Executive Summary

- WUI fire is part of nature and unavoidable. About 3% of WUI fires are so severe that they cannot be controlled.
- Fire risk reduction is not just a fire issue but a critical ecological and environmental issue that impacts the entire community. It's critical to work towards a rational approach that balances the needs for fire risk reduction with preserving the urban forest, the environment and wildlife habitat
- Home ignition potential is the principal cause of home losses in WUI fires. Structure survival increases as home ignition potential is reduced. Concurrently, WUI fires can be reduced by reducing all fuel loads, not just the "vegetative fuel load", but also the fuel load from structures and all combustible materials.
- A more significant WUI fire risk reduction can be obtained by hardening the homes and reducing their ignition potential than from only removing vegetative fuel load. Hardening the home provided a risk reduction of about twice as much as that obtained from removal of vegetative fuel load. Homes with flammable roofs survive 19% of the WUI fires, but homes with nonflammable roofs survive 70% of the fires. Homes with non flammable roofs and a vegetation clearance of 30 to 60 ft. all around the home survived 86-95% of the fires.
- Vegetative fuel load reduction does not provide significant fire risk reduction unless it is combined with home hardening. However, most often, vegetative fuel reduction is the first step taken because it's cheap and trees and vegetation are seeing and expendable. But preserving trees and vegetation is crucial for a healthy urban forest.
- A burning structure will most likely ignite adjacent structures while burning vegetation may not. Fire from neighboring homes can be much more devastating and is a greater ignition threat than fire from vegetation. When WUI fires reach combustible homes in neighborhoods, fire spreads very rapidly and becomes severe due to the high combustibility of the structures. This makes it very difficult to protect the majority of the remaining homes in the neighborhood.
- Embers are a significant ignition source during WUI fires, particularly when flammable roofs are involved. Case studies show that the majority of home fires are started by embers that travel up to 5 miles and land on combustible materials, most often a shingle roof.
- The commonly used recommendation that defensible space should be 30 ft. for zone 1 and 100 ft. for zone 2 is not validated by computer models, experimental tests, or case studies. These recommended defensible space distances have been used for at least 20 years and may be based on observation of case studies with additional safety factors added.
- Firewise recommendations aim to reduce home ignition and all fuel loads, and to disconnect all fuel loads paths from the home. Firewise recommendations include 3 defensible space zones measured from the edge of the home: 30 ft., 100 ft, and to the property line.
- Firewise defensible space guidelines (30 ft. and 100 ft. buffers) are very general guidelines that can be used as a starting point. It's critical that defensible space be decided on a case by case basis depending on the hazard level of the area, land topography and conditions, as well as structures, vegetation and irrigation on the site.
- Preserves and WQL lands are preserved for the future and for endangered species at a federal level. Fuel load reduction should be minimal to not disturb these lands to honor the commitment made to protect these lands. The new WUI code should require that future developments leave a 100 ft. buffer from the edge of the preserves in the development site.
- The new WUI code should also require that new developments in high risk wooded areas be planned and built in a Firewise manner with an upgraded fire code that includes noncombustible materials.
- Homeowners who reduce vegetation fuel loads should be required to comply with all federal, state and local laws, including the Protected and Heritage Tree Ordinance, and should obtain all necessary permits without exemptions or waivers.

Wildland fires are part of nature. The forest is cleansed and renewed with wildfires. Wildland fires typically occur when there is a combination of high temperature, low humidity and wind. Wildland fires are initiated by many reasons, including by humans. The majority of wildland fires can be controlled, but about 3% of wildland fires are so severe that they cannot be controlled (Cohen). There is no realistic way to prevent or reduce severe wildland fires unless every single tree and home were to be removed.

It's critical to work towards a rational approach that balances the needs for fire risk reduction with preserving the urban forest, the environment and wildlife habitat. It's not only a fire risk reduction issue, it's a critical ecological and environmental issue that impacts the entire community.

As development progresses, homes and subdivisions encroach on wooded areas, creating the Wildland Urban Interface (WUI) zone. This zone is not the entire interface where wildland meets the urban community, but the homes and their immediately adjacent vegetation. WUI fires cannot be prevented, so communities need to adapt to survive these fires. The principal WUI fire issues are preservation of life (evacuation of humans and domestic animals) and survival of residential structures, without endangering firefighters' lives.

Home ignition potential is the principal cause of home losses in WUI fires. Structure survival increases as home ignition potential is reduced. WUI fire cannot spread to a home unless the home and its adjacent surroundings can ignite, regardless of how intense, close or fast the fire is. For instance, a concrete structure will not burn even in the middle of a crown fire, but a highly combustible home will ignite from embers, without flames from a direct crown fire. Homes with low ignitability can survive high intensity WUI fires, but highly ignitable homes can be destroyed with lower intensity fires.

WUI fire destroys and damages homes through various ignition sources: from direct contact with the crown fire, from exposure to high temperatures (radiation), from fire spreading though surface fuels, and from embers that fall on combustible materials igniting the home.

Post incident studies show that the majority of homes that burned during the Cerro Grande Fire, Los Alamos NM, succumbed not to a crown fire, but to ground fire that advanced across surface fuels or from embers that traveled ahead of the crown fire. The crown fire did not engulf the homes. The homes burned because of the combustible materials in the roofs, homes, or in immediately adjacent structures and because of vegetation immediately adjacent to the homes (Cohen 2000).

High Intensity crown fires travel fast, but with minor exceptions, crown fires do not cause homes to catch fire. The majority of homes are destroyed and damaged from:

- embers from burning vegetation or structures, or that travel miles away from crown fires, and land on homes, igniting combustible materials (roof, attics, leaves, decks, outdoor furniture, etc.).
- exposure to high temperatures (radiation) from burning residences. The high temperatures result from structure flames and embers.
- ground fire spreading within the residential area through surface fuels, from structures or vegetation, that are in contact with homes.

Fire is a combustion process. The basic requirements for combustion are fuel, heat, and oxygen. Fires can be reduced by reducing the fuel load and by reducing the ignition potential. Fuel load is typically thought as being composed of vegetation and it's typically called "vegetative fuel load". However, structures and all combustible materials are also fuel loads.

Fuel loads are firewood piles, structures immediately adjacent to homes, flammable roofing materials (cedar or composition shingles), combustible outdoor furniture and cushions, etc., as well as vegetative sources such as dead or live burnable vegetation (trees, shrubs, grass, etc.) immediately adjacent to homes. The effect of fuel loads can be reduced by interrupting the path to the home.

All full loads (including structures, combustible materials and vegetation) should be reduced but only while concurrently hardening the home to reduce the home's ignition potential. It's critical to preserve vegetation, trees, and wildlife habitat in the urban forest so the vegetative fuel load needs to be reduced as minimally as possible, and in the least damaging manner to wildlife (including endangered species) and the environment (reducing soil compaction, stormwater runoff, erosion, etc.).

Defensible space is the area where fuel hazards are reduced near structures to provide an area between structures and burning vegetation adequate for the safe operation of firefighters (California State Board of Forestry 1996). How large should the defensible space be?

Jack Cohen, USDA Forest Service Research Physical Scientist, has developed extensive theoretical fire analyses for his computerized Structure Ignition Assessment Model (SIAM). This computer model predicts the heat flux and time for a wooden structure to ignite from exposure (radiation) to a fire source. Defensible space and the flame-wall distance at which ignitions occur depend on the flame size and the flame duration (flame residence time).

Cohen's computer analysis predicts that:

- assuming only ignition by exposure to a fire source without any obstructions, a crown fire will not ignite a wooden wall at distances greater than 130 ft. away and it would take 10 minutes for the wall to ignite,
- this shows that when a home burns, it will most likely cause nearby homes to ignite by exposure if the distance between the homes is less than 130 ft. since structure fires can last for several minutes,
- a vegetation crown fire (that only has an average 50-70 seconds flame duration) would not ignite the wall at more than 95 ft. away,
- thinning trees produces gaps in the flame front that significantly reduce the distance needed to prevent the wooden wall from igniting.

Cohen compared his computer predictions with experimental tests and case studies. The comparison between the computer prediction and experimental tests show that the computer prediction for a defensible space of 130 ft. at 10 minutes is the worse case scenario. Experimental test results show that a much smaller defensible space of 60 ft. is needed for a wood wall to not ignite from exposure to a crown fire. Comparison to case studies also shows that the computer prediction is the worse case. The case study that Cohen compared to was a fire with 90% survival of homes with nonflammable roofs and a vegetation clearance of 30 to 60 ft. from the home.

Field tests have shown that wooden walls can successfully survive intense flame fronts from as close as 30 ft. away. In fact, only 3 out of 7 wooden structures were damaged by an intense crown fire 30 ft. away and none at 60 ft. (Alexander et Al. 1998). The commonly used recommendation that defensible space should be 30 ft. for zone 1 and 100 ft. for zone 2 is not validated by computer models, experimental tests, or case studies. These recommended defensible space distances have been used for at least 20 years and may be based on observation of case studies with additional safety factors added. The defensible space distances of 30 ft. and 100 ft. are very general numbers that should be used with caution on a case by case basis.

Fires travel faster with steeper slopes, so the defensible space distances should be increased with steeper slopes. It's critical that defensible space be decided on a case by case basis depending on the land topography and conditions, as well as structures, vegetation and irrigation on the site. Some vegetation is more combustible than others. Typically, native tree species are less combustible. Evergreen tree species are more combustible than deciduous species. Some evergreen tree species (conifers, ash juniper, eucalyptus, etc.) are very combustible. Well irrigated trees are less combustible. Similar comments apply to bushes and grass.

The computer model predicts only ignition from exposure to a fire source. But case studies have shown that the majority of fires are started by embers that travel up to 5 miles and land on a combustible source, most often a shingle roof.

Embers are a significant ignition source during WUI fires, particularly when flammable roofs are involved. Post fire studies show that homes with nonflammable roofs had a 70% survival rate compared with 19% for homes with flammable roofs (Foote 1994, Davis 1990). In addition, 95% of homes with non-flammable roofs

survived WUI fires with a vegetation clearance of 30 to 60 ft. maintained around the homes (Stanford Research Institute). Similarly, another source states that 86% of homes with non-flammable roofs and a clearance of 30 ft. or more survived WUI fires. (Howard et al., 1973).

A much more significant WUI fire risk reduction can be obtained by hardening the homes and reducing their ignition potential. Recapping the previous data, homes with flammable roofs survive 19% of the WUI fires, but homes with nonflammable roofs survive 70% of the fires. Homes with non flammable roofs and a vegetation clearance of 30 to 60 ft. all around the home survived 86-95% of the fires. Thus, hardening the home provided a risk reduction of about twice as much as that obtained from removal of vegetative fuel load.

The most important home hardening measures for fire risk reduction are included in Appendix A. Wooden structures immediately adjacent to homes are just trees in a different shape. Vegetative fuel load reduction does not provide significant fire risk reduction unless it is combined with home hardening. However, most often, vegetative fuel reduction is the first step taken because it's cheap and trees and vegetation are seeing and expendable. But preserving trees and vegetation is crucial for a healthy urban forest that is already being stressed by continuous severe drought and that continues to diminish by increasing development.

Burning structures do not produce flames as large as some vegetation, but the fire burns longer on site (fire residence time). Consequently, a burning structure will most likely ignite adjacent structures while burning vegetation may not. Fire from neighboring homes can be much more devastating and is a greater ignition threat than fire from vegetation (Cohen).

When WUI fires reach combustible homes in neighborhoods, fire spreads very rapidly and becomes severe due to the high combustibility of the structures. The fuel load of a burning combustible home is so high that the fire is very intense and long lasting. Many of the homes nearby burn as well because the structural fire burns longer on site (longer residence time). In addition, many homes are built very close to each other in new subdivisions, facilitating the ignition by exposure to the long lasting intense fire and from embers from the burning home. This makes it very difficult to protect the majority of the remaining homes in the neighborhood.

Firewise recommendations are geared to disconnect all fuel load from the home and to reduce all sources fuel load. Firewise recommendations include 3 defensible space zones measured from the edge of the home: 30 ft., 100 ft, and to the property line. These distances should be flexible and modified, on case by case basis, based on the hazard level of the area. These distances are sometimes increased on the downward side of steep slopes in high risk areas.

The Firewise recommendations for reduction of vegetative fuel loads for Zone 1 are:

- locate outside plants away from the home walls and roofs (not connected to the home, no vines climbing trees or trellis),
- place container plans away from the home walls,
- rake mulch away from the home walls,
- separate mulch and combustible flower bed plantings from home walls with rocks or gravel,
- maintain vegetation more than 10 feet away from combustible fences and from utility lines (distance depending on voltage).
- select less flammable vegetation (tree, shrubs, grasses, etc.),
- cut grasses to 3 or 4 inches maximum height, but allow taller vegetation on steeper slopes to retain soil,
- keep tree branches 10 to 15 feet from the roof or chimney,
- remove lower tree limbs ("limbing up" trees) 8 ft. above ground.

The recommendations for Zone 1 that need more discussion and consideration of environmental impact are:

- Thinning of trees: The Firewise recommendation is to have a clearing from tip to tip of canopy (crown separation) of at least 10–18 feet, with closer spacing allowed for less combustible trees. However, thinning trees requires removal of trees within 30 ft., from the home. The city recommends planting trees near homes the reducing temperatures in Summer (shade) and increasing temperatures (wind shelter) in Winter. It should be clear that instead of thinning (removing) trees, the lower limbs and all other

vegetation (bushes) under the trees can be removed to achieve similar results. In addition, if trees have to be removed, the less desirable trees and younger trees can be removed so that the protected and heritage trees can remain.

- Firewise recommendation specify that no more than 1/3 of the live canopy should be removed, but this is against city code that specifies that no more than 25% of the canopy should be removed without a variance for protected and heritage trees. Standard arboricultural practices recommend that no more than 15% of the live canopy should be removed to not impact the tree.
- Removal of most shrubs, with clumps allowed if separated by at least twice the shrub height.

The recommendations for Zone 2 are:

- remove most dead material,
- limited grass heights
- crown separation of 5-10 feet
- pruning of shrubs
- limbing of trees.

The recommendations for Zone 3 extend from the end of Zone 2 to property line, and generally only require minimal vegetation management.

Preserves (such as the Balcones Canyon Preserve) and WQL are lands preserved for the future and for endangered species at a federal level. These lands have multiple ownerships (City of Austin, Travis County, Water districts, etc.). Fuel load reduction should be minimal to not disturb these lands to honor the commitment made to protect these lands.

Development has encroached on preserves and WQL lands. The new WUI code should require that future developments leave a 100 ft. buffer from the edge of the preserves in the development site, similar to floodplains.

The new WUI code should also require that new developments in high risk wooded areas be built in a Firewise manner with an upgraded fire code that includes noncombustible materials (especially a non-combustible roof and deck), double pane windows, etc. New developments in high risk areas should be planned in a Firewise manner, to include several ingress/egress roads, use roads and water features as defensible space, have evacuation plans, etc. In other cities that have new fire building codes, developers did not support the code, citing concerns that the new code would drive the price of housing up by $20,000 to $25,000 per home. Experience now shows that when totaled, the WUI code adds about four to five thousand dollars to the construction of a new home (Wildland Urban Interface Lessons Learned Part 2 Issue 20, 2007).

Homeowners who reduce vegetation fuel loads should be required to comply with all federal, state and local laws, including the Protected and Heritage Tree Ordinance, and should obtain permits when necessary. The city should establish programs to pick up debris and manage brush chipping.

Code compliance is voluntary, so city enforcement will be needed. Other cities that have WUI fire ordinances experience high non compliance due to the reluctance of homeowners to provide defensible space, maintain and irrigate their property, and use fire safe construction materials. Homeowners explain it is difficult and expensive to maintain defensible space. It's not unusual for only 25% of a city to be defensible in spite of WUI ordinances (Wildland Urban Interface Lessons Learned Part 2 Issue 20, 2007).

Use of fire resistant materials was less common than vegetation interventions, particularly at the Michigan study site. Over one-third of the Colorado, New Mexico and California homeowner respondents had built or replaced a roof with fire resistant shingles. Closing the underside of a deck or building or replacing siding, porches or decks with fire resistant materials were less common.

The ultimate responsibility for home wildfire protection lies with private homeowners. The city should provide assistance to lower-income households in high risk areas for retrofitting their homes with noncombustible materials.

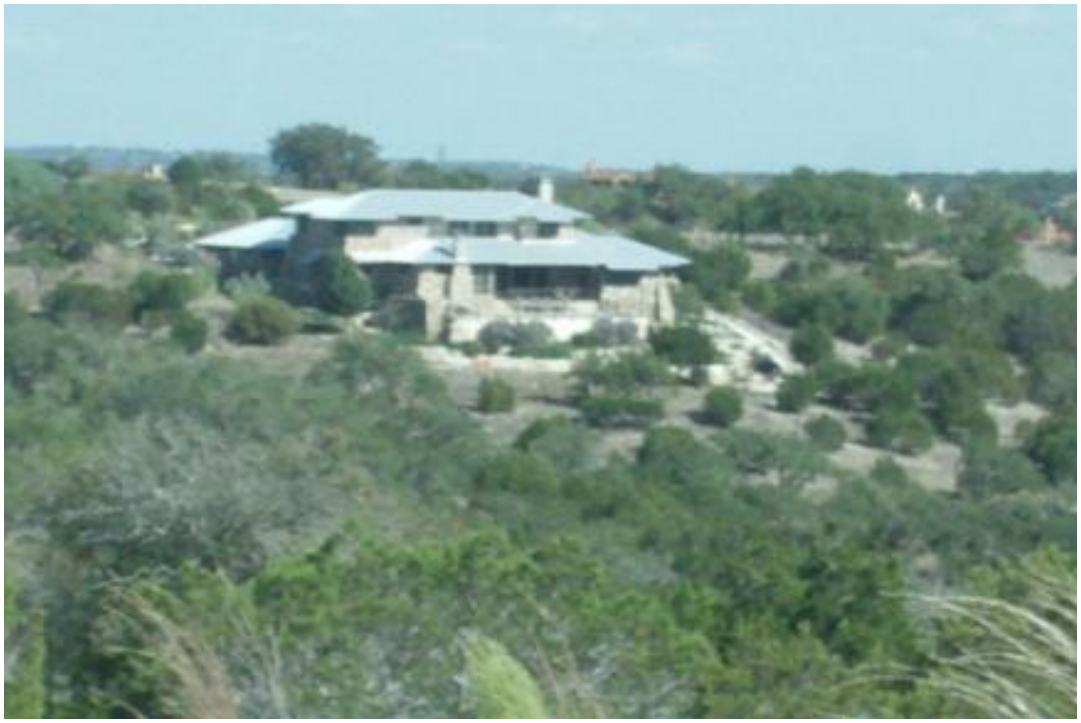
Appendix A
Home Hardening Measures

The most important home hardening measures for fire risk reduction are:

- avoiding combustible roofs in high risk areas,
- replacing wooden fences with non-combustible fences,
- sealing tiny entrances for embers to reach the attic,
- installing adequate guards on eaves soffits, foundation vents, roof vents, etc. to prevent entrance to the attic
- separating wooden and combustible structures from the home (even with a 1 inch gap). This includes sheds, detached garages, bars, etc.
- avoiding wooden decks or separating them from the home
- replacing single pane windows with double pane windows
- installing guards on gutters (even if cleaned before the fire, gutters can be filled with debris during fires)
- cleaning dry leaves and debris from roof, gutters and around home
- removing wood piles and other flammable objects (outdoor furniture, cushions, etc.) away for the home

River Place Abutting BCP Land
(Preserve Was There First)

Example Of Significant Vegetation Removal Within Defensible Space
No Trees Around Home For Shade, Only Bushes
Embers Can Reach Home In Spite Of Vegetation Removal,
Best Defense Is to Reduce Home Combustibility

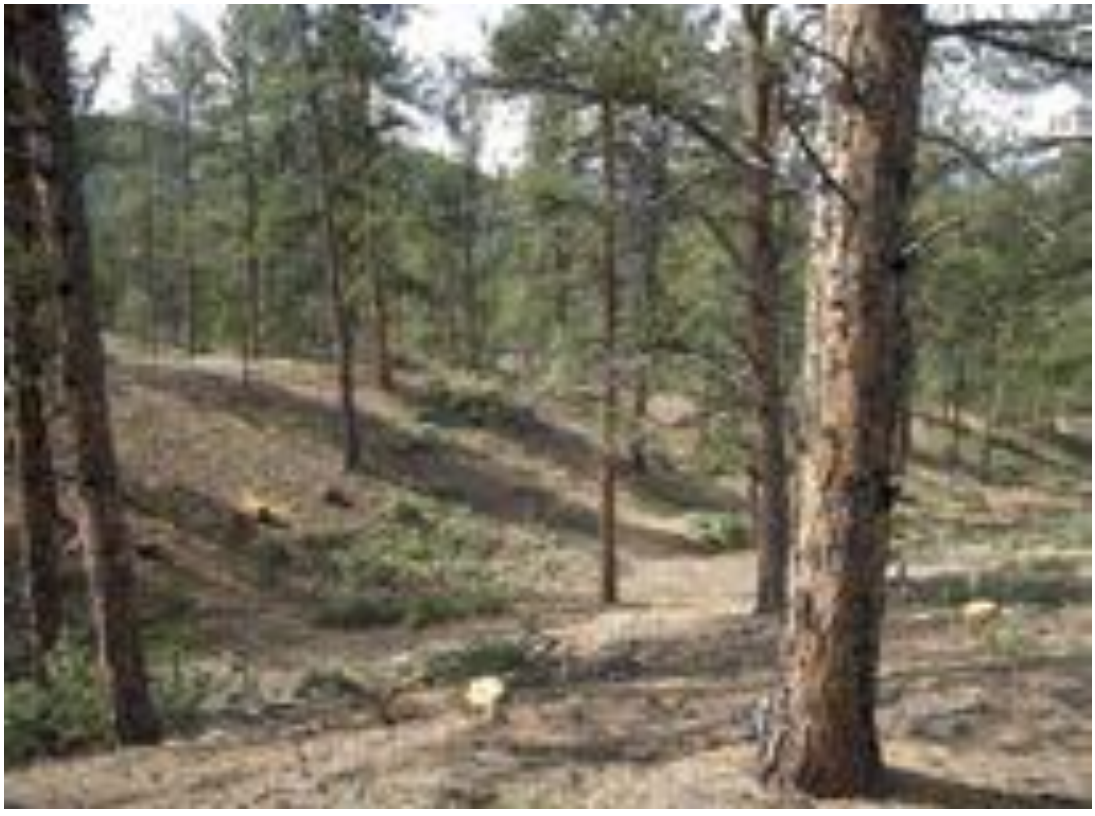


Example Of Excessive Vegetation Removal Within Defensible Space
Clear Cut Around Home
(Posted Online By CA Consultant Who Helps Homeowners Meet CA Fire Regulations)

State Forest Shaded Fuel Break
Trees Limbed Up, No underbrush

Original Forest

Trees Removed to Thin Forest



Adjacent Fuels In Conservation Easement:

Notice That Wooden Fence Needs To Be Replaced With Metal Fence
For Effective Fuel Load Reduction