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Planning Essentials

Planning and Design Strategies for Communities at Risk from Wildfire

By Robert F. Brzuszek, Chris Campany, AICP, Timothy Schauwecker, Jason Walker, and Marc Foster

As development sprawls into the urban-wildland interface in several regions of the United States, more and more communities will need to employ measures to mitigate potential losses from wildfires. While there is a wealth of information publicly available through the National Fire Protection Association's Firewise Communities Program, and even though model codes exist, there are few works specifically designed to assist planners and developers in organizing land use and placing dwellings and other structures in a way that minimizes damage in the event of wildfires. Proper wildfire planning and the imposition of design strategies can save structures from damage or loss due to advancing ground fires.

This article provides planning and design strategies that local jurisdictions can use to mitigate potential losses from wildfires in the urban-wildland interface. We ground our recommendations about wildfire planning and design on an understanding of wildfire events in Florida in 1998, development characteristics of three Firewise communities in Florida built after those events, and a review of model codes and local ordinances that promote better protection from wildfires. Though our recommendations emphasize fire risks in the southeastern region of the country, they can be applied in other regions with risks from wildfires.

WHY PLANNERS SHOULD PAY ATTENTION TO THIS ISSUE

The Urban-Wildland Interface

Changing demographics, increasing population, economic development, and a desire to live in rural areas all contribute to populated centers spreading outward into surrounding forest and agricultural lands. As our nation's urbanized areas continue to expand outward from populated centers, the number of homes and subdivisions infringing upon rural and forested areas is rapidly increasing. This zone of new development in rural areas is known as the urban-wildland interface (UWI). This concept has been described as "an area where various structures (most notably private homes) and other human developments meet or are intermingled with forest and other vegetative fuel types" (Kline et al. 2004).

Wildfire Risks in the Southeast Region

The reduction of wildfire risk is a high priority for many communities, as well as state and federal agencies across the nation, but it is becoming a more serious issue in the Southeast. The southeastern United States is the fastest growing region in the nation in terms of population, and it is projected to reach 114 million people by 2020 (Cordell and Macie 2002). The population growth of rural southern counties grew by 7.5 percent in the 1990s, and this trend is projected to rise on average to 11.5 percent (Cordell and Macie 2002).

As the population demographics in the South continue to rise, the use of prescribed fire to manage lands is anticipated to become more difficult to utilize and will result in heavier fuel buildups (Southern Group of State Foresters 2003). Forestry and forestry-related industries comprise the majority of landholdings in the South (214 million acres), and the USDA Forest Service Region 8 leads the nation in the number of wildland fires that occur each year. In 2006, 48,000 fires burned more than 2.6 million acres in this region.

Responsibility for suppression of wildland fires typically falls on local fire departments. Due to excessive vegetative fuel buildups from changing land use, fragmentation, sprawl, and additional population densities, wildland fires can sometimes exceed the capabilities of local fire responders, which makes wildland fire management and response scenarios complex (Southern Group of State Foresters 2003).

An additional factor that may compound future wildfire frequency and intensity is rising annual temperatures. El Niño and La Niña temperature fluctuations directly affect the South's climate. In the El Niño cycle, the southeastern United States is typically warmer and drier, resulting in drier vegetative fuels. As recently shown in the western states, increasing temperatures are responsible for increased duration and intensity of wildfire seasons (Running 2006).

The Broader Context of Wildfire Mitigation Planning

Planning for wildfire events is just one part of a comprehensive community planning strategy. Comprehensive hazard planning provides long- and short-term cost savings, guides land-use regulations, coordinates community activities, and protects resources (Wisconsin Department of Administration 2010). The proximity of potential fuel sources and fire-prone habitat types are high-risk factors that warrant due consideration when planning and designing development. Proper wildfire planning measures can save structures from the impacts of advancing ground fires. The geographic context of the community's development and its unique conditions, weather, topographical features, and surrounding vegetative fuel load, make it wise to utilize multiple planning strategies to optimize defensible space. Wildfire planning and management can also accomplish a number of planning goals, including promoting more compact development patterns, preserving wildlife habitats, providing recreational and scenic amenities, conserving working forest landscapes, and encouraging landscape patterns that improve the overall quality and ecology of a place.

The 1998 Florida Wildfires

In late June 1998, several wildfires began in the area inland of Florida's east coast, in Flagler, Volusia, and Brevard counties (see Figure 1). These fires spread east rapidly, powered by frontal circulation winds and assisted by unseasonably dry conditions resulting from the El Niño oscillation. The fires began to spread rapidly toward the populated east coast on July 1, crossing multiple road rights-of-way in excess of 100 feet. The advance continued until July 4, when increased humidity and decreased winds slowed the fires' advance. Rainfall, on July 5, brought the fires under control. The final wrap-up work of fully extinguishing the fires took another two weeks.

Figure 1
Geographic Extent of June 1998 Wildfires in Flagler, Volusia, and Brevard counties, Florida.

There are several reasons why the 1998 wildfires in Florida were so extensive. Severe drought conditions resulting from El Niño weather patterns contributed to the extent of the wildfires. The drought combined with dry summer thunderstorms (with lightning and no rain) further exacerbated the fires. Higher than average westerly winds, resulting from periodic frontal passage, accelerated fuel burning of the ample fuel loads in adjacent wildlands. Huge areas of dry pine forests to the west and strong west winds combined to create very intense fires burning through miles of uninterrupted forest then abruptly meeting residential development. In each of these cases, wildfires crossed the largest available defensible zones — major roads (Interstate 95 and US Highway1), large power line rights-of-way, and many smaller roads.

These wildfires in Florida had tens of thousands of forested wildlands adjacent to the sites of affected residential developments. The wildfire events demonstrate the need to better plan for protection of development that is built in the UWI.

MODEL WILDFIRE CODES AND ORDINANCES

There is a wealth of information already publicly available through Firewise (Firewise 2010) and the National Fire Protection Association (NFPA 2008) concerning architectural standards, landscape and buffer zone requirements, and other suggested design principles. What is more, localities have adopted ordinances and regulations that reflect the state of current practice. We examine these model codes and some of the local ordinances available in an effort to offer lessons about how to organize land-use elements in developments and place structures in ways that minimize external ground fire damage.

Currently, model urban-wildland regulatory codes are used to form the legal language and definitions for most community fire ordinances: NFPA 1144 (National Fire Protection Association 2008) and the International Urban-Wildland Interface Code (International Code Council 2003). These national ready-to-adopt codes were developed after several significant wildland fires produced casualties and damaged properties. The subsections summarize the contents of those model codes.

National Fire Protection Association (NFPA) Standards

The NFPA 1144 ordinance, titled "Standard for Protecting Life and Property from Wildfire," (National Fire Protection Association 2002) established specific ranking information for landscape and structural features. Responding to the research and need to focus on preventing UWI disasters, the NFPA Technical Committee for Forest and Rural Fire Protection revised the ordinance to reflect the approach offered by the National Firewise Communities Program. The new NFPA 1144, titled "Standard for Reducing Structure Ignition Hazards from Wildland Fire" (National Fire Protection Association 2008a) includes a procedure and details to assess hazards around existing homes in interface areas and design criteria for new homes. The document also includes suggested mitigation measures, based on Firewise concepts that residents can implement.

Another relevant standard is NFPA 1411, titled "Standard for Fire Protection Infrastructure for Land Development in Suburban and Rural Areas (National Fire Protection Association 2008b). The NFPA Technical Committee revised the 2002 edition of this document to include the infrastructure elements from NFPA 1144, because it recognized that the objective should be preventing ignition of structures and that water supplies, road width, and street signage were suppression issues that have little or nothing to do with preventing ignitions. NFPA 1411 outlines the essential requirements for land-use conversion that results in community design and development, including road widths and emergency vehicle accessibility, water supplies, topography, construction materials, and available fire protection strategies.

The International Urban-Wildland Interface Code

The International Code Council, Inc. (ICC) produced the International Urban-Wildland Interface Code in 2003. ICC is a nonprofit organization dedicated to developing national model codes. ICC's urban-wildland interface code is for both municipalities and county jurisdictions and bridges the code requirements of the pre-existing international building code and the international fire code. The code provides minimum regulations for land use and development in urban-wildland interface areas. It covers the administration and authority of government, definitions, special building construction regulations, fire-protection requirements, and general requirements. As with any standardized code, it is important that the local jurisdiction considering the model code decide what, if any, amendments are needed to make the code more effective and responsive, taking into account the jurisdiction's unique landscape qualities and overall community context.

Local Ordinances

Communities are increasingly adopting or strengthening wildland fire ordinances to minimize wildfire damage. The majority of community wildland ordinances address vegetative fuel clearance around structures, vegetative maintenance, and vehicular access requirements (Brzuszek and Walker 2008). These ordinances attempt primarily to reduce damage and the risk of possible injury for homeowners and firefighters in the UWI. Homeowners are more likely to accept such community ordinances if there is a high perception of risk and awareness (Gardener et al. 1987). Regulations directed toward development in fire risk areas do not guarantee a community will be free from fire risk, but they may reduce the potential for catastrophic damage.

Advantages to implementing wildfire regulations are many, as are the methods for establishing priorities. Wildfire mitigation may be written into the regulations for new developments, applied during the development review process, incorporated into zoning ordinances, or placed in private covenants and deed restrictions. Such mitigation measures can include requirements for fuel modification in high-risk zones, and building and construction standards.

Disadvantages of wildfire regulations include: potentially higher construction and maintenance costs for homeowners or associations, resistance to adopting regulations by homeowners, possible conflict with existing tree or natural resource ordinances, costs for monitoring, administration and enforcement, and lack of guarantees that proper maintenance will be achieved in the absence of administration and enforcement.

PROVISIONS FOR WILDFIRE MITIGATION

We previously examined nationwide municipal and county wildland fire codes containing provisions for landscape features and their general requirements for new or existing development (Brzuszek and Walker 2008). In that research we looked at 12 discrete ordinance provisions that fall into four categories: vegetative fuel clearance, building requirements, roadway and driveway standards, and planning and assessment.

Vegetative Fuel Clearance

A major provision of many ordinances concerns the distance between heavy vegetation types and the proposed or existing structures. These distances coincide with what firefighters term "defensible space," that is, the space that

creates a firebreak between fuels (between vegetation and structure) and allows firefighters room to fight an oncoming wildfire. Defensible space usually includes multiple zones for fuel modification, ranging from clearing flammable materials immediately surrounding a residence, to measures to protect zones that surround an entire subdivision. Most ordinances identify a gradient of two or three zones with provisions for the establishment and management of these defensible areas.

The zone immediately adjacent to a dwelling is the area of maximum fuel modification and management, and typically extends 30 feet from the structure (see Zone 1 in Figure 2). Its purpose is to reduce the spread of an external fire by limiting the height or spacing of vegetation. Ultimately, this regulation would affect any planting plan. High Fire Hazard Area Landscape Guidelines from the City of Santa Barbara, California, mirror the Uniform Fire Code. That code recommends that in Zone 1 (0-30 feet from structures) "plants should be low growing, irrigated plants. [The] focus should be on ground covers not more than 12 inches in height or succulents. Use non-flammable materials for paths, patios, and mulch" (City of Santa Barbara Fire Department 2001). The landscape guidelines also list plants to remove or avoid using in landscape zones because they are more flammable. Such plants to avoid or remove include pampas grass (Cortaderia sp.), cypress (Cupressus sp.), eucalyptus (Eucalyptus sp.), fountain grass (Pennisetum sp.), and pine (Pinus sp.). Many state fire or cooperative agencies offer a recommended Firewise plant list for their area.

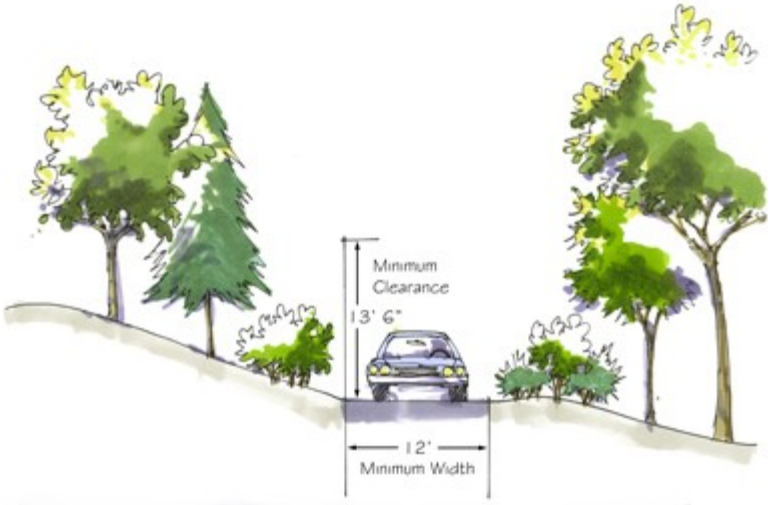

Figure 2
Wildfire mitigation zones around structures include zones of managed vegetation, fuel reduction, and transition areas.
Figure redrawn by Marc Foster.

The second zone is a transition area to any adjacent wildland. Fuel management in this zone applies to that area between the wildland and a structure, regardless of property ownership. The extent ranges from 30 to 100 feet (see Zone 2 in Figure 2); however, in high-risk areas, the distance may increase beyond 100 feet. In this zone, 10 feet or more should typically separate the edges of tree crowns. The 10-foot crown spacing is acceptable on slopes between zero and 10 percent. However, as slope increases, the spacing between tree crowns needs to increase to as much as 30 feet on slopes exceeding 40 percent (Eagle County 2004).

Although ordinances often include these two vegetative modification zones, the provisions for the establishment and management of each zone can vary. However, the different fuel modification ordinances share many commonalities including pruning, thinning, and removal of trees, shrubs, and grasses to successfully "fragment" ground and crown fires as they move across a site. Shrubs and other fuels underneath trees serve as a fire "ladder," where fire spreads into tree crowns from a ground source (e.g., shrubs and low tree branches).

In conjunction with provisions regulating vegetation fuel clearance, vegetation maintenance is critical for managing dangerous fuel loads in high fire risk areas. Our analysis reveals that vegetation maintenance is required in approximately one-half of the codes reviewed. Such vegetation maintenance requirements provide ongoing fuel load management to ensure that fuel does not substantially increase over time, thus avoiding heightened risk of an unmanageable wildfire. Many ordinances and codes, such as the California Public Resource Code 4291 (CA PRC 2005), stipulate that the property owner or manager is responsible for maintenance of vegetative fuel zones. Infractions result in penalties or fines.

Roadway and Driveway Standards

In the last decade, fires such as the Laguna Beach and Malibu (California) fires "have placed firefighters in dangerous situations as a result of inadequate planning and design of roadways, signs, water supplies, and other infrastructure considerations" (NFPA 2008). In response, many municipalities and counties have adopted requirements for roadway and driveway planning and design in UWI areas.

Road and driveway standards ensure access for large emergency vehicles by stipulating minimum road/drive widths, minimum vertical clearance, appropriate surface materials, maximum grade, turnaround distances and radii, street identification, and premise identification (see Figure 3). Among the codes reviewed, roadway widths ranged from a minimum of 18 feet to 25 feet, and vertical clearance requirements for access roads ranged from 13.5 feet to 15 feet. The most common driveway standard was 12 feet in width with a vertical clearance of 13 feet.

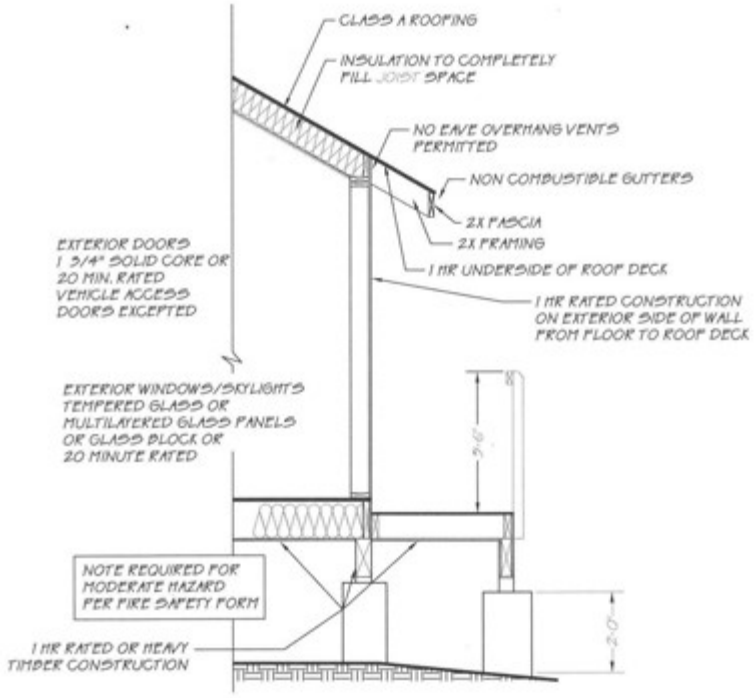

Figure 3
Illustrative Example of Minimum Roadway Dimensions.
Figure redrawn by Jeremy N. Murdock, Pima County, 2006.

Building Requirements

Most ordinances applicable to wildfire areas require that roofs, exterior materials, and appendages and projections from residential structures do not serve as a primary source of fuel (see Figure 4). Typically, the regulations mandate the use of one-hour fire-rated resistive materials and include other provisions to protect the entire appendage including the under-floor space. The under-floor space is most vulnerable from ground fire, and is often unenclosed. The under-floor space of a deck that overhangs a descending slope must be enclosed with fire resistant materials and construction.

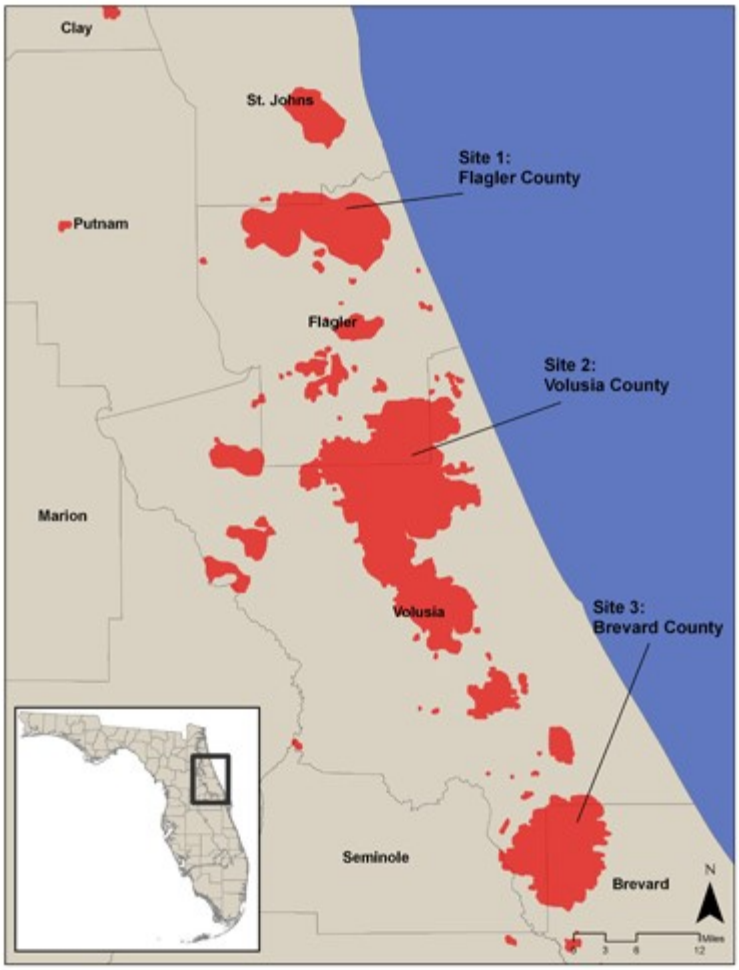

Figure 4
Illustrative Example of Ignition-resistant Construction.
Figure redrawn by Jeremy N. Murdock, Pima County, 2006.

Standards requiring setbacks from property lines for new construction are not very common in wildland fire codes. Their primary purpose is to ensure "minimal" defensible space around a residential structure. The most common setback distance from property lines is 30 feet, consistent with dimensions for Zone 1 for defensible space in most ordinances. In most cases, the standard defensible space requirements make minimum setback distances unnecessary or redundant. Setbacks may also allow space for future expansion of roadways, and for "having adequate alignment, dimensions, and vision clearance" along roadways (Lassen County 1962).

Planning and Assessment

While defensible space often refers to zones within a single property boundary, greenbelts are sometimes part of the development plan for subdivisions or developments. Greenbelts separate wildland fuels and inhabitable structures. Locating greenbelts for optimal wildfire mitigation involves a thorough understanding of the site and fire behavior. Greenbelts must be strategically located to aid in preventing a wildfire from spreading into a residential area. When the area around a single property cannot ensure adequate defensible space, due to a site constraint such as steep topography, requiring a greenbelt is particularly justified. Greenbelts also provide the community with open space for recreation. Greenbelts might include golf courses, parks, and playgrounds.

Typically, hazard assessments are only required for proposed developments or subdivisions. In the wildfire hazard areas identified, the assessment report must prove that the developer adequately meets criteria for reducing or eliminating wildfire hazards at the time of initial development. In most cases, a qualified professional forester must prepare these plans or reports. State and local planning authorities may also have to address conflicting requirements between Firewise requirements and conservation provisions in codes and laws, such as forest retention requirements.

FIREWISE PLANNED COMMUNITIES IN FLORIDA

Following the 1998 wildfires, the next four years included summer droughts, and wildfires continued to plague the state of Florida (Verdi et al. 2006). Because of these catastrophic events, there was a heightened awareness of Firewise principles as new communities continued to push into the urban-wildland interface. Three Firewise communities were developed in Florida after the 1998 wildfires. One of these, Briargate, was a direct result of the 1998 Florida fires. Briargate is located outside Ormond Beach, Florida, and is an existing subdivision evacuated at the time of the Volusia County wildfire and subsequently retrofitted with Firewise strategies. The other two — Verandah and RiverCamps on Crooked Creek — were not a direct result of the 1998 fires but were developed in a climate of increased awareness of wildfire risks.

Florida Firewise Planned Communities

Design and layout of all three Firewise communities revealed similar techniques for incorporating existing fuel breaks and integrating managed buffer space in and around the developments (see Figures 5 through 7). Although a wildland fire has not yet tested these developments, comparing development patterns and organization of these communities to the 1998 Florida Wildfires in Flagler, Volusia, and Brevard counties provides insight for the design of UWI communities and land-use planning and regulation.

Figure 5
Master Plan for RiverCamps on Crooked Creek, located near Panama City Beach, Florida.

Figure 6
Master Plan for Verandah, located in North Fort Myers, Florida.

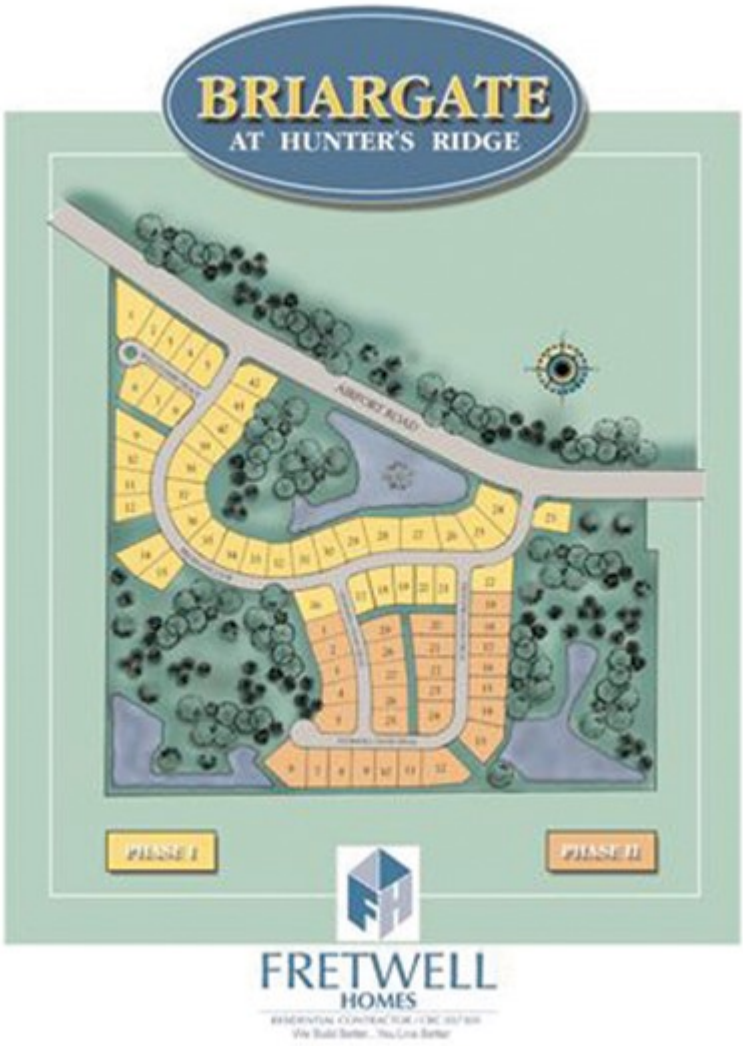

Figure 7
Master Plan for Briargate, located outside Ormond Beach, Florida.

Assess Fire Risk Prior to Land Planning

A methodology on how to develop systems and tools to assess fire hazards was published by the National Wildland/Urban Interface Fire Protection Program in 1997 and revised by the National Firewise Communities Program in 2005 to reflect the relationships between community wildfire protection plans, Firewise Communities planning, and hazard reduction considerations for the home ignition zone. This method organizes the hazard assessment process into a series of steps that include:

1. selection of areas to be evaluated
2. hazard components to be considered in the assessment
3. ranking of hazard components
4. compilation of hazard rankings into a usable format

An examination of fire risk should inform site selection and design processes, and the lessons from those insights can integrated into local development regulations. Accomplishing wildfire prevention is most successful at the regional scale and can be difficult to achieve at the scale of individual subdivisions or sites. The 1998 Florida fires occurred in large roadless areas containing heavy fuel loads. It is important to assess the regional landscape's level of fire risk (i.e., vegetated fuel loads). Ideally, localities should prevent development in areas known to be at high risk of catastrophic wildfire. If that is not feasible, localities should at minimum require compact, defensible development. It is essential that localities and individual developers work with local fire officials and community stakeholders in the early planning phases of land developments in the UWI. For instance, at RiverCamps, cooperation between the Florida

Division of Forestry and developers resulted in an extensive mitigation effort prior to land planning.

Multiple, Redundant Defensible Zones

Integrating multiple, redundant defensible zones provides the best defense in an intense fire event. All three developments use a number of Firewise design principles that address multiple fire risks, ranging from vegetative management to building and road standards. One component of this strategy is to integrate greenbelts as managed open space or vegetated buffer zones between and within developments in the UWI. The outer edge of properties is the critical boundary of the UWI. But efforts should not stop with perimeter fire breaks. Briargate and RiverCamps incorporate additional narrow greenbelts for further protection; a secondary benefit is that these greenbelts provide the community with open space amenities. Similarly, Verandah's use of golf course fairways along the periphery and development interior provide fire protection, while offering community recreation. RiverCamps's extensive pedestrian trail systems act as additional firebreaks in both woodland and savanna areas, and they also provide access to important amenity use points along the bay. Design and location of open savanna grassland areas at RiverCamps provide an important buffer from neighboring wildland fuels. The continued use of prescribed fire in this area, as well as thinning of adjacent woodlands, are important management techniques to reduce wildfire fuel loads.

Use Water Bodies and Marshlands as Fire Breaks

Communities can incorporate permanent water bodies and open-canopy or canopy-less marshlands (i.e., wetlands), where they exist. Existing water bodies stopped advancing wildfires in the 1998 Flagler County fire. All three of the Firewise developments contain newly created water bodies dispersed throughout the subdivisions. In RiverCamps, principal subdivisions are surrounded on three sides by water, which serves to protect them from fires. Intermittent streams, hardwood swamps, and drainage corridors be used strategically as fuel breaks by thinning riparian edges to reduce fire hazards in dry seasons or under low humidity conditions. As shown at RiverCamps and Verandah, riparian buffers form extensive firebreaks for protection. Also, orienting water bodies along the width of potential wildfire directions improves the effectiveness of fire defense. And the inclusion of retention ponds offers firefighters another source of water during fire operations.

Use Road Rights-of-Way as Defensible Zones

Communities should utilize existing roadways, new roads, and their rights-of-way as defensible zones. Analysis of the 1998 Florida fires shows that increased road densities were effective at stopping wildfires. Where it is practical, new road patterns and organization should be oriented perpendicular to the fire threat. An outer loop road in conjunction with a network of fine-grain roads on the interior of the development can provide multiple defensible zones of gray infrastructure. All three developments wisely utilize major and minor roads as defensive space. Briargate's use of 24-foot-wide loop roads with managed rights-of-way offers additional zones of protection for structures from wildfires originating off site.

Ensure Firefighter Access

Roadways must be of sufficient width to accommodate emergency vehicles, and such emergency access roads may also serve as fuel breaks. Multiple egress routes should be provided where possible.

Concentrate Structures

Creating denser development footprints reduces wildland fire threats by improving defensibility. Denser development also has other benefits such as reducing urban sprawl, increasing community green space, conserving wildlife and plant species, enhancing carbon sequestration, and reducing landscape fragmentation (Hellmund and Smith, 2006). Further benefits of such strategies can include increased water infiltration and stormwater runoff quality (Binford and Karty, 2006). Structures should be concentrated and located in proximity to fire barriers separating them from wildland fuels and primary fire travel directions.

CONCLUSION

Communities need to engage in various planning and assessment activities in anticipation of fire threats in the urban-wildland interface. Plans should address the fundamental question as to whether or not it is in the interest of public health, safety and welfare to allow further developments within fire prone ecosystems and the urban-wildland interface. Where developments will be allowed, best practices are available to mitigate potential losses due to wildfires. By designing new subdivisions and land developments with defensible space, we can build communities and new land developments with fire safety needs in mind.

This article has summarized model codes and highlighted provisions that localities can adopt relative to vegetative fuel clearance, roadway and driveway standards, and building requirements. Even the best defensible planning measures

cannot guarantee protection from wildfire damage. However, integrating multiple, redundant defensible spaces is the most effective tool in defending against wildfires.

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