone. Source: IBHS.

Figure D13: The defensible space at the rear of the home was very good on one side on one side (top photograph). The near home zone was poor on the other corner (bottom photograph). Source: IBHS.

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Figure D14: Bark mulch was used in areas at the rear of the home, under one of the decks. Note that the wood-based sheathing product is exposed (lower photograph). Source: IBHS

Figure D15: The defensible space in the near-home zone on the right side of the home was good. Source: IBHS.

The eave design incorporated a vented soffited eave (Figure D16). Soffited eaves have been shown to be a good detail, both in resisting ember entry into vents and being better able to resist flame contact exposures. At least some vents in the soffited eave did not have screens (Figure D16), making the vent more susceptible to ember entry. Regardless of the presence or absence of mesh, given the near-home vegetation at the front of the house, these under-eave vents could be vulnerable to flame contact exposure if the vegetation ignited.

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Figure D16: A soffited eave was used on this home. Some of the under-eave vents did not have mesh screening. Source: IBHS.

This house had a clay-barrel style roof covering. The ends of the roof covering at this house were not plugged, i.e. "bird-stopped." Debris was observed at one roof-edge location (Figure D17). Wind-blown embers could ignite this roof-edge debris, and potentially other debris that have blown under the roof. When a roof such as this one is not "bird-stopped," wind-blown embers can easily by-pass the protection offered by this Class A fire-rated (and in this case, also noncombustible) roof covering. Bird-stop materials are available from the manufacturer. The homeowner can also plug the openings with a mortar mix. The tiles at the hip are also open; these openings should also be plugged.

Figure D17: The ends of the barrel-tile roof covering on this home were not "bird-stopped." Note the debris in the under-roof area at the end of the roof (lower photograph). Source: IBHS.

Most decks are built using combustible materials for both the structural support system and the walking surfaces. Combustible materials used for the structural support system are typically wood joists (2 x lumber) and larger dimension posts and beams (i.e. 4 x material and larger). Combustible materials used for walking surfaces include wood, plastic and wood-plastic composite decking materials. One deck on this home incorporated a noncombustible (flagstone) walking surface and the typical wood-based structural support system (Figures D18 and D19). The solid surface, noncombustible walking surface option is considered a better choice for homes in wildfire-prone areas,

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although this option is more expensive. Given the typical combustible structural support system with these decks, unless the underside is enclosed with a noncombustible material, the advantage applies most directly to an ember exposure to the top of the deck, and would assume a noncombustible material at the deck-to-wall intersection, where embers might accumulate.

As seen in Figure D19, a between flagstone joint failed, allowing water to enter behind the surfacing material. Water entry occurred long enough for fungal decay to occur in the underlying wood and wood-based structural support system (Figure D19, lower photograph). If dry, this material would be more easily ignited. Vegetation was observed growing under the deck (Figure D18, lower photograph) – ignition of this vegetation by embers or other adjacent burning vegetation would result in a flame contact exposure to the underside of this deck. A flaming exposure to any part of the home should be avoided. In this case, the damaged deck should be repaired, and the under-deck and adjacent vegetation removed.

Figure D18: These photographs show the solid surface deck (upper) and the near-home vegetation under and near the deck (lower). The lower photograph was taken while under the deck. Source: IBHS.

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Darien Way

The undamaged Mountain Shadows home included this case study was located on Darien Way, show in Figure D20.

The defensible space for this home is shown in Figures D21 and D22. As seen in these figures, with the exception of the area in the front of the home, the defensible space, particularly in the 0-5 foot "near-home" zone is good. Rock mulch or a concrete walk was used next to the home and under the decks on the other sides of the home. Rock mulch was used at the front of the house, but if ignited, the low-to-ground vegetation, located under the drip line of the adjacent tree, could serve as ladder fuel. Removal of the ladder fuel vegetation and pruning the tree would improve the defensible space in this area.

The window well shown in Figure D22 contained accumulated debris. Burned-out embers were observed on the ground, but the number that accumulated was insufficient for ignition. Use of a rock retaining wall, as shown in this photograph, would be a better option.

Figure D19: The flagstone covering on this solid surface (noncombustible) deck had failed (upper) allowing water to get below the covering, eventually resulting in fungal decay in the horizontal wood-based sheathing (lower). Source: IBHS.

Figure D20: The Darien Way home, located in the Mountain Shadows neighborhood. Source: IBHS.

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Figure D21: Defensible space on the front and left side of the home. Source: IBHS.

Figure D22: Defensible space in the right side and rear of the home. Source: IBHS.

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The decks on this house used wood joists and beams for the structural support system and a wood-plastic composite (walking surface) product for the deck boards. The space under the deck consisted of noncombustible rock mulch. No storage of combustible materials was observed. Deck furniture was only observed on one of the decks (Figure D23). Wood and wood-plastic composite decking are both combustible materials. Ignition of these decks can be caused by a flame contact to the underside of the deck, or potentially by ignition of combustible materials on top of the deck. Ignition of wood decks by an ember exposure was recently demonstrated. This study did not evaluate the performance of wood-plastic composite and other decking products with a plastic component. The California Office of the State Fire Marshal (OSFM) standard test method (SFM 12-7A-4 and 12-7A-4A) uses two different exposures to evaluate the performance of combustible decking products. The first is an under-deck flame contact exposure and the second uses a 6 inch x 6 inch standard Class B burning brand placed on top of the deck. This brand is specified in the American Society for Testing and Materials (ASTM) Standard E108 (a standard test method used to classify the fire rating of roof coverings). Since both of these decking products are combustible, and based on performance from the OSFM standard test they can perform similarly, the same mitigation options should apply to each (e.g., no storage of combustible materials under the deck, etc.)

Home ignitions from ember entry into dryer vents were reported during the recent Washoe Drive Fire (January 2012) in the Reno, Nevada area[10]. The closure plate used on the exhaust vents on this house would reduce the chance of ember entry into these exhaust vents (Figure D24) since the plate would be in the closed position unless the dryer was operating.

Figure D23: The decks at this home used wood for the structural support system and a combustible wood-plastic composite decking (walking surface) product. Source: IBHS.

[10]"Personal Communication (2012). Mark Regan, North Lake Tahoe Fire Protection District and Ed Smith, University of Nevada Cooperative Extension."

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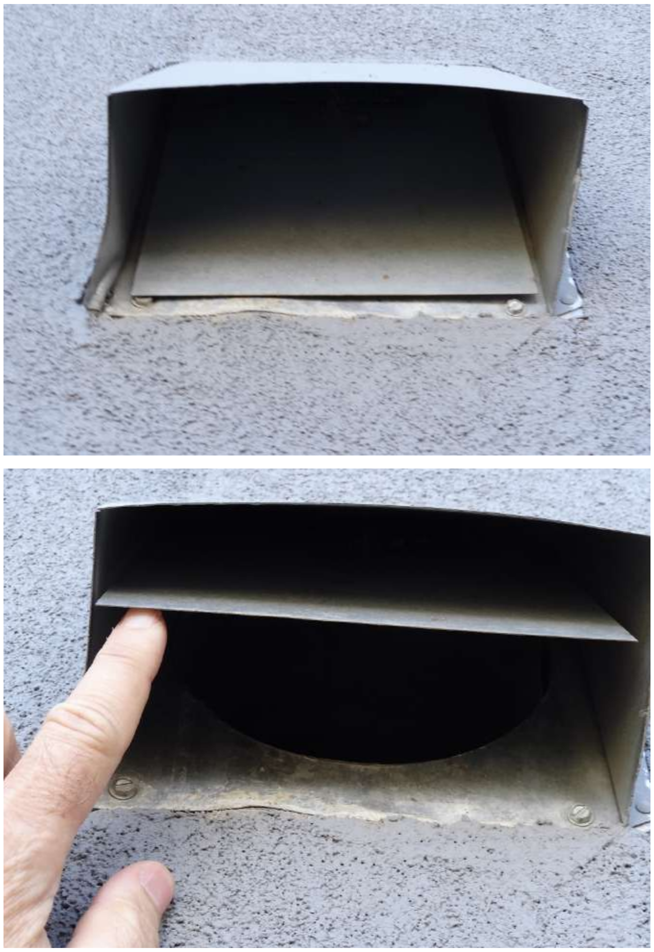

Figure D24: Dryer and other exhaust vents used vents coverings that were normally closed (upper left); when operating positive pressure in the duct would force open the closure flam to at the outlet. Source: IBHS.

Figure D25: A flat concrete tile was used for the roof covering on this house. Note the openings at the hip and edge of the roof. Source: IBHS.

This house had a flat-tile covering (Figure D25). As was the case with the Outer Vista Point Road home the hip openings were not plugged with a noncombustible materials (e.g., with a mortar mix). As a result of the installation details of this covering, openings also occurred at the end of the roof (i.e., the area above the gutter) along the ridge and hip that must also be plugged with a noncombustible material. These openings should be plugged to minimize the opportunity for embers to get under the noncombustible roof covering, potentially igniting fine fuels that have accumulated.

Lessons Learned from Waldo Canyon

FIRE ADAPTED COMMUNITIES
MITIGATION ASSESSMENT TEAM FINDINGS