5.0 MITIGATION STRATEGIES

Fire is a natural process and means for biological renewal across forest, rangeland and grassland (Wildland Fire Leadership Council 2012b). Understanding and embracing the concept that it's not *if* an area will burn but *when* and at what intensity (Andreu and Hermansen-Báez 2008) will help determine appropriate mitigation for fuel reduction.

A devastating wildfire affects every citizen in some way: loss of life and property, interruption of services, environmental damage to habitats and watersheds, and economic damage. The 2011 Bastrop County Complex Fire will forever be an example of what a catastrophic wildfire can do to a community. Many families lost a lifetime of possessions, mementos, clothing, pets, documents, and other valuables. Citizens of Bastrop and the surrounding communities have faced various levels of emotional and psychological stresses. The magnitude and far-reaching effects of this horrible disaster have overwhelmed county and city leaders, public safety officials, and the public. The significant costs of rebuilding and the overall economic recovery have been huge; taxing entities will be struggling with budget deficits for years (Ridenour et al. 2012).

The Bastrop County Complex Fire was the largest per capita loss in the nation's history, with losses estimated at $209,318,741 (Bastrop Tax Appraisal). That's approximately $2,822 per person based on the 2010 Bastrop County census of 74,171. The financial impact to the community during the prolonged recovery period has yet to be fully estimated. With more complete information on the full magnitude of wildfire impacts, Texas counties, with their limited regulatory authority, could work with the Texas Legislature in order to grant counties greater capacity to write and enforce codes that lead to reducing future losses within the WUI (Ridenour et al. 2012).

Building a fire-adapted community is complex, as illustrated in **Figure 30**. Reducing structure vulnerability happens through the direct correlation of multiple, interrelated components. When even a single piece of the puzzle is missing a structure is more vulnerable to fire damage or destruction.

Homeowners and community leaders must understand the individual and large-scale components of fire behavior, fuels, weather, and home construction, as well as the potential impacts of what can happen without preventative mitigation measures (Ridenour et al. 2012). This understanding will help leaders at all levels make decisions to ensure their communities are more fire resistant.

This section of the Austin-Travis County CWPP describes various wildfire mitigation strategies to improve and increase safety for the community and emergency responders as well as protection for properties throughout the plan area. Recommendations for their implementation are discussed in **Section 6.0.** Topics include:

- Increasing wildfire awareness through public education to engage the community in personal responsibility by creating a fire-adapted community, a fire-resilient landscape, and providing a safe, effective, and efficient firefighting environment;
- Development of local-level CWPPs to provide the framework for translating strategic principles into tactical solutions and community action;
- Detailing a Home Ignition Zone (HIZ) mitigation strategy that WUI homeowners can implement to protect life and property;
- Further detailing hazardous fuel reduction, as a companion to the HIZ discussion, because this mitigation strategy contributes significantly to minimizing wildfire impacts. This detailed section builds into **Section 6.2.7** and introduces the Wildfire Mitigation Strategies Builder (WMS Builder) found in **Section 5.6**, a tool to determine appropriate structural hardening and fuel reduction treatments for specific site conditions. And,
- Coordinating codes and regulations across all jurisdictions within the planning area to accomplish a balance between each respective entity's mission and needed wildfire mitigation.

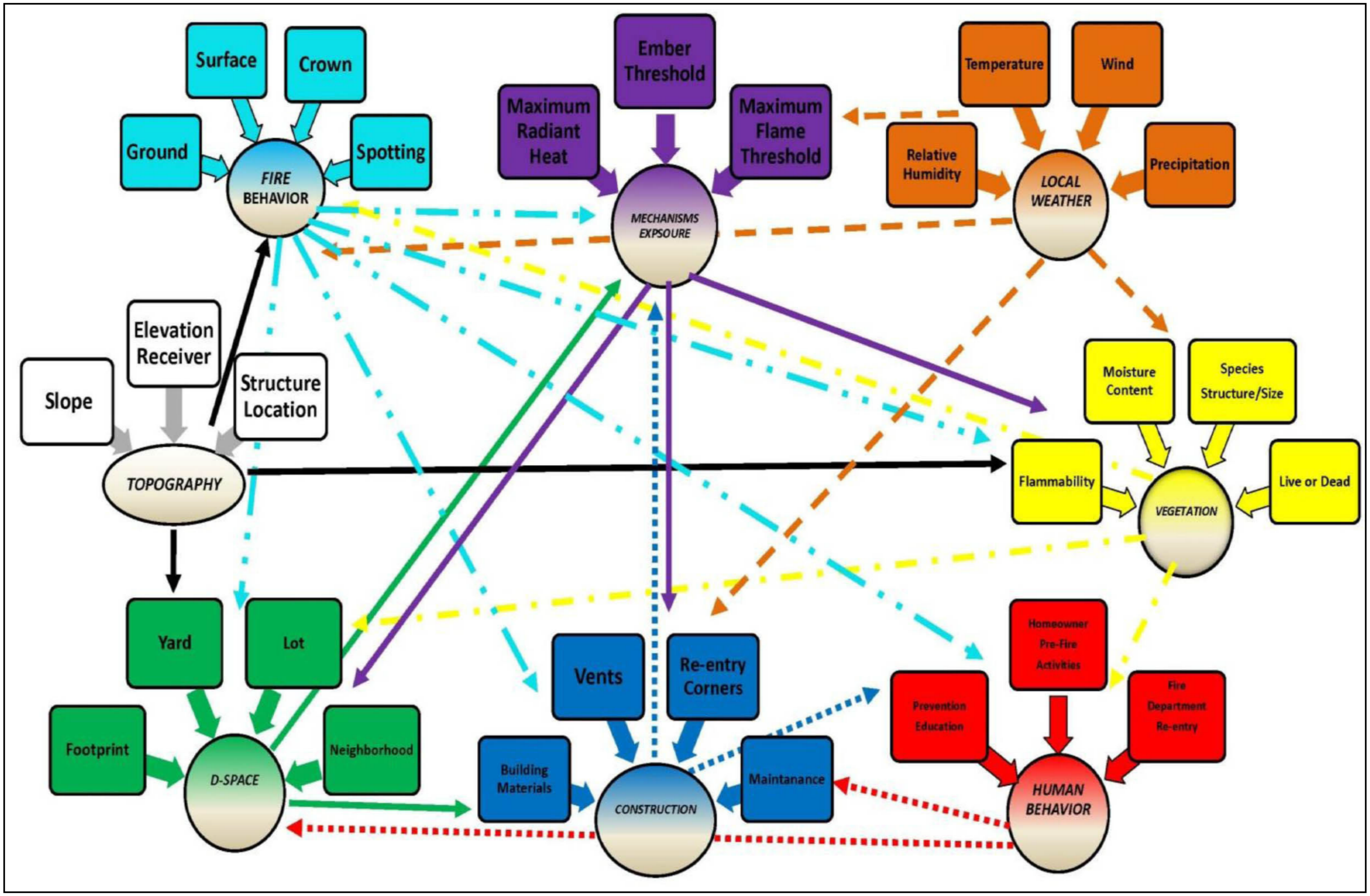


Figure 30. Home survivability can be attributed to multiple factors that cannot be separated as individual units. They must be examined equally and concurrently if we are to understand all aspects of wildfire impacts on structures relative to the type and length of exposure from a wildfire event (Ridenour et al 2012)

5.1 PUBLIC EDUCATION

Fires are becoming more severe. Property losses are increasing. Communities and natural resources are under increased threats from wildfires. All the while the WUI continues to expand across the nation and within the planning area for this CWPP.

To address these wildfire threats, policy makers, fire management professionals and other stakeholders realized that it would take a broad-based, collaborative, and cohesive response. Building on the foundations of previous national fire policy efforts, the Federal Land Assistance, Management, and Enhancement Act of 2009 (the FLAME Act) was adopted. Along with establishing separate funding sources for emergency wildfire suppression activities on certain federal lands, the act required that a cohesive strategy addressing wildland fire be developed. The Cohesive Strategy Oversight Committee, established by the Wildland Fire Leadership Council, engaged a diverse array of stakeholders throughout the nation and produced *A National Cohesive Wildland Fire Management Strategy* (the Cohesive Strategy) (USDA and DOI 2011a), to meet the requirements of the FLAME Act.

The Cohesive Strategy identifies the following vision for national wildland fire management policy in this century: “Safely and effectively extinguish fire, when needed; use fire where allowable; manage our natural resources; and as a nation, live with wildland fire.”

The Cohesive Strategy recognizes three primary factors that will present the greatest challenges and opportunities for addressing national wildland fire problems and achieving the vision:

1. Restoring and maintaining resilient landscapes – Goal: “Landscapes across all jurisdictions are resilient to fire-related disturbances in accordance with management objectives.”

2. Creating fire-adapted communities – Goal: “Human populations and infrastructure can withstand a wildfire without loss of life and property.”

3. Responding to wildfires – Goal: “All jurisdictions participate in making and implementing safe, effective, efficient risk-based wildfire management decisions.”

The success of the Cohesive Strategy depends on overcoming one of the main national challenges: engaging the public to such a degree that individuals and communities assume responsibility for creating and maintaining fire-resistant properties. Implementing wildfire mitigation strategies *before* wildfire provides the most effective protection for homes and communities. It is essential that the general public participates and takes the initiative in creating fire-adapted communities because, according to *The FLAME Act: Report to Congress* (2011b), "Inclusion, collaboration, and cooperation are absolute requirements in today's wildland fire environment."

The Cohesive Strategy relies on local and regional knowledge to develop specific regional assessments that evaluate and develop strategies to address each region's challenges and opportunities for creating a cohesive and collaborative wildfire management policy. The Southeast Regional Assessment (USDA and DOI 2011c), which encompasses 13 states including Texas, listed the following regionally specific strategic opportunities to lessen wildfire threat and impact:

- Expand outreach and education to landowners and residents, particularly those new to the region and/or with a non-traditional ownership background. The outreach and education should stress prevention, increase awareness and acceptance of wildland fire management activities across the landscape, explain smoke dynamics between wildfire and prescribed fire, and encourage WUI residents to take personal responsibility of making their home and communities more fire adapted.
- Enhance collaboration, training, and capacity building across agencies to increase firefighter safety, wildfire response, and management effectiveness.
- Continue proactive fuels mitigation through all management techniques, including prescribed burning where smoke can be effectively managed to allow for maintenance of ecosystem function and to reduce fire hazard.

To do this requires engaging and educating the general public. Implementing wildfire mitigation strategies and creating fire-resilient communities must include efforts that increase knowledge and commitment, and develop a sense of personal responsibility among private landowners, homeowners, the insurance industry, fire districts, local governments, and other key players in WUI communities (Quadrenniel Fire Review 2009).

Travis County and the City of Austin are working to minimize the effects and impacts of wildfire on their local communities by integrating the Cohesive Strategy's three primary factors into their overall missions and in community planning. This planning document is part of that effort.

In order to become a fire-adapted community, residents of Travis County and the City of Austin must be educated and supported in their role as the primary defense against wildfire. They must understand that by taking appropriate actions, they can safely co-exist with wildland fire, support effective, efficient, and safe firefighting, and protect life and property. To become a fire-adapted community, planning areas, subdivisions, and communities need to achieve or be actively pursuing (USDA and DOI 2011b):

- Implementing Firewise principles to safeguard homes and "Ready, Set, Go!" principles to prepare for fire and evacuation;
- Developing adequate local fire suppression capacity to meet community protection needs;
- Designing, constructing, retrofitting, and maintaining structures and landscaping in a manner that is resistant to ignition;
- Adopting and enforcing local codes that require fire-resistant home design and building materials;
- Raising the awareness of and creating incentives for growth planning and management that reduces, rather than increases, fire-prone development;
- Properly spacing, sequencing, and maintaining fuel treatments across the landscape;
- Developing and implementing a CWPP or equivalent;
- Establishing interagency mutual aid agreements,
- Designating internal safety zones or areas of temporary refuge.

Firewise is a national education program to help the public reduce fuel around their homes, retrofit homes with non-combustible materials, and take action around structures on their properties to reduce ignition potential and risk. Firewise principles assist in meeting the goals of the Cohesive Strategy and can be taught to, and then implemented by, a full suite of individuals in the planning area -- homeowners, homeowner associations, planning unit communities, public utility providers, landscape architects, land developers, firefighting professionals, and other emergency service personnel.

Firewise principles include the following tenets:

- A set of three conditions -- topography, weather, and fuel -- determine a home's ignition potential. Of the three conditions, individuals have the greatest influence over the fuel loads around and on a home.
- The Home Ignition Zone (HIZ) and structure construction materials determine the ignition risk of a property. Reduce fuels: leaf litter in rain gutters, low-hanging tree branches, and highly flammable vegetation. Harden a structure: replace existing construction material with non-flammable or low-flammability materials.
- Home and property owners must take primary responsibility for providing wildfire safety on their properties.
- Communities must work together towards the common goal of becoming a fire-adapted community within a fire-resilient landscape.

"Ready, Set, Go!" (RSG) is a federally funded, national program distributed by local fire departments to residents within their jurisdictions. The JWTF, AFD, and the Fire Marshal tailored the national RSG program language for the central Texas area and published a brochure in English and Spanish versions for distribution among fire departments and other appropriate agencies. The RSG principles complement the Firewise principles by assisting individuals and families to prepare for and to stay safe in the event of a wildfire.

1. "Ready" – prepare for the threat of wildland fire by creating a family disaster plan, registering for emergency notifications, communicating and rehearsing evacuation plans and routes, meeting locations, and contingency plans, and assembling emergency supply kits and other emergency equipment such as portable radios and fire extinguishers.

2. "Set" – cultivate situational awareness prior to and when wildfire occurs by being aware of imminent fire danger and by preparing to evacuate. The key to a successful evacuation is communication among family members about evacuation plans, changing circumstances, and contingency plans.

3. "Go!" - emphasizes the importance of evacuating when set and when instructed to do so in order to increase chances of survival and create a safer and more effective environment for fire fighters to suppress wildfire.

Developing situational awareness among all residents within the planning area is an important part of the public education wildfire mitigation strategy. Recently, the Capital Area Fire Chiefs Association adopted the National Fire Danger Rating System as a comprehensive means to provide the general public with fire danger information. By adopting the fire-danger rating, which provides a broad-scale assessment based on fuels, weather, topography, and risks, the general public and fire professionals can adequately plan activities and readiness levels based on wildfire potential. Fire departments within the planning area anticipate installing countywide fire danger signs to cultivate situational awareness. The Texas Weather Connection (TWC) (http://twc.tamu.edu/drought/tfdforecast) and the Texas Interagency Coordination Center (TICC) (http://ticc.tamu.edu/PredictiveServices/FuelsFireDanger.htm) provide many tools for the general public that assist in cultivating situational awareness of potential wildfires, such as the daily fire danger map in **Figure 31**.

Anyone within the planning area can adopt Firewise and RSG principles regardless if they are part of a recognized Firewise Community or part of a local CWPP. Everyone can assist in making Travis County a fire-adapted community.

A convergence of urbanization and development in the WUI; decades of fire suppression; and longer, hotter, and drier fire seasons from climate change have made ecosystems less resilient to wildfire. Fire-resilient landscapes are imperative to minimize the impact of human-caused ignitions in the WUI.

Ecosystem resiliency to catastrophic wildland fire can be mitigated by: fire prevention and conservation education programs, landowner assistance education, wildlife habitat management, appropriate fire management -- prescribed fire and hazardous fuel reduction -- and invasive species control. Landowner fire prevention and

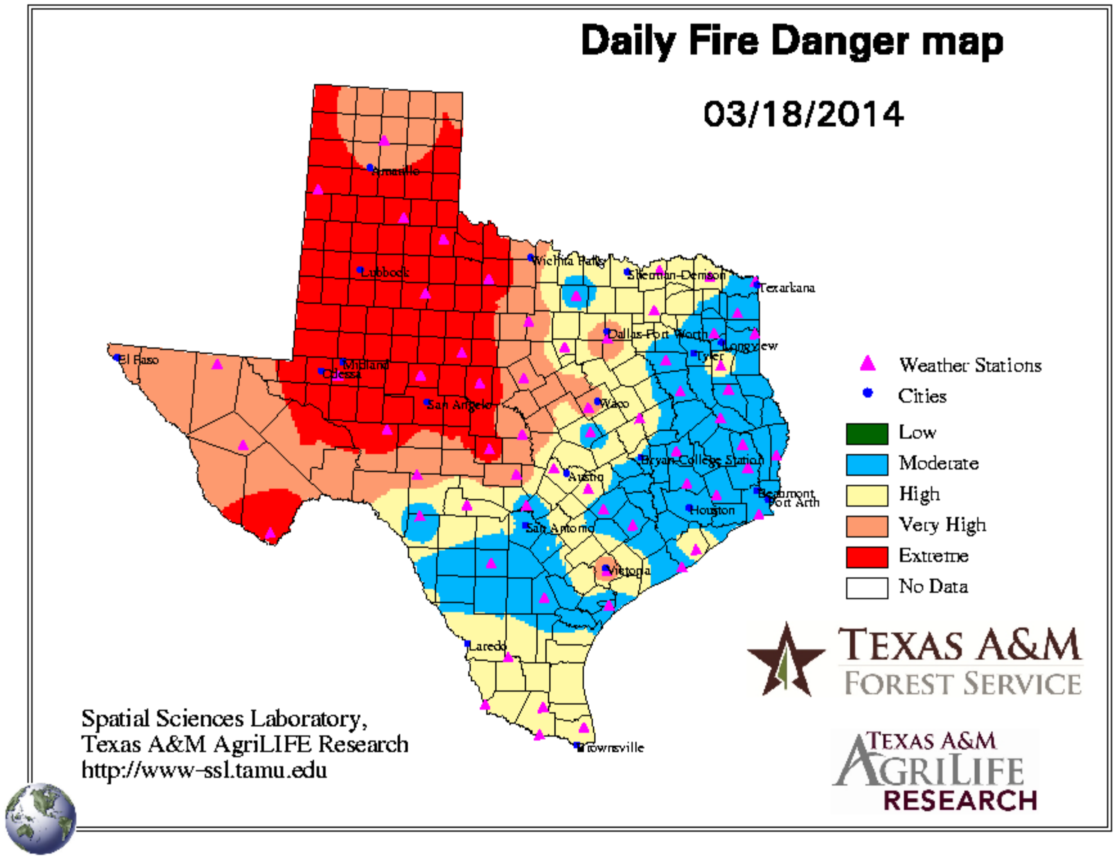


Figure 31. Example of a Daily Fire Danger Map available from TWC and TICC.

preparedness education programs and efforts must focus on the individual's responsibility in creating fire-resilient systems in either human or natural environments, two environments that are not mutually exclusive. Residents of the WUI are integral parts of the natural landscape around them and public education efforts must emphasize a holistic approach to creating fire resiliency.

Fire fighter safety is of paramount concern for all communities regardless of wildfire risk. Particularly in wildfire-prone areas, every individual has a responsibility to ensure the safety of fire fighters by implementing Firewise and RSG principles at their homes and properties and family emergency planning. Furthering public education of these principles will be one way Travis County and the City of Austin achieve effective and efficient firefighting responses to wildfire occurrences.

5.2 LOCAL-LEVEL CWPPS

HFRA requires that a CWPP address collaboration, fuels reduction, and structural hardening. There is an appreciable difference in the approach to addressing these elements, depending on whether the CWPP is to primarily serve a regional community -- and secondarily its constituent, local-level communities -- or if it is directly focused on a specific, local-level community. **Table 19** provides an overview comparing the elements and topics of these two planning tools.

Table 19. Comparison of Regional and Local-Level CWPP.

Elements:	Regional/Countywide CWPP	Local-Level CWPP
Meets HFRA	Yes – collaboration, fuel reduction, structure hardening – satisfies TFS review	Yes – collaboration, fuel reduction, structure hardening – satisfies TFS review
Funding a CWPP	Preparation and updates by sponsoring entity – substantial initially depending on availability of applicable research and mitigation information	Preparation and updates by sponsoring entity –nominal depending on strength of supporting systems (countywide CWPP, TxWRAP, etc.)
Planning area	Determined by boundaries of funding entities	Driven by functional application of mitigation strategies within a specific portion of the WUI with cooperative neighbors
Source material	Broad search for applicable info. from federal and state agencies across the nation and local subject matter experts	Primarily drawn from available regional (countywide CWPP) and state (TxWRAP) sources and local subject matter experts
Topics:	**Big picture approach to broad area:**	**Focused discussion scaled to specific planning area:**
Community Values and Concerns	Extensive public and stakeholder input process – document covers full spectrum but light on some scale-specific details (facilities of concern and evacuation route/refuge identification, etc.)	Localized public and stakeholder input process – document covers full spectrum with substantial attention to scale-specific details (facilities of concern and evacuation route/refuge identification, etc.)
Community Profile	More info. on some topics to cover variety across broad area (vegetation types, protected species, codes and regulations, etc.) with lighter coverage of some scale-specific topics (land use, utilities, etc.)	Covers full spectrum with substantial attention to scale-specific details (restricted to applicable vegetation types, land uses and utilities, etc.) with approximations for some elements (population, etc.)

Topics: (Cont'd)	Big picture approach to broad area:	Focused discussion scaled to specific planning area:
Fire Environment	Expanded discussion of wildfire behaviors, covers full range of fuel types in the planning area	Limited discussion of wildfire behavior with focus on fuel types specific to the planning area
Risk Assessment	Covers full spectrum with additional detail regarding unique environment – heavily data and model driven to guide strategic planning and support tactical implementation	Uses available data and model information to guide "ground truthing" assessment of planning-area specific conditions – leaning on high/medium/low scale as interpreted by local fire professionals and/or TFS WUI specialist
Mitigation Strategies	Covers full spectrum including public education, local-level CWPPs, HIZ, fuel reduction, code coordination	Primarily HIZ and fuel reduction – touches on public education and code coordination per location specific needs
Plan Implementation	Covers full spectrum including public education, local-level CWPPs, regional wildfire cooperative, database access, RSG, fuel reduction, mitigation research, response capability monitoring	Primarily HIZ and fuel reduction – touches on public education and code coordination per location specific needs

Countywide or regional-level CWPPs formulate broad strategies, develop tools, and organize resources. Local-level CWPPs facilitate the tactical implementation of these requirements within specific WUI subareas. By organizing the appropriate stakeholders, local leaders can customize a wildfire mitigation plan among their neighbors. Local-level CWPP development provides property owners a means to be vested in regional wildfire mitigation efforts by becoming engaged in a program closer to home.

One of the objectives for this CWPP was the development of a Tool Kit to aid local leaders and fire professionals in the process of developing local-level CWPPs. **Appendix E** -- Tool Kit for Local-Level CWPPs -- contains guidelines for the process, a template for a local-level CWPP, and instructions for transforming the template into an approved and implementable plan. This Tool Kit offers local leaders and wildfire professionals a framework for creating a scaled-CWPP that meets HFRA requirements and is cohesive with the countywide CWPP.

The spark for initiating a local-level CWPP can come from inside the local community or from an outreach program instituted at a regional level. **Sections 6.2.1** and

6.2.2 include recommendations for outreach and promotion of local-level CWPPs based on priorities driven by the relative risk ranking developed in **Section 4.3.3**. Proliferation of local-level CWPPs across the WUI will enhance the fire-adapted characteristics of the plan area as a whole, thereby making the widespread promotion and creation of them one of the most effective wildfire mitigation strategies available.

5.3 HOME IGNITION ZONE STRATEGIES

The intent of the Austin-Travis County Community Wildfire Protection Plan is collaboration and coordination among individuals to make our communities wildfire ready. As individuals, each of us must do what we can within the law to protect our lives and property from wildfire. Our hands – more so than firefighters – are the best ones to protect our future.

There are not enough firefighters to protect every home threatened in a Wildland Urban Interface Fire. If the worst happens, your home's chances of survival increase when you evaluate it from the perspective of it standing alone in a wildfire. By increasing your home's resiliency to ignition you also enhance your neighbors' safety and that of the whole community. By taking this approach, you ensure that a firefighter is able to respond and that they have the greatest chance of saving your home. Homeowners often inquire as to how the fire service will defend their home, when the real question is how defensible have you made your home. We achieve wildfire protection and resilience when each of us as individuals comes together and commits to becoming wildfire ready.

Mitigating wildfire risk is the **protection of life** – yours, your family's, and, just as important, the lives of firefighters. The act of sacrifice for the preservation of life is heroic, allowing our public servants to die for anything less is unacceptable.

It is not acceptable for responders to die for homes or wildland. From 2002- 2012, 192 firefighters lost their lives during wildland fires. In 2013, another 19 municipal firefighters died in the line of duty while attempting to suppress the Yarnell Hill fire in Arizona. The fire occurred in an area where residents had done little to prepare for wildfire (Cook 2013). It was never the residents' intent to place those firefighters' lives in jeopardy. However, like many residents, they expected that someone would show up and defend their homes, regardless of whether or not they had done anything to prepare for a wildfire.

Wildfire is Everyone's Fight. Breaking the cycle of wildland fire-related deaths will take a monumental shift in cultural values and the way citizens view their role in fighting the growing threat of wildfire. It's urgent that each individual do what they can – before a wildfire occurs – to reduce their wildfire risk. It is just as important to understand that if the flame length of available fuels cannot be mitigated or reduced due to site-specific conditions, you better harden your home to withstand the fire. Your home is your last refuge of survival.

The founding principle behind successful wildfire mitigation strategies is to **focus on what you can do to protect your life and property**, and not be discouraged by the things that you cannot do. Any action is better than no action at all. Whether your home is in the woods of the Edwards Plateau or in the grasslands east of the Balcones Escarpment, unless you live in the heart of metropolitan Austin, wildfire can be a threat. **To protect your life, protect your home!** Homeowners who understand that risk and take actions to reduce it have created a fire-adapted environment that will increase their home's survival prospects.

The following sections discuss the importance of wildfire mitigation and the mitigation strategies available for individuals, neighbors, local communities, municipalities, land managers, and others.

5.3.1 DEBUNKING MYTHS ABOUT WILDFIRE

1. **Myth:** "I am helpless to protect my home and property from the raging beast of wildfire."
   Fact: Reducing fuel around the home has the potential to reduce or prevent home ignitions in more than 50 percent of homes impacted by wildfire. The home itself and the Home Ignition Zone within the property lines are under the direct control of the homeowners.

2. **Myth:** Wildfire is like a flood or tsunami, engulfing everything in its path.
   Fact: Fire burns only where there is fuel to sustain it.

3. **Myth:** The fire department will protect my home.
   Fact: Fire departments lack the resources to protect every home when a fast-moving wildfire and associated spot fires simultaneously threaten dozens of homes.

4. **Myth:** Insurance will take care of it.
   Fact: Insurance won't compensate for lost family mementos, time spent rebuilding the home and replacing possessions, the stress of temporary relocation, and so forth.

5. **Myth:** A Firewise landscape consists entirely of rock and cacti.
   Fact: A Firewise landscape can include trees and lush landscape plants, provided careful attention is paid to placement, spacing, and maintenance.

5.3.2 FIRST THINGS FIRST: TARGET THE HOME IGNITION ZONE

Most people believe that wildfire is an uncontrollable force of nature that consumes everything in its path. They imagine flames engulfing a home and incinerating it. The truth is that many homeowners have more control over their homes' fate than they realize. In recent decades, fire scientists performing post-fire assessments have discovered that the majority of homes burned during wildfires were ignited by secondary fires – smaller fires that started in the home's immediate vicinity but disconnected from the original fire's flame front. To learn more about why homes burned during the 2011 wildfire outbreaks, the *2011 Texas Wildfires: Common Denominators of Home Destruction* report is available from: http://tfsweb.tamu.edu/main/popup.aspx?id=10080.

The ignitability of a home's building materials and its surrounding environment are often deciding factors in its survival. They key to anticipating a wildfire's behavior is to stop thinking of structures as homes and to start thinking of them as fuel. This led to the development of the Home Ignition Zone concept – a concept that returns to homeowners the power and responsibility to protect their own homes through careful management, reduction of structural ignitability, and reduction of fuels in and around their homes.

5.3.3 HOW EMBERS, NOT DIRECT OR RADIENT HEAT, BURN MORE HOMES

Fire requires three elements: fuel, heat, and oxygen. Eliminate any one of those and fire ceases. In a wildfire, eliminating oxygen is not possible, and having sufficient water to cool the fire is also generally not possible. However, reducing or interrupting the continuity of available fuel reduces wildfire's intensity, making it more controllable.

Post-wildfire investigations have revealed that more than half of the homes that burn in wildfires are the result of spot fires ignited by embers originating from the main fire. Embers (firebrands) are bits of burning wood and ash generated by intense wildfires that are carried on the wind. **A single ember from a wildfire can travel over a mile.** In Texas, the *2011 Texas Wildfires: Common Denominators of Home Destruction* report documents that embers traveled up to four miles. **You can't control where it will land, but you can affect what happens after it does.**

Embers create a series of secondary ignitions, also referred to as spot fires, which are not always connected to the original wildfire. Once homes ignite they become a secondary source of embers, often producing viable embers long after the main fire has past. They then become an ignition source for surrounding homes that survived the initial flame front.

Fire research scientist Dr. Jack Cohen of the USDA Forest Service found in post-fire home examinations that embers were often the main source of home ignition in areas where wildfires had burned through. The Insurance Institute for Business and Home Safety's (IIBHS) Research Center highlights Wildfire/Ember Testing in a four-minute video demonstration of how embers ignite homes: ***IIBHS Research Center Ember Storm Test Highlights***.

Embers gain footholds in flammable materials, typically fine fuels on and around the structure, igniting the home independently from the flame front of the main wildfire. In other words, flames from the original wildfire never touched more than half the homes that burned. Those house fires originated on the property, starting with embers that landed on or around the home, in a place that allowed the flames to spread and intensify. The embers would have faded and died in the absence of fine fuels or highly combustible materials in opportunistic configurations.

This knowledge, coupled with a series of crown fire experiments performed in the late 1990s, led to the development of the concept of the Home Ignition Zone: a 200-foot-wide area immediately surrounding the home and its attachments where fuels can be managed to reduce the probability of ignition. The 200-foot distance is the area most vulnerable to blown embers from a distant fire or the radiant heat from nearby flames. It is also the location in the WUI that can most easily be mitigated to reduce wildfire risk and to prepare a space for defense against wildfire.

Over the years the concept of the Home Ignition Zone has evolved and subdivided into two or three zones. Guidelines for the management of specific fuel types in each zone have also developed over time. It's helpful to think of the Home Ignition Zone as a target with the home at the center and three zones radiating out from the center.

Just as center of the target is worth the most points, with successively fewer points awarded for hits closer to the edge of the target, homeowners will get the greatest benefit by starting with the home and working their way out (**Figure 32**). No one can guarantee any structure located in a wildfire risk area will not burn, but implementing the best-

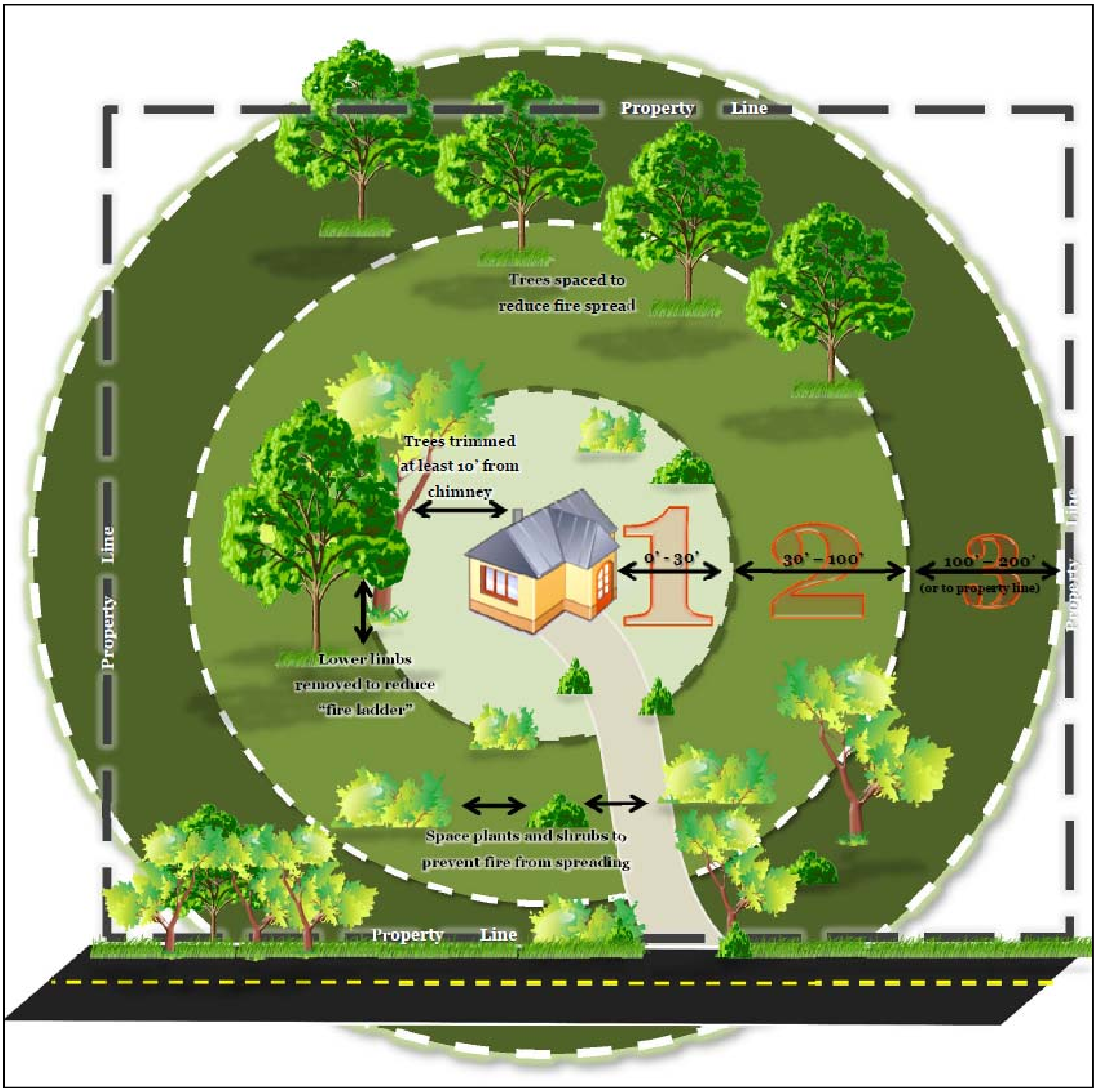


Figure 32. Home Ignition Zone – Example of Defensible Space (Bowman 2014).

practice options most appropriate to your situation will reduce that risk. While the HIZ frequently extends beyond the property line, homeowners need to take action on their own property and participate in a CWPP or other program that facilitates a coordinated effort with neighboring properties.

All citizens in Travis County areas at risk of wildfire must be aware of the specific steps they can take to become fire adapted, be they homeowners, renters, or other property owners. Specific recommendations for home protection and property owners are provided in the following sections, including effective measures for the Home Ignition Zone, defensible space, and structure ignitability.

Recognizing that your home is potential fuel, take time to assess the items in what has been termed your home's ignition zone, which may also include your neighbors' homes. Your goal is to create in your Home Ignition Zone an environment that prevents ignition from wildfire or reduces ignition possibility.

Several excellent resources written specifically for citizens and homeowners of Austin and Travis County are included in **Appendix D**.

The first one is the *Ready, Set, Go!* guide developed by the county and city for use in our area. The most important action item of the RSG! program is the development of a **wildfire action plan**. Communities and homeowners should use this document as the start of wildfire prevention planning efforts. It has a Wildfire Action Plan template and important guidance on how to be ready for wildfire, how to prepare for a possible evacuation, and what to do if an evacuation is necessary. This useful guide also describes the Wildland–Urban Interface (WUI), defines defensible space and has specific recommendations, including home hardening ideas (also discussed below).

Travis County and the City of Austin, through the COA Watershed Protection Department (WPD), have joined to prepare the attached Wildfire Ready Austin poster, *Maintain a Defensible Space*.

A companion document, which elaborates on the *Maintain a Defensible Space* poster, is the Wildfire Ready Austin document developed by the Austin/Travis County

Joint Wildfire Task Force, *Before and After the Fire: Environmental Best Management Practices for Wildfire Risk Reduction and Recovery*.

The Texas A&M Forest Service has produced a four-page publication, *Be Embers Aware*, which focuses on the importance of home hardening and defensible space.

5.3.4 HARDEN YOUR HOME

Conduction poses the greatest threat to structures. A continuing heat source against a flammable surface, conduction is caused by direct flame contact against flammable exterior surfaces or by embers blown into gutter debris or through openings in the structure.

Embers are the most frequent source of conduction. Wind can carry embers more than a mile from the original fire source. Every home has vulnerable points where embers can intrude; even apparently fireproof homes like stucco or brick.

A Class A, flame-resistant roof is one of the single most important factors in home wildfire survival. Fuels on the home's surface, including fine ones like leaves on the roof or in the gutters, can burn intensely enough to ignite trim or even the attic interior. Stepping back and viewing your home as a fuel source, decks, stairs, and wooden fences attached to the home are also fuels.

Section 5.3.5 includes specific subsections on Structure Ignitability and Fire-Resistant Materials as the home at the core of the HIZ is integrally connected to the mitigation efforts that take place in the center ring of the HIZ target. For more information about home hardening:

- Texas A&M Forest Service: *Fire Resistant Materials for Home Repair and Construction*

Figure 33. Homeowner reducing spot fire risk by cleaning out gutters

- Institute for Business and Home Safety: *Protect Your Property from Wildfire, Southwest Edition*
- For a more in-depth look at each HIZ zone and the applicable actions steps (within that zone) that homeowners can take to reduce the risk of wildfire damage to their home and property is provided in *Firewise Landscaping and Construction Guide* by the National Fire Protection Association.

5.3.5 ZONE ONE: DEFENSIBLE SPACE

If your home is your castle then consider defensible space as your mote. Zone one extends 30 feet out from the edge of the home and its attachments, or to the property line.

This first 30 feet around your home is the most important because it has the fuel most likely to catch your house on fire. Also called your Defensible Space Zone, it provides the buffer your home needs to survive a wildfire and ensures a sufficient space and safe zone for firefighters and their equipment.

Look first at your home and any structures around it. Assess these buildings for fire risk from the top of the roof down to the eaves, then from the eaves to the foundation. Next, assess the risk in the yard. Look for items that might easily burn or situations that might allow flames into the structure itself. In this ignition zone, look for these danger signals:

LOOKING UP

- ✓ Leaves and debris in gutters and roof crevices - clear debris on a regular basis. Even non-flammable roofing materials will not prevent the heat of burning gutter debris from igniting the wooden structure supporting the roof.
- ✓ Tree limbs hanging over or touching your roof or chimney – trim back at least eight feet from the roof. Burning limbs on the roof can provide sufficient heat to ignite the sub-attic.
- ✓ Vines growing up the side of the house and into eaves – remove this ladder fuel that will provide a pathway into the attic for flames.

- ✓ Loose roof shingles or tiles – repair or replace to prevent penetration by embers.

LOOKING AROUND

- ✓ Leaves and debris on porches, decks, and blown into corners – regularly clean out these beds of kindling to remove fuel for embers.
- ✓ Dead vegetation under your deck or porch – clean out this potential fuel.
- ✓ Vegetation growing against the foundation or into the space between siding and foundation. Maintain a foundation clear of dry vegetation and debris. Flames can easily creep into the walls of the building from this fuel.
- ✓ Items stored under your deck or porch – remove to a location that does not pose a fuel threat to the house.
- ✓ Dead vegetation near any structures – clean it out. If the vegetation can touch the structure, flames can also reach the structure.
- ✓ Firewood stack – move the woodpile at least 30 feet from any structure.
- ✓ Low-hanging tree limbs – in the 30-foot HIZ, prune tree limbs in accordance with International Society of Arborists (ISA) standards with no more than 25 percent of live canopy removed. This will help prevent what may have started as a grass fire from becoming a crown fire.
- ✓ Dry, brown lawn – reduce this grass fire threat by irrigating, if possible, and keeping it mowed. If water conservation is paramount, keep the lawn cut short. Put even more emphasis on other mitigation tasks if irrigation is not an option. All vegetation is fuel, but mowing and appropriate watering will reduce a potential fire's intensity.
- ✓ Piles of lawn clippings, leaves or other vegetative debris – dispose of these quickly to reduce fuel for fire. A compost bin outside the 30-foot HIZ is a good way to reuse this material.
- ✓ Shrubbery in direct contact with or less than 12 inches from windows or wooden fixtures – reduce the height or remove it altogether. Flames from the

shrub can radiate enough heat to ignite wood framing, crack windows, or ignite interior draperies through the glass.

LANDSCAPE REVIEW

- ✓ Plants in the 30-foot HIZ should be carefully spaced and low growing – low-growing, well-spaced plantings keeps flames on the ground where the fire is more easily controlled.
- ✓ The oils and resins in evergreen leaves can also be extremely flammable and increase fire intensity. Evergreen plant varieties should be used with caution in this 30-foot HIZ.
- ✓ Leave adequate spacing between clusters of two to three trees, as well as between individual trees – this arrangement reduces the risk of flames from one tree igniting adjacent trees and creating a crown fire.
- ✓ Create a firebreak around the home's footprint using landscaping materials such as pea gravel, rock, or pavers - this nonflammable perimeter will reduce the opportunity for ground fire to infiltrate the structure's foundation.
- ✓ Give yourself added protection with other fuel breaks - driveways, sidewalks, gravel walkways, and non-flammable patios can limit fire spread.
- ✓ Avoid window plantings as shrubbery once ignited can radiate heat through windows to combustibles in the interior.

Implementing fuel reduction activities in combination with home hardening projects increases a home's wildfire survival probability. Accomplishing one set of tasks without the other will not create a truly fire-adapted residence, but could still dramatically reduce the home's ignitability.

STRUCTURE IGNITABILITY

A major element in assessing the threat in your 30-foot HIZ is looking at your home and outbuildings to determine how structurally vulnerable they are to a wildfire. For existing structures, making modifications that improve the fire resistance of your house is called home hardening or retrofitting. Key areas and useful tips for home hardening are included below in **Table 20**.

Table 20. Key areas and useful tips for home hardening.

Unenclosed areas beneath decks and porches	✓ Screen or box-in these areas to prevent debris and combustible materials from blowing underneath to create fuel for embers or grass fire flames. ✓ Keep these areas clean of combustible debris.
Unenclosed attic, soffit or foundation vents	✓ Cover external vents with metal mesh wire no larger than 1/8 inch to prevent sparks from entering.
Unenclosed eaves	✓ Box in eaves with non-combustible materials to reduce the possibility of embers blowing into the attic, particularly if there are unscreened ventilation openings in the eaves.
Wood shingle roof	✓ Replace this type of roof with a Class A roof covering, such as asphalt, tile, or metal.
Open rain gutters	✓ Keep gutters clear of leaves and debris. ✓ To reduce leaf and debris build up, install leaf guards on gutters.
Single pane windows	✓ Single-pane windows are more vulnerable to flame and radiant heat. Install double-pane or tempered-glass windows to decrease the risk of heat intrusion into the structure. ✓ Several, smaller panes provide more protection than large, picture windows.
Wooden window frames	✓ Install metal or aluminum window frames to reduce the risk of the frames catching on fire, thus failing to hold the panes in place, and allowing flames into the house.

Table 20. Key areas and useful tips for home hardening.

Dried out, unsealed decking or porch planks	✓ Reseal decking or replace planks with non-combustible materials to inhibit ignition from embers. ✓ Install a non-flammable buffer, such as metal flashing, between the deck and the house.
Wooden fencing attached to the house structure	✓ Prevent burning fence flames from contacting the house by inserting a non-flammable buffer between the fence and the house. ✓ Consider a wire, metal section, or metal gate adjoining the structure.
Unenclosed pier and beam foundation	✓ Install non-combustible skirting to inhibit flames and embers from getting under the house.

FIRE-RESISTANT MATERIALS

Whether you are retrofitting an existing structure or building a new home, there are recognized Firewise options you should consider when choosing construction materials.

ROOFS – Roofs can be ignited on the surface and along the edges where the gutters are connected, usually by embers landing in combustible debris. Flames penetrating roof materials or heating the sub-roof can cause fire in the attic. Roofing materials are classified as Class A, B, or C, with Class A offering the highest fire resistance. All roofing materials should be properly installed and stopped or sealed to prevent ember entry. Examples include:

- ✓ Concrete or clay roof tiles (with bird stops)
- ✓ Fiberglass asphalt composition shingles
- ✓ Metal roofing

GUTTERS – Gutters represent another vulnerable aspect of your home. Vinyl gutters can melt from flame heat, leaving the roof edge open to flame intrusion where there may be an opening between the roof decking and the fascia board behind the gutter.

Angle flashing installed over this opening and behind the metal gutter will improve fire survivability. Fire resistant materials recommended include:

- ✓ Metal gutters
- ✓ Metal leaf guards on gutters
- ✓ Metal angle flashing for edge protection

EAVES AND SOFFITS – Eaves function much like an umbrella to protect the sides of the house from rainwater. Unenclosed eaves with unscreened ventilation openings are particularly vulnerable to embers and direct flame contact, and should be boxed in with soffits. Soffits will need to be vented to allow air circulation out of the attic from under the eaves. Soffit material should be non-combustible and vents should be screened with 1/8-inch metal mesh. Recommended soffit materials are:

- ✓ Metal
- ✓ Concrete board (which can now be purchased with ready-drilled vent holes.)
- ✓ Stucco

EXTERIOR WALLS – Exterior walls should be resistant to radiant heat and direct flame. Siding that melts (vinyl), or otherwise lifts away from the exterior wall construction, can expose crevices that will allow flame or ember entrance into the home's interior. Recommendations for exterior walls include:

- ✓ Cement board
- ✓ Masonry
- ✓ Rock
- ✓ Stucco

WINDOWS AND WINDOW SCREENS – Radiant heat and direct flame can cause windows to crack and allow flames to enter the house. Wooden window frames may ignite, and vinyl frames may melt. Both instances expose the interior of the structure to radiant heat and flames. Landscaping should be designed to allow space between plants and the house, reducing fuel and the possibility of flame or radiant heat adjacent to the windows. Window screens play an important protective role for the windows by absorbing and redirecting radiant heat, thus reducing the amount of heat absorbed by the glass. If the glass breaks, screens aid in preventing embers from entering the home's interior. Recommended window materials include:

- ✓ Tempered window glass (deflects more heat than non-tempered glass)
- ✓ Double-paned windows (the second pane provides additional protection against flame and embers)
- ✓ Metal or aluminum framing (will not burn or melt and allow panes to fall out, opening interior to flames)
- ✓ Metal screening

VENTS – Vents play a vital role in allowing air to circulate through a structure, reducing moisture and preventing mold growth. Locations for vents include eaves, soffits, the roof flat, chimneys, roof ridges, turbines, gables, the foundation, and the clothes dryer. These same structurally important vents, however, present serious vulnerabilities during a wildfire. All these vents should be screened with 1/8-inch non-combustible mesh to protect the home from intrusive embers. Be aware that the size of the mesh may need to be adjusted for some vent locations whose purpose may be impaired by a reduced airflow. All screened vents should be cleaned regularly to keep them clear of debris. Recommended screening materials include:

- ✓ 1/8-inch metal mesh
- ✓ Vents specifically designed to reduce ember intrusion
- ✓ Baffled vents

DECKS AND FENCING – Wooden decks and privacy fencing directly attached to the structure make the home highly vulnerable to wildfire. Flames or embers from the burning fence may reach to the eaves and enter the attic. Radiant heat from the fence can heat internal wall structures sufficiently to cause flaming. A deck represents the same threat, but is more likely to produce radiant heat. These attachments should be built of non-combustible materials, or be separated from the structure by a non-flammable buffer. Suggested materials are:

- ✓ Brick or masonry

- ✓ Cement board
- ✓ Metal
- ✓ Composite decking material

SKIRTING – Pier-and-beam foundations should be enclosed with skirting to prevent flames and embers from traveling underneath the home. Non-combustible materials are:

- ✓ Masonry
- ✓ Rock
- ✓ Cement board
- ✓ Metal

Figure 34. Homes that survived wildfire by implementing the Home Ignition Zone principles.

"You don't have to live in a concrete block home with stainless steel doors and a metal deck all the way around it. You just have to remember – it's the little things that count." Jack Cohen, Research Physical Scientist, U.S. Forest Service

5.3.6 ZONE TWO: REDUCED FUEL ZONE

Zone Two extends 30 to 100 feet from the home, structures, decks, and other buildings, or to the property line. You can minimize the chance of fire jumping from plant to plant by removing dead material and thinning vegetation. Plants in this zone should be low growing, well irrigated and less flammable.

- Leave adequate spacing between clusters of two to three trees, as well as between individual trees.
- Protect valuable residential trees by not placing combustible mulch and landscaping around the base or underneath the drip line as this can carry fire into the tops of your trees.
- Encourage a mixture of deciduous and coniferous trees.
- Create fuel breaks such as driveways, gravel walks, and lawns.

- Prune trees in accordance with ISA standards - Remove ladder fuels.
- Cut or mow annual grass down to a maximum height of four inches.
- Trim tree canopies regularly to reduce continuity between branches and dense underbrush.

5.3.7 ZONE THREE: COMMUNITY PROTECTION ZONE

Many points of fire ignition are aggregated around the vicinity of wildland. Whether those ignition sources are roads, homes, or natural events, wildland interfaces are at risk of wildfire. Zone Three extends an additional 100 to 200 feet from the home, or to the property line. This is the Community Protection Zone – the first line of defense in the event of an approaching wildfire and the area where the focus should be on reducing the amount of available fuels in and around the home. Fuels within this area should be thinned, although less space is required than in Zone Two. NOTE: For site-specific conditions such as topography, the recommended distances to mitigate for radiant heat exposure can actually extend between 100 to 200 feet from the home.

- Plan and confirm for proper disposal of debris, before starting any thinning or other fuel reduction. Don't leave trimmed debris lying around.
- Remove smaller conifers that are growing between taller trees.
- Remove heavy accumulation of woody debris.
- Reduce the density of tall trees so canopies are not overlapping.
- Keep trees and shrubs pruned in accordance with International Society of Arboriculture (ISA) standards.
- Remove leaf litter, dead limbs, and overhanging branches.
- Mow the lawn regularly and dispose of cutting and debris promptly.
- Store firewood away from the house.
- Maintain the irrigation system regularly.
- Familiarize yourself with local regulations regarding vegetation clearance, debris disposal, and fire safety requirements for equipment.

5.3.8 STOP AT THE PROPERTY LINE AND OVERLAPPING HOME IGNITION ZONES

Most fuels present on today's landscape do not recognize property lines, not all parcels are platted as equal-sided squares, and most homes are not built in the center of a parcel. **Figure 35** shows a representative example of how Home Ignition Zones can be distributed across a parcel. It is imperative to keep these concepts and the following considerations in mind as you take responsibility to harden your home and maintain a defensible space:

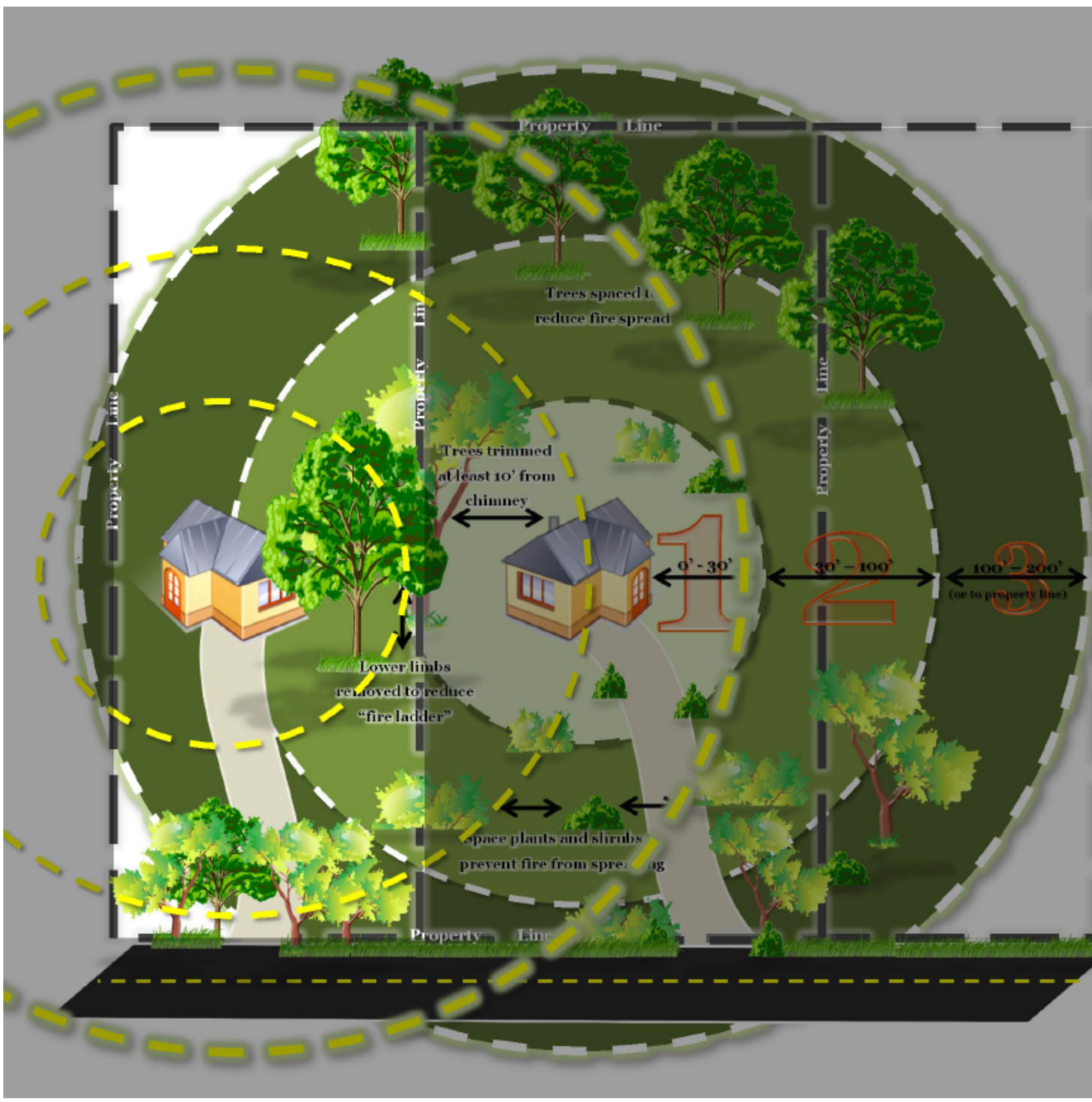


Figure 35. Stop at the property line (Bowman 2014).

- No trespassing – it's the law and you wouldn't want someone on your property without your permission.

- Arboricultural law - When a tree crosses property lines, that tree is considered shared property. If you have a neighbor's tree with limbs growing over your property there are a few things to know. There is no written law regarding trees, only legal precedent. The tree belongs to the person with the trunk on their property. You have a right to maintain your property. If a tree is threatening your house, landscaping or any other identifiable asset, you have legal right to maintain the tree to protect your property. However, if you compromise the life of the tree without just cause while maintaining the portion occurring on your property, your neighbor will have a right to pursue restitution.

- Protected/heritage trees – Before any fuel reduction to maintain your defensible space, be sure to check with your local municipality to make sure there is not a tree ordinance or other regulation or law that would prevent you from reducing fuel loads surrounding your home. It is also important to consult a professional arborist before any major pruning to ensure that the overall health of the tree is not compromised. Under the City of Austin's Tree and Natural Area Preservation Ordinance, removal of a tree with a trunk circumference of 60 inches or greater, measured 4½ feet above natural grade (equal to a 19-inch diameter), requires a permit from the Planning and Development Review Department. It is important to note that "removal" can mean more than just cutting a tree down – it covers "an act that causes or may be reasonably expected to cause a tree to die," including uprooting, severing the main trunk, damaging the root system, and excessive pruning. Illegal tree removal can net a fine of up to $2,000 per tree. Additional information on protected/heritage trees pertaining to parcels within the City of Austin can be found at http://austintexas.gov/department/city-arborist/.

As discussed above and shown in **Figure 35**, the spatial layout of the Home Ignition Zone surrounding your home does not always occur entirely within your individual property boundary, but extends onto your neighbors. Keeping in mind that the result of the whole is always greater than the sum of its parts, one of the easiest ways for a community to come together to achieve wildfire protection and resilience is for each of us to share what we've learned about defensible space with our neighbors and those around us. While you are in the process of hardening your own home and creating a defensible space, use it as an opportunity to talk to those living around you. Don't be afraid to reach out. Whether the conversation begins at a neighborhood function in front of a group or just as a visit with your next-door neighbor while you are getting ready for the bulk brush pick-up day, be sure to share what you have accomplished and learned with others.

5.3.9 WHY FUEL REDUCTION IN THE COMMUNITY PROTECTION ZONE WILL PROTECT MOST HOMES

Fuel reduction in the HIZ is most effective within the 200-foot zone surrounding the structure. This Community Protection Zone encompasses the 100- to 200-foot-zone surrounding the home and has proven to be the area where fuels modifications have the greatest impact on home survival. No one can guarantee any structure located in a wildfire risk area will not burn, but implementing the best practice options most appropriate to your situation will reduce that risk.

There is a large difference between home protection and wildland mitigation. While wildland mitigation may reduce the overall wildfire risk to the surrounding communities, it has the least impact on reducing the wildfire risk to your own home. In the late 1990s, the International Crown Fire Modeling Experiments quantified the effects of direct flame contact and radiant heat on structures. Blocks of Canadian forest were set afire in controlled conditions in order to observe wildfire intensity, duration, and its effects on wooden structures. The results:

- In four out of seven tests, wall sections placed 33 feet from the crown fires were severely scorched but did not ignite.
- In all cases, heat from the crown fires was insufficient to ignite structures 100 feet away.
- The crown fires burned rapidly and with great intensity for a minute or two as fine fuels were consumed, but not for the duration necessary to ignite a wooden structure.

- The same level of heat that can cause second-degree burns to a person in five seconds takes over 27 minutes to ignite a wooden wall. (video: ***Radiant Heat versus Firebrands*** *at* ***http://www.youtube.com/watch?v=Dq6wy_tffpg***)

So, if the intense flames burn through in about a minute, and it takes so much longer than that to ignite the home, why are homes still burning? Fine- and mid-sized fuels in the home and surrounding landscape can catch, carry, and perpetuate the fire so it keeps burning after the wildfire has moved through. Also, embers from the fire pile up on and around the home, smoldering and starting new fires in the house and yard.

It's important to identify and understand the potential ignition corridors within and surrounding your home and community. Knowing where these corridors are and the potential ignition sources will help determine the appropriate treatment strategies and home hardening and mitigation work. Fuels on and around the home that ignite are responsible for house fires that occur in the vicinity of wildland fires. Homeowners can mitigate these fuels if you concentrate on what you can change within your home ignition zone. Wildland fires are inevitable; the destruction of homes and property is not. We may not be able to stop wildland fires from occurring but we do have a choice in whether our homes survive a wildfire.

Each year fire departments respond to thousands of fires started by people using equipment the wrong way. Whether working to create defensible space around your home, mowing dry grass, or pulling your dirt bike over to the side of the road, if you live in a wildland area you must use all equipment responsibly. Lawnmowers, weed trimmers, chainsaws, grinders, welders, tractors, and trimmers can all spark a wildland fire. Do your part, the right way, to keep your community fire safe.

5.4 FUEL REDUCTION

Remember the introduction to this section: in a fire-adapted ecosystem it's not *whether* an area will burn but *when* it will burn and at what intensity. Understanding that concept will help determine appropriate mitigation strategies and fuel reduction work. Therefore, it is essential that land managers, fire agency planners, and property owners understand their role within the fire-adapted community through proactive and dynamic land management to reduce the severity of potential wildfires and prevent a catastrophe. Protecting life and property while maintaining healthy ecosystems requires a dynamic land management approach to wildfire mitigation. It takes into account fuels management, access for fire-suppression equipment, and fire's natural role on the landscape.

Understanding wildfire behavior and the local fire environment, as described in **Section 3.0**, is an integral component in identifying fuel mitigation needs. Three natural characteristics influence wildfire behavior: weather, topography, and fuel. Fuel is the only one of the three that can be easily changed. The purpose of fuel management is to modify vegetation to affect potential fire behavior. Effective fuel mitigation for wildfire risk reduction also requires that land managers and property owners understand the regulatory requirements, costs, advantages, concerns, and potential impacts of the treatments being considered in relation to the treatment approach.

Potential advantages of land management focused on fuel reduction include reducing wildfire risk to human development, improving ecosystem health, and managing natural resources. The way an area reacts to ignition and burning, as well as the way fire behaves, is influenced by managing height and density of available fuels. Appropriate vegetation reduction can help restore landscapes to a sustainable, healthy condition. Fuel management influences ecosystem health, particularly for fire-adapted regimes. Many of the same benefits to ecosystems natural fires once provided can be replicated through the implementation of various fuel management approaches.

Fuel management focused on reducing dead fuel, removing ladder fuels, and minimizing non-native and invasive species reduces the risk for catastrophic wildfires and benefits ecosystem health. While focused on decreasing wildfire intensity, when performed under certain conditions, fuel management effectively decreases competition between native vegetation and undesirable, non-native/invasive species.

Residents in the WUI benefit most when fuel mitigation and management reduce the intensity of wildfires. Low intensity, smaller wildfires are less costly to suppress and can be more effectively controlled.

Before beginning any fuel management treatment for wildfire mitigation, land managers and property owners alike must verify that the proposed mitigation is in compliance with all applicable regulations, codes, ordinances, covenants, and CCRs. **Section 2.0** discusses the typical codes and ordinances within Travis County and local municipal jurisdictions that may apply to wildfire mitigation activities. However, it is important to note that regulations, codes, and ordinances are constantly reviewed, amended, and revised to meet the needs of the local government and the communities within its jurisdiction. It is the responsibility of land managers or property owners to ensure that any proposed wildfire mitigation activities are in compliance with all regulations, codes, and ordinances, as they are written at the time of the proposed fuel management treatment. The WMS Builder in **Section 5.6** includes information on where to find the regulations, codes, and ordinances that apply to property within Travis County.

Fuel reduction can involve management strategies that remove and/or rearrange vegetation and other combustible materials in wildfire risk areas. While fuel reduction throughout the wildland is generally not efficient or effective, it can be very efficient and effective within the WUI. Well-managed WUI fuels can improve protection for both the wildland and the urban space by altering fire behavior in both. This detailed discussion of fuel reduction includes six subsections that address the following topics:

1. Issues such as the general purpose of fuel reduction, the difference between a treatment and a strategy, various site constraints, and the appropriate scale of various applications;
2. Principles at work in altering wildfire behavior, objectives of fuel reduction, and conditions that influence implementation;
3. Treatments and how applications can be mixed;
4. Strategies for various fuel types, property ownership, and constraints;
5. Management of biomass generated by fuel reduction,
6. Additional resources available for customizing a fuel management system.

Guided by conservation-based principles, fuel-hazard reduction can facilitate long-term, positive environmental outcomes. Fuel reduction helps restore health to the woodlands, shrublands, grasslands, watersheds, and ecosystems within the plan area while providing for community wildfire resilience.

5.4.1 GENERAL ISSUES FOR FUEL REDUCTION

The landscape-scale concepts of fuel reduction and wildfire mitigation are the general issues that develop conservation-based, fuel-hazard reduction. The development of a solid foundation and understanding of the general purposes of fuel reduction, the difference between a treatment and a strategy, various site constraints, and the appropriate scale of various applications provides wildfire resilience to communities while facilitating long-term, positive environmental restoration.

PURPOSE OF FUEL REDUCTION

The purpose of any fuel management treatment is the modification of potential fire behavior to achieve a desired goal, such as protection of life and property and natural resources. There are two primary functions of fuels management:

1. Reduce the current risk and potential impact of wildfire under the current vegetation regime, and
2. Guide the mitigation area toward a vegetation regime with a lower risk as a desired future state.

In developing fuel management strategies, it is important to define a desired future condition and then implement strategies to support that goal. As a rule deciduous woodlands (timber litter) and short-grass prairies or savannas are the most favorable fuel types because they have low intensities, moderate frequencies, and rapid post-fire recoveries. It is also important to note that any change to a property's vegetative successional regime and associated fuel type classification also changes the wildfire risks associated with the property. Exercise caution when doing landscape-scale mitigation work that promotes or reduces the successional regime of the existing habitat from one fuel type classification to another, as wildfire risk is tied to fuel type. A change or transition to a different fuel type changes the wildfire risk and the mitigation needed to successfully reduce risk.

For the purposes of fuel treatment and management for wildfire mitigation, vegetative succession is defined as the change in the composition or structure of an ecological community over time that is more-or-less predictable and orderly, and by which the existing trajectory can be manipulated by some form of disturbance (e.g., manual, mechanical, fire, chemical, grazing) to achieve a specific result.

Mitigation for fuel reduction should focus on stabilizing the existing or potential vegetative regimes present on a property or whenever possible, restoring. Stable ecological states, such as grasslands, savanna or woodland (i.e., vegetation communities/fuel types) do not require significant work to be maintained, but most will require some form of routine management (Austin Water Utility 2010). Fuel treatment to mitigate wildfire damage can increase ecosystem resilience and promote ecological stability of the vegetative regime.

Routine and/or intensive management can stabilize existing vegetation regimes. Intensive management can also be used to move between different stable or intermediate states but may be impractical to use based on the amount of resources needed to undertake them, resulting soil disturbance, or conflicting land uses (Austin Water Utility 2010).

The desired regime type in which natural balance is restored through mitigation should be a natural and stable ecological state such as grasslands, savanna or woodland (e.g., fuel types) so that wildfire is less difficult, disruptive, and destructive. In any given landscape, the natural, historical regime is considered to be the role fire would have played prior to modern land use and fire suppression, but including the use of fire by native people in that area (Barrett et al. 2010).

Before fire was suppressed and all but disappeared from the landscape, the fire regime in central Texas was historically seasonal, and occurred in the spring and fall to provide summer and winter forage for grazing and controlling invading brush. Fire regime is defined as the combination of fire frequency, predictability, intensity, seasonality, and size characteristics of fire in a particular ecosystem [Sequoia and Kings Canyon National Parks (SKCNP)]. Disturbance regimes are used to characterize the spatial scale and temporal patterns of disturbance and subsequent response and recovery of ecosystems (Averill et al., 1995). An integration of disturbance attributes includes type, frequency, intensity, duration, and extent (Chelan RD, 2003). Classifications of fire regimes can be based on the characteristics of the fire itself or on the effects produced by the fire (Agee 1993).

When assessing a property to determine appropriate fuel management, understanding the fire regime and current condition class is important to modify potential fire behavior to achieve a desired goal. Condition classes are a function of the degree of departure from historical fire regimes resulting in alterations of key ecosystem components such as composition structural stage, stand age, and canopy closure (Chelan RD, 2003). Typical condition classes for the landscape can be broken down into three categories. Category One – current conditions match historic ones (e.g., occurrence of seasonal burns across the landscape). Category Two – current conditions somewhat match historic ones (e.g., occasional burning of the landscape, but far greater time spans between each burn, sometimes in excess of years). Category Three – current conditions do not match historic ones (e.g., fire has been removed from the landscape for such a significant time that little to no evidence of a previous fire remains).

The existing landscape across the majority of the plan area has departed from the historical regime of vegetation composition as well as fire frequency and severity. Indications of this departure from the historical regime include the presence of invasive species; the loss of large trees to severe fire, or the encroachment of smaller, less-fire-tolerant species (Ridenour et al. 2012). Research has shown that the greater the degree these non-representative conditions are present in the landscape or ecosystem, the higher the departure from the natural historical regime (Barrett et al. 2010).

Manipulation of the successional regime of a vegetation community present on a property (e.g., conversion of an aggrading juniper shrubland to grassland) is a key way to integrate wildfire risk reduction into the existing land uses and management goals. Fuel reduction targeted at manipulating the composition, abundance, and distribution of species within a vegetation regime can be split into three primary categories:

- Sustain – the application of management strategies to maintain and stabilize the existing vegetation regime in its current ecological state (e.g., management of woody vegetation in a grassland to prevent succession into a savanna).
- Promote – application of management strategies to transition the existing vegetation regime to a more mature vegetative regime (e.g., management of a grassland to encourage succession into a savanna).
- Reduce – application of management strategies to transition the existing vegetation regime to less mature vegetative regime (e.g., conversion of a woodland to a savanna).

TREATMENT VERSUS STRATEGY

The Austin-Travis County CWPP generally approaches fuel reduction by targeting a particular fuel type with a cohesive strategy of various treatments. While many strategies are made up of multiple treatment methods, the suite of the tools selected will vary depending on the site-specific conditions. With transitions in fuel types reaching across condition changes in soil type, topography, etc., and with proximity to protected habitats and watersheds, the treatments making up the general strategy for a common fuel type may vary within a single patch of that fuel type. That is, a treatment that disturbs the surface may not be allowed near a Critical Environmental Feature (CEF).

The WMS Builder in **Section 5.6** provides information based on geographic location for properties within the plan area in which natural resource considerations or regulatory mechanisms exist that would require a multidisciplinary review. **Section 5.4.7** also contains additional information on site conditions and considerations before implementing fuel mitigation treatments.

CONSTRAINTS

Fuels, as well as weather and topography, affect fire behavior, so there are limitations to what can be accomplished with fuel treatments. Additional limitations, such as steep slopes or limited access, may further restrict fuel treatment options on a particular site or within a given area.

Resource management objectives requiring fuel management are often diverse and complex. As such, fuel reduction treatments are site-specific and should be adapted to best meet the needs, goals, constraints, and resources available while remaining sensitive to the values of area residents.

SCALE

Similarly, depending n the size of the proposed mitigation area and the number of fuel types involved, a variety of strategies may be employed within a particular project. Consider the following examples:

- A single-family home on a lot up to an acre usually entails one fuel type and can achieve optimum fuel reduction through the implementation of the HIZ discussed previously.
- A single-family home on one to 10 acres may involve multiple fuel types and, while achieving optimum fuel reduction for the one acre around the home

through HIZ implementation, the balance of the site will require fuel reduction strategies aligned with and scaled to the area occupied by that fuel type.

- A tract of land 10 acres or more likely has more than one fuel type and may contain other constraints -- preserve, watershed, critical environmental features, steep slopes, riparian areas -- requiring multiple strategies.

Understanding the general issues for fuel mitigation and how the purpose, treatments, constraints, and scale correlate to the specific conditions at the site will result in a cohesive strategy for successful fuel mitigation and wildfire risk reduction.

5.4.2 FUEL TYPES

To affect fire behavior in specific ways it is imperative to not only understand the characteristics of fire and the fuel type, but also the desired fuel reduction objectives in order to select the appropriate mitigation strategy. For the purposes of demonstrating the relationship between fire, fuel types, and strategies, a brief discussion of fire and fuel characteristics is included below. **Section 3.2.1** includes additional discussion on fuel types.

A brief overview of the fuel characteristics requiring assessment for the development of fuels type strategies is provided below (adapted from Van Wagtendonk 2006; Florida Division of Forestry 2010).

Fuels range in size from small (fine) fuels less than a quarter-inch in diameter (e.g. grasses, leaves, twigs) to large fuels such as trees and logs. As stated before, fine fuels can ignite easily and burn rapidly because they have more surface area for contact with oxygen. Large fuels require more heat to ignite and burn slower but generate more heat. Large fuels are harder to extinguish than fine fuels.

Identification of fuel size classes, such as one, 10, and 100 hour, is based on the maximum width of downed and dead woody biomass. This woody biomass usually is in the form of twig, stem, and branch fragments that have fallen from the canopy onto the woodland soil surface. These sizes have been established based the average time it takes for the moisture content of the fuel to reach equilibrium with the relative humidity of the surrounding air. A one-hour fuel is defined by having a maximum width of 0 to 0.25 inches. A 10-hour fuel has a width that ranges from 0.25 to one inch. A 100-hour fuel has a width that ranges from one to three inches. Woody fuel that is larger than three inches, such as downed tree trunks, contributes to the overall coarse, woody debris of a site; however, it generally does not support initial ignition and sustain fire. Larger fuels burn and release energy and affect fire reaction intensity.

To assess fuel loading and size classes, the method developed by Brown (1974) is generally accepted as the standard. Briefly, this method establishes a line, or transect, within a study area. Fuel particles touching or crossing the line are counted, classified based on sizes listed above. This type of sampling method is referred to as the line-intercept method.

Once the fuel has been counted and classified, the values are converted into mass-per-unit-area value, referred to as the fuel loading. For each fuel size class, this loading value may be used for modeling or monitoring where fuel reduction has occurred. Generally, smaller, one-hour fuels provide conditions favorable for fire ignition. Larger fuels, such as 10 and 100 hour, sustain the temperature of the fire and release heat energy.

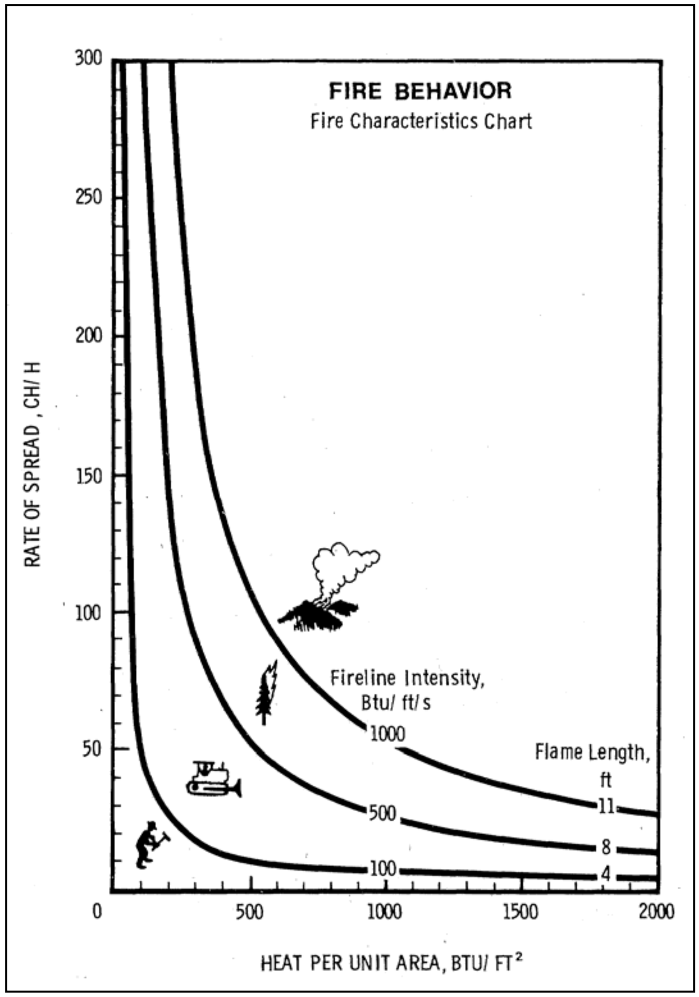


Figure 36. Fire behavior characteristics chart.

The two primary characteristics of fire behavior -- spread rate and fire intensity -- can be illustrated with a graph commonly referred to as a fire characteristics chart (**Figure 36**). Overall fire severity, as well as the character of the fire, can be inferred from the location of a point representing the fire on the chart. **Figure 37** shows the relationship of surface fire flame length and fireline intensity to suppression capabilities (Andrews and

Rothermel 1981). The model estimates actual fire behavior from specific descriptions of fuel type, fuel moisture, topography, and wind. The four descriptors of fire behavior that are plotted as a single point on the chart are:

1. Rate of spread (chains/hour), the forward rate of spread at the head of a surface fire.

2. Heat per unit area (~tulfta~) measure of the amount of heat that is released by a square foot of fuel while the flaming zone of the fire is in that area.

Flame Length		Fireline Intensity		Interpretation
ft	m	Btu/ft/s	kJ/m/s	
< 4	< 1.2	< 100	<350	• Fires can generally be attacked at the head or flanks by persons using hand tools. • Hand line should hold the fire.
4 – 8	1.2 – 2.4	100 – 500 350	- 1700	• Fires are too intense for direct attack on the head by persons using hand tools. • Hand line cannot be relied on to hold the fire. • Equipment such as dozers, pumpers, and retardant aircraft can be effective.
8 – 11	2.4 – 3.4	500 – 1000	1700 - 3500	• Fires may present serious control problems -- torching out, crowning, and spotting. • Control efforts at the fire head will probably be ineffective
> 11 >	3.4	> 1000	> 3500	• Crowning, spotting, and major fire runs are probable. • Control efforts at head of fire are ineffective.

Figure 37. Fire behavior/fire characteristics – intensity and Potential suppression can be affected by fuel types and their quantity (Andrews and Rothermel 1981).

3. Flame length (feet), the length of the flame at the head of the fire measured from the middle of the combustion zone to the average position of the flame tip. Flame length is determined by the rate of spread and the heat per unit area of the fire.

4. Fireline intensity (Btu/ft/s), the amount of heat released per second by a foot-wide slice of the flaming combustion zone (Byram 1959). This value has been directly

related to flame length, an observable characteristic of fire behavior. Fireline intensity is indicative of the heat that would be experienced by a person working near the fire.

There is a pressing need for analysis of fire behavior and a clear understanding of the analysis at all levels of management. In addition to traditional fire control and use activities, a successful fire manager must also evaluate alternative fire management strategies in relation to land and resource management objectives.

The desired regime type in which natural balance is restored through mitigation should be a stable ecological state such as grasslands, savanna, or woodland (i.e., fuel types) so that wildfire is less difficult, disruptive, and destructive. Urban and suburban developments may experience structural fire losses during a wildland fire; however, ignition is either house to house or by firebrands. If sufficient vegetation surrounds structures such that wildland fire spread is possible, the fuel mitigation strategies should be selected based on the appropriate vegetation characteristics present (Scott and Burgess 2005).

The corresponding risk assessment fuel types, mitigation strategy fuel types, and associated vegetation communities are briefly described below and further described in the following sections. The risk assessment general fuel types are based on Scott and Burgan (2005), while woodland categories utilize the types derived from the BCNWR study (White et al. 2009). Detailed vegetation types within the CWPP Plan Area are described in detail in **Section 2.0**. The mitigation strategy fuel types as discussed in this section are based on the 13 original fuel models developed by Anderson (1982). These fuel types are a more generalized classification of vegetation communities found throughout Texas and the United States. The correlation between the Baylor fuel types and the mitigation strategy fuel types by Anderson are shown below in **Table 21**.

The **timber litter** mitigation strategy fuel type (Anderson 1982) includes red oak woodlands, riparian woodlands, cedar elm woodlands, old-field woodlands, and post oak woodlands. Surface fuel consists of leaf litter. Overstory is at least 75-percent deciduous. Mid-story vegetation covers less than 25 percent of area. If midstory vegetation covers more than 25 percent of area it’s considered shrub fuel type. Fire intensity and spread rates typical of the timber litter fuel types range from 1.6 to 7.9 chains/hour and flame lengths of one to five feet.

Two risk model fuel types correspond to the timber litter mitigation strategy fuel type: closed juniper woodland and mixed juniper hardwood forest.

Table 21. Relationship Between Risk Assessment and Mitigation Strategy Fuel Types

	Mitigation Strategy Fuel Types (Anderson #) (Anderson 1982)				
Risk Assessment Fuel Types (White et al. 2009)	Timber Litter (8,9)	Grass (1,2,3)	Shrub (5,6)	Slash (11,12)	Special (4)
Sparse dry climate grass or grassland		X			
Aggrading juniper shrub		X	X	X	
Closed juniper woodland	X			X	X
Mixed juniper hardwood forest	X		X	X	X
Low load blowdown (dead canopy)	X	X	X		X
Low load activity fuel (slash)	X	X	X	X	

The corresponding risk model fuel type, **closed juniper woodland**, occurs where canopy closure is sufficient to limit growth of tall grass (18 inches or more tall) to less than 50 percent of the ground cover. Juniper (including Ashe juniper and/or eastern red cedar) and deciduous trees are the dominant vegetation types. Fire spread rate is moderate and flame length ranges from three to 26 feet (White et al. 2009).

The corresponding risk model fuel type, **mixed juniper hardwood forest,** is the 25-percent juniper, 75-percent deciduous class. Fire spread rate is moderate and flame length ranges from one to three feet (White et al. 2009).

Fuel treatment strategies for mitigation of wildfire risk for timber litter fuel types include:

SUSTAIN – Low-intensity prescribed fire during the winter when deciduous trees have dropped their leaves. Grazing, mechanical, manual, and chemical treatments are used to reduce ground cover and ladder fuels. Manual, mechanical, and prescribed fire treatments are employed to reduce CBD and wildfire risk.

PROMOTE – This is a climax community.

REDUCE – High-intensity mechanical or manual with follow-up via fire, mowing, chemical. Can be costly, cause soil issues, and vegetation reestablishment issues.

The **shrub** mitigation strategy fuel type (Anderson 1982) includes juniper woodlands and red cedar woodlands. Surface fuel is light and consists of cedar scales and duff. Overstory is at least 75-percent coniferous. Fire intensity and spread rates typical of the shrub fuel types range from 18 to 75 chains/hour rate of spread and flame lengths of four to 19 feet.

The corresponding risk model fuel type, **aggrading juniper shrub,** is one where live oak-juniper and juniper savanna are the dominant vegetation types. This fuel type is present throughout the entire county, and includes both Ashe juniper (*Juniperus ashei*), predominantly found in western Travis County, and eastern red cedar (*Juniperus virginiana*), predominantly found throughout eastern Travis County. Fire spread rate is four times greater than that of closed juniper woodland and flame lengths range from eight to 30 feet (White et al. 2009).

Fuel treatment strategies for mitigation of wildfire risk for shrub fuel types include:

SUSTAIN – Fuel management treatments that maintain the amount of woody vegetation within the property would be best suited for this regime change. These treatments could include mowing or grazing grasslands but avoiding areas of new and existing woody vegetation growth. Use manual (pruning/thinning) techniques to reduce CBD while keeping trees but reducing wildfire risk.

PROMOTE – Mow but avoid new woody vegetation growth. Conversion of shrubland to more woody regimes increases wildfire risk until woody vegetation stands are of sufficient size to withstand surface fires.

REDUCE – High-intensity prescribed fire, mechanical, manual, or chemical treatments to remove smaller woody vegetation (under five feet). Use mechanical or manual means to remove larger vegetation.

The **grass** mitigation strategy fuel types (Anderson 1982), includes short grass prairie, mid-grass prairie, tall grass prairie, live oak savanna, juniper savanna, and red cedar savanna. Surface fuel consists of grass. Trees or shrubs cover less than 50 percent of area. If trees or shrubs cover more than 50 percent of area consider as shrub or timber litter fuel type. Fire intensity and spread rates typical of the grass fuel types range from 78 to 104 chains/hour rate of spread and flame lengths of four to 12 feet.

The corresponding risk model fuel type **sparse dry climate grass** (Scott and Burgan 2005), or grasslands, is described as vegetative regimes dominated by grasses that are generally short and may be sparse or discontinuous (Scott and Burgan 2005). Pastures are also considered grasslands. Fire spread rate varies from moderate spread rate and low flame length in the sparse grass to extreme spread rate and flame length in the tall grass models (**Figure 38**) (Scott and Burgan 2005).

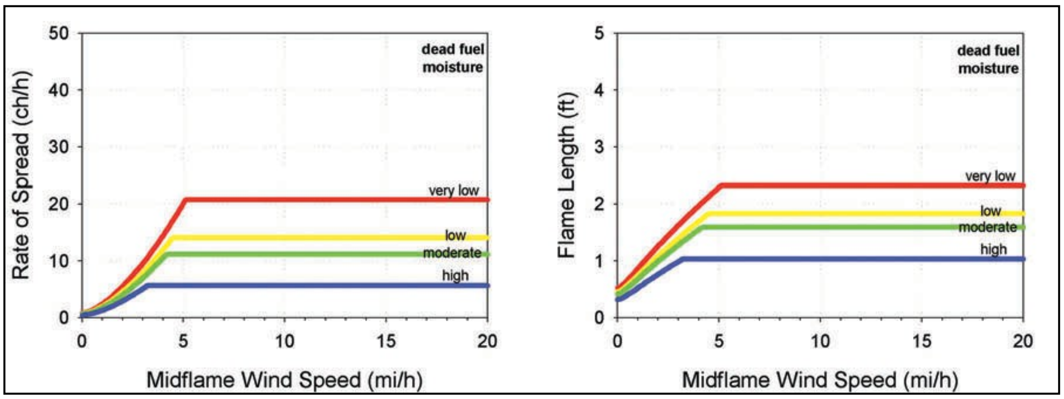


Figure 38. Rate of spread and flame length for sparse dry climate grass fuels (Scott and Burgan 2005).

Fuel treatment strategies for mitigation of wildfire risk associated with **grass fuel types** include:

SUSTAIN – Regularly applied, low-intensity prescribed fire, mowing, and grazing would be the most effective treatments to sustain the grassland regime. These treatments generally don't remove existing larger woody vegetation and keep new woody vegetation from establishing.

PROMOTE – Fuel management treatments that increase the amount of woody vegetation within the property would be best suited for this regime change. These treatments could include mowing or grazing grasslands but avoiding areas of new and existing woody vegetation growth. Conversion of grasslands to more woody regimes increases wildfire risk until woody vegetation stands are of sufficient size to withstand surface fires.

REDUCE – Most grasslands contain some woody vegetation. A reduction in vegetative regime would involve removal of all woody vegetation. Fuel management treatments such as high-intensity prescribed fire, mechanical, manual, or chemical that remove smaller woody vegetation (under five feet) combined with mechanical or manual treatments to remove larger vegetation would be best suited for this regime.

The **slash** mitigation strategy fuel type (Anderson 1982) represents vegetation that has been cut and lying on the ground. It includes mulch, distributed slash, windrows, and brush piles. Slash may also include significant wind or ice-damaged vegetation. Fire intensity rates typical of slash fuel types range from six to 13.5 chains/hour rate of spread and flame lengths of four to 11 feet.

The corresponding risk model fuel type, **low load activity,** represents mapped slash piles. Fire spread rate is moderate and flame length low (**Figure 39**) (Scott and Burgan 2005).

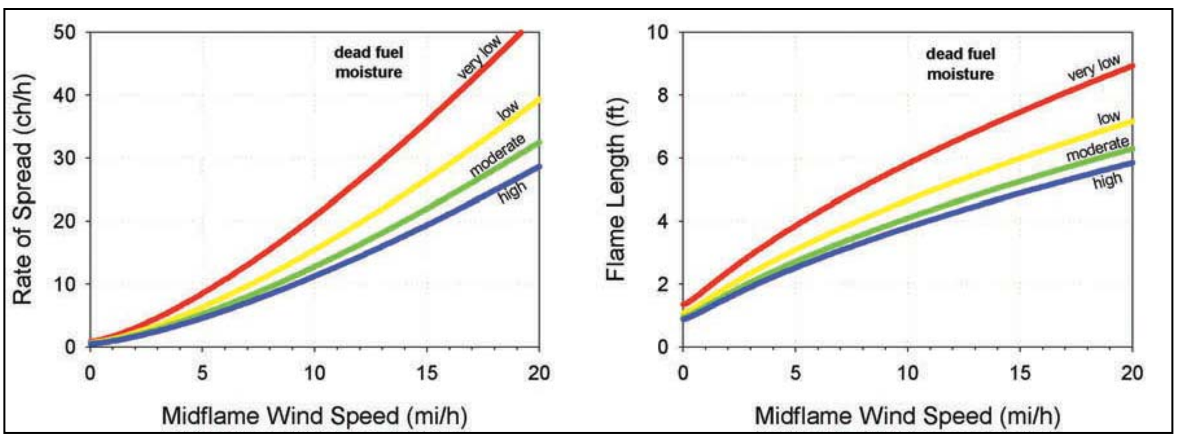


Figure 39. Rate of spread and flame length for low load activity fuels (Scott and Burgan 2005).

The **special** mitigation strategy fuel type (Anderson 1982) represents drought stress. It is vegetation not covered by other fuel types and typically has a high proportion of dead fuels and/or dense live fuels. Fire intensity and spread rates typical of the special fuel type are 75 chains/hour rate of spread and flame lengths of 19 feet.

The corresponding risk model fuel type, **low load blowdown,** represents dead canopy from the 2011 summer drought. Spread rate is moderate; flame length moderate (**Figure 40**) (Scott and Burgan 2005).

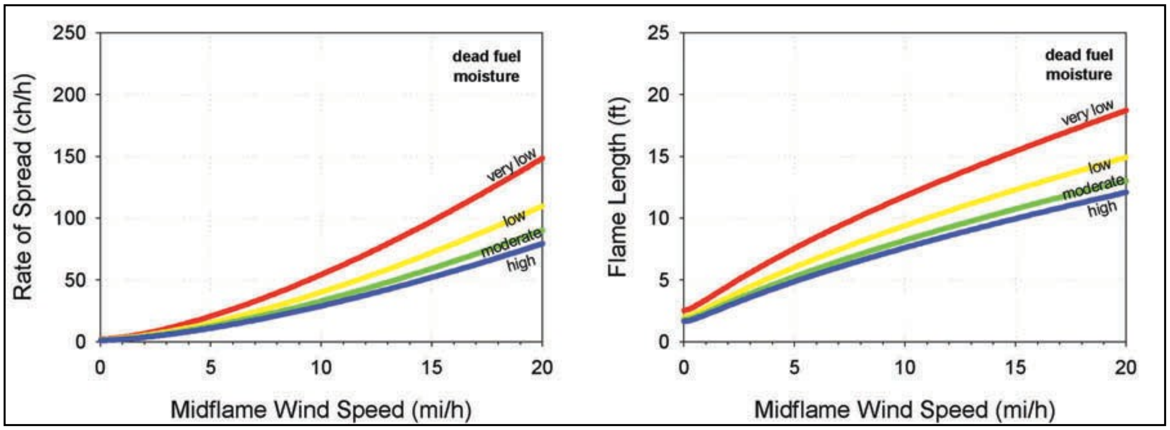


Figure 40. Rate of spread and flame length for low load blowdown fuels (Scott and Burgan 2005).

5.4.2.1 FUEL TYPE NUMBER ONE - TIMBER LITTER

Vegetation Types – Red oak woodlands, riparian woodlands, cedar elm woodlands, old-field woodlands, and post oak woodlands.

Vegetation Description – Surface fuel consists of leaf litter. Overstory is at least 75-percent deciduous. Mid-story vegetation covers less than 25 percent of area. If mid-story vegetation covers more than 25 percent of area consider as shrub fuel type.

Figure 41. Closed juniper woodland (Photos courtesy Glen Gillman).

Unique Vegetation Types – Mature live oak woodlands -- includes live oak woodlands with high crowns and limited overstory. Mature juniper woodlands or red cedar woodlands -- includes mature juniper woodlands with high crowns and few low branches. **If it can be walked though without stooping it can be classified as a timber litter fuel type.**

Figure 42. Mixed juniper hardwood forest (Photos courtesy Glen Gillman).

Specific Fuel Treatments - None

Anderson Fuel Model – Eight: Closed, Short Needle Timber Litter and Nine: Hardwood or Long Needle Pine Timber Litter

Baylor Fuel Model – Mixed juniper hardwood forest (model may have more juniper), and closed juniper woodland

Fire Description – A favorable fuel type with the lowest potential intensity, moderate frequency, and moderate rates of recovery. Fire intensity is generally low with limited movement of surface fire into the crowns due to lack of low branches, lack of leaves in winter, and high fuel moisture in summer. Frequency varies from high to low. Vegetation readily recovers after a fire although full recovery may take decades. Rate of spread varies between 1.6 to 7.9 chains/hour with flame lengths of one to five feet.

Ownership – Typical of small private lots with canopies. Typical of undeveloped public lands. Includes much of the Balcones Canyonlands Preserve and other largely public properties on the west side of the county, specifically along creeks, along the rim rocks at the upper slopes, and on slopes that face north. On the east side of the county, this includes most vegetation along creeks and, in some locations, healthy upland woodland communities.

Location – West side: Rim rocks at the top of slopes, riparian corridors. East side: Riparian corridors, discrete upland woodlands.

Treatment Options – If you currently have a timber litter fuel type, implementing no treatments will allow the site to slowly convert to a shrub fuel type. Implementing limited, periodic thinning, limbing, and some tree planting will maintain the site as a timber litter fuel type. Some periodic fine fuel removal through raking or prescribed burning may be required. Initial treatments may require greater fuel removal, as described below:

Treatments (in order of cost effectiveness)

1. Maintain fine fuel amounts.
2. Remove deadwood.
3. Thin smaller-sized juniper and brush.
4. Remove larger-sized juniper and trees in poor health under hardwood canopies.
5. Create canopy gaps between juniper canopies.
6. Plant hardwoods in canopy gaps.

Treatment Goals – To maintain system as hardwood woodland with low intensity surface fire and intact crowns. Primary strategy is to remove ladder fuels and minimize surface fuel build up. Periodic removal of understory trees and a focus on hardwood recruitment is critical. May require planting, deer control and/or periodic burning. Initial and periodic maintenance treatments are generally low intensity and produce limited fuel that requires disposal.

Constraints – Steep slopes, access locations, endangered species habitat, oak wilt, GIS data gaps, prescribed fire maintenance, riparian corridor objectives.

5.4.2.2 FUEL TYPE NUMBER TWO - SHRUB

Vegetation Types – Juniper woodlands, red cedar woodlands.

Vegetation Description – Surface fuel is light and consists of cedar scales and duff. Overstory is at least 75-percent coniferous.

Unique Vegetation Types – Immature live oak woodlands: includes live oak woodlands with defined trunks but low canopies. Mid story vegetation is present. **If it can**

be walked though with some difficulty but requires some stooping it can be classified as a shrub fuel type.

Specific Fuel Treatments - Shaded Fuel Breaks: a type of fuel treatment where woodlands or forests are limbed and/or thinned in an effort to minimize the movement of a fire from the surface to the crowns. They have some effect on reducing intensities but are primarily intended to minimize the development of crown fires and increase fire suppression effectiveness. They can be used adjacent to homes but could also be located away from homes to minimize ignitions. They may reduce canopy fire intensities

Figure 43. Juniper shrub/savannas (Photos courtesy Glen Gillman).

but may not be completely effective in stopping canopy fires once they ignite. A shaded fuel break in juniper fuels reduces intensities and may increase frequencies but the fuel reduction is not sufficient to shift the fuel complex to the timber litter fuel type. Naturally occurring timber litter fuel types function much like a shaded fuel break but are generally more effective due to the higher crowns.

Anderson Fuel Model – Five: Young brush and Six: Intermediate brush

Baylor Fuel Model – Aggrading juniper shrub and closed juniper woodland

Fire Description – An unfavorable fuel type with the highest potential intensities, the lowest frequency and the slowest rates of recovery. Fire intensity varies from low to high based primarily on vegetation moisture content. Under high-moisture conditions, fires burn with low intensity but under low-moisture conditions fires burn intensely. Stand structure also influences intensity; stands with fewer low branches, fewer small trees, variety in tree species and size class, more hardwoods and canopy gaps will decrease the ability of a fire to move through the crowns. Fire frequency is low. Vegetation does not generally recover rapidly after a fire. After recovery, the vegetation community will be dramatically different and may require intervention to reduce negative impacts. Fire spread rates range from 18 to 75 chains/hour with flame lengths from four to 19 feet.

Ownership – Representative of small, private lots with little management in all parts of county. Typical of unmanaged ranches and farms or development property. Includes much of the Balcones Canyonlands Preserve and other public properties on the west side of the county. On the east side, this fuel type is wide spread in discrete patches.

Location – West side: Well distributed. Common along Colorado River Valley. East side: Discrete upland woodlands.

Treatment Options – If you currently have a shrub fuel type, implementing no treatments will allow the site to remain as a shrub fuel type and, over time, increase in density. Implementing treatments will require significant resources. All treatments require significant thinning and may require mechanical equipment and fuel disposal planning.

In moist areas with good soils it may be possible to slowly shift the site to a timber litter fuel type through limbing, thinning, and tree planting. In dry areas with good soils it may be possible to quickly shift the site to a grass fuel type through thinning. In dry areas with poor soils it may be possible to quickly shift the site to a grassland. In all areas, it is acceptable to limit treatments to limbing and a limited amount of thinning to maintain the site as a brush fuel type.

In any case, treatments should be planned and implemented to minimize soil loss, which may require completing the project incrementally, and/or limiting the treatments conducted on steep slopes. Prescribed burning has limited use in shrub fuel models with the exception of pile burning or broadcast burning as a fuel disposal or restoration tool.

Treatments (in order of cost effectiveness)

1. Remove deadwood.
2. Create canopy gaps between juniper canopies.
3. Thin small-sized juniper and brush.

4. Remove larger-sized juniper and trees in poor health under hardwood canopies.

5. Plant hardwoods.

Treatment Goals – The goals vary depending on the site. In areas it may be possible to shift the site to a hardwood-dominated system by thinning and planting. In other areas, specifically those on poor soils, the site may best be shifted back to a grassland through thinning. In other locations due to cost, topography, or other considerations it may be best maintained as a shrub fuel type with some understory thinning and/or removal of a limited number of trees.

Constraints – Steep slopes, access locations, endangered species habitat, oak wilt, data gaps, biomass disposal.

5.4.2.3 FUEL TYPE NUMBER THREE - GRASS

Vegetation Types – Short grass prairie, mid-grass prairie, tall grass prairie, live

Figure 44. Tall grass (may include oak savannas) (Photo courtesy Glen Gillman).

oak savanna, juniper savanna, red cedar savanna.

Vegetation Description – Surface fuel consists of grass. Trees or shrubs cover less than 50 percent of area. If trees or shrubs cover more than 50 percent of area consider as shrub or timber litter fuel type.

Unique Vegetation Types – None.

Specific Fuel Treatments – Hay Baling-The collection and storing of grass as hay is a common agricultural practice. Haying reduces surface fire intensities but the storage of hay bales concentrates fuels in a small area. Suppression of hay bale fires is problematic. If the hay bales ignite, generally all of the bales will burn if there is insufficient separation between them.

Anderson Fuel Model – One: Short grass, Two: Grass with timber/shrub overstory, and Three: Tall grass

Baylor Fuel Model – Sparse dry climate grass

Fire Description – A favorable fuel type with moderate intensities, high frequencies and the highest rates of recovery. Fire intensity varies from low to high based

Figure 45. Tall grass (may include oak savannas) (Photo courtesy Glen Gillman).

on the height and density of grass. Rates of spread are generally high. Movement of surface fire into the crowns varies with type, structure, and density of overstory vegetation. Deciduous trees are less likely to torch than coniferous trees. Trees with high crowns are less likely to torch than trees with low crowns and greater spacing between trees reduces crown fire potential. Frequency varies from low to high based on density of grass. Vegetation readily recovers after a fire, often in less than six months. Rate of spread varies between 78 to 104 chains/hour and a flame length of four to 12 feet.

Ownership – Typical of small lots without canopies and private property on the south and east sides of the county. Typical of actively managed ranches or farms. Typical of developed public lands. Includes much of the Water Quality Protection Lands and other public properties located on the south and east sides of the county. May include some areas on the west side of the county, especially at mid-slopes.

Location – West side: Mid-slopes on poor soils, level areas north, west, and southwest of Colorado River. East side: well distributed.

Treatment Options – If you currently have a grass fuel type, implementing no treatments will allow the site to quickly convert to a shrub fuel type. Implementing limited periodic thinning in grasslands and savannas and limbing in savannas will maintain the site as a grass fuel type. Some periodic fine fuel removal through mowing, disking, or prescribed burning may be required. Initial treatments may require greater fuel removal, as described below.

Treatments (in order of cost effectiveness)

1. Maintain fine fuel amounts.
2. Remove deadwood.
3. Mow periodically and/or encourage low-growing grasses.
4. Remove junipers to favor grasslands or savannas in uplands.
5. Plant hardwood trees to favor development of woodlands in bottomlands.

Treatment Goals – Goal is to maintain system as a grassland or savanna with widely spaced and well-maintained trees or, where appropriate, shift system to less fire-prone woodlands. Primary strategy is to minimize encroachment by trees and brush and shift to a less-favorable fuel type by removing whole trees. In savannas it is also necessary to remove ladder fuels and minimize surface fuel build up. May require periodic mowing or burning. Initial treatments may create significant amounts of brush that must be removed but subsequent treatments are generally low intensity.

Constraints – Prescribed fire maintenance.

5.4.2.4 FUEL TYPE NUMBER FOUR - SLASH

Vegetation Types – Cut vegetation.

Figure 46. Slash (Photo courtesy BCP)

Vegetation Description – Vegetation that has been cut and is lying on the ground. Includes mulch, distributed slash, windrows, and brush piles. May also include significant wind or ice damage.

Unique Vegetation Types – None.

Specific Fuel Treatments - Mulching treatments use machinery to masticate woody fuels and convert them to mulch. They have some effect on reducing intensities and the movement of a fire from the surface to the crowns. They do increase the amount of heat at the surface and increase the amount of tree mortality and slow recovery rates.

Fire suppression in mulch fuels is problematic. Mulched areas generally burn for a long time and are difficult to suppress.

Anderson Fuel Model – 11: Light slash and 12: Medium slash

Baylor Fuel Model – Low load blowdown.

Fire Description – An unfavorable fuel type with high intensities, high frequencies, and slow rates of recovery. Generally these fuels are created by human activities. Dead fuels usually are a component of other fuel types and in most cases not the primary fuel type. However, their presence will increase the intensity and frequency of fires and increase the time required for recovery. Fire intensity rates typical of the slash fuel types range from six to 13.5 chains/hour rate of spread and flame lengths of four to 11 feet.

Ownership – Widely distributed. Generally small areas although development or restoration activities, specifically mulching, can create high volumes across a large area. On the east side, concentrations of dead trees areas evident in old-fields with unfavorable conditions from tree growth.

Location – West side: well distributed. Generally associated with mulching operations. East side: well distributed. Generally associated with old-fields.

Treatment Options – Remove dead fuel. Remove small-diameter fuels first and larger fuels second. Fuels over six inches in diameter can be left on site provided they are well distributed.

Treatments (in order of cost effectiveness)

1. Remove deadwood.
2. Distribute material across landscape.
3. Chip in piles.
4. Chip and scatter or stack in piles or windrows.

Treatment Goals – Fuels should be removed. After the initial treatment, fuel volumes should be low and, with regular maintenance, fuel loads can be maintained.

Constraints – Pre-planning, data gaps, biomass disposal.

5.4.2.5 FUEL TYPE NUMBER FIVE - SPECIAL

Vegetation Types – Drought stress.

Vegetation Description – Vegetation that is not covered by other fuel types and typically has a high proportion of dead fuels and/or dense live fuels.

Unique Vegetation Types – Immature live oak woodlands, includes live oak shrublands with low canopies and undefined trunks. Mid-story vegetation is present. **If it is very difficult to walk through it can be identified as a special fuel type.**

Specific Fuel Treatments - None

Anderson Fuel Model – Four: Mature brush

Baylor Fuel Model – Low-load activity.

Fire Description – This category covers unique fuel types currently in the landscape but is also intended to cover fuel types that have not yet been identified but anticipated to develop as drought stress and other factors adversely affect current fuel types. These are expected to be unfavorable fuel types with high intensities, moderate frequencies, and moderate rates of recovery. Fire intensity and spread rates typical of the special fuel type are 75 chains/hour rate of spread and flame lengths of 19 feet.

Ownership – Oak shrub is limited to discrete patches generally in the northwestern part of the county. Drought stress fuels are currently well distributed across all parts of the county. Drought stress has increased the number of dead trees but they are widely distributed on the west side.

Location – West side: Primarily in northwest part of county. East side: Uncommon.

Treatment Options – Request Consultation.

Treatments -- Request Consultation.

Treatment Goals – Request Consultation.

Constraints – Steep slopes, access locations, endangered species habitat, oak wilt, GIS data gaps, prescribed fire maintenance, riparian corridor objectives.

5.4.3 FUEL REDUCTION PRINCIPLES

The planning considerations for fuel reduction include objectives and benefits to develop fuel reduction treatments and strategies to combat wildfire. The following sections highlight the basics of fuel reduction for managing fire behavior and describe the objectives, benefits, and desired outcomes of the Austin-Travis County CWPP.

BASICS OF FUEL REDUCTION FOR COMBATING FIRE BEHAVIOR

Reduction in available fuels can aid in mitigating the impacts of wildland fire by altering the conditions that surface fires and canopy fires encounter on reaching the WUI. Fuel reduction can diminish the impact of surface fire by reducing the risk of ignition, disrupting the horizontal and vertical transmission, and regulating the intensity of the fire. Canopy fires are significantly more difficult to combat, and can be mitigated somewhat by reducing intensity through reduction in bulk canopy density, or by increasing breaks in the canopy. These objectives are also applicable in the HIZ as discussed previously and strategies for implementing them are covered in detail in this section.

Break horizontal continuity to reduce the ability of fire to move through the surface vegetation. A horizontally continuous and unbroken layer of fuel is generally necessary to allow fire to spread across the landscape. Breaks in horizontal continuity -- fuel breaks, roads -- can act as barriers and help slow and even prevent the spread of wildfire.

Break vertical continuity to reduce the fire’s ability to move from the surface vegetation to the tree canopies. Vertical continuity is the continuous connection between fuels on the surface and fuels in the tree canopy or up the side of a house. Dense understory vegetation, tall grasses, shrubs, and vines are examples of fuels that can provide vertical continuity if they grow into the tree canopy. A vertically continuous and unbroken layer of fuels is necessary for a surface fire to spread into the tree canopy or up the side of a house. These vertical fuels are often referred to as ladder fuels and include vines, low-hanging branches, or a high understory layer of shrubs and small trees. As with horizontal breaks, breaks in vertical continuity -- removal of ladder fuels -- can slow or prevent the spread of fire into the tree canopy.

Break canopy continuity to reduce the ability of a fire to move through tree canopies. Canopy continuity or compactness refers to the spacing between fuels. Tightly compacted surface fuels do not burn as well as lightly compacted ones due to the reduced amount of oxygen between the fuels.

5.4.4 TREATMENT OBJECTIVES

The primary objective of fuel management is the protection of life and property through mitigation strategies and treatments to existing fuel types and loads in order to reduce wildfire risk. Fuel treatments for wildlands are designed to alter fuel conditions so that wildfire is less difficult, disruptive, and destructive (Reinhardt et al. 2008). Other major objectives of fuel management include:

- Promote lower intensity, smaller wildfires that decrease the risk of life and property loss as a result of fuel management in conjunction with home hardening and defensible space actions taken by homeowners.
- Provide safety for both firefighters and the public during wildfire suppression.
- Keep periodic wildfires on the ground, leaving the woodland intact with reduced energy releases and flame length on areas where fuel loads are actively managed.
- Decrease the potential for catastrophic wildfires that may put lives and property at risk, and permanently damage vegetation regimes and ecosystems.
- Reduce the potential for a catastrophic crown fire.
- Provide time for fire suppression resources to arrive, to evaluate, manage, and/or extinguish fuels, which results in a wildfire with a reduced rate of spread.

The benefits and desired outcomes from the Austin-Travis County CWPP and fuel management strategies that have been developed include:

- To provide residents, public officials, and land managers with effective tools to reduce the impacts of wildfire.
- To reduce the likelihood of crown fire initiation.
- To reduce wildfire intensity through activities that separate surface and ladder fuel continuity and volume.

- To manage and modify fuels and configurations of trees and plants.
- To reintroduce low-intensity (cool-burning) fire.
- To positively contribute to the ecological processes and functions of local forest and plant communities.
- To improve the health of vegetation most suited to the site.
- To emulate a plant regime similar to what occurred with natural fire.
- To maintain and enhance native species diversity.
- To maintain and enhance wildlife habitat.
- To control problematic, invasive, non-native species.
- To enhance soil stability where appropriate, in conjunction with fuel-reduction.
- To make fire-suppression efforts safer and more effective as a result of reduced fuel loads in the vicinity of roads, homes, and other important areas.
- To utilize byproducts of fuel-reduction work where ecologically appropriate and economically feasible, to help offset costs.

5.4.5 GENERAL FUEL REDUCTION STRATEGIES

Fuel management strategies are actions that can be taken to remove and/or rearrange vegetation in order to affect potential fire behavior. Fuel treatments are designed to affect fire behavior in specific ways and different strategies are required based on the site characteristics, risk, fuel type, and land management goals. The following fuel management strategies are identified by the primary strategy and the specific actions that can support that strategy. Generally, these strategies are appropriate in any fuel type and only the relative importance varies by fuel type. The strategies are not independent and multiple strategies are likely to be needed in any given fuel type.

1) Reduce the intensity of the surface fire.

   a) Reduce the amount of fine fuels such as leaf litter and grass.

   b) Reduce the amount of branch wood, especially material less than three inches in diameter.

2) Reduce the ability of the fire to move through the surface vegetation (break horizontal continuity).
   a) Construct non-flammable barriers.
   b) Construct fuel breaks with reduced fuel loadings.
   c) Encourage diversity in vegetation communities.
3) Reduce the ability of the fire to move from the surface vegetation to the tree canopies (break vertical continuity).
   a) Limb lower branches.
   b) Remove smaller diameter trees.
4) Reduce the ability of the fire to move through tree canopies (break canopy continuity).
   a) Provide spacing between trees and/or clusters of trees.
   b) Reduce bulk canopy density.

It is important to recognize that the first three strategies are focused exclusively on managing surface fire spread. If fire managers can keep fires on the surface they have a much higher likelihood of managing them than if the fires begin to move through the canopies. However, due to the sensitivity, longevity, and importance of trees, precautions are necessary before removing whole trees. In general, reducing biomass within the canopy and providing diversity in species and/or size classes are effective treatments in the canopy. The following guidelines should be adopted when conducting fuel treatments that affect the canopy:

- Deciduous trees should be encouraged over coniferous trees;
- Remove smaller diameter trees under the drip line of larger ones;
- Remove smaller diameter trees to ensure there are no overlapping canopies;
- Remove smaller diameter trees that are sensitive to disease and pests;

If there are insufficient deciduous trees, limited small diameter trees, or few overlapping canopies, but a continuous canopy remains (common in juniper woodlands), then the removal of individual, larger diameter trees is acceptable provided no more than 20 percent of the canopy is removed and there is a high likelihood of infill by younger trees. However, it is also important to include other primary and secondary land management goals. Even removal of less than 20 percent of the tree canopy might have significant effects on wildlife habitat values, plant community composition, or hydrology.

Fuel management approaches are as varied as the environments to which they are applied. More than one approach may be combined to achieve the desired fuel reduction objectives and support other primary and secondary land management goals, since treatments should be designed for a specific location to ensure the most effective outcome.

5.4.6 TREATMENTS FOR FUEL REDUCTION

A variety of treatments or techniques to reduce fuel accumulation and reduce fire hazard have been advocated for some time (Martinson and Omi 2003). Understanding the costs, advantages, concerns, and potential impacts of the treatments being considered in relation to the treatment approach is an integral component in determining the appropriate fuel reduction treatments or the right combination of treatments. Factors to be considered in selecting fuel reduction treatments are: diameter of the vegetative materials, acreage of the project, slope and topography, fuel density and moisture content, proximity to structures and other values at risk, treatment costs, the accessibility of the area, worker safety, and the overall project objectives.

Protection of life and property in concert with any applicable land management goals should always guide selection of the appropriate fuel-reduction treatment. When treating canopy fuels, they should generally be designed as linear treatments located adjacent to structures, as linear treatments located along ignition corridors (roads), or in areas where favorable conditions already exist (drainages) to limit ignitions and fire spread. In areas that have little variability in vegetation and/or areas on steep slopes, canopy treatments may extend farther down slope to minimize the intensity of a canopy fire.

These few, of the myriad condition combinations existing across the county, illustrate the need for a tool like the WMS Builder provided in **Section 5.6** to help determine the appropriate strategy and component treatments for fuel reduction.

Fuel management approaches are as varied as the environments to which they are applied. Fuel reduction treatments focus on the fuel characteristics and fuel types present, as well as site-specific considerations/constraints such as environmentally sensitive areas, endangered species, water quality, and topography. Most properties are composed of multiple fuel types with varying characteristics. Each fuel type and characteristic should be evaluated independently, as well as a component of the whole when managing fuels to reduce wildfire intensity.

More than one approach may be combined to achieve the desired fuel reduction objectives, since treatments should be designed for a specific location to ensure the most effective outcome. Treatments can be mixed spatially (adjacent to each other) or temporally (in sequence on the same site). Combined fuel management treatments may particularly be necessary when treating dense vegetation or in areas with habitat used by protected species such as the golden-cheeked warbler and black-capped vireo.

Examples of spatial (adjacent) fuels management treatments include:

- Mechanical or manual clearing of fuels around homes combined with the use of regular prescribed fire, mowing, or grazing to maintain greenspace surrounding the high-risk area.
- Manual clearing or grazing in sensitive areas (e.g., steep slopes, karst) or areas where trees are too thick to allow access (e.g., stream banks) combined with prescribed fire or mowing on open or flat areas of the site.

Examples of temporal (time-sequence) fuels management treatments include:

- Mechanical or manual clearing, chemical treatment, or mowing to reduce or remove high shrubby vegetation, followed by prescribed fire or mowing every few years to maintain the site.
- Grazing to increase visibility and expose hazards to machinery, such as fixed improvements (e.g., wells, vents) or debris, followed by the use of prescribed fire or mowing every few years to maintain the site.

Fuel treatments -- manual, mechanical, fire, chemical, or grazing -- can promote, sustain, or reduce the existing vegetation regime in order to reduce wildfire risk. However, management that transitions vegetation regimes from one ecological state to another may increase wildfire risk until the new regime is stable. A general discussion of fuel management treatment applications in relation to vegetative successional regimes is summarized below.

The primary fuel treatment method recommended for wildfire risk mitigation activities is the fuelbreak. Fuelbreaks are a natural, temporary or permanent manmade feature that isolates an area from a fire hazard, and can create a safety zone for firefighters and give them access to remote areas during suppression activities.

5.4.6.1 WOODLAND SHADED FUELBREAK

Shaded fuelbreaks are a type of fuel treatment where woodlands or forests are limbed and/or thinned in an effort to minimize fire movement from the surface to the crowns. They have some effect on reducing intensities but are primarily intended to minimize the development of crown fires and increase fire suppression effectiveness. They can be used adjacent to homes but could also be located away from homes to minimize ignitions. They may reduce canopy fire intensities but may not be completely effective in stopping canopy fires once they ignite. A shaded fuelbreak in juniper fuels reduces intensities and may increase frequencies but the fuel reduction is insufficient to shift the fuel complex to the timber litter fuel type. Shaded fuelbreaks mimic the natural timber litter fuel type, which are least prone to the occurrence of crown fires. Naturally occurring timber litter fuel types function much like a shaded fuel break but are generally more effective due to the higher crowns.

5.4.6.2 SHRUBLAND FUELBREAK

Shrublands are unique fuels in that they are often a transitional vegetation type, though not always, between a grassland and woodland. They have features of both and, depending on conditions, may react as a surface fuel or as a canopy fuel. If the goal is to shift the shrubland to a woodland, then selective thinning and reducing ladder fuels can encourage the growth of fewer, larger trees. If a grassland is desired, then more thinning is required to minimize shrubs and encourage grass growth.

Shrubs are generally prolific resprouters and multiple strategies are typically necessary to encourage the transition to either end state, which can be costly and difficult to achieve. Some systems, such as oak shrub, may maintain themselves as a shrub system due to site characteristics.

For linear treatments, it is generally necessary to clear an area and then maintain it with regular mowing. Periodic limbing would be required.

5.4.6.3 GRASSLAND FUELBREAK

Grasslands can be maintained easily with regular tree and brush removal. This should be done when the trees and/or shrubs are small and can be effectively removed. When small, they can be readily cut and left on site. As they grow larger, the material cannot be left on-site and should be removed.

For large areas, a combination of mechanical, chemical, and prescribed burning is most acceptable. For a linear treatment, mechanical, chemical, and mowing can be effective.

5.4.6.4 PRUNING INDIVIDUAL TREES

The practices set forth in this section are consistent with the pruning guidelines and Best Management Practices adopted by the International Society of Arboriculture, the American National Standard for Tree Care Operations – Tree, Shrub, and Other Woody Plant Maintenance-Standard Practices (ANSI A300), the U.S. Forest Service, and the National Arbor Day Foundation. The ANZI standard 301 should be utilized for proper tree pruning and implementation of activities should follow ANSI Z133.1 Safety Requriements for Aboricultural Operations. In addition, the following oak wilt standards provided below should also be utilized, including the City of Austin oak wilt suppression guidelines that cover proper disposal of infected debris.

- http://austintexas.gov/sites/default/files/files/Planning/City_Arborist/Oak_Wilt_Policy.pdf
- http://www.texasoakwilt.org/Professionals/ISATTFSOakwiltpruningofficial_v2.pdf

There are four primary types of pruning:

Cleaning: The removal of dead, dying, diseased, crowded, weakly attached, and low-vigor branches from the crown of a tree.

Thinning: The selective removal of branches to increase light penetration and air movement through the crown. Thinning opens the foliage of a tree, reduces weight on heavy limbs, and helps retain the tree's natural shape.

Raising: Removes the lower branches from a tree in order to provide clearance for buildings, vehicles, pedestrians, and vistas.

Reduction: Reduces the size of a tree, often for utility line clearance. Reducing the height or spread of a tree is best accomplished by pruning back the leaders and branch terminals to lateral branches that are large enough to assume the terminal roles (at least one-third the diameter of the cut stem). Compared to topping, this helps maintain the form and structural integrity of the tree.

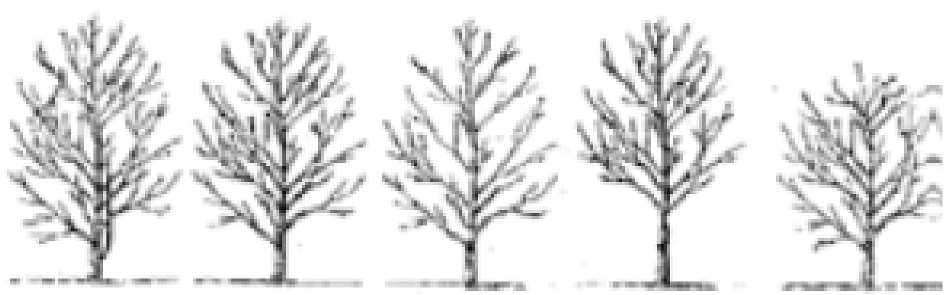


Figure 47. Examples of types of tree pruning (International Society of Arboriculture)

There are two important points to highlight with respect to pruning:

1. It is okay to maintain natural tree form. In such cases, select alternative techniques to mitigate around the desired tree.
2. Pruning can exacerbate fire risk if done improperly.

It is important to make proper pruning cuts when implementing pruning techniques to reduce fuel loads. The specifications from the International Society of Arboriculture for pruning should be following before implementing any pruning.

5.4.6.5 DRIP-LINE THINNING

The technique of drip-line thinning can be used to reduce ladder fuels and relieve desired trees from competition for nutrients, sunlight, and water by removing the nearby small trees and shrubs. The drip line is the area at the end of the longest branches of a tree or shrub where water drips vertically to the forest floor. Drip-line thinning is accomplished by clearing away the ladder fuels within the drip-line circumference around the desired leave tree. The best place to begin is by picking out the healthiest, largest, desired leave trees and drip-line thin around them. You can then reevaluate what vegetation is left and plan how to shape the remaining plants and stands of trees. Trees may be left individually, or standing in groups.

Primary methods of fuel management are summarized in **Table 23** and further described in the following sections:

Table 23. Primary fuel management treatments for wildfire risk reduction.

Treatment Method	Advantages	Concerns	WUI Application	Maintenance and Scheduling
Manual Treatment *(hand tools)* (incl. thinning, pruning, hand piling, raking)	-Large local labor/contract pool - Can treat areas that cannot be treated by prescribed fire or mechanical means	- Labor intensive; may not be cost effective in areas of heavy fuels - May require more than one entry to achieve objectives for site - Operations influenced by weather - Chainsaw use may be constrained by fire season requirements - Cut material needs to be handled off-site or mulched. Otherwise, it is still fuel.	- Very effective within or adjacent to WUI, either as a stand-alone treatment or in conjunction with follow-up fuels treatment methods	- Timing for subsequent treatments dependent upon conditions, resources, goals and degree of change made via initial treatment
Mechanized Treatments *(large equipment)* (incl. thinning, pruning, lop and scatter, mowing, crushing, chipping)	- Cost effective over larger areas	- Labor intensive - Large equipment has limited access - Potential for soil disturbance/damage - May be less economically feasible on small sites due to move-in/move-out costs - May create short-term increase in fire risk - Influenced by seasons and weather, habitat, fire season, crew safety/exposure	- Can be very effective within or adjacent to WUI, either as a stand-alone treatment or in conjunction with follow-up by other treatment methods	- Timing for subsequent treatments dependent on fuel types/amounts, degree of change via initial treatment, increased canopy cover, reduced fine fuels
Prescribed Burning (incl. broadcast, understory or pile burning)	- Encourages and maintains herbaceous cover for habitat and watershed protection - Reduces fine, cured fuels and downed woody fuels where present - Minimal soil disturbance in most cases - Cost effective in most cases	- Broadcast and understory burns require skilled application by certified professionals - Time and resources needed to inform and educate the public - Air quality - Erosion on steep slopes - Potential to kill non-target vegetation - Burning constrained by weather, fuels characteristics, and smoke management constraints	- Burning may be effective within/adjacent to WUI, as a stand-alone treatment or in conjunction with mechanized or manual treatment methods - Most burning opportunities are on public lands and along outer perimeters of urban areas or boundaries	- Timing for subsequent treatments dependent on location, condition class, goals, and degree of change made via initial treatment
Chemical Treatment (incl. selective herbicide applications, foliar sprays/wipes, basal sprays/ wipes, stem injection, frill-girdle, cut stump, broadcast)	- Application can be targeted - Little soil disturbance - Maintains cover for wildlife	- Air quality impacts - Water quality impacts - Potential to eliminate desirable plants - Targeted applications are labor intensive - Dead vegetation remains part of fuel load - Some herbicides are effective only when target plant is in specific growth stage - Most treatment methods require application by personnel with Certified Applicators License for Pesticides – for both Structural Application and Lawn and Ornamental Application.	-Targeted applications in small areas not amenable to prescribed fire -Broadcast on ROW or fence lines	- Chemical treatments will probably require repeat applications over a period of time for on-going control - Timing for subsequent treatments dependent upon conditions, resources, goals, and degree of change made via initial treatment
Grazing Treatment (Biomass conversion)	- Can treat areas that cannot be treated by prescribed fire or mechanical means (i.e., dense woodlands and steep slopes) - Reduces the levels of fine fuels -Application can be targeted	- Potential to eliminate desirable plants - Potential for soil disturbance/damage from overstocking or unlimited access to sensitive areas - May be less economically feasible on small sites due to move-in/move-out costs - May require more than one entry to achieve objectives for site - May be labor intensive to properly maintain the animals and protect them and the property - May require higher stocking rates or extended durations on the property depending on fuel loads - Potential spread of invasive species through manure	- Very effective within or adjacent to WUI, either as a stand-alone treatment or in conjunction with follow-up fuels treatment methods	- Timing for subsequent treatments dependent upon conditions, resources, goals, and degree of change made via initial treatment

5.4.6.6 MANUAL TREATMENT

Proper manual treatments for brush control involve selective removal of an individual stem or stems by hand tools, rather than broad-scale removal by heavy equipment. Certain soil types, soil loss, and erosion factors on a property where brush management is needed diminish the suitability of using heavy equipment. Selective cutting helps prevent soil erosion and can be used to prevent damage to desirable trees and shrubs. Selective, single-stem removal brush management is the best tool for helping to prevent the spread of certain tree disease as well. Use of broad-scale removal methods and/or heavy equipment can damage healthy trees, increasing the opportunity to spread disease. Manual treatments for brush removal should be targeted at regrowth vegetation invading open areas and conducted to avoid disturbing habitat during the breeding season for most native songbirds (generally March 1 through August 31).

Consider the following items when determining whether manual treatment is the appropriate fuel management treatment for the property:

- Use only selective methods, such as cutting with chainsaws or loppers, to remove undesirable brush. Do not scrape the area with a front-end loader or bulldozer. These non-selective removal methods could result in excessive damage to thin and easily erodible soils and increase the opportunity to spread oak wilt.
- Retain some areas of brush to provide cover for wildlife. Brushy, escape cover is an essential habitat component for many wildlife species.
- Learn to identify the common signs of oak wilt and other tree diseases and how to property prevent, treat, and remove infected species (**Section 2.3.3**, **Section 5.4.7**, and **Appendix D**).

5.4.6.7 MECHANICAL TREATMENT

Mechanical treatments are often most appropriately used in areas within or directly surrounding communities as well as in combination with other types of treatments. Examples of mechanical treatment to remove live and dead fuels include disking, chopping, masticating, chipping, grinding, cutting, or mulching.

Chopping – the most basic mechanical treatment where weight alone is used to reposition fuels close to the ground and typically used to prepare the area for burning.

Disking - an efficient and cost-effective surface fuel management practice commonly used to create early successional plant communities. It inhibits woody growth, promotes favored seed producing plants, reduces plant residue, increases bare ground, and increases insect abundance.

Mastication – a surface fuel modification technique involving the use of heavy machinery to reduce standing live and dead shrubs and tree saplings into small chunks. Types of mechanical mastication include grinding, crushing, shredding, chipping, mulching, and chopping of fuel that can reduce fire line intensity and the rate of fire spread.

Mulching – the cut, chop, or grinding of vegetation into particles that are usually left on-site as mulch.

Chipping - the use of machinery to reduce branches and other small materials to small chips, or wood chips. It is another method for treating thinned materials, with both advantages and disadvantages.

Advantages: You can work on most days when other options may not be feasible. Chips can be used for landscaping, such as on paths around a home site (but not within the five-foot, fire-free zone). Chips spread along roadsides will suppress the growth of vegetation, thereby keeping down fire hazards. There is no chance for escaped fires or smoke.

Disadvantages: Chipping can be expensive if you are doing it on your own. Chippers break down and need to be serviced. Production levels for slash disposal can be slow, especially with large materials and a small chipper. Chippers are limited to where they can be staged; they generally need to be close to roads. Chippers are noisy.

Lop and Scatter – a method whereby thinned materials are spread about to rot on the forest floor—taking care not to form large piles of slash (jackpots). Lop and scatter can be very cost-effective; it is definitely a site-specific treatment. This is the best method for improving site soil fertility and the ecosystem’s long-term productivity. By removing the ladder fuels and scattering them low to the ground, you are improving the chances of your wildland surviving a wildfire. However, because of short-term increased hazard this is not a method to use near structures within the Defensible Space Zone. It is more appropriate in the Community Protection Zone. If feasible, it's preferable to remove residual fuels from the treatment area.

Removing both live and dead fuel can require large equipment such as feller bunchers, skidders, and grapplers that may cause damage to the environment in which they are being used. Prescriptive mechanical treatment is labor intensive, but can be more precise than prescribed fire and avoids concerns regarding smoke or scorch damage. With appropriate planning, chipped, crushed, or masticated debris can be recycled, moved to a different location requiring mulch, and/or distributed in place to enrich the ecosystem with nutrients.

Consider the following items when determining whether mechanical treatment is the appropriate fuel management treatment for the property:

- Most mechanical methods such as disking or grubbing generally disturb the soil and may not be suitable for areas with steep slopes, karst features, or adjacent to surface water such as rivers, streams, or creeks. Consider using other fuel treatments in these areas.
- Most mechanical methods utilize heavy machinery that can also result in excessive soil disturbance. These impacts can be lessened by choosing equipment with rubber tires instead of tracks, utilizing soil stabilization BMPs (**Section 5.4.7**) and avoiding repeated driving over the same area to stack material.
- Use of mechanical methods that leave the root structure of woody vegetation intact should be considered (e.g., roller chopper and shredding).

5.4.6.8 BIOMASS REMOVAL (THINNING)

Thinning modifies the fuel structure and reduces canopy bulk density (CBD) in forests that have become denser due to fire exclusion. Thinning projects that reduce ladder fuel or crown fuel continuity can be effective at moderating crown fire behavior.

This method of vegetation removal includes chipped biomass harvesting, vegetation or tree thinning, or timber harvesting. Thinning vegetation may be designed to remove trees below a certain defined diameter, ladder fuels, or crown fuel continuity. Within juniper woodlands, thinning should focus on maintaining the existing tree spacing in order to maintain adequate canopy cover. These treatments modify crown fire behavior, particularly when fine surface fuels are also removed. Thinning is also a means of improving forest health and promoting long-term viability of some fuel types and forest regimes. It helps to maintain diverse wildlife and plant habitat. Thinning encourages trees that are more drought and insect resistant. It benefits larger, old-growth stands that will thrive from decreased competitive stress. Creating shaded fuel breaks and fuel mosaics in central Texas improves recovery from severe wildfire by reducing the potential for crown fire spread.

5.4.6.9 PRESCRIBED BURNING

Prescribed burning (prescribed fire) is the use of fire in a skilled manner, under prescribed conditions planned to achieve specific fire behavior and effects in order to accomplish predetermined management and land use objectives in a specific area. Burning can be used to: reduce hazardous fuels; control insects and disease; remove non-native and/or invasive species; provide forage for wildlife; improve habitat for wildlife, including threatened and endangered species; recycle nutrients into the soil, and promote growth of trees, wildflowers, and other plants.

Using prescribed fire for fuel mitigation and land management requires a thorough understanding of fire’s dichotomous role.

Prescribed burning is intended to mimic the natural fire of ecosystems while reducing fuels that contribute to wildfire risk. Prescribed fire is a well-organized and explicit activity. It begins with a prescriptive burn plan that details the parameters of the burn, including the specific characteristics of the site, management goals for the site and the surrounding community, parameters for acceptable weather conditions, and tactics and resources for controlling and/or suppressing the fire within the project boundaries.

Prescribed burning can be an important fuel and debris management tool. Burning woody and herbaceous debris opens surface areas to sunlight, reduces plant competition, prepares a seedbed, and recycles key organic chemicals that help to naturally fertilize nutrient-poor soils. However, depending on the property conditions and fuel loads, prescribed fire alone may not achieve land and fuel management goals.

There's a difference between prescribed burning in open grasslands versus understory burns in closed canopy woodlands. Currently, only grass sites are broadly burned. Grassland burning reduces cured fine fuels and any woody fuels such as woody plants and dead and downed material. Understory burns, if applied appropriately, would limit the mortality of overstory trees to 10 percent, have sufficient scorch height to affect ladder fuels, and reduce large fuel (10- to 100-hour) loads.

Figure 48. Prescribed fire fuel reduction project at Commons Ford (Commons Ford PRO).

Consider the following items when determining whether prescribed fire is the appropriate fuel management treatment for the property:

- Conduct any prescribed burns in accordance with a detailed burn plan prepared by an experienced Prescribed Fire Burn Boss, as defined by Section 153 of the Texas Natural Resource Code.

- Compliance with local fire or burning ordinances and prior notification of appropriate local governmental jurisdictions must be verified. Advance notification of the Texas Commission on Environmental Quality, in accordance with Title 30 of the Texas Administrative Code (Sections 111.201 – 111.221) is also required.

- *Recommended Land Management for the Water Quality Protection Lands Austin, Texas* (Austin Water Utility 2010) includes information on how to implement prescribed burns relevant to Texas ecosystems.

- The *Land In Balance* video is also a useful for information on prescribed burning: https://www.youtube.com/watch?v=r-VanyPG3QI.

5.4.6.10 CHEMICAL TREATMENT

A chemical fuels treatment is the application of chemical agents to kill or restrict the growth of existing vegetation. Land managers/land owners can also use herbicides as a fuels management treatment. Using herbicides to manage vegetation requires the consideration a variety of factors. Some of these factors are:

- Product selectivity - the resistance various classes of plants have to a specific herbicide.
- Herbicide activity –the product may enter the plant through the foliage, stem, or roots.
- Application method – the size and number of stems, number of acres, and time of year will influence application method choice. For instance, if the site contains a number of acres of fine-fuel invasives in the understory, a ground foliar broadcast treatment using mechanization such as a skidder-mounted mist blower would be the most appropriate application method (Jackson and Finley 2011).

Application methods for herbicide include aerial spraying, truck-mounted spraying, or hand spraying. While aerial spraying can treat large areas quickly with minimal soil disturbance, it can be costly and is subject to strict weather conditions to minimize potential drift onto non-target species. Hand spraying can be an efficient method in areas where access is limited and for controlling resprouting species such as mesquite. Chemical treatments for fuel reduction must read and follow the product label for chemical application and be performed by a licensed professional. Techniques for some of the more common chemical treatments are described below.

Frill Girdle (Hack and Squirt) - Use a hatchet, machete, or similar tool to make a frill or cut at a downward angle and at the proper spacing, then follow label recommendations. Cuts should penetrate through the bark into the living cambium tissue (the wood next to the bark) and produce a cupping effect to hold the herbicide. Spray a measured quantity into the cuts using squirt bottle. Do not allow the herbicide to run out of the cut. This method is not recommended for use during heavy sap flow in the spring. It is generally used to control individual trees larger than five inches in diameter.

Stem Injection - Use a hatchet or lance-type tree injector calibrated to deliver the proper amount of herbicide with each blow. Following the label recommendations, penetrate through the bark into the living cambium tissue at properly spaced intervals.

This method is not recommended for use during heavy sap flow in the spring. It is generally used to control individual trees larger than five inches in diameter.

Cut Stump - For water-soluble herbicide mixtures, spray or paint the cambial area (the wood next to the bark) of freshly cut stumps immediately after cutting. If using an oil-soluble mixture, treatments can be applied to stumps up to one month following cutting. In this case, spray the sides of the stump to the root collar and the cambium area around the entire circumference of the cut surface until thoroughly wet, but not to the point of runoff. This method is generally used to control re-sprouting of cut hardwood stumps.

Basal Bark - Using a low-pressure backpack sprayer, thoroughly wet the lower 12 to 15 inches of the stem completely around tree including the root collar area. Do not spray to the point of runoff. This method is generally used to control thin-barked trees less than six inches in basal diameter.

Foliar Spray - Using aerial or ground spray application equipment such as a helicopter, skidder, or backpack sprayer, mist herbicide mixture onto the foliage of targeted plants. Direct the spray to evenly cover plant foliage. Do not spray to the point of runoff. This method may be used to control many woody plants, herbaceous weeds, grasses, and vines.

Basal Soil - Using an exact-delivery spot-gun applicator, direct the spray at the soil within two to three feet of the target plant root collar, or in a grid pattern across the entire treatment area. The square grid pattern can range from three to six feet between soil application spots. This method is used as a treatment to control many annual and perennial weeds and woody plants.

Consider the following when determining whether chemical use is the appropriate fuel management treatment for the property:

- If there is an Integrated Pest Management (IPM) Plan for the property, procedures regarding herbicide use should be followed. If no IPM plan exists, consider using existing plans such as those developed for the City of Austin Water Quality Protection Lands or the City of Austin's Invasive Species Management Plan.

- Depending on the chemical being used, herbicide applicators may need to be licensed by Texas Department of Agriculture.

- Chemical treatment kills vegetation in-place. Leaving dead or dying vegetation may provide cover for wildlife but also increases the fuel load for the property. Removal of treated vegetation by other fuel management methods should be weighed against other management goals for the property.

- Extreme care should be taken when using chemical treatments in or near sensitive areas such as waterways and karst features to avoid contamination.

5.4.6.11 GRAZING

Moderate livestock grazing can be used to strategically reduce fine fuels and correspondingly limit impacts and economic losses of wildfire. Use of herding, placement of feed or supplements, of distribution of water sources are common techniques used to concentrate or distribute grazing on the landscape. Domestic grazing removes or reduces the availability of fine fuels for fires. Grazing techniques are economically viable, and could be effective throughout the CWPP plan areas, particularly in limited access areas across the county.

Consider the following when determining whether grazing is the appropriate fuel management treatment for the property:

- Grazing can be an effective treatment method in areas with limited or difficult access such as dense woodland or steep slopes.

- Proper management of the animals is essential to protect them and the property. Management considerations include fencing, water, predator control, additional food (Austin Water Utility 2010), stocking rates, time on the property, and potential spread of invasive species through manure.

- Some plant species, such as mountain laurel, are toxic to livestock.

5.4.7 SITE CONDITIONS CONSIDERATIONS

Reduction of wildfire risk involves understanding what vegetation communities and corresponding fuel types occur on the property, the primary land uses and goals, mitigation strategies, and the fuel treatments and activities required to achieve and maintain those goals and uses.

Land managers and property owners today are faced with the challenge of knowing how to properly manage their land and protect it from wildfire. Understanding the components of wildfires (presence of fuel, suitable weather conditions, and an ignition source) and wildfire behavior are critical in determining potential risk, setting priorities and identifying appropriate mitigation treatments.

The landscape known today as natural is a result of plant succession that responded for more than a century to human fire suppression, road building, urban sprawl, the introduction of non-native plants, and vegetation conversion for agriculture and livestock. Ecological consequences of these practices include: increased forest stand density with low-level growth or vigor; increased susceptibility of forest stands to insect attacks and pathogens; changed species composition and structure of forestlands, grasslands, shrublands, and oak woodlands, and habitat alteration of forestlands, shrublands, oak woodlands, and savannas.

The changes to the natural state have caused an increase in fire hazard, as well as a shift in the intensity and effects of wildfire. When determining appropriate fuel reduction treatment method, it is important to consider not only the current state of the landscape, but how the landscape conditions will impact each specific management activity in relation to all of the environmental components relevant to the property and the overall ecosystem health (i.e., forest health, watershed protection, slopes and soil conditions, protected habitats, critical environmental features).

Fuel reduction assists in initiating and enhancing the process of restoring health to forestlands, woodlands, shrublands, and grasslands. Fuel reduction work guided by conservation principles and designed with ecological treatment prescriptions will facilitate long-term, positive environmental outcomes. Important attention and consideration should be paid to the existing condition of the ecosystem before doing any mitigation work. **Section 2.3** discusses specific sensitive environments for consideration associated with various unique ecosystems within the Austin-Travis County CWPP Plan Area.

FOREST HEALTH

Forest health threats include wildfire, drought, disease, pests, and invasive species (**Section 2.3.3**). The following section discusses the site condition objectives for ensuring fuel mitigation treatments do not increase the potential threats to the health of the forests. Taking proper precautions to prevent the spread of tree diseases and/or increase stressors is essential for retaining the large and valuable trees that occur within the treatment area.

While wildfires can benefit the ecosystem and forest stand, massive fires can do major damage to the landscape, damage that won't heal on its own. Drought can stress and promote tree diseases and increase fuel loads. Tree diseases, such as oak decline, hypoxylon canker, and oak wilt can be stimulated by improper management activities. Pests can have a devastating impact on stand health and improper pest management can harm people, pets, and the environment. The presence of invasive species decreases overall forest health. Each of these conditions causes an increase in fire hazard, as well as a shift in the intensity and effects of a wildfire.

DISEASE AND PESTS

Oak wilt is spread from tree to tree by beetles attracted to the sap from fresh wounds on the trunks, limbs, or exposed roots of oak trees, or via the connected root system of nearby oak trees. There is no cure for oak wilt. To best prevent the spread of oak wilt any and all tree work within Travis County (including any clearing, trimming, pruning, or limbing of trees) should follow these provisions:

- Avoid wounding oaks (including trimming, limbing, and pruning) anywhere on the property from February through June. The least hazardous periods for trimming or clearing are during the coldest days in midwinter and extended hot periods in mid- to late summer.
- Regardless of season, all trimming cuts or other wounds to oak trees, including freshly cut stumps and damaged surface roots, should be treated immediately with a wound or latex paint to prevent exposure to contaminated insect vectors.

- All clearing or pruning equipment should be sterilized with a solution of bleach and water before working on a property and between every oak tree that is to be cut or wounded.

Effective and appropriate management strategies to contain oak wilt or restore landscapes damaged by oak wilt infection are not currently practicable on a large scale or over rough terrain, or are not well researched or tested. (See also **Section 2.3.3.3 Tree Diseases**)

Hypoxylon canker is a fungus that causes cankers and death of oak and other hardwood trees. Prolonged drought usually increases Hypoxylon canker activity. The Texas A&M Forest Service suggests following the guidelines below for prevention, identification, and management of Hypoxylon canker infections:

- Prevention is the best practice for management of this disease. During drought periods where Hypoxylon canker has been identified, if the trees are near a watering source, supplemental watering is recommended, which will help maintain the health of the trees and decrease their susceptibility to Hypoxylon canker infection.
- Increase the health of existing trees within the management area with practices that increase stand vigor (i.e., thinning); however, if improperly applied, these practices can increase the Hypoxylon infection through injury, exposure, and site changes. It is recommended that any type of stand disturbance activity be delayed during drought.
- Identify the early signs of Hypoxylon canker infection. An early indicator that hypoxylon canker is invading a tree is a noticeable crown thinning, and some species exhibit branch dieback. As the infection progresses, small sections of bark will slough from the trunk and branches, collecting at the base of the tree. Typically, tan, olive-green, or reddish-brown powdery spores can be seen where the bark has sloughed off an infected tree. However, by the time spores become visible, the tree is dead. In about four to eight weeks these tan areas will turn dark brown to black and become hard, typically with the appearance of solidified tar. After several months these areas will become a silver-gray color.

- When Hypoxylon canker is present in a forested stand, evaluate it from the aspect of tree species and number of trees affected. If practicable, salvage infected trees before they die. Tree species showing fruiting structures of Hypoxylon typically will not survive, regardless of treatment. Carefully prune branches that have a local infection to help slow the advance of the fungus. However, proceed carefully, because removal and disturbance of the site area can stress surrounding trees and increase tree stress, making them more susceptible to Hypoxylon infection.
- Infected trees or trees that have died from Hypoxylon canker near structures, roads, powerlines, fences, etc., should be removed as soon as possible.
- Do not climb trees that have been killed by Hypoxylon canker. Since the fungus decays the wood so rapidly, the tree may not support the weight of a climber. Instead use bucket trucks or other mechanical lift devices.

Regenerate an area infected by Hyopxylon canker with tree species that are immune or resistant to the fungus. The key again is prevention. Minimize injury to trees during construction, avoid herbicide injury, and minimize site changes. These steps will help to maintain tree vigor. Healthy soils, watering during droughts, and mulching will help ward off losses due to Hypoxylon canker. (See also **Section 2.3.3.3 Tree Diseases**)

NON-NATIVE AND INVASIVE SPECIES

Non-native and/or invasive plant species can reduce the diversity of natural vegetation communities and change the composition or function of the community. Since these plants are not in their natural environment, many are able to flourish unchecked by their natural competitors, forming dense stands of vegetation that often outcompete native plants for light, water, and nutrients. In some cases, non-native or invasive species may even completely replace natural communities. Where non-native or invasive plants have become well established in an area, control or eradication of these species can be difficult or impossible. Therefore, preventing the establishment of non-native or invasive plants (particularly woody species), to the extent practicable, is recommended.

Management of the target property should address strategies for control of individual problem species or problem areas, as appropriate, based on site conditions. Recommended strategies for preventing the establishment of non-native or invasive species include avoiding the use of non-native plants in landscaping or pasture plantings, monitoring and recording the presence of non-native or invasive plants within and adjacent to protected habitats, and removing such individuals with selective mechanical or chemical means, as practicable. For detailed guidance on invasive species management, refer to the City of Austin Invasive Plants Management website: www.austintexas.gov/department/austin-invasive-plants-management. (See also **Section 2.3.3.4 Non-native and Invasive Species**)

WATERSHED PROTECTION AND CRITICAL ENVIRONMENTAL FEATURES

Loss of vegetation often leads to a loss of soil, increased runoff and erosion, decreases in water quality, lower soil infiltration, and reduced groundwater recharge. The protection and management of water quality and quantity derived from these vital, sensitive natural resources is critical to public health and sustainable economic development. Protection and improvement of water quality and quantity is achieved through land management practices centered on restoration of prairie, savanna, and riparian vegetative communities (Austin Water Utility 2010). Establishing a buffer of native vegetation around surface waters and sensitive environmental features -- wetlands, springs, caves, sinkholes, and bluffs -- will inhibit degradation of the water quality and karst systems.

Sustainable protection of water quality and water quantity requires preserving pervious cover, maintaining the basic hydrologic regimen, and managing land to maintain proper ecosystem function (Austin Water Utility 2010). Additionally, in water-limited environments, the quality and quantity of groundwater recharge and stream flow can be affected by the type and pattern of woody vegetation (Wilcox 2002, Huxman et al. 2005, Scanlon et al. 2005, Newman et al. 2006, Bautista et al. 2007). Research indicates a likely exponential relationship between woody cover and water yield (McCaw 2009). It is also important to note that when doing wildfire risk mitigation work (such as large-scale clearing of woody vegetation) any change to the property's fuel type classification (i.e., conversion of a closed canopy woodland to an aggrading juniper shrubland) also changes the wildfire risks associated with the property, positively or negatively.

At a minimum, fuels management activities should consider the following measures to protect water quality:

- Improperly selected and applied chemical herbicides damage surface water and groundwater quality. Use other methods of vegetation management for wildfire risk mitigation in areas where protection and preservation of water quality is necessary. Use of chemical herbicides should always be used as part of an IPM approach to fuels mitigation strategies. If herbicide application is the only feasible vegetation management solution, take care to implement all measures necessary to prevent water quality degradation.
- Provide setbacks from surface water for mechanical or chemical treatments.
- Avoid soil disturbance near sensitive sites, such as riparian corridors and internal drainage basins associated with karst features.
- Avoid storing or maintaining mechanical equipment that uses petroleum products (e.g., diesel, gasoline, hydraulic fluid) near surface or groundwater sources.
- Implement soil stabilization and erosion control BMPs identified, as necessary.

For detailed guidance and requirements for fuel management activities associated with water quality and critical environmental features, refer to the City of Austin Watershed Protection Department Requirements for Fuels Management Projects in **Appendix D** and Austin Water Utility Water Quality Protection Lands Land Management Plans.

SLOPES AND SOIL CONDITIONS

Closed-canopy forest habitats inhibit the growth of herbaceous vegetation. For this reason, no herbaceous roots are available to hold the soil after a disturbance. Areas with grades less than five percent typically have less significant erosion; however, after a disturbance these areas can become vulnerable to future erosion from heavy rainfall and/or sustained high winds due to extended slope lengths and other factors.

Soil damage from implementation of wildfire mitigation treatments could reduce soil stability. The reduction of soil stability could increase the soil's erosive potential and slow vegetative recovery from degradation of its organic component. Soil loss in the form of erosion and sedimentation can have devastating impacts on the environment. Erosion strips nutrient-rich topsoil from the land, diminishes productivity, and impedes reestablishment of native vegetation. Excess amounts of fine-grained soil particles lost though erosion pollute surface waters and aquatic habitats. Erosion and subsequent sedimentation requires continuous, ongoing management to prevent, control, and minimize damage to both water quality and the landscape.

Examine the site carefully before implementing wildfire mitigation treatments. Be aware of the slope, drainage patterns, and soil types. Proper treatment design and planning will help avoid expensive stabilization work. Proper and applicable erosion and sedimentation control measures should be implemented and maintained during all wildfire mitigation activities.

Reestablish permanent vegetation as soon as possible on disturbed areas. Vegetation species should be native to the area and provide adequate soil stabilization once established. Herbaceous species with thick root formations and spreading rhizomes are best suited for surface protection and soil stabilization. Further, closely monitor all impacted areas for any signs of soil and/or vegetative loss after initial reestablishment and potential encroachment of opportunistic, non-native/invasive vegetation species. Take action to mitigate and prevent further soil degradation at the sign of any soil loss, non-establishment of seed, and/or encroachment of non-native/invasive species identified during monitoring. To increase the likelihood of successful restoration on treated areas, consider the development of an erosion control plan. Potential erosion and sedimentation from mitigation activities should be evaluated and considered before, during, and after implementation of migration treatments.

PROTECTED HABITATS

Travis County contains habitats that support 23 animal and plant species considered as threatened or endangered by state and/or federal authorities (TPWD 2012b, USFWS 2013). Threatened and endangered species and their habitat are protected by federal, state, and local regulations, even on private property. You must acquire and comply with all appropriate permits before doing any fuel mitigation treatments within these protected habitats. The Texas Parks and Wildlife Department provides management guidelines for several of the threatened and endangered species that occur in Travis County at:

www.tpwd.state.tx.us/huntwild/wild/wildlife_diversity/texas_rare_species/management/.

For additional assistance in identifying and managing protected habitats, contact:

- Texas Parks and Wildlife Department: (512) 389-4800
- United States Fish and Wildlife Service, Austin Ecological Services: (512) 490-0057

Golden-cheeked Warbler Habitat (Also see **Section 2.3.1.1**)

High-quality golden-cheeked warbler (*Setophaga chrysoparia,* GCW) breeding habitat is characterized by mature woodlands of Ashe juniper and a mix of oaks and other broad-leaved species with dense canopy cover, as described by Campbell (2003). After coordinating with all appropriate regulatory agencies for guidance and receiving all required authorizations for proposed fuel mitigation in potential GCW habitat, the following measures, at a minimum, should be considered:

- Conduct vegetation management practices only between September 1 and February 28 when GCWs are typically absent from the breeding range;
- Limit vegetation management work in GCW habitat to those described in **Appendix D**. The USFWS advised the BCCP Coordinating Committee that the recommendations from TPWD in *Management Guidelines for the Golden-cheeked Warbler in Rural Landscapes* (Campbell 2003) are only applicable to agricultural practices, not fuel mitigation (Conrad 2014).
- Avoid impacting the majority of such habitat on an individual property in a single year,
- To the extent practicable, choose specific management practices that minimize the disturbance, removal, or compaction of top soil (thereby preserving soil structure and texture) in the treated area, including but not limited to practices that utilize hand tools instead of heavy equipment or, if it is necessary to use heavy equipment, choosing equipment with rubber tires instead of tracks.

The City of Austin developed USFWS-approved BMPs for treating and minimizing woodland habitat fuels along the WUI of the Balcones Canyonlands Preserve. Goal was to reduce the impact of wildland fire and reduce potential impacts of fuel treatment to GCW habitat and minimize wildfire risks to adjacent homes and/or commercial structures (City of Austin 2013c).

The USFWS published similar voluntary BMPs for private landowners across the entire range of the species (USFWS [date unknown]). The USFWS BMPs do not apply to hazardous fuel reduction activities on lands that have been identified and protected as mitigation for the take of GCW or GCW habitat. The BMPs are designed to further reduce fuels in woodlands while sustaining the vegetation regime, and at the same time minimize potential impacts to the vegetation community from the effects of the fuel treatment, and reduce wildfire risk. The USFWS BMPs included in **Appendix D** are applicable to the entire CWPP plan area and should be used when doing any fuel mitigation work in woodland habitats within Travis County. By following the process outlined in this specification private property owners can assure that their fuel mitigation work in potential endangered species habitats is done in compliance with the Endangered Species Act and its locally applicable regulations. Presence of woodland and forest canopies with diverse species composition helps to reduce fire spread and lower the probability of burn (White et al. 2009). As such, maintaining or promoting closed canopy woodland is critical to the success of the BMPs.

Land managers and property owners should contact the Balcones Canyonlands National Wildlife Refuge Fire Program at (512) 339-9432, USFWS Austin Ecological Services Office at (512) 490-0057, or the Texas A&M Forest Service, Mitigation and Prevention Office at (979) 458-7362 for further guidance on planning and implementing hazard mitigation activities within GCW habitat and questions concerning fuel reduction BMPs.

Black-capped Vireo Habitat (Also see **Section 2.3.1.2**)

In many parts of the black-capped vireo (*Vireo atricapilla*, BCV) range (including the Edwards Plateau), the habitat used by the species is in vegetation of short-statured (<2 meter) trees frequently maintained by prescribed fire. Closely spaced shrub clusters separated by grassy vegetation create the heterogeneous cover the species requires (USFWS 1991). The most common and distinguishing habitat element throughout the species' ranges is dense, low, deciduous foliage at ground level to approximately 10 feet (USFWS 1991, Grzybowski 1995, Maresh 2005). Horizontal woody canopy cover generally averages between 30 and 60 percent or more, with most of this cover from deciduous shrubs (Campbell 2003, USFWS 2007).

After coordinating with all appropriate regulatory agencies for guidance and receiving all required authorizations for proposed fuel management in potential BCV habitat, the following measures, at a minimum, should be considered:

- Conduct vegetation management only during the non-nesting period (September-February);
- Limit vegetation management to those described by species experts. The USFWS advised the BCCP Coordinating Committee that the recommendations from TPWD in *Management Guidelines for the Black-capped Vireo* (Campbell 2003) are only applicable to agricultural practices, not fuel mitigation (Conrad 2014).
- By TPWD in *Management Guidelines for the Black-capped Vireo* as being appropriate for maintaining, enhancing, or creating BCV habitat (Campbell 2003);
- To the extent practicable, choose specific management practices that minimize the disturbance, removal, or compaction of top soil (thereby preserving soil structure and texture) in the treated area, including but not limited to practices that employ hand tools instead of heavy equipment. If it is necessary to use heavy equipment, choose equipment with rubber tires instead of tracks.
- Because of the potential for BCV habitat to be a fuel type with higher wildfire risk, it is recommended that fuel breaks between management units and adjacent non-public properties be considered to reduce the probability of fire spread. Because the fuel structure of BCV habitat tends to be low with surface fires prevalent, the fuel treatment may be a simple surface fuel break. With higher shrub size, however, ember formation near habitat and management unit edges is likely.

Basic BCV habitat management should include the periodic use of selective mechanical treatments (such as hand cutting with a chainsaw) or prescribed burns. This will encourage vigorous growth of deciduous shrubs as mixed-aged stands to be maintained in early- to mid-successional stages. Burning intervals suggested for maintaining BCV habitat range from five to seven years (Campbell 2003) or even 25 years (Tazik et al. 1993).

Fuels management work may be compatible with disturbances that maintain suitable BCV habitat described above and as determined appropriate for the Edwards Plateau region. Since BCV habitat may require periodic and cyclical disturbance of woody vegetation, it is recognized that the short-term condition of vegetation within a management area may not always be BCV habitat. It is recommended that no more than 25 percent of the original area identified as BCV habitat be temporarily unsuitable due to maintenance (e.g., prescribed fire, mulching, fire breaks) and promote mixed-age vegetative stands. Treatments causing non-suitable habitat conditions over concentrated areas should be avoided when plausible.

Salamanders (Also see **Section 2.3.1.3**)

The Barton Springs Zone is a portion of the Edward's Aquifer Recharge Zone with direct surface connections to the salamanders' critical habitat at Barton Springs Pool. Extra precautions should be taken during fuel treatments and fire suppression operations in the Barton Springs Zone so that the critical habitat is not adversely affected.

Karst Habitat (Also see **Section 2.3.1.4**)

Karst features and their sensitive and unique biota are threatened by any changes to the humidity, structure, or nutrient flow into the system (Culver 1982). Protection of surface and subsurface drainage areas adjacent to the identified karst feature is needed to protect the invertebrates living within the karst. At a minimum, fuels management activities in karst areas should consider the following measures:

- Avoid filling or covering of caves, and other karst and recharge features with impervious cover (BCP 2007) such as brush or rocks.
- Avoid fuels management activities that alter the surface flow into karst features or the nutrient level by removal of native vegetation or adding synthetic fertilizers (Veni 2000).
- Limit the vegetation management activities to those described by TPWD in *Management Guidelines for Karst Invertebrates* as being appropriate for maintaining karst invertebrate habitat (Campbell 2003).
- Establish a buffer zone around the karst feature sufficient to protect the surface drainage to the feature, the subsurface drainage to it, and the known extent of the karst feature (TCEQ 2007).

- Avoid use of herbicides within the buffer zone (TCEQ 2007).
- Avoid storing or maintaining equipment that uses petroleum products (e.g., diesel, gasoline, hydraulic fluid) within the buffer zone.

OTHER CONSIDERATIONS

Community education and outreach about the purpose of fuel reduction and typical recognized management techniques will help promote neighborhood and community-wide support for becoming a fire-adapted community. Items that should be considered and solutions presented to homeowners include:

- Air quality concerns associated with prescribed fire, mechanical, and chemical treatments;
- Smoke and traffic management associated with prescribed fire treatments,
- Noise concerns associated with mechanical treatments.

5.4.8 MANAGEMENT OF MITIGATION BYPRODUCTS

The appropriate management of fuel mitigation treatment byproducts is another key to reducing wildfire risk. As with the various fuel types, improper management of mitigation byproducts can lead to fuel buildup and increase wildfire risk. The overall purpose of fuel mitigation treatments is the reduction and removal of fuel from the landscape, not redispersal. Don't pile your byproducts if you don't know that you can burn them, and don't burn your byproducts unless as a last resort and only if you can do it legally.

The most environmentally appropriate way of debris management is reuse and recycling. Biomass byproduct removal services provide added-value economies and some have even developed niche markets. Other options and resources for reuse of mitigation byproducts can be found on the TFS information portal, http://texasforestinfo.com/ for alternatives to biomass removal, mitigation, and disposal. This section discusses the options available for management of mitigation byproducts.

Bulk Brush Pickup and Drop off

Within the CWPP plan area, communities are already coming together to help with mitigation fuel byproducts. The City of Austin has a bulk brush pickup and drop-off program and Travis County ESD 4 has a courtesy brush disposal service.

Chipping/Mulching

Figure 49. ESD 4 Courtesy Brush Disposal Service (ESD 4).

Mulch is any material used to cover the soil surface for a variety of purposes. Organic mulches usually come from plant materials and include pine needles, pine bark nuggets, shredded western cedar, and even ground or shredded rubber. Chipping and/or mulching of fuel mitigation byproducts should be limited to no greater than a two-inch depth, and should not be redistributed across the landscape unless to prevent or mitigate soil erosion from the fuel mitigation work.

Combustible mulches (such as organic mulches) should not be used within the 30-foot HIZ zone. An evaluation of mulch combustibility to provide recommendations for uses of mulch within wildfire hazard mitigation areas (Quarles and Smith 2008) showed that the eight mulch types evaluated were all combustible, but varied greatly in terms of flame height, rate of spread, and temperature. Only noncombustible mulch and landscaping should be used within the HIZ. Inorganic mulches include rock, gravel, and brick chips. These inorganic mulches tend not to burn and are safe to use in any setting.

Shredded fuels are still fuels - fuels with different structural arrangement and perhaps a different moisture content.

Lop and Scatter

This is not a recommended mitigation byproduct disposal method to implement near structures or within the Defensible Space Zone because of short-term increased hazards, the potential to reduce effectiveness of vertical fuel arrangement, and potential to increase the load of 10-hour and 100-hour fuels. Lop and scatter of mitigation byproducts is more appropriate in the Community Protection Zone; however, the preference, if feasible, is to remove residual fuels from the treatment area altogether.

Lop and scatter is the one of the best methods for improving site soil fertility and the ecosystem's long-term productivity. By removing the ladder fuels and scattering them low to the ground, you are improving the chances of your wildland surviving a wildfire.

Lop and scatter is a method whereby thinned materials are spread about to rot on the forest floor—taking care not to form large piles of slash (known as jackpots to firefighters). Lop and scatter can be very cost-effective; it is definitely a site-specific treatment.

Pile Burning

Pile burning takes many forms and no single standard can be applied.

Maintenance Pile Burning

Most rural homeowners manage a single pile composed of clearing debris they burn periodically. Piles are generally in a readily accessible location and the size depends on the adjacent fuels and equipment available for extinguishment. A level, accessible location with no fuels within 10 feet of the pile and no canopies within 50 feet is recommended. Piles should be at least 200 feet from structures and burned on a day with little fire risk and embers blowing away from structures.

Similar pre-planned maintenance piles can be set up at other locations, provided a pre-planned site has favorable control standards: access, limited ground fuels, and wide canopy spacing. Piles as large as 30 feet in diameter and 15 feet in height are acceptable.

For landscape-scale thinning operations, a large number of piles may be constructed. These will be distributed over the landscape and few controls are feasible; therefore, active management by trained personnel is required and a prescribed fire plan is often required. Generally, sizes are smaller and the spacing between piles and the canopy are defined.

Windrows are an alternative pile-burning technique where large volumes of debris are generated. The windrows are constructed as linear piles.

For all pile burns the following should be required:

- Access defined;

- Equipment, either water or heavy equipment available;
- Permit and notification;
- Size limits;
- Spacing limits;
- Vegetation around the pile defined-surface and canopy,
- Mop up and patrol.

Prescribed Grazing

Tall, thick, healthy grasses will often out-compete woody seeds trying to sprout. It is possible to clear small juniper and other woody brush with goats; however this is not preferred. Goats generally eat everything else first and should be used December through February.

Prescribed grazing is the managing of grazing and/or browsing livestock to control the harvest of vegetation. The purpose of prescribed grazing practices is to achieve desired conditions through the management of fine fuel loads through use of livestock. This practice is applicable to all lands where grazing and/or browsing animals are managed. Additional information on specifications for prescribed grazing is included in **Appendix D**.

5.4.9 SUPPLEMENTAL INFORMATION

Sections 1.5 and 1.6.3 describe the integral role of the JWTF in the review and discussion of how to define a desired future condition and then implement strategies to support that goal. These subject matter experts and representatives of the community reviewed numerous sources of existing content from which fuel management strategies in this section were developed. As an additional planning resource for local-level CWPPs, the source documents and materials reviewed by the JWTF are included in **Appendix D**. The results of how to implement these fuel mitigation principles, strategies, and treatments, as well as additional resources are included in **Section 5.6 - The WMS Builder.**

5.5 COORDINATE CODES TO SUPPORT FIRE-ADAPTED COMMUNITIES

Establishing regulation through enforceable codes and ordinances is a major challenge in achieving the goals of creating a fire-adapted community within a fire-resilient landscape that firefighters can protect. Within the planning area, there are 22 incorporated cities, nine census-designated places, thousands of neighborhoods and subdivisions (**see Section 2.4** for more details), and countless organizations and groups with some form of land-management responsibilities.

Typically, governments and their respective departments cooperate in code and ordinance development and regulation within shared jurisdictions by addressing their own community's needs first and then accommodate other jurisdictions. Despite these collaborations, constraints are inevitable due to competing goals, priorities, and responsibilities.

It will be essential to better communicate and collaborate among government entities, emergency service providers, land managers, and other stakeholders to successfully prepare for wildfire and mitigate risk. The collaborative nature of the JWTF provides guidance to assist in the adoption of WUI Code that advances wildfire mitigation and preparedness. However, to develop comprehensive and cohesive regulations, other members of the community that own and/or manage land within the planning area -- utility providers, land trusts, and other private entities -- must be engaged to contribute their specific land-management needs to this process.

The following steps provide a framework for WUI Code construction and implementation within the plan area.

STEP ONE: RISK ASSESSMENT

Any regulatory approach to minimize wildfire risk should start with risk assessment. This process is similar to floodplain extent and risk mapping: likelihood of occurrence, vulnerable areas, at-risk ecotypes, structures, and populations. Supporting code development with the risk assessment helps the regulator(s) and the public to better understand underlying reasons for proposed regulations, increases the effectiveness of public resources (time, human capital, budgets), and reduces the risk of catastrophic loss. The risk assessment can also help define logical partnerships for interlocal agreements or memoranda of understanding that could unify code development and implementation across jurisdictions. An accessible public campaign should be developed to roll out the risk assessment prior to code development, as it will be the foundation of any stakeholder understanding in code development.

STEP TWO: DEFINE GOALS AND OBJECTIVES

Goals and objectives for any code should be clearly defined in a document for stakeholders and regulators to review. The goals and objectives should reveal the issue(s) the code could solve that cannot be solved by voluntary measures (benefits), measures to define effectiveness if implemented, and how often will the code be reviewed and by what standards, such as adaptive management.

STEP THREE: IDENTIFY THE STAKEHOLDERS

Not all wildfire-interested stakeholders would need to be engaged in every code revision or development. Audiences should be targeted, defined by goals and objectives. They may include structural fire and wildfire professionals, land and water resource managers, infrastructure providers, community representatives by risk type/area, inspectors and enforcement programs, and local/regional wildfire behavior/fuel experts to assure alignment with or inclusion in plans, programs, community concerns, and budgets.

Stakeholders can:

- Assist in mapping and ranking community values -- what makes our community look and function like “our” community -- to identify value-laden constraints or opportunities;
- Prioritize current budget commitments. What do we shift or lose to respond to this need until the expense can be a planned and programmed, fully funded mandate upon adoption;
- Define agencies’ or organizations’ capacity to implement codes effectively and sustainably -- full-time to volunteer employees, impacts to non-fire departments like development services and environmental reviewers, budgeting ongoing planning review and training needs;
- Recommend timing for code execution and define compatibility with other regulations and permitting -- other municipal, county, state, federal codes

related to development planning, construction and environmental constraints;

- Align various fire-suppression entities' requirements and constraints;
- Map compatible and incompatible infrastructure in wildfire risk zones and classify potential exceptions -- hydrants, water sources, transmission lines, electrical services above the potential impact zone, communications or other underground infrastructure below the potential impact zone, accessibility related to these issues;
- Define program and budget needs for inspection and enforcement capacity and feasibility -- code with penalties should not be created without feasible enforcement,
- Define program and budget needs for policy review and revision supported by regularly updated risk assessment data, changed land-use categories, advisory boards, and public input. Governments and organizations must have the capacity to support the public processes key to review, adoption, and implementation.

In Travis County, there are 24 governmental jurisdictions and numerous Homeowners'/Neighborhood Associations, advisory panels, communities, and organizations that identify strongly with various communities' values. Any regulatory framework proposed will only be effective if widely adopted; therefore, a coordinated, fully scoped effort to identify benefits and constraints will aid code construction and encourage comprehensive implementation.

STEP FOUR: CRAFTING THE CODE

Existing codes that already align with the purpose, goals, and objectives should be identified in various jurisdictions to determine if existing code could be amended or whether new compatible or overarching code needs to be developed. Consider a phased approach for regulation adoption in high-risk communities so concrete steps can be taken quickly to reduce wildfire risk and promote public safety. For example, communities in Florida and New Mexico have integrated wildfire risk reduction requirements into existing land-development regulations.

There are a number of cities and communities throughout the country that have based their WUI codes on three primary guidance documents:

- International Code Council (ICC) Wildland Urban Interface Code (2012);
- National Fire Protection Association (NFPA) Standards for Reducing Structure Ignition Hazards from Wildland Fire (2008a),
- Standard for Fire Protection Infrastructure for Land Development in Suburban and Rural Areas (NFPA 2008b).

NFPA Codes specifically reference the value of Firewise Communities programs in regard to structure protection and emphasize the value of homeowner/citizen understanding and participation in wildfire mitigation. Representatives from fire and forest health professionals to engineers, environmentalists and planners, and citizen input developed these general codes. The codes are potentially adaptable to various areas of the country, including Travis County.

The contents are based upon recommendations, historical data, life, environment and property losses, and current scientific data, but are general guidance not fuel-type or regionally specific. These resources are highly recommended as a starting place for communities to develop more specific guidance and policy related to wildfire preparedness and community engagement in that issue. Code examples are provided in the Authorities sections. Whether piggybacking on existing or developing new code, each piece needs to define the programmatic (governance, staffing, equipment) and related budget impacts to affected jurisdictions.

STEP FIVE: IMPLEMENTATION

Implementation engages the public and affected programs across jurisdictions; therefore, it should tie closely to stakeholder input:

- Clearly define volunteer, employee, and budget impacts and priorities to fully fund implementation, inspection, education, and enforcement;
- Integrate into existing web-based planning and project development tools to help landowners, developers, and communities more easily comply;

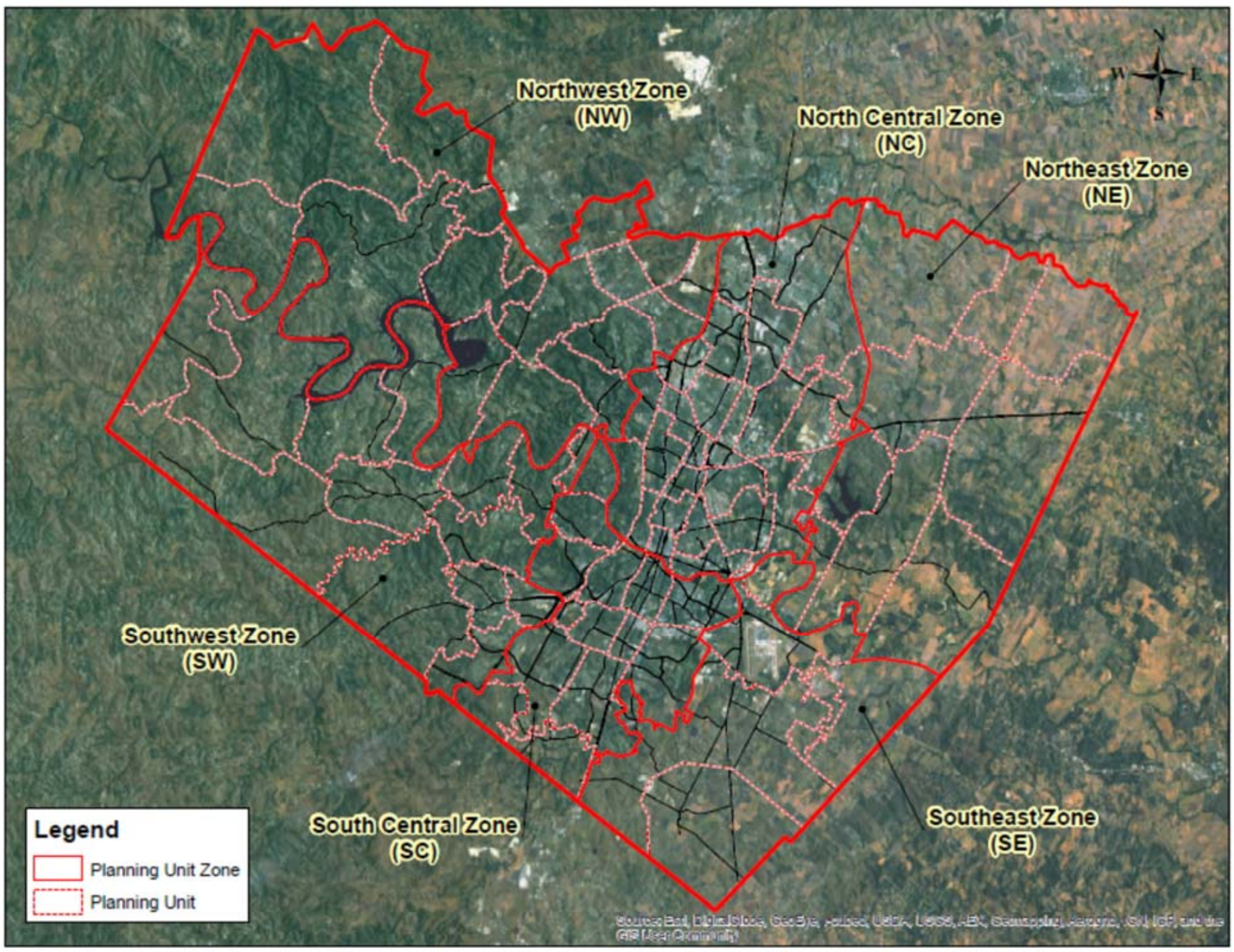
- Craft a unified fire suppression departments, land managers (parks and preserves), and jurisdictions development services public campaign and FAQ, with risk assessment interpretation;
- Combine or develop new tracking tools to help assess and report on development services delivery, inspection, and enforcement to be reviewed at regular intervals among collaborating partners and to use in developing future staffing and budget needs,
- Define steering committee (e.g. Joint Wildfire Task Force) policies and milestones for policy review and revision.

In summary, these wildfire mitigation strategies provide a framework for minimizing the potential for wildfire risk and impacts within the planning area. The mitigation strategies included in this section reflect current wildfire prevention and preparedness principles, best scientific knowledge available, national cohesive strategies, and local policies and codes and ordinances. However, these strategies must be adapted to changing circumstances -- shifting areas of high wildfire risk and fire research findings -- to remain operational. To assess the effectiveness of the wildfire mitigation strategies, activities must be monitored, analyzed, and shared with appropriate practitioners.

5.6 WILDFIRE MITIGATION STRATEGIES BUILDER

The myriad of condition combinations at each home across the county illustrates the need for a tool to help determine appropriate strategies and component treatments for Home Hardening, Defensible Space, and Fuel Reduction. The Wildfire Mitigation Strategies (WMS) Builder has been specifically developed to aid and guide each county resident in navigating these conditions to determine the most appropriate strategies and treatments for Home Hardening, Defensible Space, and Fuel Reduction.

Wildfire Mitigation Strategies (WMS) Builder



Follow the steps below to build your custom Wildfire Mitigation Strategy

Planning Unit #	
Category	
Mitigation Strategies	
Fuel Group and treatment options	

Your category and planning unit help you to determine what is appropriate and allowable on your property. Your fuel group, Mitigation Strategies, and treatment options provide insight for managing that fuel in a manner that reduces the negative impacts of wildfire to you and your property.

Step One.

Enter your Planning Unit: This will provide a list of constraints and considerations in relation to fuels mitigation and relative risk level. Each planning unit is associated with a reference number outlinning applicable Authority(s) Having Jurisdiction, environmental restrictions, Endangered Species Habitat, and seasonal constraints including: Watershed COA-ETJ, City limits, Fire Dept., BCCP, etc.

Step Two.

Determine your Category: All categories with structures present should start with implementing the HIZ BMPs.

Private property on less than an acre:

- Mitigation Strategy- Home Ignition Zone recommendations

Private Property with more than an acre but less than 10 acres:

- Implement HIZ on and around structures and fuels management strategies as allowable.

Private or communal property with more than 10 acres:

- Implement HIZ on and around structures. State and federal resources exist to provide assistance and or guidance in developing a land management plan, it is highly encouraged that landowners utilize this resource when planning for wildfire. In addition you can use the fuels management strategies as allowable to guide your efforts.

Public Property:

- Implement Best Practices for public lands management, implement HIZ on and around structures and utilize the key below to determine your Fuel Group and associated mitigation consideration.

Step Three.

Wildfire Mitigation Strategies: Based on the category you indicated, note which strategies apply to your situation. More than one may apply based on category.

- Home Ignition Zone
- Fuels Management
- Public Land management

Step Four.

Determining your Fuels/Vegetative Group and treatment options

Wildfire Mitigation Strategies on project areas without structures or are at least 250 feet away from a structure are based on vegetation type. Follow the steps in the key below to determine what Fuel Groups exist on your property and what treatment options are available. Enter your fuel group and treatment options in the table.

Dichotomous Fuel Key

Grass Group: Mostly Grass, less than 50% of the ground is shaded by a tree. Surface fuel consists of grass. Trees or shrubs cover less than 50% of area. If trees or shrubs cover more than 50% of area consider as shrub or timber litter fuel type. Short grass prairie, Mid-grass prairie, Tall grass prairie, Live oak savanna, Juniper savanna, Red cedar savanna.

Fire Description: A favorable fuel type with moderate intensities, high frequencies and the highest rates of post fire recovery. Fire intensity varies from low to high based on the height and density of grass. Rates of spread are generally high. Movement of surface fire into the crowns varies with type, structure and density of overstory vegetation. Deciduous trees are less likely to torch than coniferous trees. Trees with high crowns are less likely to torch than trees with low crowns and greater spacing between trees reduces crown fire potential. Frequency varies from low to high based on density of grass. Vegetation readily recovers after a fire, often in less than 6 months. Rate of spread varies between 78 to 104 chains/hour and a flame length of 4 to 12 feet.

Treatment Options: If you currently have a grass fuel type, implementing no treatments will allow the site to quickly convert to a shrub fuel type. Implementing limited periodic thinning in grasslands and savannas and limbing in savannas will maintain the site as a grass fuel type. Some periodic fine fuel removal through mowing, disking or prescribed burning may be required. Initial treatments may require greater fuel removal, as described below.

Treatment in order of effectiveness:

- Maintain fine fuel amounts.
- Remove deadwood.
- Mow periodically and/or encourage low growing grasses.
- Remove junipers to favor grasslands or savannas in uplands.
- Plant hardwood trees to favor development of woodlands in bottomlands

Timber Group/mature woodlands: Trees you can walk under cover 75% of the area. Leaves and twigs cover the ground. Shrubs and trees with branches lower than six feet high make up less than a quarter of the forest. It's very shady. It's common for these types of areas to have a creek. Surface fuel consists of leaf litter. Overstory is at least 75% deciduous. Mid-story vegetation covers less than 25% of area. If midstory vegetation covers more than 25% of area consider as shrub fuel type. Mature live oak woodlands- includes live oak woodlands with high crowns and limited overstory. Mature juniper woodlands or red cedar woodlands-includes mature juniper woodlands with high crowns and few low branches. If it can be walked through without stooping it can be classified as a timber litter fuel type. Red oak woodlands, Riparian woodlands, Cedar elm woodlands, Old-field woodlands.

Figure 50. Short grass (may include oak savannas) (Photo courtesy of Glen Gillman).

Figure 51. Tall grass (may include oak savannas) (Photo courtesy of Glen Gillman).

Fire Description: A favorable fuel type with the lowest potential intensity, moderate frequency and moderate rates of recovery. Fire intensity is generally low with limited movement of surface fire into the crowns due to lack of low branches, lack of leaves in winter and high fuel moisture in summer. Frequency varies from high to low. Vegetation readily recovers after a fire although full recovery may take decades. Rate of spread varies between 1.6 to 7.9 chains/hour with flame lengths of one to five feet.

Treatments in order of effectiveness:

- Maintain fine fuel amounts.
- Remove deadwood.
- Thin smaller sized juniper and brush.
- Remove larger sized juniper and trees in poor health under hardwood canopies.
- Create canopy gaps between juniper canopies.
- Plant hardwoods in canopy gaps.

Shrub Group: Evergreens, like Ashe Juniper (cedar trees), make up the majority of the forest. There may be a mix of immature live oaks, Mountain Laurel, and other small mid-height plants. It is so dense that it can be difficult to walk though in many places. Surface fuel is light and consists of cedar scales and duff. Overstory is at least 75 percent coniferous. Immature live oak woodlands-includes live oak woodlands with defined trunks but low canopies. Mid-story vegetation is present. If it can be walked through with some difficulty but requires some stooping it can be classified as a shrub fuel type. Juniper woodlands, Red cedar woodlands.

Fire Description: An unfavorable fuel type with the highest potential intensities, the lowest frequency and the slowest rates of recovery. Fire intensity varies from low to high based primarily on the moisture content of the vegetation. Under high moisture conditions fires burn with low intensity but under low moisture conditions fires burn intensely. Stand structure also influences intensity; stands with fewer low branches, fewer small trees, variety in tree species and size class, more hardwoods and canopy gaps will decrease the ability of a fire to move through the crowns. Fire frequency is low. Vegetation does not generally recover rapidly after a fire. The vegetation community will be dramatically different and may require intervention to reduce negative impacts. Fire spread rates range from 18 to 75 chains/hour rate of spread with flame lengths from four to 19 feet.

Figure 52. Closed juniper woodland (Photos courtesy of Glen Gillman).

Figure 53. Mixed juniper hardwood forest (Photos courtesy of Glen Gillman).

Treatment Options: If you currently have a timber litter fuel type, implementing no treatments will allow the site to slowly convert to a shrub fuel type. Implementing limited, periodic thinning and limbing, and some tree planting will maintain the site as a timber litter fuel type. Some periodic fine fuel removal through raking or prescribed burning may be required.

Figure 54. Juniper shrub / savannas (Photos courtesy of Glen Gillman).

Treatment Options: If you currently have a shrub fuel type, implementing no treatments will allow the site to remain as a shrub fuel type and, over time, will increase in density. Implementing treatments will require significant resources. All treatments require significant thinning and may require mechanical equipment and fuel disposal planning. In moist areas with good soils it may be possible to slowly shift the site to a timber litter fuel type through limbing, thinning and tree planting. In dry areas with good soils it may be possible to quickly shift the site to a grass fuel type through thinning. In dry areas with poor soils it may be possible to quickly shift the site to a grassland. In all areas, it is acceptable to limit treatments to limbing and a limited amount of thinning to maintain the site as a brush fuel type. In any case, treatments should be planned and implemented to minimize soil loss, which may require completing the project incrementally and/or limiting the treatments conducted on steep slopes. Prescribed burning has limited use in shrub fuel models with the exception of pile burning or broadcast burning as a fuel disposal or restoration tool.

Treatments in order of cost effectiveness:

- Remove deadwood.
- Create canopy gaps between juniper canopies.
- Thin small sized juniper and brush. Remove larger sized juniper and trees in poor health under hardwood canopies.
- Plant hardwoods.

Slash Group: Piles of dead plants or pieces of plants. Maybe brush piles, or cuttings from tree thinning projects. Mulch is also included in this vegetation type. Vegetation that has been cut and laid on the ground. Includes, mulch, distributed slash, windrows, and brush piles. May also include significant wind or ice damage.

Fire Description: An unfavorable fuel type with high intensities, high frequencies and slow rates of recovery. Generally these fuels are created by human activities. Dead fuels are generally a component of the other fuel types and in most cases are not the primarily fuel type. However, their presence will increase the intensity and frequency of fires and increase the time required for recovery. Fire intensity rates typical of the slash fuel types range from six to 13.5 chains/hour rate of spread and flame lengths of four to 11 feet.

Treatment options: Remove dead fuel. Remove small diameter fuels first and larger fuels second. Fuels over six inches in diameter can be left on site provided they are well distributed.

Figure 55. Slash (Photo courtesy of the BCP).

Treatment order of cost effectiveness:

- Remove deadwood.
- Distribute material across landscape.
- Chip in piles.
- Chip and scatter or stack in piles or windrows.

Special Group: This is a young forest comprised mainly of deciduous tree. They may not yet have well defined trunks and are much too short to walk under and through, but they lose their leaves in the fall. It's not a grove of evergreens. These types of areas often develop as a result of drought stress. Vegetation that is not covered by other fuel types and typically has a high proportion of dead fuels and/or dense live fuels. Immature live oak woodlands-includes live oak shrub lands with low canopies and undefined trunks. Mid story vegetation is present. If it is very difficult to walk through it can be identified as a special fuel type. Drought stress.

Fire Description: This category covers unique fuel types currently in the landscape but is also intended to cover fuel types that have not yet been identified but that are anticipated to develop as drought stress and other factors affect current fuel types in a negative way. These are expected to be unfavorable fuel types with high intensities, moderate frequencies and moderate rates of recovery. Fire intensity and spread rates typical of the special fuel type is 75 chains/hour rate of spread and flame lengths of 19 feet.

Treatment options: If working in this unique fuel group it is recommended to request a consultation.

Congratulations! You now have the information you need to make informed decisions on how to best mitigate your specific factors related to wildfire risk.

Remember that the MOST EFFECTIVE way to protect a structure is through an effectively mitigated home ignition zone, any other method can be rendered totally ineffective at protecting a home without it.

5.6.1 SUPPLEMENTAL TOOLS BUILDER

L. Home Ignition Zone Structure Assessment Guide[1]

Note: This assessment is designed to help determine "how vulnerable the structure" will be during the wildfire and to convey recommendations that should be taken so that the home will have a better chance to survive a wildfire.

Remember, the following assessment items are for prevention/mitigation measures to be done well in advance of wildfire season.

Date of Assessment:	Property Address:	Resident Name:	Assessor:

	Assessment Items	Mitigation Recommendations
1.	**OVERVIEW OF SURROUNDINGS:**	
	How is the structure positioned in relationship to severe fire behavior?	
	Type of Construction.	
2.	**PEAKS TO EAVES:**	
	Inspect the roof – noncombustible? Shingles missing? Shingles flat with no gaps?	
	Gutters – present? Noncombustible?	
	Litter on roof, in gutters, and crevices.	
3.	**EAVES TO FOUNDATION:**	
	Attic, eaves, soffit vents, and crawl spaces.	
	Inspect windows and screens – metal screens? Multi-paned windows? Picture windows facing vegetation? Metal screening on all windows. Walls and attachments: noncombustible? Will they collect litter?	

Austin Fire Department, Wildfire Mitigation Division *www.austintexas.gov/wildfire*

	Assessment Items	Mitigation Recommendations
3.	**EAVES TO FOUNDATION:** *(Continued)*	
	Flammable materials next to or under the structure.	
	Crawl space, attic vents, soffits.	
	Nooks and crannies and other small spaces.	
4.	**FOUNDATION TO IMMEDIATE LANDSCAPED AREA:**	
	Decks/Porches (combustible?)	
	Fences (combustible?)	
	Landscaped (Managed) Vegetation – Separation distances, maintenance, plant selection; Firewise Landscaping Zones?	
	Propane Tanks.	
	Vehicle and RV use and parking, including lawn mowers, etc.	
5.	**IMMEDIATE LANDSCAPED AREA TO EXTENT OF THE HOME IGNITION ZONE:**	
	Inspect vegetation clearance and crown separation.	

Austin Fire Department, Wildfire Mitigation Division *www.austintexas.gov/wildfire*

WILDLAND URBAN INTERFACE

COMMUNITY WILDFIRE HAZARD ASSESSMENT

Subdivision Name(s) _____

Location: _____

Latitude: _____ Longitude: _____

Fire Department Jurisdiction: _____

Date _____ Date Evaluated: _____

No. Acres: _____ No. Lots: _____ No. Homes Built: _____

No. Homes Under Construction: ____

CALCULATING THE WILDFIRE HAZARD RATING

SUBDIVISION DESIGN HAZARD RATING	+ **SITE** HAZARD RATING	+ **BUILDING CONSTRUCTION** HAZARD RATING	+ **ADDITIONAL FACTOR** HAZARD RATING	= **OVERALL WILDFIRE** HAZARD RATING
	+	+	+	=

SUBDIVISION DESIGN RATING	**Rating**	
ACCESS		
2 or more roads in and out One road in and out (entrance and exit is the same)	0 5	
SUBDIVISION BRIDGES		
No bridges or bridges with no weight and/or restrictions Low weight bridges restricting emergency vehicle access	0 5	
ROAD WIDTH		
At least 20 feet wide Less than 20 feet wide	2 4	
ROAD ACCESSABILITY		
All weather access Limited access or unmaintained access	0 5	
SECONDARY ROAD CHARACTERISTICS		
Road ends in a cul-de-sac Cul-de-sac diameter > 100 feet Cul-de-sac diameter < 100 feet Dead end road < 200 feet long Dead end road > 200 feet long	 1 2 3 5	
STREET SIGNS		
Present with > 4 inch letters and reflective Missing, < 4 inches or non-reflective	1 3	
TOTAL SUBDIVISION HAZARD RATING		

WILDLAND URBAN INTERFACE

COMMUNITY WILDFIRE HAZARD ASSESSMENT

SITE HAZARD RATING: (Within 30 feet of structure based on a majority of the properties)	**Rating**	
DRIVEWAY CHARACTERISTICS		
Less than 150 feet long More than 150 feet with minimum 45 foot outside radius turnaround More than 150 feet with an inadequate turnaround	0 3 5	
Average driveway width more than 12 feet wide Average driveway width less than 12 feet wide	0 5	
No obstructing overhead branches below 15 feet Obstructing overhead branches below 15 feet	0 5	
No bridges or bridges with no weight/or width restrictions Inadequate surface of law bridges restricting emergency vehicle access	0 5	
Slopes level or less than 10% Slopes over 10%	0 5	
No gate/non-locking gate Locked gate restricting access	0 5	
Address clearly visible from the road Address not visible from the road	0 2	
DOMINANT TREES (within 100 feet of homes)		
Deciduous (Hardwoods) Mixed (Hardwoods and Conifers) Conifers (Juniper and Cedar)	1 5 10	
LADDER FUELS		
Branches close to the ground Branches pruned up	5 0	
VEGETATION (predominant type throughout the community)		
Low fire intensity Grasses less than 6 inches tall Hardwood leaves	5	
Medium fire intensity Grasses greater than 6 inches tall Mixed stands of hardwoods and conifers	10	
High fire hazards Dense stands of conifers Moderate to heavy dead and downed vegetation	20	
SLOPE OF PROPERTY		
Flat (0-5%) Moderate (6-20%) Steep (over 20%)	0 2 4	
DEFENSIBLE SPACE (around the majority of homes)		
No trees, shrubs or tall grass within the 30 foot zone Will spaced trees and shrubs within the 30 foot zone Touching crowns or tall grass within the 30 foot zone	0 10 20	
DEFENSIBLE SPACE (around the majority of homes)		
No un-thinned or unmanaged timber within the 100 foot zone Un-thinned or unmanaged timber with in the 100 foot zone	0 5	
TOTAL SITE HAZARD RATING		

WILDLAND URBAN INTERFACE

COMMUNITY WILDFIRE HAZARD ASSESSMENT

BUILDING CONSTRUCTION HAZARD RATING	**Rating**	
ROOFING MATERIALS		
Greater than 75% of homes have metal, tile or class A asphalt or fiberglass shingles	0	
50 to 75% of homes have metal, tile or class A asphalt or fiberglass shingles	10	
Less than 50% of homes have metal, tile or class A asphalt or fiberglass shingles	15	
SIDING / SOFFETS		
Greater than 75% of homes have fire resistant siding and soffets	0	
50 to 75% of homes have fire resistant siding and soffets	5	
Less than 50% of homes have fire resistant siding and soffets	10	
UNDERSKIRTING (if applicable)		
Greater than 75% of homes have the equivalent of fine mesh screening underneath	0	
50 to 75% of homes have the equivalent of fine mesh screening underneath	5	
Less than 50% of homes have the equivalent of fine mesh screening underneath	10	
TOTAL BUILDING CONSTRUCTION HAZARD RATING		

ADDITIONAL HAZARD FACTORS:	**Rating**	
FIRE CONTROL WATER SUPPY		
Pressurized hydrants with minimum 500 GPM spaced less than 1000 feet apart	0	
Pressurized hydrants with less than 500 GPM or spaced more than 1000 feet apart	2	
Dry hydrant(s) available year round within the community	2	
Other accessible sources within community	5	
Water sources located within 4 road miles of the community	1	
No water sources in or within 4 miles of the community	15	
ELECTRIC UTILITIES		
Underground clearly marked	0	
Underground not clearly marked	2	
Overhead with adequate (at least 20 foot) right of way	2	
Overhead with right of way unmaintained	5	
GAS UTILITIES		
Underground clearly marked	0	
Underground not clearly marked	1	
Above ground with 15 feet of brush clearance, greater than 30 feet from the homes	2	
Above ground no brush clearance or within 30 feet from the homes	5	
SURROUNDING ENVIRONMENT		
Community is not surrounded by wildland areas	0	
Wildland area adjoins one side of the community	5	
Wildland area adjoins 2 sides of the community	10	
Wildland area Large adjoins 3 sides of the community	15	
Community is completely surrounded by large forested areas	20	
UNDEVELOPED LOTS		
Less than 10% of lots have not been developed and pose an additional wildfire hazard due to lack of maintenance or restricted access	0	
10 to 50% of lots have not been developed	3	
51 to 75% of lots have not been developed	5	
Greater than 75% of lots have not been developed	10	

WILDLAND URBAN INTERFACE

COMMUNITY WILDFIRE HAZARD ASSESSMENT

RISK LOCATION		
Community is located within the following designated Wildfire Risk Areas according to the Kentucky Division of Forestry's Risk Analysis		
Low	0	
Medium	10	
High	20	
TOTAL ADDITIONAL HAZARD FACTORS		

What does the Wildfire Hazard Rating number mean?

Using the Wildfire Hazard Assessment, the highest possible rating is 206 points. Woodland communities can be divided into the following three/four risk categories:

Low Risk: **Total wildfire risk rating is 0 – 75 points**

The chances of your home surviving a wildfire are GOOD. Little is needed to improve your situation. Keep up the good work.

Moderate Risk: **Total wildfire risk rating is 76 – 130 points**

The chances of your home surviving a wildfire are FAIR. Some minor improvements will make your home more fire resistant. Check the area on the form in which you scored poorly.

High Risk: **Total wildfire risk rating is over 130 points**

The chances of your home surviving a wildfire are NOT GOOD. Improvements are necessary. Some improvements in structure and site are necessary.

Extreme Risk: **Total wildfire risk rating is over 140 points**

Your home MAY NOT SURVIVE if a wildfire passes through the area. In fact, a fire could even start on your property. Take a serious look at your property and make improvements. If you don't you may be facing a disaster. You'll find that even small changes make the difference between losing or saving your home.

HAZARD is defined as the potential fire behavior based on physical fuel characteristics.

RISK is defined as the probability of fire occurrence determined by the number, presence and activity of potential ignition sources.

This form may be used to evaluate your community and determine the level of wildfire risk. It covers roughly one-half of the hazards normally taken into account in calculating fire risk, but does provide an approximate indication of true risk. For more information on your home's fire risk or for a more complete evaluation of your property contact your local fire department.