Heartburn: Mitigating wildfire risk to interface communities in America's heartland

by

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Abstract

The simultaneous growth of wildfires and developed areas creates increasing conflict between human settlements and destructive natural systems. While wildfire mitigation strategies have been explored widely in recent decades, less attention has been paid to their application in the grasslands of the Great Plains of the United States, where wildfire risk is increasing. This study addresses this issue by identifying wildland-urban interface typologies, examining wildfire perceptions and mitigation preferences of residents and industry professionals in the region, and proposing design and planning strategies for wildfire mitigation. More specifically, this study investigates the application of these mitigation preferences and precedents to the identified Great Plains wildland-urban interface typologies.

This study identifies common arrangements of built and natural landscape factors of the wildland-urban interface in Manhattan, Kansas. It then conducts community and expert surveys among residents of Manhattan and fire professionals across the Great Plains region, respectively. These outcomes are applied to typologies developed from the study of landscape factors to mitigate Great Plains wildfire risk at the city, neighborhood, and individual household scales. The results of this research offers insight into the physical makeup of the Great Plains wildland-urban interface, the risk perceptions of Great Plains residents, and mitigation preferences among the region's wildfire professionals. It then utilizes this information to envision the conceptual application of mitigation strategies to the identified typologies.

Heartburn

Mitigating Wildfire Risk to Interface Communities in America's Heartland

Landon Ochsner | 2024

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Figure 1. Headlines of Great Plains Wildfire Events

Cover Image: Stylized study site wildfire risk map.

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Abstract

The simultaneous growth of wildfires and developed areas creates increasing conflict between human settlements and destructive natural systems. While wildfire mitigation strategies have been explored widely in recent decades, less attention has been paid to their application in the grasslands of the Great Plains of the United States, where wildfire risk is increasing. This study addresses this issue by identifying wildland-urban interface typologies, examining wildfire perceptions and mitigation preferences of residents and industry professionals in the region, and proposing design and planning strategies for wildfire mitigation. More specifically, this study investigates the application of these mitigation preferences and precedents to the identified Great Plains wildland-urban interface typologies.

This study identifies common arrangements of built and natural landscape factors of the wildland-urban interface in Manhattan, Kansas. It then conducts community and expert surveys among residents of Manhattan and fire professionals across the Great Plains region, respectively. These outcomes are applied to typologies developed from the study of landscape factors to mitigate Great Plains wildfire risk at the city, neighborhood, and individual household scales. The results of this research offers insight into the physical makeup of the Great Plains wildland-urban interface, the risk perceptions of Great Plains residents, and mitigation preferences among the region's wildfire professionals. It then utilizes this information to envision the conceptual application of mitigation strategies to the identified typologies.

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1 Introduction

Figure 2. Marshall Fire in Progress
The 2021 Marshall Fire burns across open grasslands and suburban neighborhoods in Boulder County, Colorado. The Marshall Fire destroyed over 1000 homes and is the most destructive fire in Colorado history.

Introduction

On the afternoon of February 26, 2024 a fire ignited near the small town of Stinnett, Texas. Abnormally dry weather and high winds carried the fire east across the Texas prairie. The blaze, named the Smokehouse Creek Fire, consumed 200,000 acres of grassland within 24 hours, 500,000 acres within 48, and over 1,000,000 acres within 72. Reports from officials note that the fire grew 150 acres every minute. A second fire, the Windy Deuce Fire, ignited just southwest of Smokehouse Creek and burned nearly 150,000 acres within the same three day period.

Though much of these fires burned through sparsely populated rangeland, the towns of Canadian and Fritch were significantly impacted. Both communities sustained substantial damage, losing dozens of homes and structures. Hundreds of buildings were destroyed in total. Tragically, the Smokehouse Creek Fire resulted in the deaths of two people.

The Smokehouse Creek Fire became the second largest wildfire in American history, and the largest and most destructive fire in Texas history, within three days of ignition. Though the cause of the blaze is yet undetermined, its catalysts can likely be pinpointed. Climate change, volatile grassland fuels, and unprepared communities intensified the fire's impacts and created the conditions that allowed the blaze to spread with such intensity.

As climate change alters weather patterns, these catastrophic wildfire events will become more frequent. Though wildfire is often synonymous with "forest fire," risk and occurrence is growing nearly universally across the United States (Donovan, Wonkka, and Twidwell 2017; Gao et al. 2021; Jolly et al. 2015; Radeloff et al. 2018), grassland ecosystems of the Great Plains are often overlooked when analyzing fire risk and proposing mitigation strategies, making communities within them vulnerable to the effects of wildfire (Donovan et al. 2020).

Figure 3. Marshall Fire burning through Boulder County homes

Urban growth within the Great Plains has spurred development into the region's expansive grasslands, which places the leading edge of development along an increasingly volatile wildland-urban interface (WUI)— the area where human settlement comes into contact with large areas of combustible vegetation. While cities expand into these fire-prone landscapes, the size, frequency, and seasonal distribution of wildfires in the region is changing. Between 1985 and 2014, the area burned by large fires in the Great Plains increased by more than 400%, and the seasonal occurrence of wildfires shifted across the region (Donovan, Wonkka, and Twidwell 2017).

Numerous regional fires have demonstrated these changing fire regimes (fig.s 4-5), but none have been as destructive as Colorado's 2021 Marshall Fire. The Marshall Fire began as a grass fire in suburban Boulder County before being carried by high winds into adjacent subdivisions (fig. 3) (FEMA Mitigation Assessment Team 2023b). The resulting urban conflagration destroyed over 1,000 homes in under 12 hours and became the most destructive wildfire in Colorado's history. A FEMA Mitigation Assessment Team (2023b) report found that the affected developments' combination of built and natural landscape features facilitated the fire's spread, highlighting the importance of wildfire mitigation within grassland communities.

Despite this growing risk, little research has been conducted into wildfire mitigation strategies in these vulnerable communities (Donovan et al. 2020). Though numerous wildfire mitigation techniques have shown varying degrees of success across the western United States (Knapp et al. 2021; Syphard et al. 2014; Troy et al. 2022), the feasibility of their implementation in prairie communities is largely understudied. Strategies that successfully defend communities from fire in California's coniferous forests and scrublands may require unique applications in the grasslands of the Great Plains. Numerous factors, such as topography, development patterns, and weather patterns likely complicate the direct transfer of these strategies to the country's heartland.

This study aims to expand on the rapidly emerging topic of wildfire-resilient urban design within the fields of landscape architecture, planning, fire science, and land management ("Designing Communities for Wildfire Resilience" 2021; "Best Practices for Wildfire-Resilient Subdivision Planning" 2023; Susskin 2023), with the specific study of mitigation strategies and their applications in Great Plains WUI communities.

Though a few studies have examined emerging wildfire threats to Great Plains WUI areas and the region (Noble 2023; Donovan et al. 2017; Donovan et al. 2020), no study has proposed specific strategies to mitigate the growing threat in the region.

As one of these rare studies examining wildfire growth and behavior in the Great Plains, Donovan et al. (2020) highlight the importance of land-use planning and design in mitigating wildfire effects across the region. Rather than attempting to decrease wildfire occurrence, as has often been the focus of past fire management efforts, Donovan et al. suggest designing a wildland-urban interface more capable of withstanding the effects of wildfire.

The research team notes, "WUI growth rates in the Great Plains are equivalent to the Western U.S., and yet there has been relatively little focus on the wildland-urban interface in [the region]" (Donovan et al. 2020, 12). Though Donovan et al.'s research focuses on the management of the natural dimensions of human-fire relationships (e.g., strategic siting and fuels thinning), mitigation extends to the built environment through fire-specific urban design and planning methods.

This study will fill this research gap by proposing wildland-urban interface mitigation strategies for use in Great Plains communities by asking, "How can design, planning, and land management strategies mitigate Great Plains wildfire risk at the city, neighborhood, and individual household scales?"

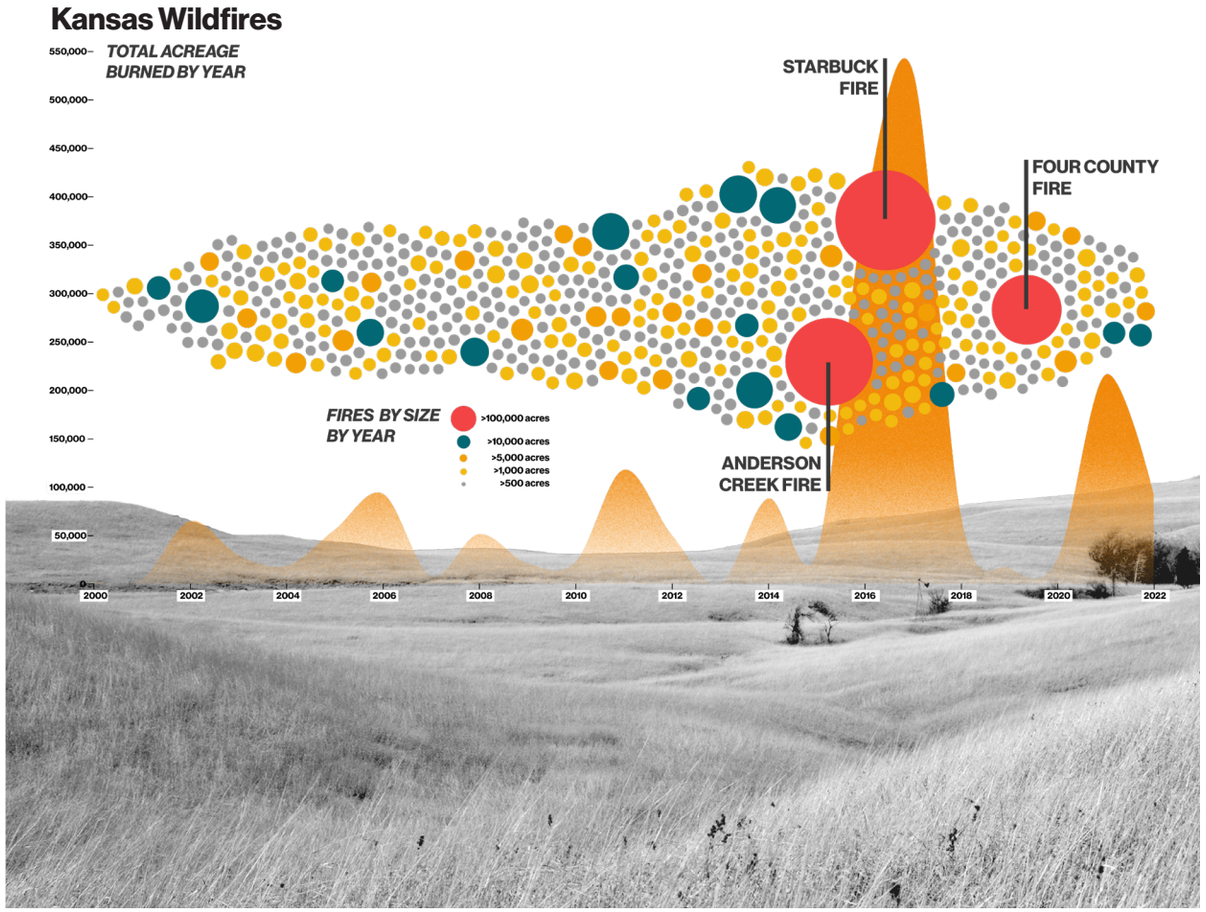
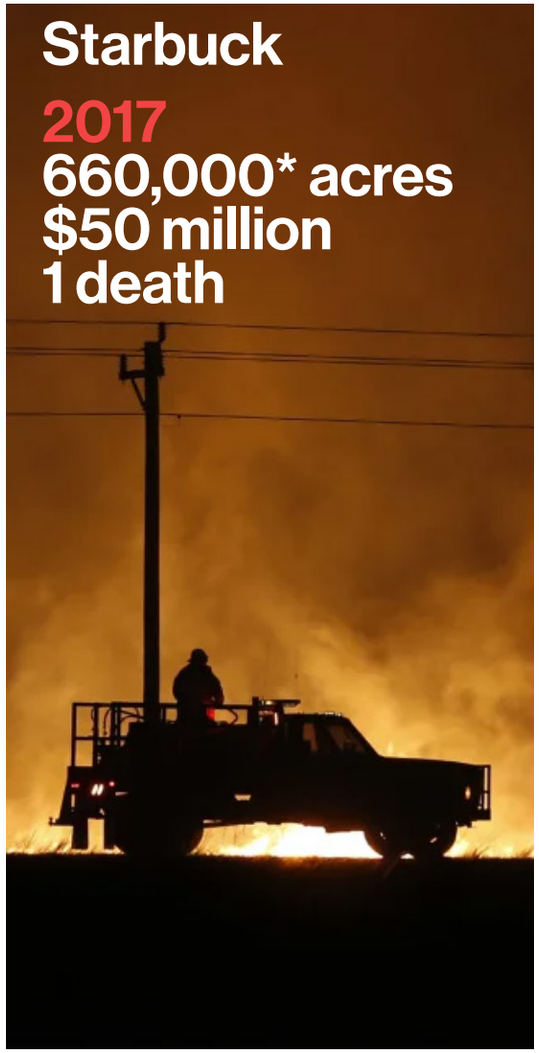


Figure 4. Kansas Wildfire Acreage and Occurrence by Year

Wildfires are common occurrences in the Great Plains; however, their size and frequency appear to be increasing due to shifting fire seasons and climate change (Donovan, Wonkka, and Twidwell 2017). Kansas has experienced its top four largest or most destructive wildfires in the past decade.

Significant Kansas Fires



*(acreage notes total area burned between Oklahoma and Kansas)

Figure 5. Major Kansas Fires

2016's Anderson Creek Fires, 2017's Starbuck Fire, and 2021's Four County Fire were among the largest wildfires in the United States in their respective years, while the Starbuck and Anderson Creek Fires are among the largest wildfires in American history.

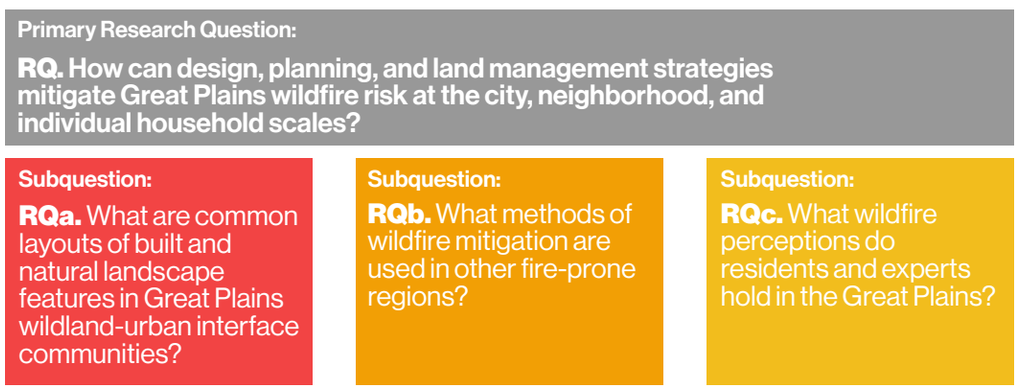


Figure 6. Research Question Diagram

Research Question

The following research applies wildfire mitigation strategies to exposed communities in the Great Plains through research informed design, planning, and land management methods. The research is guided by the primary research question: RQ) How can design, planning, and land management strategies mitigate wildfire risk at the city, neighborhood, and individual household scales? and subquestions RQa) What are common layouts of built and natural landscape features in Great Plains wildland-urban interface communities?, RQb) What methods of wildfire mitigation are used in other fire-prone regions, and RQc) What wildfire perceptions do residents and wildfire experts hold in the Great Plains (fig. 6)?

II Background

Figure 7. Smokehouse Creek Fire Aftermath
The 2024 Smokehouse Creek Fire left over a million acres of charred land across the Texas panhandle. The Smokehouse Creek Fire is the largest fire in Texas history and the second largest in American history.

Glossary

Crown Fire
Fire that burns through the crowns or tops of trees or shrubs.

Deciduous Species
Plants that lose their leaves seasonally. Includes most hardwood species and few conifers.

Ecoregion
An area of similar ecosystems, such as the Great Plains.

Fine Fuels
Easily ignitable fuels with a thin form. Includes grasses, leaves, and needles.

Fire Behavior
The manner in which a fire reacts to fuels, weather, and topography.

Fire Regime
The patterns, size, frequency, severity, and type of fires that typically occur in a specific area or region.

Fire Weather
Weather conditions that influence fire ignition, behavior, and suppression.

Forb
A plant with a soft stem. Does not include grasses.

Fuel
Any burnable material, includes all combustible vegetation.

Fuel Load
The amount of fuels present in a specified area.

Hardwood Species
Broadleaved tree species, in contrast to softwoods (conifers).

Herbaceous Species
Fleshy, soft plants without a durable woody stem. Includes grasses and wildflowers.

Invasive Species
Non-native, introduced species that spread readily and cause harm to ecosystems.

Ladder Fuels
Fuels that allow lower-intensity surface fires to climb to higher-intensity crown fires.

Mitigation
The process or result of making something less damaging or impactful.

Multi-family Housing
One structure housing multiple families, such as apartments or condos.

Nuisance Species
Native species whose presence is unwanted. May also cause harm to ecosystems in large numbers or when present in atypical locations.

Prescribed Fire
An intentionally ignited fire meant to achieve land management or ecological goals.

Single-family Attached Housing
Single-family housing that shares walls with adjacent properties, such as townhomes, rowhouses, and duplexes.

Single-family Detached Housing
A standalone single-family residential structure.

Spot Fire
A fire ignited outside the main fire by windblown sparks or embers.

Surface Fire
Fire that burns near the surface of the ground.

Urban Conflagration
A destructive, large fire that occurs in an urbanized setting.

Wildland Fire
Any fire that occurs in a wildland area, excludes isolated structure fires.

Wildland-Urban Interface (WUI)
The area where structures and other development meet or intermingle with undeveloped wildlands or combustible vegetation.

Interface
Wildland-urban interface classification where homes press against wildland vegetation with a clear delineation between development and vegetation.

Intermix
Wildland-urban interface classification where homes and wildland vegetation intermix. No clear delineation between development and vegetation.

Woody Encroachment
The movement of woody species into areas previously dominated by herbaceous species.

Woody Species
Trees or shrubs with durable woody stems

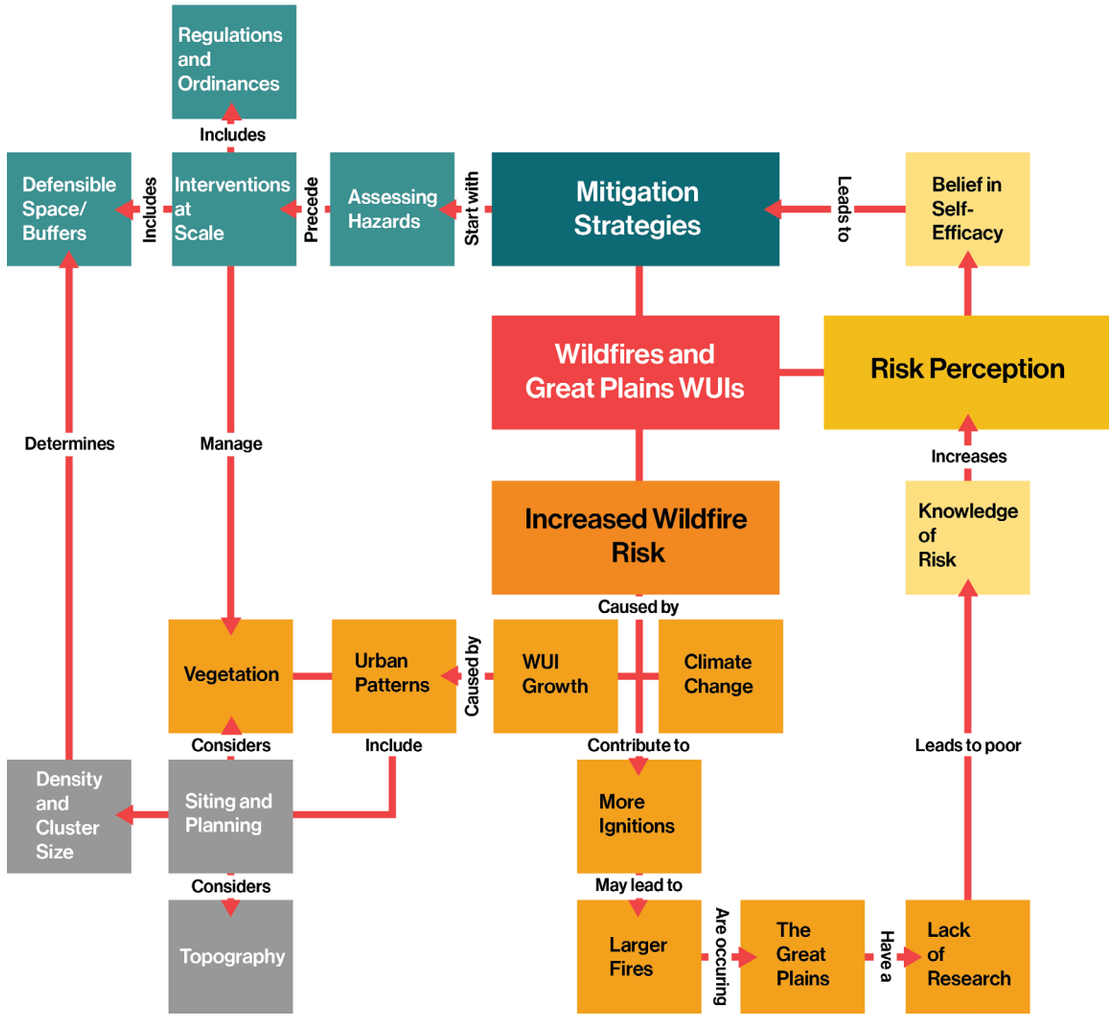


Figure 8. Literature Map

This literature map shows how topics are linked throughout wildfire literature. General topics are shown in large boxes, while subtopics within each topic are denoted by color. Links between topics are shown with arrows noting their relationship to each other.

Literature Review

Communities must prepare for unprecedented disasters as the frequency and severity of wildfires grow across the United States (Donovan et al. 2017; Jolly et al. 2015; Radeloff et al. 2018). Shifting climatic conditions may bring periods of extreme drought and strong winds, increasing the risk of fire where little may have existed before. Despite this near-universal growth in risk across North American ecosystems, most established research focuses on wildfire hazards of the West due to greater supposed risk and human impact (Donovan et al. 2017; Donovan et al. 2020; "Understand Risk" n.d.).

This research imbalance leaves a significant knowledge gap in the Great Plains region of the United States, where the area burned annually across the region's expansive grasslands is comparable to Western totals (Donovan et al. 2020). Fires across the Great Plains in 2011 accounted for over 50% of the total area burned within the Continental United States (Donovan et al. 2017).

Wildfire risk is typically quantified as the sum of three parts: the likelihood of ignition, wildfire intensity, and the susceptibility of valuable assets such as development ("Quantitative Wildfire Risk Assessment Considerations" 2023). Though Great Plains wildfire risk and its constituent factors are perceived as low to moderate relative to the West (fig. 9), wildfire frequency, size, and human impact will likely increase in the coming decades as the probability of ignition increases, climatic factors become increasingly volatile, and urban growth continues to encroach on previously undeveloped land. Between 1985 and 2014, the annual average burned area in the Great Plains increased by 400%, while large wildfire incidents increased by 350% (Donovan et al. 2017).

Like the West, the Great Plains has seen considerable urban growth along the wildland-urban interface, where houses and development mesh with combustible vegetation. This growth, coupled with an apparent (and growing) wildfire hazard (Donovan et al. 2017), lack of risk awareness, and little to no mitigation planning among the region's municipalities, may leave these communities highly exposed to the increasing likelihood of wildfire.

Climate change is expected to increase the occurrence of wildfires globally due to altered precipitation patterns, temperature shifts, and strong winds. By 2100, the global burnable area will have more than doubled under current climate projections, while the frequency of long fire seasons will increase across 53% of the planet (Jolly et al. 2015). The projected increase of fire probability varies across the Great Plains, with the more humid northern and eastern portions expected to experience a 50-75% increase in fire probability by 2100, while the southwestern portions will experience a minimal increase due to aridification (Gao et al. 2021).

Though no empirical evidence explicitly links the growth in Great Plains fire occurrence or burned area to climate change, numerous studies (Abatzoglou and Williams 2016; Jones et al. 2020; Williams et al. 2019) observed a significant correlation between anthropogenic atmospheric warming and fire occurrence and burned area across Western fire seasons.

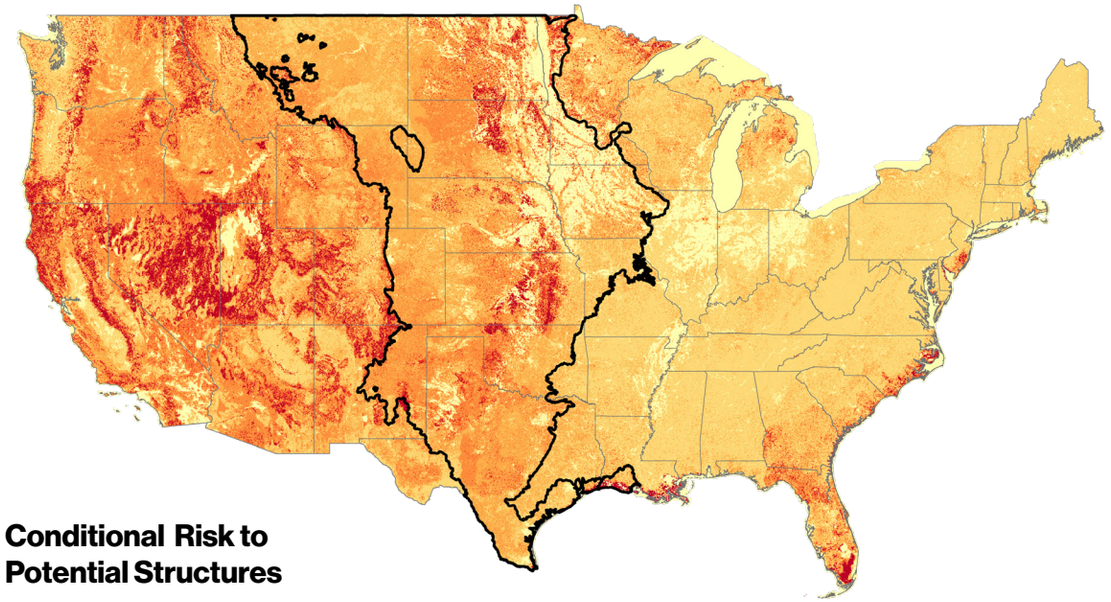


Figure 9. Conditional risk to potential structures
Conditional risk to potential structures indicates the impact of a fire occurring at any given location if a structure were present. Unlike traditional risk models, this metric does not include the likelihood of fire ignition. Ignition likelihood is based, in part, on past ignitions and may be inaccurate given shifting fire regimes.

Wildland-Urban Interface

The communities most at risk of these growing, more frequent fires lie along the wildland-urban interface, where human settlement meshes with wildland ecosystems. Structures in these areas are most exposed to wildfire due to their proximity to combustible vegetation and a higher likelihood of ignition (Radeloff et al. 2018). These areas have seen explosive growth across the United States, with new homes in WUI areas ballooning 41% and new WUI land area growing by 33% from 1990 to 2010 nationally (Radeloff et al. 2018). The Great Plains has seen an increase consistent with the rest of the country, with some communities experiencing WUI growth above the national average (Donovan et al. 2020; "The National Strategy" 2014).

These emerging WUI areas fall within two categories—intermix and interface. As the name implies, intermix WUI comprises homes and wildlands integrated within the same area. Interface WUI comprises homes directly adjacent to, but not within, wildland vegetation (Evers et al. 2019). Both WUI categories present unique challenges when managing wildland fire events, primarily due to different residential densities associated with each land use type. Though intermix WUI typically contains fewer structures per acre than interface WUI, the increased lot size and lower density require greater resource allocation for structure protection. Fire agencies must protect more land when individual development parcels grow, stretching firefighting resources more thinly (Radeloff et al. 2018).

Exposure to wildfire along the WUI is a product of a relationship in which homes abutting the WUI are more exposed to fires due to proximity to vegetation while increasing the likelihood of fires igniting the vegetation (fig. 10) (Ager et al. 2019; Syphard et al. 2012). Human-caused ignitions account for nearly 85 percent of wildfire ignitions nationally. A disproportionately large number of these ignitions occur near the WUI despite the land use making up less than 10 percent of the total land area in the United States (Hanberry 2020; Price and Bradstock 2014).

Compounding this problem is the human alteration of vegetation distribution near towns and cities. Historic wildfire suppression due to societal intolerance of wildland fires near developed areas has increased fuel loads across the West, meaning fires now burn more intensely and spread faster than they would under natural states (Calkin et al. 2014).

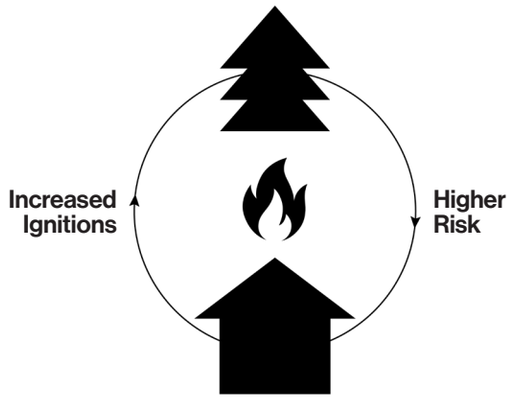


Figure 10. Home-Vegetation Relationship in the WUI

Great Plains Fuels

The Great Plains faces similar challenges due to shifting prescribed fire regimes near developed areas. Historically, prescribed fire controlled invasive and nuisance species across the region's prairies and encouraged the growth of grasses palatable to cattle and bison (Allen and Palmer 2011). However, residential expansion into grasslands often curtails prescribed fire treatments, allowing woody species such as eastern redcedar to encroach on WUI neighborhoods (fig. 11) (Noble 2023; Ratajczak et al. 2014).

Though eastern redcedar is native to the Great Plains, its presence presents challenges for managing Great Plains WUI areas. Eastern redcedar burns quickly and violently, allowing relatively low-burning surface fires to transition to intense crown fires, producing flames as high as 50 feet and sending embers deep into developed areas. These windblown embers may start spot fires in distant vegetation and homes, increasing the potential damage of wildland fire events (Armbrust 2018; Donovan et al. 2020).

In Kansas alone, the number of eastern redcedar has increased by more thn 23,000% since 1965 (Armbrust 2018). In the Flint Hills region of the Great Plains, Ratajczak et al. (2016) found that 56% of the region's grasslands are susceptible to conversion to shrubland or woodlands under current prescribed fire regimes. The best way to prevent these changes is likely to prevent them before they occur with increased fire prescription (Donovan et al. 2017; Ratajczak et al. 2014); however, residents may be wary of prescribed fires near their homes and landowners may be hesitant to perform fire treatments near

Figure 11. Tallgrass Prairie with areas of significant woody encroachment

developed areas (Harr et al. 2014). Much like fire ignition near the WUI, WUI expansion and resulting vegetation changes result in a self-fulfilling increase in wildfire exposure.

Though eastern redcedar presents an emerging threat to wildfire management in the Great Plains, grasses remain the primary fuel for the region's fires (Donovan et al. 2020; Hanberry 2020). Prairie fires create challenges for fire mitigation efforts due to a relative lack of research into grassland fire behavior and poor modeling capabilities (Alexandre et al. 2016a; Donovan et al. 2017; Syphard et al. 2012). Despite this information gap, grasses may threaten communities more than conventionally thought, due to ease of ignition and low moisture content (Syphard et al. 2012). Syphard et al. (2012) found that property loss was more likely to occur within herbaceous fuels than woody fuels with higher fuel volumes. Likewise, Alexandre et al. (2016a) found that the grasslands of the Great Plains had the most fire incidents resulting in structure loss nationally. Both authors posit that high wind speeds and rapid fire spread typical of grassland ecosystems may be responsible for these findings. This high rate of spread makes reactive suppression difficult, making proactive mitigation necessary to prevent damage.

These studies and others highlight the potential for inadequate modeling of grassland fires, which may inappropriately label areas as low-risk. Syphard et al. (2012) found that vegetation fuel types, which are often important factors in wildfire risk modeling, are poor indicators of actual wildfire outcomes. Grasslands may present a more significant wildfire hazard than previously understood, likely increasing as climatic patterns shift.

Design Implications

Numerous methods of wildfire mitigation have been implemented across the United States, but no research exists on their application in the Great Plains. Mitigation efforts attempt to decrease the impact of an event when it occurs rather than attempting to prevent the occurrence altogether. This mitigation typically occurs across spatial scales, from ecosystem-level vegetation management to construction standards for individual structures (Schlickman and Milligan 2023). Wildfire mitigation in the West has shown varied levels of success, with established research often in disagreement on which variables contribute most to structure survival.

Historically, wildfire mitigation has focused on controlling the vegetation surrounding homes and developed areas. Mitigation operations attempt to reduce the amount of combustible material capable of spreading fire to buildings, thus reducing the likelihood that spread will occur. This vegetation control may include fuels thinning, defensible space buffers, and species management. Like all mitigation efforts, these interventions occur across scales. The most common form of mitigation is likely the creation of defensible space, which involves the clearance of combustible material within the home ignition zone, a buffered radius around a structure (Syphard and Keeley 2019). Federal, state, and local agencies offer guidelines for creating defensible space, highlighting its perceived importance in preventing structure loss during fires.

Despite the focus on this method, numerous studies have examined its success in preventing damage and structure loss, leading to varied findings. Troy et al. (2022) found that defensible space did not significantly reduce structure loss, as did Syphard and Keeley (2019). Syphard et al. (2014) found that the success of defensible space was only significant at small distances (0-50 feet), while Knapp et al. (2021) found that vegetation clearance within a large buffer zone was most successful at defending homes (100-300 feet). The discrepancy in these findings may come from complicated fire processes in which localized climatic conditions and suppression actions lead to varied, inconsistent outcomes (Knapp et al. 2021; Syphard et al. 2014; Troy et al. 2022).

Regardless of vegetation, many studies have found that the spatial relationships between built and natural landscape features are the most critical determinants of wildfire outcomes (Alexandre et al. 2016a; 2016b; Syphard and Keeley 2019). Syphard et al. (2012) found that risk maps created with development density and landscape location performed better in determining wildfire outcomes than those developed with traditional means, such as vegetative fuel distribution (fig. 12). Similarly, Alexandre et al. (2016a) determined that arrangement, cluster size, number of buildings, and density were crucial factors in deciding building loss and destruction, though outcomes varied by study site. Findings from Alexandre et al. (2016b) expand on this outcome, noting that smaller, denser building clusters lose a higher percentage of structures, while larger clusters are most likely to be affected by wildfire.

The authors posit this may be due to the proportion of buildings exposed to fire within each cluster type. Though some development patterns may be more resistant to wildfire damage, each has weaknesses. Knapp et al. (2021) note that denser developments fare better when exposed to wildfire so long as homes do not ignite, at which point density allows for structure-to-structure spread that may not occur in less dense developments. This challenges designers and planners, who must determine what wildfire threats a community faces and how risk can be reduced based on potential wildfire scenarios.

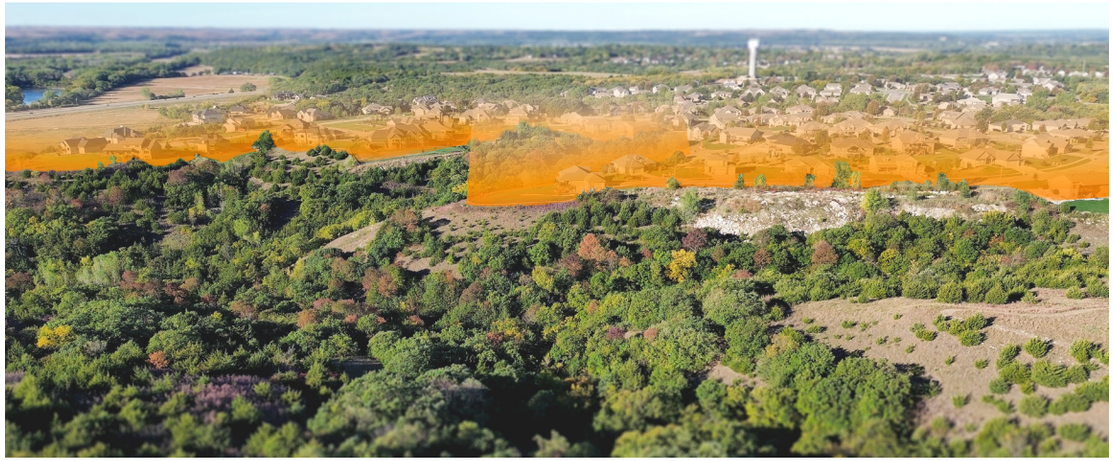


Figure 12. Low-density suburban-style development on a hilltop

The inconsistent findings of these studies indicate that wildfire mitigation must account for elements within both human and natural systems. Vegetative, topographic, climatic, and development conditions are inextricably intertwined, creating location-specific fire conditions that must be considered (Syphard et al. 2019). These findings carry important implications for planning and design, where decision-makers must balance factors contributing to wildfire risk. Wildland-urban interface mitigation strategies have been explored in-depth throughout the Western United States; however, little mitigation work has been done in America's heartland.

The increasing wildfire threat across the United States is evident, and the Great Plains is no exception. Climate change and urban growth create an increasingly volatile combination of factors ripe for more frequent extreme fires near WUI areas. Until Great Plains communities understand the landscape factors contributing to risk and begin working toward mitigation, the threat of wildfire impacting the region's communities will constantly grow.

II Methodology

Figure 13. Anderson Creek From Space
Smoke billows from the 2016 Anderson Creek Fire along the Kansas-Oklahoma border. The Anderson Creek fire burned nearly 400,000 acres between the two states and , at the time, was the largest fire in Kansas history.

Chapter III Overview

This chapter introduces the study area and details the methods used to answer the research questions introduced in Chapter I. The chapter is structured around the methods used and the corresponding objectives achieved through each method. Method 1 employs spatial analysis to achieve Objectives 1a and 1b, Method 2 outlines the use of precedent research to achieve Objective 2, and Method 3 describes use of surveys to accomplish Objectives 3a and 3b (fig. 14).

Spatial analysis was chosen as Method 1 due to its effectiveness in analyzing and identifying spatial patterns. This allows for effective and efficient evaluation of the study area to select a study site (Objective 1a), and the identification of landscape elements and patterns that contribute to wildfire risk (Objective 1b). Precedent research was selected as Method 2 because it allows for the study of existing strategies used in other fire-prone regions, providing insight into mitigation strategies that may be effective in the Great Plains. Finally, surveys were employed as Method 3 due to their convenience, accessibility, and ease of distribution. This method allowed Manhattan-area residents to easily respond (Objective 3a) and for the survey to be efficiently distributed to experts across the Great Plains (Objective 3b).

The integration of each of these methods allows for a comprehensive understanding of the human and spatial dimensions of wildfire risk in the region, as well as the strategies that may be effective in mitigating that risk. The findings from each of these methods are employed to design conceptual mitigation strategies tailored to Great Plains landscapes in Chapter V.

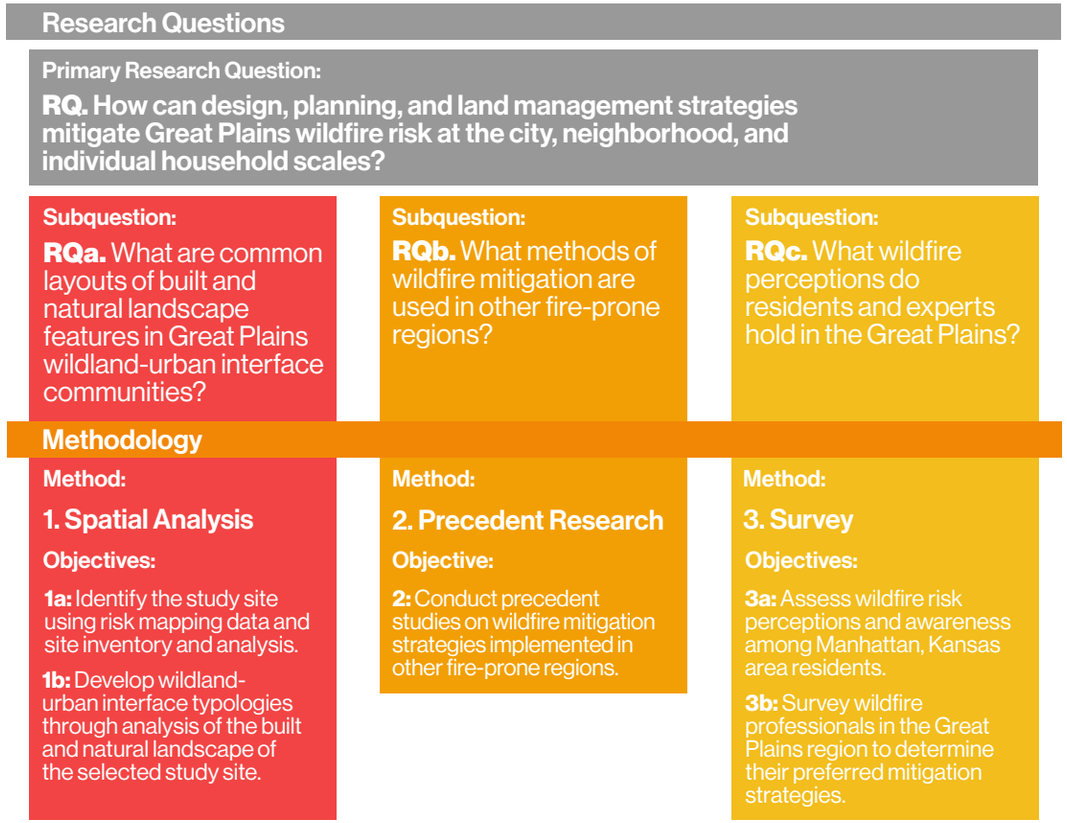


Figure 14. Methodology Diagram

Study Area and Survey Population

Study Area

The study area consists of Manhattan, Kansas and its immediate surroundings in Riley and Pottawatomie Counties (fig.s 15-16). Manhattan is a city of approximately 52,000 residents in the northern portion of the Flint Hills ecoregion, which contains North America's largest remaining tract of tallgrass prairie.

Much of the tallgrass prairie of the Flint Hills has never been cultivated for farming due to the region's shallow limestone geology ("What Are the Flint Hills?" 2023). This lack of tillage means undeveloped prairie often directly abuts development, placing homes and businesses adjacent to flammable prairie vegetation.

Though not atypical of the region, this landscape arrangement differs from many cities across the Great Plains, where development borders less flammable cropland (Donovan et al. 2020; Hanberry 2020). Manhattan typifies numerous higher-risk communities throughout the Great Plains, where undeveloped vegetation meshes with urban areas.

The city also faces many of the challenges complicating wildfire mitigation and increasing risk across the region, including eastern redcedar encroachment and considerable growth along the wildland-urban interface. Both Riley and Pottawatomie Counties experienced nationally above-average WUI growth at 45.2% and 75.5%, respectively, between 1990 and 2020. 66% of housing units in Riley County and 40% in Pottawatomie County now lie within the wildland-urban interface, placing both counties on par with exposure in many western communities (USDA Forest Service Northern Research Station 2023).

Manhattan's combination of substantial WUI growth, the proximity of significant combustible vegetation to homes, and the presence of complicating ecosystem factors provides ample opportunity to investigate the application of wildfire mitigation strategies to Great Plains communities.

Survey Population

This research includes two distinct survey populations. Manhattan-area residents comprise one target group, while wildfire experts and professionals working within the Great Plains comprise the other. Manhattan-area residents live within the immediate Manhattan area and are over the age of 18. Great Plains wildfire professionals were targeted from each of the 13 states within the region and are employed in wildfire related industries, such as emergency management, design, planning, or firefighting.

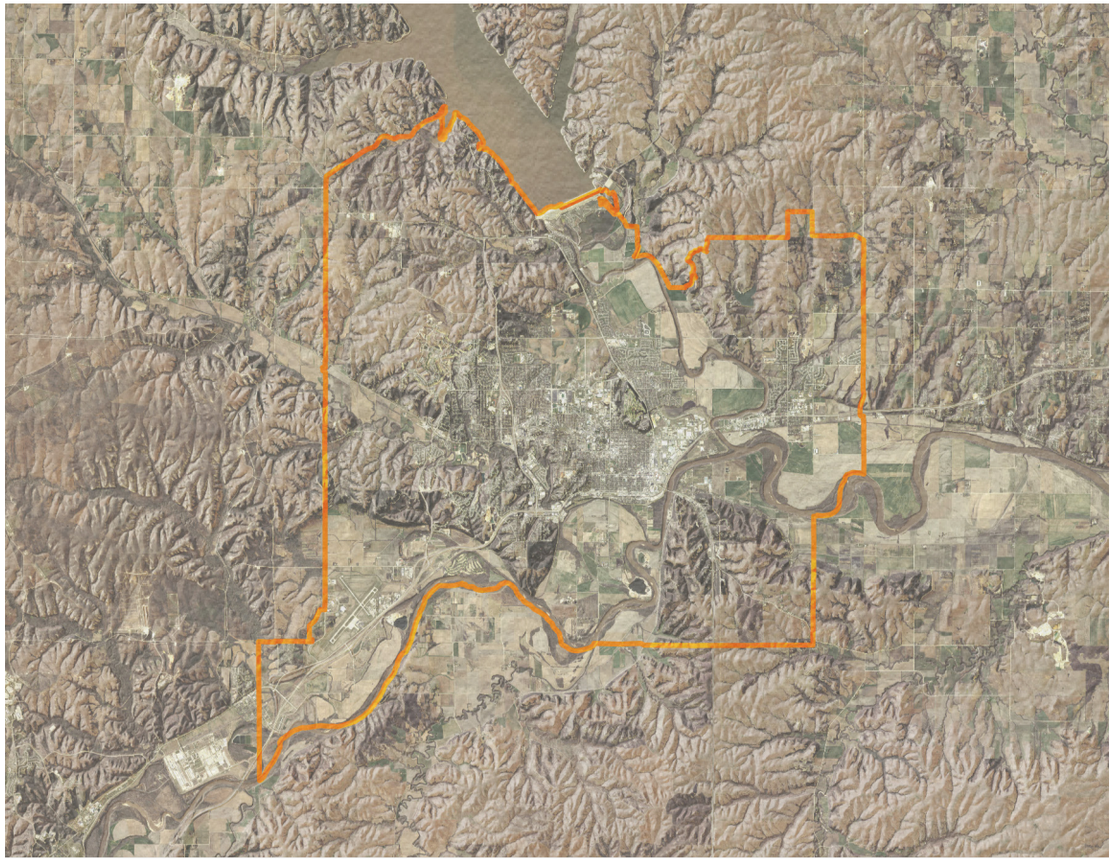


Figure 15.
Study Area Boundary

Study Area Boundary

0 2 4 8 Miles

Figure 16.
Study Area Location in Kansas

Method 1: Spatial Analysis

Objective 1a: Identify the study site using mapping data and site analysis.

The study site search took place within the broader study area (fig. 17) and attempted to identify areas suitable for further research. The selected study site served as a case study for in-depth analysis of the wildland-urban interface of Manhattan, Kansas. The study site was identified using wildfire risk mapping data from the Kansas Wildfire Risk Assessment Portal, SILVIS Lab's Global Wildland-Urban Interface 2020 map, and subjective analysis of factors contributing to wildfire risk, including topography, vegetation adjacency, and urban form.

The Kansas Wildfire Risk Assessment Portal (WRAP) was developed by the Kansas Forest Service in 2023 to provide wildfire risk modeling tailored to Kansas landscapes and stakeholder concerns. As such, WRAP data provides a much more granular assessment of wildfire risk than national models administered by federal agencies. The portal provides a number of datasets relevant to wildfire mitigation, though only the "Wildfire Risk" raster layer was used in the site selection process. This layer considers modeled fire likelihood and the consequence of fire occurring at any given location to evaluate overall wildfire risk to specified locations (fig. 17).

SILVIS Lab's Global Wildland-Urban Interface 2020 dataset classifies areas by WUI type and vegetative makeup. This dataset was developed with remote sensing to identify areas of development and vegetation type. Though the map data is more generalized than WRAP outputs, it provides an efficient method to identify locations exposed to combustible vegetation.

These datasets were considered alongside subjective analysis of landscape factors contributing to wildfire risk, such as topography (slope and landscape position), adjacent vegetation type, and urban form (neighborhood layout, land use, and density). Site selection focused on areas with high wildfire risk, the presence of multiple WUI classes, urban form, and an assortment of landscape factors to allow for a more in-depth study of the wildland-urban interface.

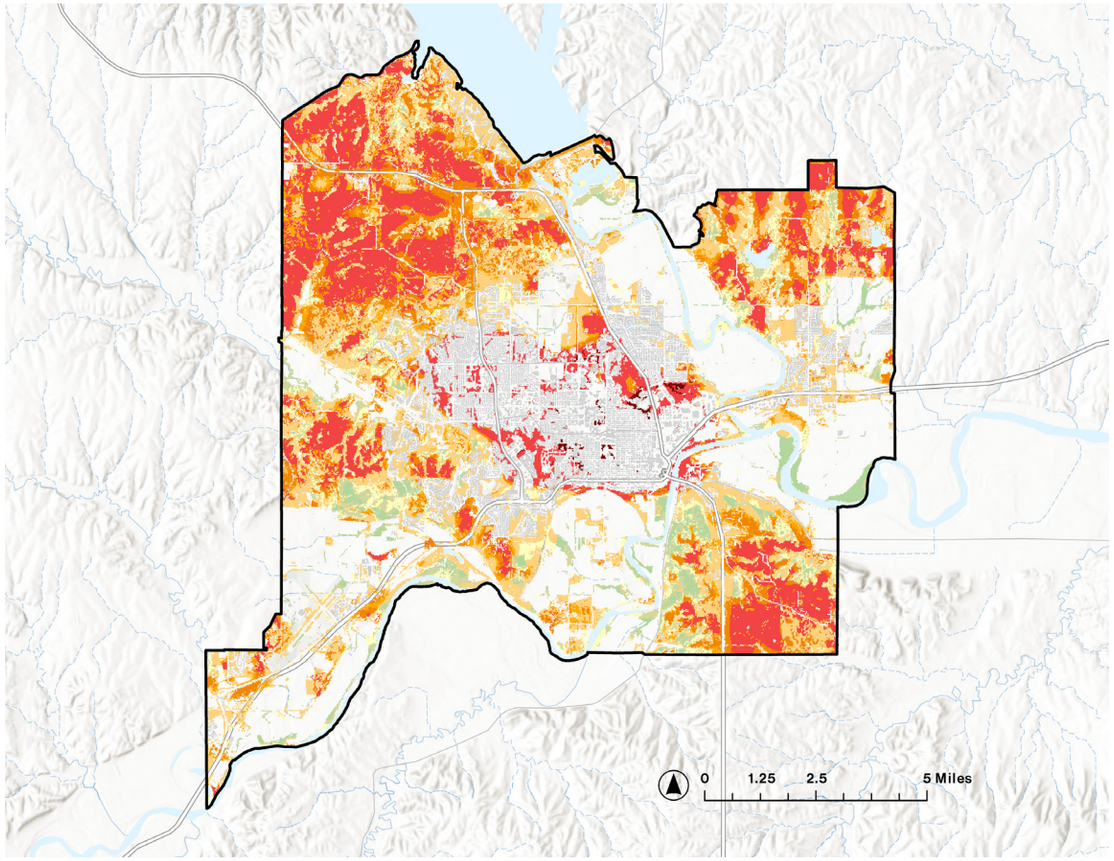


Figure 17.
Study Area Wildfire Risk

Method 1: Spatial Analysis

Objective 1b: Develop wildland-urban interface typologies through analysis of the built and natural landscape of the selected study site.

Since the application of wildfire mitigation strategies is highly location specific, understanding the makeup of the built and natural landscape is necessary before mitigation can be considered. Achieving Objective 1b involved assessing the wildland-urban interface to inform the development of typologies at each scale and exploring RQa.) "What are common layouts of built and natural landscape features in Great Plains wildland-urban interface communities?"

ArcGIS Pro was used to generate 50 random points within each neighborhood. These points were assigned to the nearest structure within the neighborhood and data was collected for 16 variables at each point. These variables attempt to capture features of the built and natural landscape that contribute to wildfire risk, as indicated by the literature review, and include both quantitative and qualitative observations. A 'typological classification manual' was developed to ensure consistent observations throughout the process and is shown in Appendix I. Variables at 150 data points were collected across the three study neighborhoods using the classification manual and were recorded in spreadsheet software.

This data was then analyzed using the K-modes clustering algorithm in Python. The K-modes clustering method was chosen for its ability to group categorical data and output distinct clusters. These output clusters represent the most likely combination of the input variables. K-modes cluster order does not carry any significance, meaning that cluster one does not occur more frequently in the study area than cluster two or three.

However, K-modes clustering can facilitate the comparison of individual variable frequencies across clusters. This means that if a variable occurs in two of the three clusters, it will occur more frequently in the data than the dissimilar variable in the third cluster. The use of categorical grouping and cross-cluster comparison is useful for developing simplified typologies of the study area and study neighborhoods, allowing for the application of mitigation strategies identified in Objectives 2 and 3b (fig. 18).

These simplified typologies do not reflect every variable and cluster arrangement but are intended to be representative of landscapes within the study area at each scale. Typological development is informed by the cluster outputs rather than directly representative of the data. Cluster outputs and variable frequencies are reported in Chapter IV, while simplified typologies are reported in Chapter V.

To develop the basis for these typologies, three clusters were calculated for each study neighborhood, creating the three most likely combinations of variables in each respective area. The clusters at the city scale were determined in the same manner but for the entire 150-point dataset, thus providing the three most common layouts across the entire study area. Cluster arrangement and variable frequency were considered in typological development. The typological development of individual structures was performed more simply, with each structure type present in the data receiving a typological representation for the application of mitigation strategies.

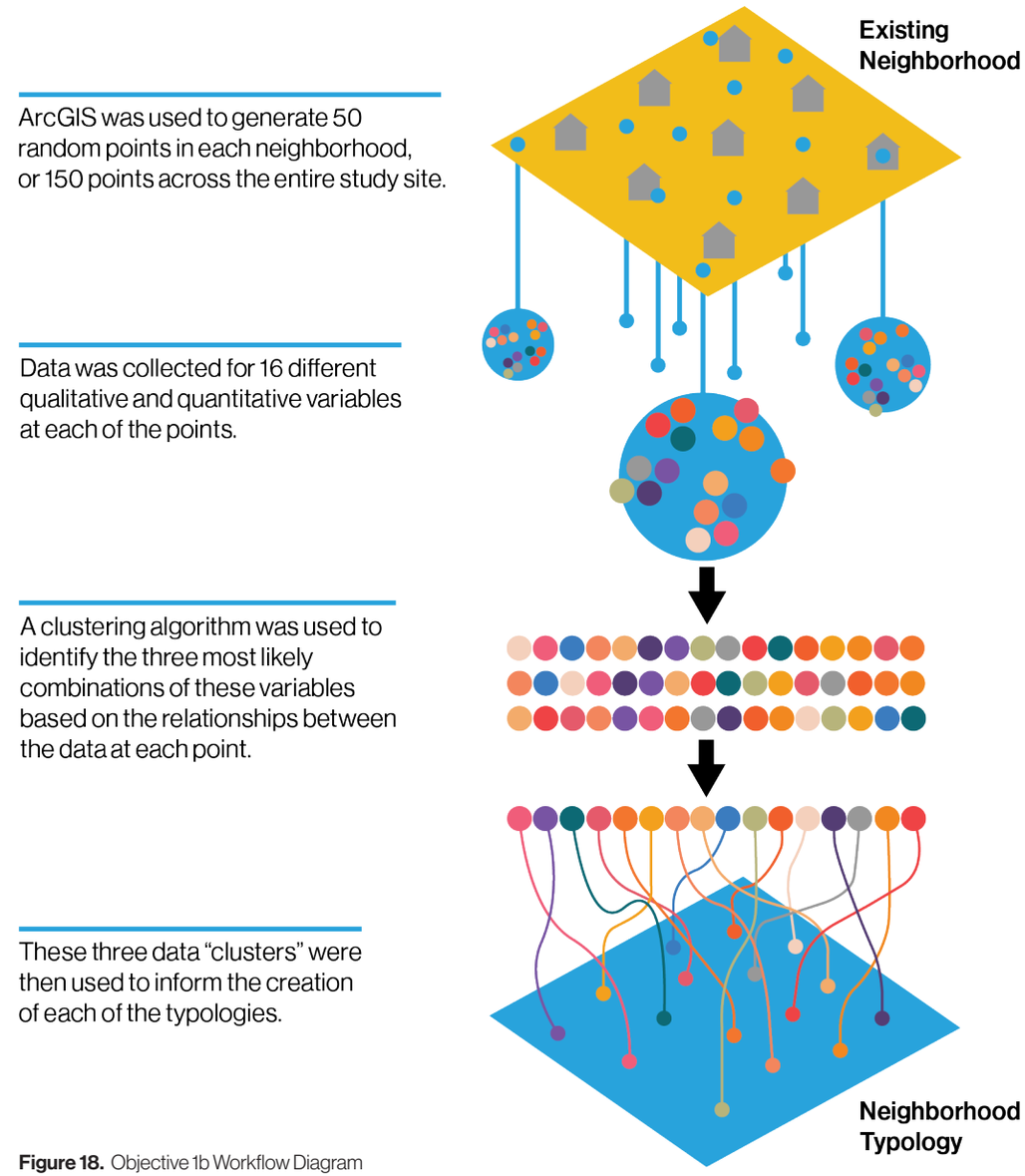


Figure 18. Objective 1b Workflow Diagram

Method 2: Precedent Research

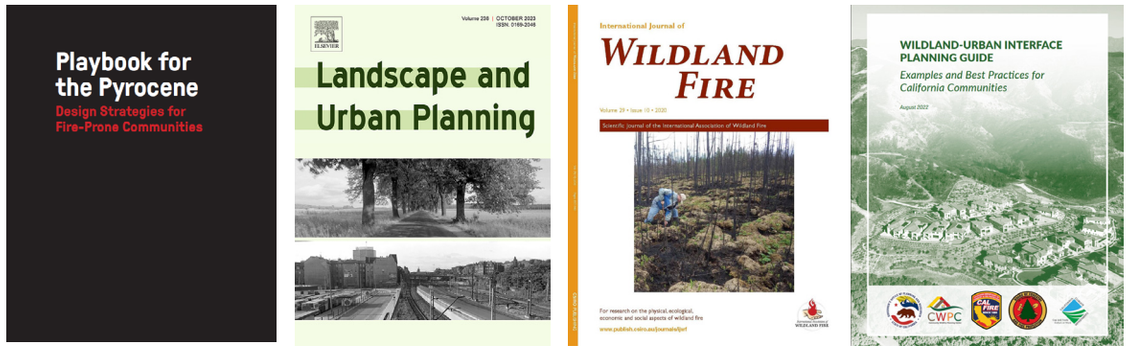


Figure 19. Precedent Source Examples

Objective 2: Conduct precedent studies on wildfire mitigation strategies implemented in other fire-prone regions.

Objective 2 was achieved by conducting informal precedent studies on existing wildfire mitigation techniques used in other fire-prone regions. This objective answers RQb.) "What methods of wildfire mitigation are used in other fire-prone regions?" Limited mitigation actions in the Great Plains meant precedent research considered areas well outside the area. This precedent research included city-wide, neighborhood, and individual structure scale interventions. Information sources included industry publications, academic journals, government websites, and design and planning guidebooks (fig. 19). Information collected during this phase guided the survey development in Objectives 3a and 3b and the design process of Chapter V.

Due to the informal nature of precedent studies, the findings are not a systematic review of wildfire mitigation strategies. Rather, the findings of Method 2 represent a selection of wildfire mitigation strategies from across a variety of academic, governmental, and industry publications.

Method 3: Survey

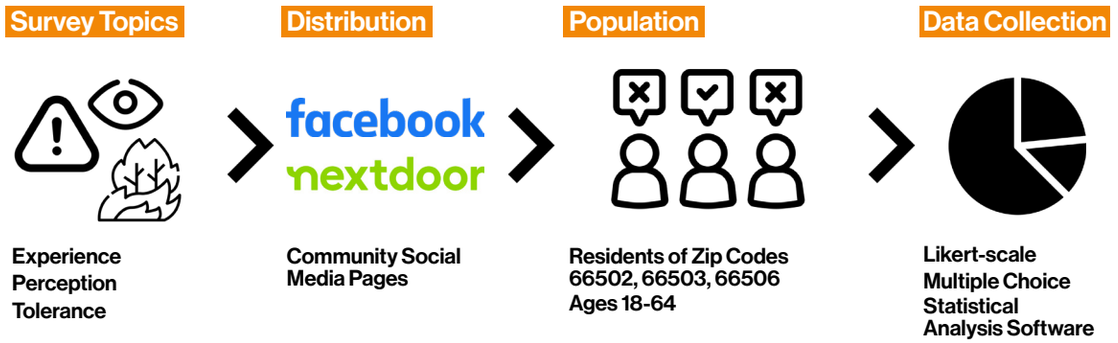


Figure 20. Resident Survey Workflow

Objective 3a: Assess wildfire risk perceptions and awareness among Manhattan, Kansas area residents.

Achieving Objectives 3a and 3b involved the use of web-based surveys to evaluate RQc) "What wildfire perceptions do residents and experts hold in the Great Plains?" Method 3a utilized an 18-question electronic survey to collect wildfire risk perceptions, wildfire awareness, home information, landscape preferences, and existing mitigation actions of Manhattan area residents (see Appendix II). This survey employed convenience sampling and was distributed via local groups on social media websites, Facebook and Nextdoor. Participants accessed the survey via an external web service where the survey was hosted. The survey was available for a month period from December 20th, 2023 to January 20th, 2024.

Surveys were collected from residents within zip codes 66502, 66503, and 66506 to adequately capture the greater Manhattan population (fig. 21). Surveys from respondents outside of these zip codes or under the age of 18 were discarded. 216 responses were collected, with 185 analyzed (n=185) after ineligible responses were removed. Survey questions were collected in multiple choice and Likert scale format and analyzed using the IBM's SPSS program (fig. 20).

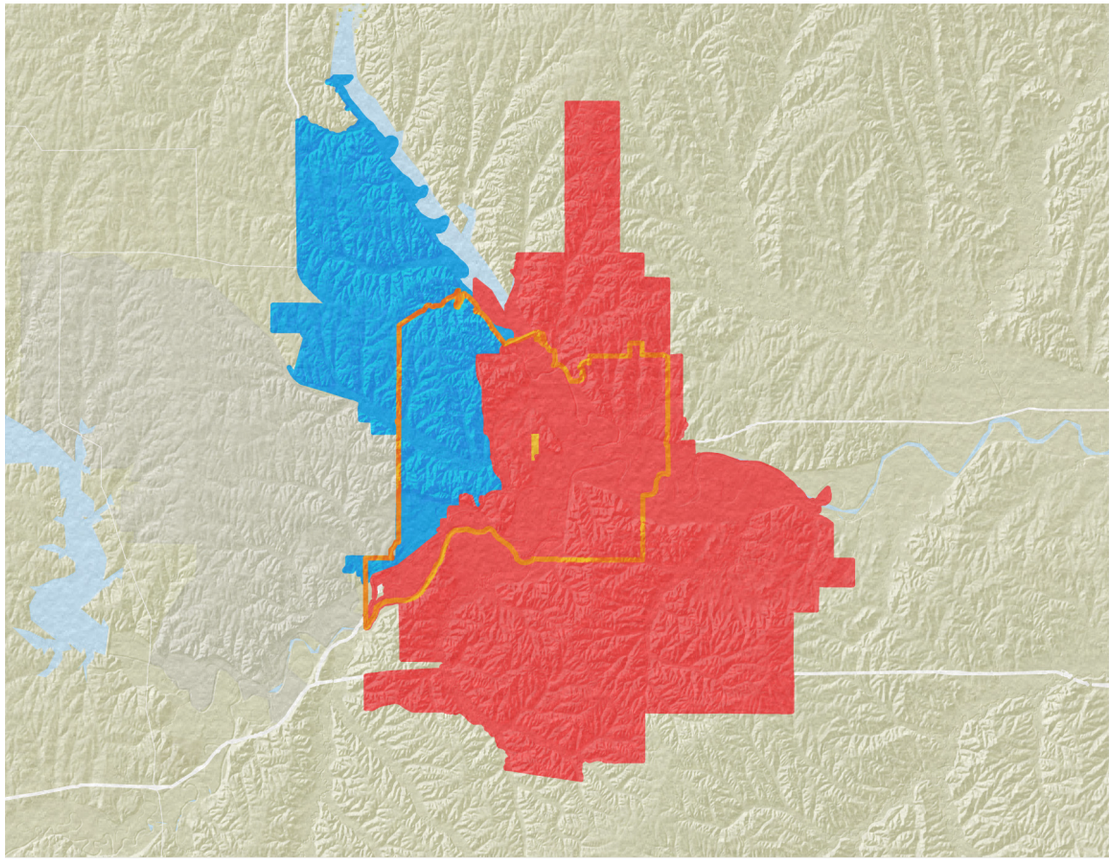


Figure 21.
Survey Zip Codes

Method 3: Survey

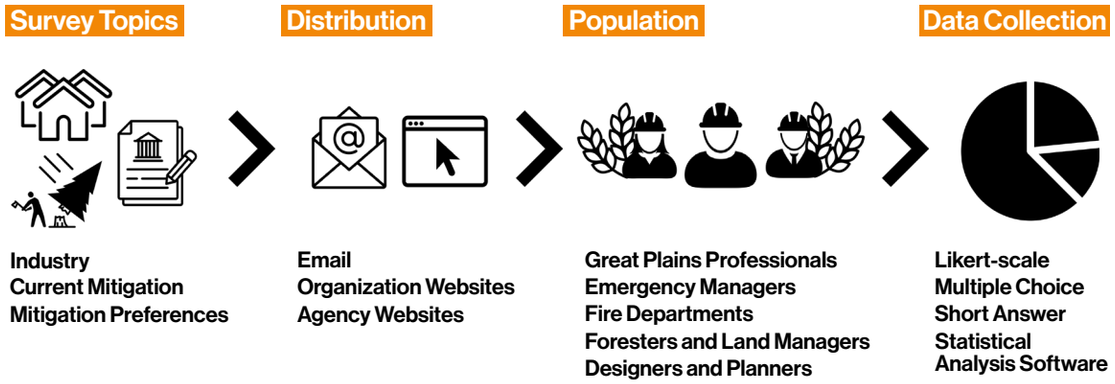


Figure 22. Expert Survey Workflow

Objective 3b: Survey wildfire professionals in the Great Plains region to determine their preferred mitigation strategies.

Objective 3b was achieved with a web-based survey and purposive sampling to survey planning, design, fire, natural resources, and emergency management professionals across the Great Plains (fig. 23). This survey was developed with topics identified during the literature review and precedent research of Objective 2.

Approximately 700 individuals from regional planning agencies, design firms, forest services, fire departments, and state and federal agencies were contacted via email. This survey collected information regarding existing wildfire mitigation practices and gauged the perceived success of specific mitigation techniques at each of the three scales.

Experts were also surveyed on the importance of additional considerations in wildfire mitigation such as affordability, ecosystem health, and aesthetics. Participants evaluated how effective they believe specific mitigation strategies identified in Objective 2, such as defensible space, vegetation management, and landscape buffers, may be at preventing wildfires in their communities. The survey then allowed participants to comment on actions they think may be most successful at mitigating wildfire threats (see Appendix III).

Data in this method was collected with multiple choice, short answer, and Likert scale responses. Short-answer responses were then analyzed for common answers, allowing for statistical analysis in SPSS (fig. 22). A total of 47 responses (n=47) were collected and analyzed.

Figure 23.
Great Plains States
Wildfire experts were contacted in each of the Great Plains region states, except for Louisiana.

IV Findings

Figure 24. Starbuck Fire Burn Scars
Burn scars from the 2017 Starbuck Fire surround the town of Ashland, Kansas. At nearly 465,000 acres, the Starbuck Fire is the largest wildfire in Kansas history.

Chapter IV Overview

Chapter IV discusses the findings produced using the methods described in the previous chapter. The chapter begins with a discussion of the selected study site identified in completion of Objective 1a. It then reports on the results of Objective 1b, which revealed the most common combinations of built and natural landscape variables at the city scale, three distinct combinations of variables within each neighborhood, and the structure types present in the identified study site. The chapter then discusses the application of precedents researched in achievement of Objective 2 to the design outcomes of Chapter V. Discussion of the findings of Objective 3a reveals varied levels of wildfire preparedness and awareness among residents of the study area, while the results of Objective 3b highlight expert preference for wildfire mitigation strategies in the Great Plains. The findings from each of these methods contributes to the design strategies of Chapter V.

Method 1: Spatial Analysis

Objective 1a: Identify the study site using mapping data and site inventory and analysis.

Selected Study Site

The study site lies on the southwestern edge of Manhattan and is approximately 1,500 acres of suburban-style development (fig.s 25-26). These developments lie among and adjacent to numerous ecosystem types and land uses, which contribute to wildfire risk and the formation of interface typologies. The study area was selected for its adjacency to areas at high risk of wildfire, its position in the wildland-urban interface, and its variety of urban forms and topography (see Appendix IV).

Development pressure from the city's expanding population has spurred considerable growth in the study site over the last two decades, with few homes existing in the area prior to 2005. As is typical of WUI areas, neighborhoods in the study site press against large tracts of combustible vegetation. This vegetation is composed of tallgrass prairie in varying states of transition to an eastern redcedar-dominated landscape.

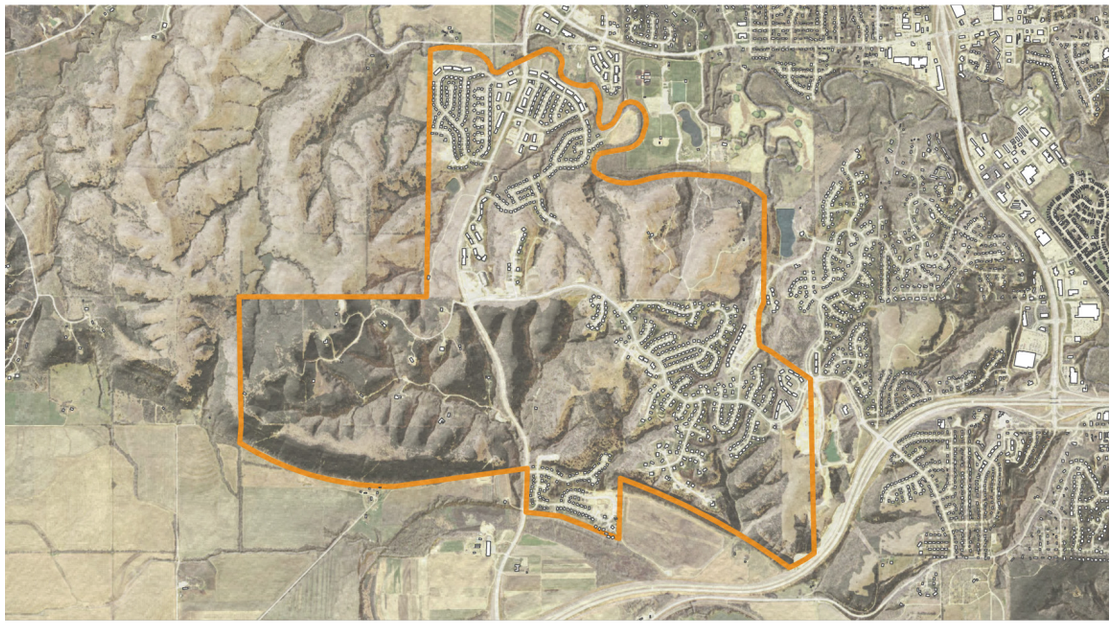


Figure 25.
Selected Study Site

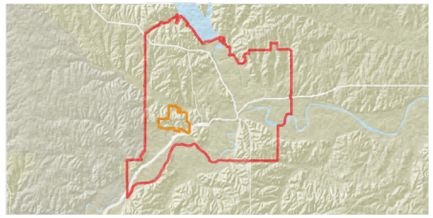


Figure 26.
Study Site Location in Study Area

Neighborhoods

Since factors contributing to wildfire risk are highly location specific, the selected study site was divided into three distinct neighborhoods (fig. 27). These neighborhoods allowed for more in-depth study of specific landscape factors contributing to each neighborhood's risk and for a tailored application of mitigation strategies. Neighborhood divisions were identified based on clear spatial separation between developments and with barriers such as roads, ridges, and streams.

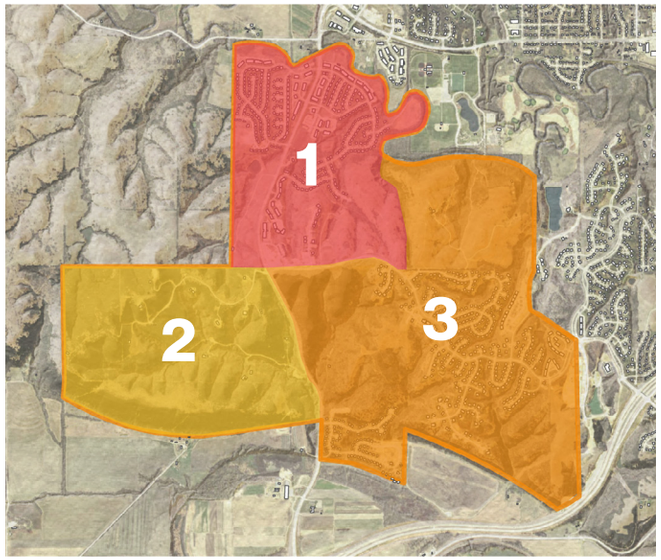


Figure 27. Study-site Neighborhood Divisions

Neighborhood 1

Neighborhood 1 is approximately 270 acres in the northern portion of the study site (fig. 28). The neighborhood is bound by Wildcat Creek to the north and northeast, an undeveloped park to the southeast, and privately owned open space to the east, south and west. This open space and park area is the primary source of the neighborhood's wildfire threat. Two major streets, Scenic Drive and Miller Parkway bisect and border the neighborhood's southernmost extent, respectively. Development in this neighborhood is a mixture of single family detached housing, single family attached housing (duplexes), and multifamily apartment buildings.

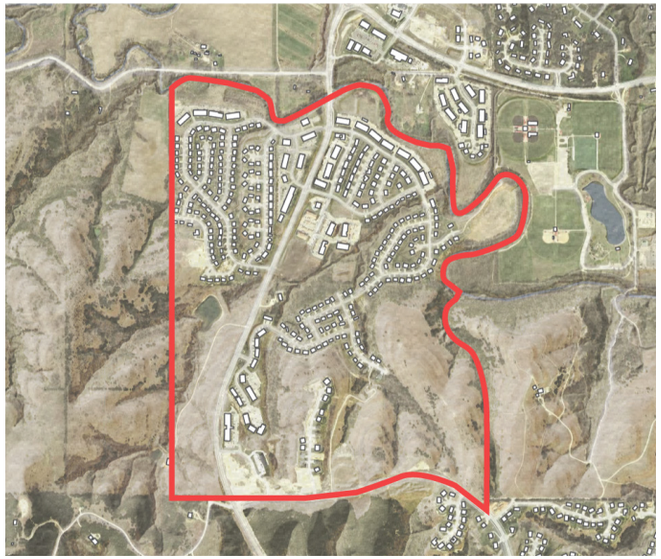


Figure 28. Neighborhood 1 Boundary

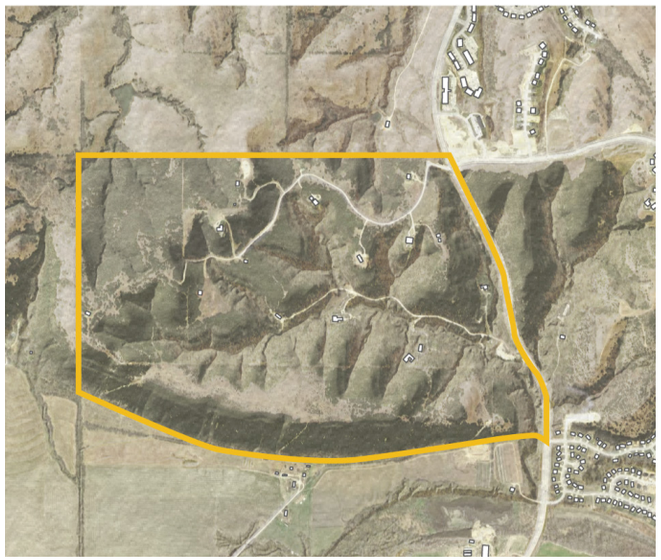


Figure 29. Neighborhood 2 Boundary

Neighborhood 2

Neighborhood 2 is approximately 225 acres and lies in the southwest corner of the study site (fig. 29). The neighborhood is bound by Scenic Drive to the east and privately owned open space to the north, south, and west. Development in this neighborhood is single-family estate-style, with large homes on large tracts of land. Notably, Neighborhood 2 is nearly completely forested with highly varied topography. The neighborhood lies atop a large forested ridge.

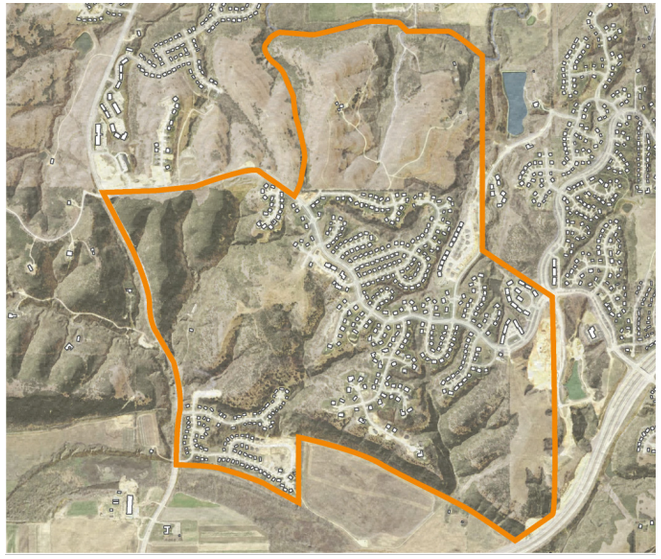


Figure 30. Neighborhood 3 Boundary

Neighborhood 3

Neighborhood 3 lies at the southeast corner of the study site and is roughly 415 acres (fig. 30). The neighborhood is bisected by Miller Parkway and Wreath Avenue, and is bound by privately-owned open space to the north, northwest, south and southeast; additional residential development to the northeast; park space to the southwest; and agriculture to the south. Like Neighborhood 2, Neighborhood 3's topography is highly varied with ridges, hilltops, and valleys. Neighborhood 3 is composed of single-family detached and attached housing.

Method 1: Spatial Analysis

Objective 1b: Develop wildland-urban interface typologies through analysis of the built and natural landscape of the selected study site.

City scale

At the city-scale, the K-modes output revealed clusters with varying levels of sameness within variables (table 1). Each of the three clusters identifies single-family detached housing as the primary land use at any given point within the study site. In all but one of the clusters, neighboring land use was the same as the primary land use except for rear neighbor category, which was "open space" in each cluster.

Density differed between each of the clusters (very low, low, medium) as did urban form (undefined, combination, curvilinear), access and egress (poor, moderate, good), adjacent cedar encroachment (low, high, severe), and interior cedar encroachment (insignificant, high, severe). Slopes were between 0-20 percent, with 0-10 percent occurring most frequently. Hilltop landscape position occurred in two of the three clusters, as did "open space" in adjacent land use outside the study area, and "woody fingers" as interior vegetation. Many ladder fuels were present in each cluster.

Variables	Cluster 1	Cluster 2	Cluster 3
Land Use	Single Family Detached	Single Family Detached	Single Family Detached
Front Neighboring Land Use	Open Space	Single Family Detached	Single Family Detached
Rear Neighboring Land Use	Open Space	Open Space	Multifamily
Side Neighboring Land Use	Open Space	Single Family Detached	Single Family Detached
Side Neighboring Land Use	Open Space	Single Family Detached	Single Family Detached
Density	Very Low	Medium	Low
Urban Form	Undefined	Combination	Curvilinear
Access and Egress	Poor	Good	Moderate
Slope	10-20	0-10	10-20
Topography	Hilltop	Bottomland	Hilltop
Adjacent Land Use Outside Study Area	Open Space	Open Space	Open Space
Adjacent Vegetation Outside Study Area	Open Canopy Forest/ Mid-transition Grassland	Savanna/Early Transition Grassland	Open Canopy Forest/ Mid-transition Grassland
Adjacent Cedar Encroachment	Severe	Low	High
Ladder Fuels	Many	Many	Many
Interior Vegetation	Woody Fingers	Insignificant	Woody Fingers
Interior Cedar Encroachment	Severe	Insignificant	High

Table 1. City-scale K-modes Output

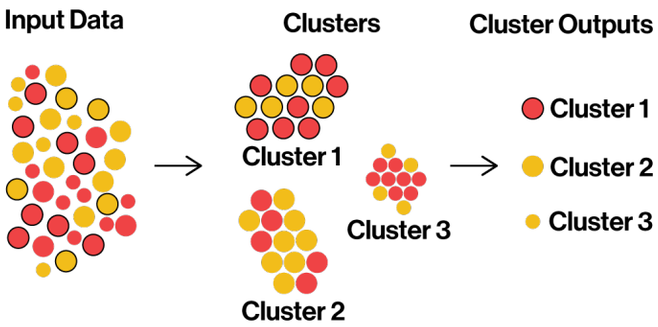


Figure 31. Clustering Process

The K-modes algorithm groups data by similarities, leading to an output of the most likely combination of variables in the given cluster. This example shows three clusters and outputs considering size, outline, and color. The cluster outputs represent the most frequent variable combination in each group. This same process was performed in completion of Objective 1b above.

Variables	Cluster 1	Cluster 2	Cluster 3
Land Use	Single Family Detached	Multifamily	Multifamily
Front Neighboring Land Use	Single Family Detached	Multifamily	Multifamily
Rear Neighboring Land Use	Open Space	Single Family Detached	Multifamily
Side Neighboring Land Use	Single Family Detached	Single Family Detached	Multifamily
Side Neighboring Land Use	Single Family Detached	Single Family Detached	Multifamily
Density	Medium	High	High
Urban Form	Combination	Combination	Combination
Access and Egress	Good	Good	Good
Slope	0-10	10-20	0-10
Topography	Midslope	Bottomland	Bottomland
Adjacent Land Use Outside Study Area	Open Space	Open Space	Open Space
Adjacent Vegetation Outside Study Area	Savanna/Early Transition Grassland	Open Canopy Forest/ Mid-transition Grassland	Tallgrass Prairie
Adjacent Cedar Encroachment	Low	Low	Low
Ladder Fuels	Many	Many	Many
Interior Vegetation	Woody Fingers	Woody Fingers	Woody Fingers
Interior Cedar Encroachment	Insignificant	Low	Not Applicable

Table 2. Neighborhood 1 K-modes Output

Neighborhood 1

Neighborhood 1 is typified by a mixture of single-family detached and multifamily housing, bordered on most sides by land use of the same type. Single-family housing is likely to have direct exposure to open space to the rear of the home, while multifamily structures are surrounded by development on all sides. Density in Neighborhood 1 is medium to high and its urban form is "combination" (table 2).

Access and egress in Neighborhood 1 is good with all clusters having good access to major roads. Slopes within Neighborhood 1 are primarily between 0-10 percent with 10-20 percent occurring less frequently. Similarly, much of Neighborhood 1 lies within bottomlands with midslope positions occurring less frequently. Adjacent land use outside the study area is open space for each of the three clusters, while adjacent vegetation types vary between each (savanna or scrub/early transition grassland, open canopy/ mid-transition grassland, agriculture).

Within this adjacent vegetation, cedar encroachment is low while many ladder fuels are present. Woody fingers are present in the interior of two of the clusters, while interior vegetation is not significant in the third. Cedar encroachment within these fingers is low in one of the clusters, while insignificant or not applicable in the other two.

Neighborhood 2

Neighborhood 2 exhibited greater homogeneity than Neighborhood 1, with single-family detached housing surrounded by open space present in each of the three clusters (table 3). Likewise, each cluster has very low density, undefined urban form, poor access and egress, lies on or near 10-20 percent slopes, is adjacent to open space outside the study area with the presence of many ladder fuels, and has woody fingers within the study area with severe cedar encroachment.

Topography, adjacent vegetation, and adjacent cedar encroachment differ between clusters, with open canopy/mid-transition grassland, severe adjacent cedar encroachment, and hilltop landscape position present in two of the three clusters while closed canopy/transitioned grassland, low cedar encroachment, and midslope landscape position are each present in one cluster.

Variables	Cluster 1	Cluster 2	Cluster 3
Land Use	Single Family Detached	Single Family Detached	Single Family Detached
Front Neighboring Land Use	Open Space	Open Space	Open Space
Rear Neighboring Land Use	Open Space	Open Space	Open Space
Side Neighboring Land Use	Open Space	Open Space	Open Space
Side Neighboring Land Use	Open Space	Open Space	Open Space
Density	Very Low	Very Low	Very Low
Urban Form	Undefined	Undefined	Undefined
Access and Egress	Poor	Poor	Poor
Slope	10-20	10-20	10-20
Topography	Hilltop	Hilltop	Hilltop
Adjacent Land Use Outside Study Area	Open Space	Open Space	Open Space
Adjacent Vegetation Outside Study Area	Open Canopy Forest/ Mid-transition Grassland	Closed Canopy/ Transitioned Grassland	Open Canopy Forest/ Mid-transition Grassland
Adjacent Cedar Encroachment	Severe	Severe	Severe
Ladder Fuels	Many	Many	Many
Interior Vegetation	Woody Fingers	Woody Fingers	Woody Fingers
Interior Cedar Encroachment	Severe	Severe	Severe

Table 3. Neighborhood 2 K-modes Output

Neighborhood 3

Neighborhood 3 primarily consists of single-family detached housing, with single-family attached occurring less frequently (table 4). These housing typologies are likely neighbored by the same housing type on all sides but the rear, which is most frequently open space. Density within Neighborhood 3 is most frequently low, with medium density occurring with single-family attached housing. Urban form is curvilinear with moderate access and egress occurring most frequently and in association with single-family attached housing.

Slopes are between 0-20 percent with 0-10 percent slopes occurring most frequently. Hilltop landscape position occurs in two of the three clusters, as does open space as adjacent land use outside the study area, open canopy/mid-transition grassland adjacent vegetation, and woody fingers as interior vegetation. Adjacent cedar encroachment (low, moderate, high) and interior cedar encroachment (insignificant, low, high) varies between each cluster.

Variables	Cluster 1	Cluster 2	Cluster 3
Land Use	Single Family Detached	Single Family Detached	Single Family Attached
Front Neighboring Land Use	Single Family Detached	Single Family Detached	Single Family Attached
Rear Neighboring Land Use	Open Space	Single Family Detached	Multifamily
Side Neighboring Land Use	Single Family Detached	Single Family Detached	Single Family Attached
Side Neighboring Land Use	Single Family Detached	Single Family Detached	Single Family Attached
Density	Low	Low	Medium
Urban Form	Curvilinear	Curvilinear	Curvilinear
Access and Egress	Moderate	Moderate	Good
Slope	10-20	0-10	0-10
Topography	Ridgeline	Hilltop	Hilltop
Adjacent Land Use Outside Study Area	Open Space	Park	Open Space
Adjacent Vegetation Outside Study Area	Open Canopy Forest/ Mid-transition Grassland	Open Canopy Forest/ Mid-transition Grassland	Tallgrass Prairie
Adjacent Cedar Encroachment	High	Moderate	Low
Ladder Fuels	Many	Many	Many
Interior Vegetation	Woody Fingers	Woody Fingers	Woody Fingers
Interior Cedar Encroachment	High	Insignificant	Low

Table 4. Neighborhood 3 K-modes Output

Structure scale

Clustering was not performed for individual structure attributes, but data from the neighborhood-scale K-modes cluster analysis identified each structure type in each neighborhood (fig. 31). Neighborhood 1 consists of single-family detached housing, single-family attached housing, and multifamily housing; Neighborhood 2 consists entirely of single-family housing, while Neighborhood 3 has single-family detached and single-family attached housing. Other variables from the cluster analysis, such as landscape position, slope, and adjacent vegetation, are used to develop simplified structure typologies as seen in Chapter V.

Neighborhood 1	Neighborhood 2	Neighborhood 3
Single Family Detached	Single Family Detached	Single Family Detached
Single Family Attached		Single Family Attached
Multifamily		

Table 5. Structure Typologies

Method 2: Precedent Research

Objective 2: Conduct precedent studies on wildfire mitigation strategies implemented in other fire-prone regions.

Precedent Findings

Objective 2 identified mitigation strategies used in other fire-prone regions. These strategies were divided between the city, neighborhood, and structure scales. The city scale study identified 9 mitigation strategies, the neighborhood scale study identified 16 mitigation techniques, and 11 techniques were identified at the structure/site scale (fig. 32). These strategies fall into two broad categories: natural landscape and built landscape. The strategies identified in this research were used to develop the survey instrument used in Objective 3b, and assisted in the application of strategies to typologies in Chapter V.

Since this precedent study did not involve a systematic review of academic literature, the strategies below represent selected techniques found across academic, governmental, and industry publications. The findings are not representative of the frequency of strategy implementation.

Figure 32. Precedent Mitigation Strategies

Popular mitigation strategies

City-scale

Natural Landscape
- Cutting firebreaks
- Selective thinning
- Species control
- Prescribed burning
- Targeted grazing
- Conditions monitoring
- Utility easement clearing
- Windbreaks to trap embers

Built Landscape
- Limiting development

Neighborhood-scale

Natural Landscape
- Cutting firebreaks
- Selective thinning
- Species control
- Prescribed burning
- Targeted grazing
- Utility easement clearing
- Windbreaks to trap embers
- Agricultural buffers

Built Landscape
- Planting standards
- Plant spacing standards
- Limiting development
- Clustering structures
- Spreading out structures
- Ensuring access and egress
- Managed greenbelts

Structure-scale

Natural Landscape
- Defensible space zone 1
- Defensible space zone 2
- Defensible space zone 3
- Regular irrigation
- Managing native vegetation
- Species control

Built Landscape
- Hardscape landscape selection
- Noncombustible materials
- Hardening with walls/landforms
- Planting standards
- Plant spacing standards

Method 3: Survey

Objective 3a: Assess wildfire risk perceptions and awareness among Manhattan, Kansas area residents.

Resident Survey

A total of 216 surveys were collected during the month-long survey period. 31 surveys were discarded due to respondents living outside the survey zip codes. The remaining 185 surveys were analyzed using statistical analysis software (fig. 33).

The majority of survey respondents live within the 66502 zip code, while Neighborhood 8 has the largest single number of respondents with 34. However, responses by neighborhood are highly varied. Respondents neither agree nor disagree that a fire similar to the 2023 Maui Fire is possible in the Great Plains, though the majority of respondents (52.6%) agree that communities in the Great Plains are at risk of wildfire.

The majority of respondents (86.8%) have some knowledge or experience with wildfire in the Great Plains, and 45.6% have direct experience with fire through observation, knowing others who have been impacted, or have been directly impacted themselves by wildfire.

On average, respondents have lived in their current residence for 6-10 years, though a plurality (31.22%) have lived in their residence for more than 20 years. 72.4% of respondents identify as living within or on the edge of the city, while 27.7% report living in a rural setting. A majority of respondents (56.1%) agree that they live where they do, in part, because of the aesthetic features of the landscape. Of which, topographic features (20.1%), woods or forested areas (19.1%), and wildlife (17.2%) were most likely to contribute to respondents' appreciation of the landscape.

A slim majority of respondents (51.7%) agree that wildfire could be a threat to their neighborhood, while 39.8% disagree. 42.5% of respondents disagree that their community is prepared to handle a wildfire, while 34.4% agree.

The average respondent disagrees that they have taken steps to reduce their personal wildfire risk. However, results are fairly evenly divided between strongly disagree (20.4%), somewhat disagree (22.0%), neither agree nor disagree (21.5%), and somewhat agree (25.8%). Only 10.2% are in strong agreement with the statement.

79.6% of respondents have never discussed their wildfire threat with their neighbors or friends. Similarly, 70.1% do not know where to find information about their wildfire risk. A large majority (83.0%) support wildfire mitigation measures at the city scale, 76.4% support mitigation efforts at the neighborhood scale, while 70.9% would be willing to make changes to their home or yard to make it safer from wildfires.

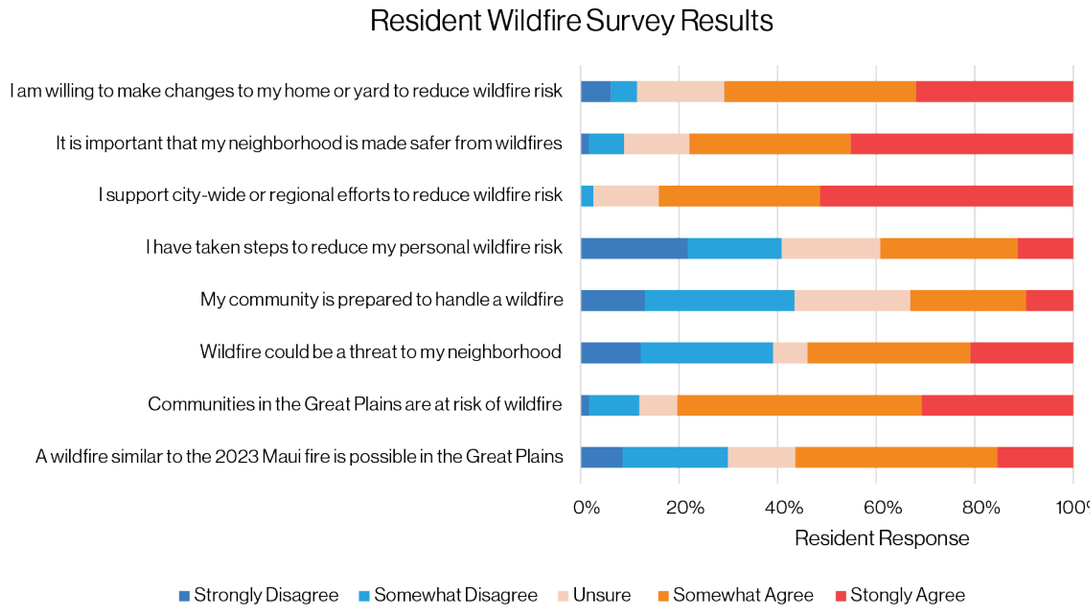


Figure 33. Resident Wildfire Survey Results

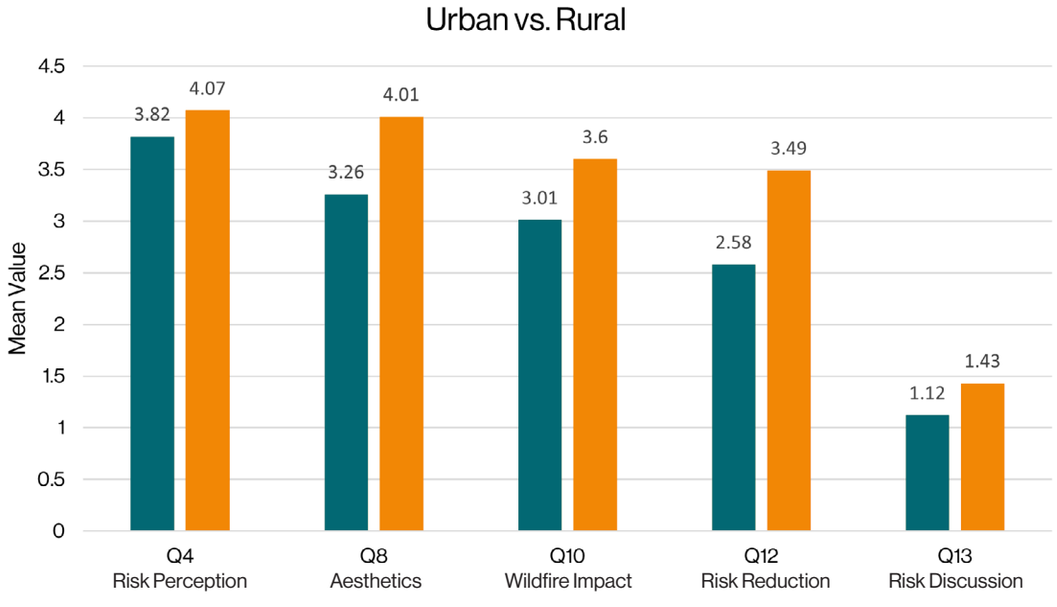


Figure 34. Urban vs. Rural Survey Feedback

Mean differences are statistically significant at the .05 level.

Urban vs. Rural

An independent samples t-test (see Appendix V) was used to compare survey responses from residents identifying as living in an urban area or rural area. The survey area included the urban boundaries of Manhattan, Kansas as well as considerable rural land around the city to capture a variety of wildfire experiences and perceptions.. Responses to Question 7 were categorized as urban if respondents identified as living "within the city" or "on the edge of the city," or rural if they answered "close to the city but not in it" or "in the country or a rural area." The t-test identified five questions at the .05 level of significance in which responses were statistically different between the two groups (fig. 34).

Respondents identifying as living in rural areas are statistically more likely to believe that Great Plains communities are at risk of wildfire (Q4), live where they do because of aesthetic landscape elements (Q8), believe wildfire could threaten their neighborhood (Q10), have taken steps to reduce their personal wildfire risk (Q12), and discussed wildfire risk with their neighbors or friends (Q13).

These findings indicate that rural residents have a greater understanding of the risk associated with the location of their homes. Predictably, this increased understanding spurs risk reduction behaviors and risk discussion among peers. Though rural and urban residents demonstrate similar levels of experience with wildfire in the Great Plains, rural residents are more likely to believe that they could be impacted by wildfire.

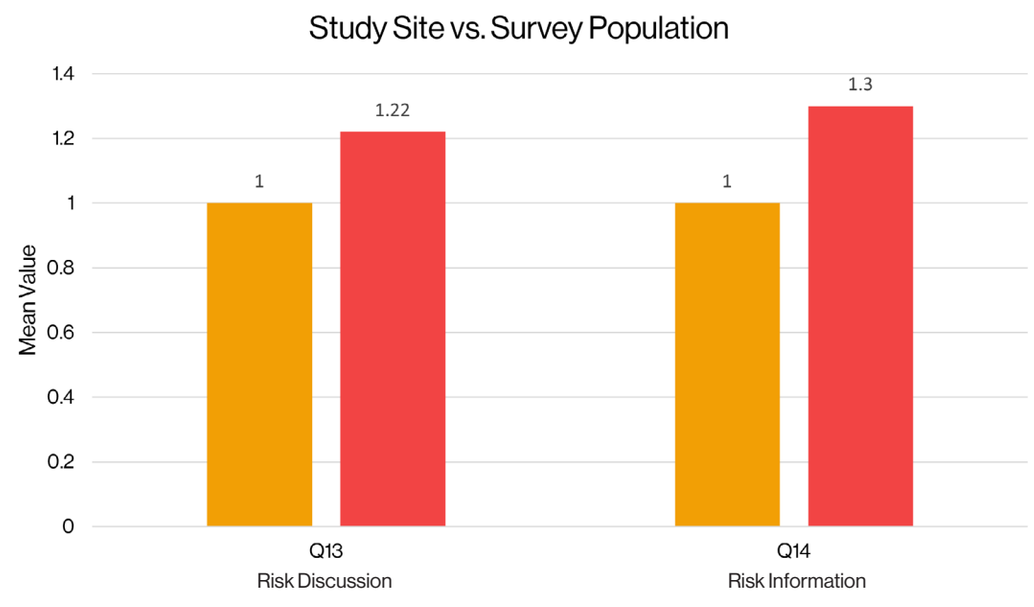


Figure 35. Study Site vs. Survey Population Feedback

Mean differences are statistically significant at the .05 level.

Survey Population vs. Study Site

An independent samples t-test (see Appendix VI) was also used to compare responses from the entire survey population and the study site. Responses to Question 2 were categorized as study site and non-study site to serve as both sample groups. Responses with an answer of neighborhood "11" were coded as the study site.

The t-test identified two questions that varied statistically between the sample groups. Respondents in the study site are less likely to have discussed wildfire risk with neighbors or friends (Q13) and are less likely to know where to find information about their wildfire risk (Q14) than the survey population at large (fig. 35).

Method 3: Survey

Objective 3b: Survey wildfire professionals in the Great Plains region to determine their preferred mitigation strategies.

Expert Survey

A total of 609 surveys were sent to professionals working in wildfire-related industries across the Great Plains region. 47 experts responded, for a response rate of 7.7%.

Respondents worked in fire agencies (43%), public administration/emergency management (37%), Design/Planning (11%), and Natural Resources/Forestry (9%) (fig. 36). The largest number of respondents work in Kansas (29.8%), followed by Colorado (25.5%), Oklahoma (23.4%), Texas (4.3%), New Mexico (2.1%), and South Dakota (2.1%) (fig. 37). Three respondents (6.4%) did not include the state in which they work. The majority of survey respondents (66%) have been employed in their field for more than 10 years.

A large majority of respondents (80%) agree that wildfires are a growing threat in the Great Plains. Likewise, 80% agree that a fire similar to the 2023 Maui Fire is possible in the region. 93% of respondents agree that WUI communities should work to mitigate wildfire risk. When asked to rate the wildfire risk currently faced by their community, 19% answered very high, 35% answered high, 40% answered moderate, and 7% answered low (fig. 38).

A small majority (53%) of respondents' communities already have existing wildfire mitigation measures in place. Of these measures, Firewise is the most prevalent (45% of communities with mitigation measures), followed by fuels management programs (40%), and community wildfire protection plans (35%). Other methods include WUI building codes or suggestions (15%), landscape recommendations (10%), and emergency access and egress requirements (10%).

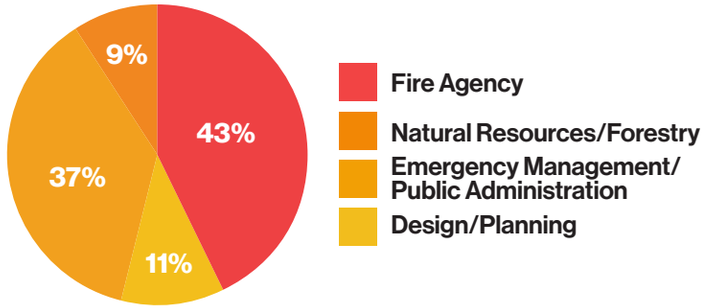


Figure 36. Respondent Industry

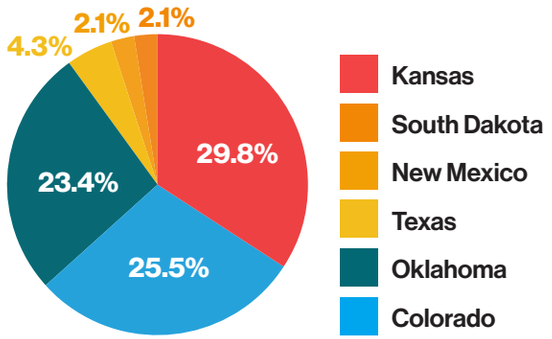


Figure 37. Respondent State of Employment

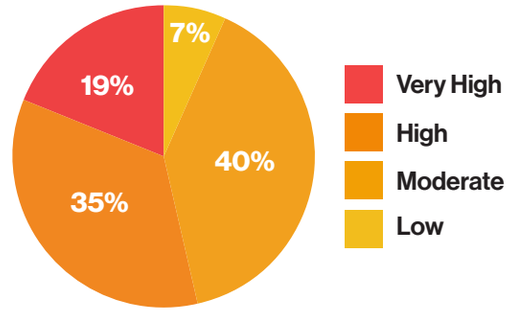


Figure 38. Respondent Wildfire Risk to Community

City-scale Mitigation Strategies

Responses to mitigation preference questions were collected via Likert scale. Each response option was assigned a value (not effective at all=1, slightly effective=2, moderately effective=3, etc.). Scores were then averaged to determine the most preferred methods for each scale.

At the city scale, experts ranked "invasive/nuisance species management" as the most effective strategy to mitigate wildfire risk to exposed Great Plains Communities (score: 3.91), followed by "selective thinning of combustible vegetation" (3.83), "prescribed burning to reduce combustible material" (3.81), "livestock grazing to reduce combustible material" (3.55), and "cutting permanent/seasonal firebreaks" (3.52) (fig. 40).

Experts ranked "ease of maintenance," "invasive/nuisance species control," "preserving/promoting ecological function," "ensuring public access," and "aesthetics/visual quality" as the top five most important additional considerations when developing wildfire mitigation strategies at the city scale (fig. 41).

In addition to close-ended responses, experts were encouraged to leave comments regarding other aspects of mitigation they consider important (fig. 39).

Beyond reducing wildfire risk, what other aspects do you consider when developing mitigation strategies?

"What we often see is that trees and 'Firewise' landscapes are often in conflict, in that trees are seen as fuel and their other benefits, such as shading, are not brought into to equation."

"Very little about mitigation is pretty, so none of these [additional considerations] are important in the larger sense of protecting infrastructure and saving lives including livestock. Something has to give since most wildland fires are started by humans on private land. You can't have your cake and eat it to."

Figure 39. City-scale Expert Commentary

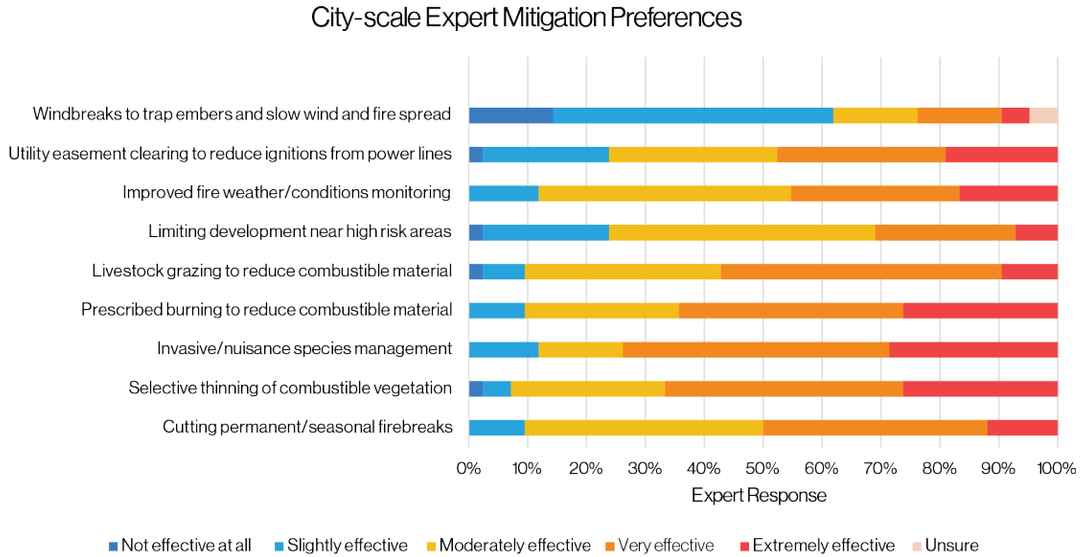


Figure 40. City-scale Expert Mitigation Preferences

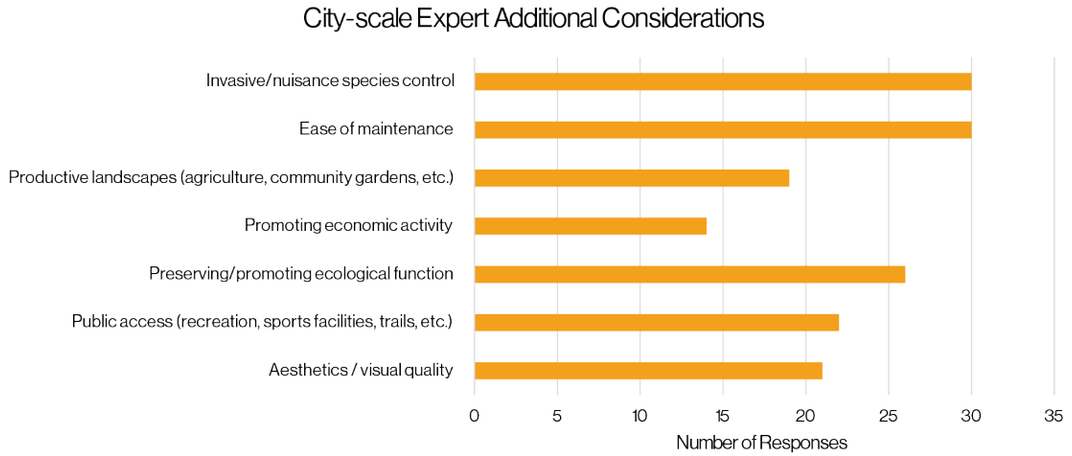


Figure 41. City-scale Expert Additional Considerations

Neighborhood-scale Mitigation Strategies

At the neighborhood scale, experts ranked "ensuring access and egress for evacuation and emergency personnel" as the most effective risk mitigation strategy (4.05), followed by "selective thinning of combustible vegetation near neighborhoods" (3.71), "invasive/nuisance species management" (3.54), "cutting permanent/seasonal firebreaks" (3.31), "utility easement clearing to reduce ignitions from downed power lines" (3.29), and "landscape planting standards regarding the use of low fire hazard plants" (3.29) as the most effective strategies to mitigate wildfire risk and the neighborhood scale (fig. 43).

Experts ranked "ease of maintenance," "aesthetics/visual quality," "productive landscapes," "invasive/nuisance species control," and "public access" as the five most important additional considerations when developing wildfire mitigation strategies at the neighborhood scale (fig. 44).

Additional comments included concerns about water use in arid areas, urging community-based groups to lead fire mitigation, and public safety through environmental design (fig. 42).

Beyond reducing wildfire risk, what other aspects do you consider when developing mitigation strategies?

"We need to think about the ecosystem and not detach fire as a stand alone problem. What are the benefits of the aspects that are seen as a fire risk?"

"Water. Colorado is quite arid and we are actively trying to reduce the amount of water used in irrigating urban and suburban landscaping."

Figure 42. Neighborhood-scale Expert Commentary

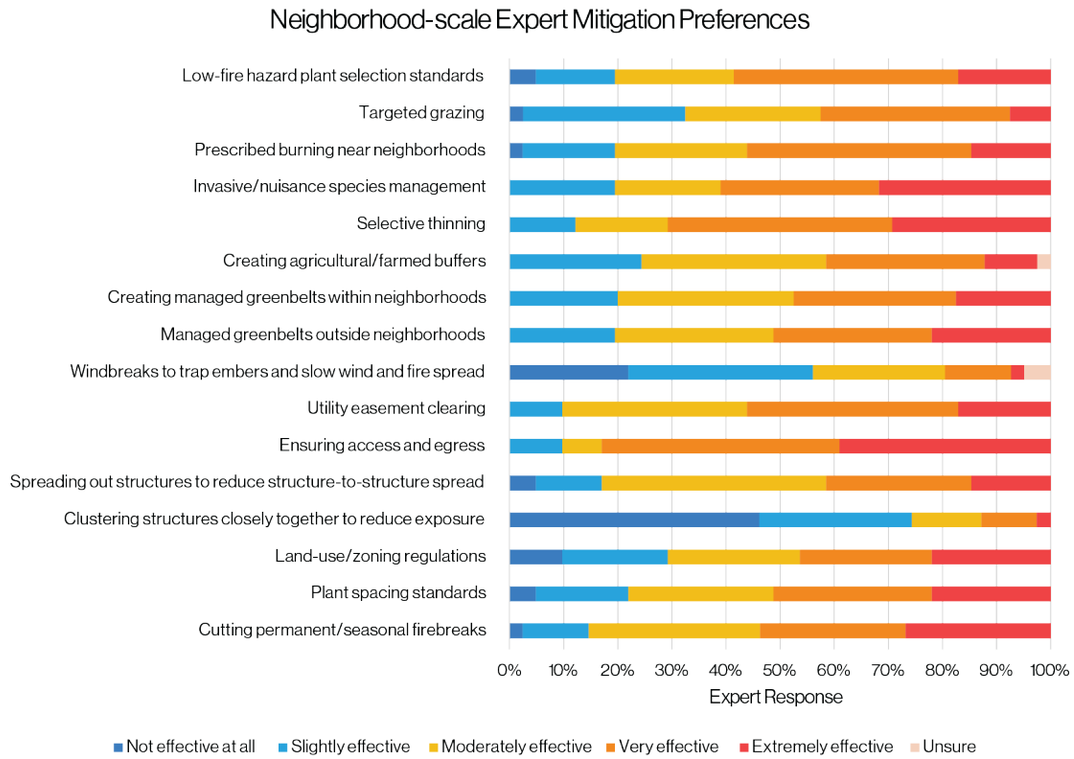


Figure 43. Neighborhood-scale Expert Mitigation Preferences

Figure 44. Neighborhood-scale Expert Additional Considerations

Structure/Site-scale Mitigation Strategies

At the individual structure/site scale, experts ranked "creating defensible space from 30 feet to 100 feet of a structure" as the most effective risk mitigation strategy (4.11), followed by "using hardscape materials such as pavers and gravel instead of mulch" (3.87), "creating defensible space from 5 feet to 30 feet of a structure" (3.82), "keeping native vegetation short through mowing or other means" (3.69), and "using noncombustible materials for fences, gates, and outdoor furniture" (3.59) as the five most effective strategies at mitigating wildfire risk at the structure/site scale (fig. 46).

Experts ranked "ease of maintenance," "cost of implementation," "aesthetics/visual quality," "ease of implementation," and "invasive/nuisance species control" as the top five additional considerations to keep in mind when developing structure and site scale mitigation strategies (fig. 47).

Additional comments note that mitigation may lead to reduced insurance rates, and highlight the importance of aesthetics and ease and cost of implementation and maintenance to individual homeowners (fig. 45).

Beyond reducing wildfire risk, what other aspects do you consider when developing mitigation strategies?

"Although invasive species control and native natural resource preservation should always be undertaken as a high priority- for the homeowner/tenant- cost and effort of implementation and maintenance, and aesthetics will be of very high importance."

"People believe it will never happen to them. They live where they live and don't want to spend the money or cut a tree. Education has never worked and we have been at it for decades. There is nothing urban about the interface so we need to quit building and start the retreat."

Figure 45. Structure/site-scale Expert Commentary

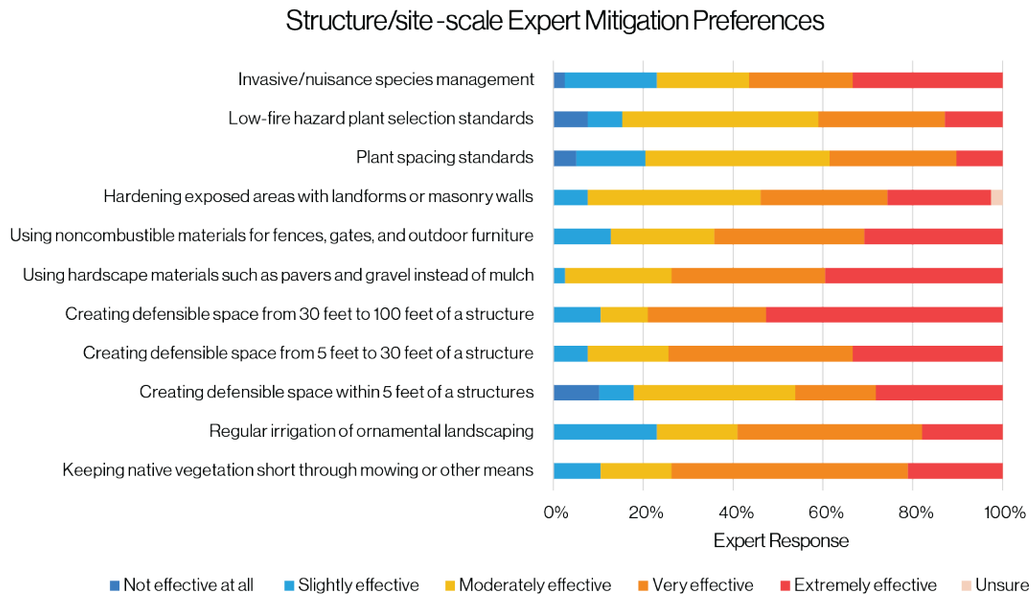


Figure 46. Structure/site-scale Expert Mitigation Preferences

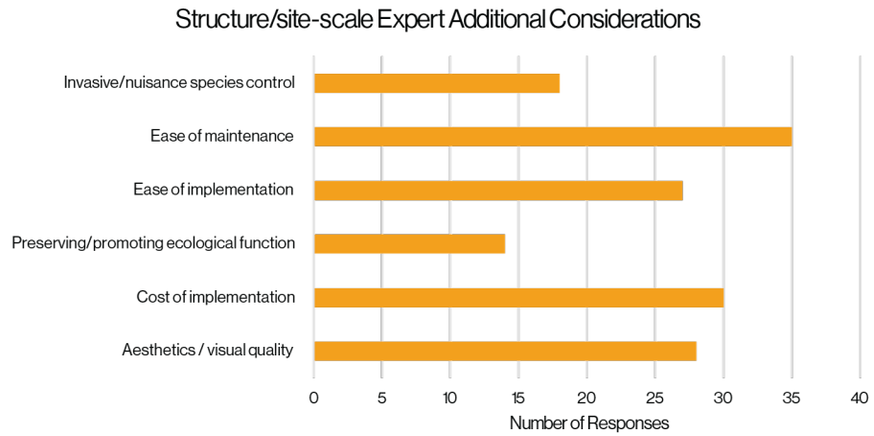


Figure 47. Structure/site-scale Expert Additional Considerations

Expert Commentary and Input

Experts were asked to provide commentary on innovative, emerging, or unconventional methods of wildfire mitigation they would like to see considered for use in the Great Plains (fig. 48). These methods include the use drones to identify high risk areas and assist in coordination during emergencies, tax credits to motivate homeowners to maintain defensible space around their homes, and the creation of large, conifer-free buffers along highways to serve as firebreaks. Notably, the importance of defensible space was mentioned by multiple respondents.

In addition to specific proposals, respondents were allowed to leave general comments on wildfire risk and mitigation in the Great Plains (fig. 49), many of which note the challenge of mitigating risk in the region. Several experts highlighted the distinctive nature of Great Plains wildfire events, characterized by their "high risk, short duration" nature, where fires ignite and spread rapidly, leaving little time to coordinate a response. Mitigation measures in the region may also be harder to maintain than mitigation in woody dominated landscapes. Unlike woody fuels in forested regions, grasses regrow to their full sizes seasonally, necessitating continuous mitigation in grassland ecosystems. Multiple respondents also emphasized the importance of fire as a natural process in grassland ecosystems.

Strategy Commentary

"We need to remind folks that defensible space is not just for the mountains. Outbuildings, windbreaks/shelter belts, and seasonal ag debris (corn shucks, tumble weeks) are all very flammable for 4-6 months of an average year in the Great Plains, sometimes longer during droughts. If it's not green, or white (covered with snow) it will burn.

That message needs to be reiterated to residents, we have to look no further than the December 30th, 2021 Marshall Fire in Colorado to see what wind and seasonal dead vegetation can do. In a matter of hours a wildland fire driven by winds of up to 100 mph burned over 1000 homes."

"Historically, the plains are used as a resource with little consequence due to wind farms, solar farms, and oil and gas sites being in remote areas. With increased demand for energy and increased urban sprawl, these two land uses are at odds.

Locally, we have seen numerous ignitions from solar farms. This has led to a requirement of noncombustible ground cover within 20ft of panels, especially as subdivisions are now being built within 1/4 mile of one of these solar farms."

Figure 48. Expert Strategy Commentary

General Commentary

"The Great Plains is likely one of the most difficult ecosystems in which to mitigate wildfire. Unlike the timbered west, a mitigation project to remove or reduce grass may be effective only until the next growing season has ended.

Further, because emergency response is so efficient at extinguishing undesirable fires, many people have the mistaken notion that wildfire is less dangerous on the prairie than in other locales.

It cannot be lost in this discussion that fire is a natural part of the ecosystem and is required for the ecosystem to function. Fire has burned the prairie since long before man walked here and man will not keep fire out. Our only choice is to choose when and how fires burn through prescribed burning, or let fire make the choice."

"Wildfire is one of the only natural disasters that society often times tries to eradicate, which is unreasonable. Instead, we should compare it to a blizzard, or any other natural event that we prepare for. Then when it does happen, it passes by with less impact.

Here in our area, we categorize most of our wildfires as "high risk, short duration" events that hit quickly without much warning, regardless of the time of year."

"The Great Plains historically [has] not been thought of as a fire prone area. Our fires are not months long like in a forest, but we can have just as much damage and destruction in a two day fire."

"Particularly in neighborhoods and subdivisions, creating defensible space >30' from structures becomes challenging because that is the neighbor or neighbor's neighbor's property.

Risk must be evaluated and mitigated at the community level to be effective and efficient. It is still critical to take individual actions to protect lives and structures, but community-level action becomes much more important."

Figure 49. Expert General Commentary

For full commentary, see Appendices 7-8.

Chapter IV Summary

The findings in this chapter paint a picture of the human and environmental factors influencing wildfire risk in Great Plains wildland-urban interface communities. Objective 1 revealed the most common combination of variables across the entire study site, the most likely layouts of each neighborhood, and identified building typologies. At the city scale, each neighborhood exhibits the same primary land use at any given point, while each other factor varies significantly by cluster. Neighborhood scale clusters are more specific, with varied landscape factors by neighborhood. Objective 2 identified wildfire mitigation strategies used successfully in other fire-prone regions.

Objective 3a revealed varied perceptions, preparedness, and limited awareness of wildfire risk in the study area. This objective identified statistically higher levels of aesthetic landscape preference and wildfire risk awareness, perception, and preparedness in rural residents versus urban populations. Objective 3a also found that respondents residing within the designated study site were less likely to have discussed wildfires or know where to find information about their risk than the survey area at large.

Objective 3b highlighted relative consensus for wildfire mitigation preferences in the region. Respondents overwhelmingly agreed that various forms of vegetation management were the most effective methods for reducing wildfire risk across each scale. Ease of maintenance was cited as the most critical additional factor to consider when developing mitigation strategies.

V Design Application

Figure 50. Smokehouse Creek Flames
Flames from the Smokehouse Creek Fire approach a firebreak in the Texas panhandle. Great Plains fuels present challenges to wildfire mitigation due to ease of ignition, rapid spread, and ecosystem transition.

Chapter V Overview

Chapter V utilizes the research findings from Research Questions a, b, and c to develop landscape typologies specific to the Great Plains and conceptually apply wildfire mitigation strategies to each. The chapter begins by introducing the typologies established across each of the three scales. These typologies are informed by the findings of Objective 1 and provide a generalized layout of built and natural features within the landscape.

Once the typologies are introduced, the chapter proceeds to the conceptual application of mitigation methods. Each strategy receives its own overview, which discusses expert feedback and describes the strategy implementation with text and visuals. This structured approach facilitates a thorough exploration of wildfire mitigation strategies tailored to the unique characteristics of Great Plains landscapes.

The City Scale Typology

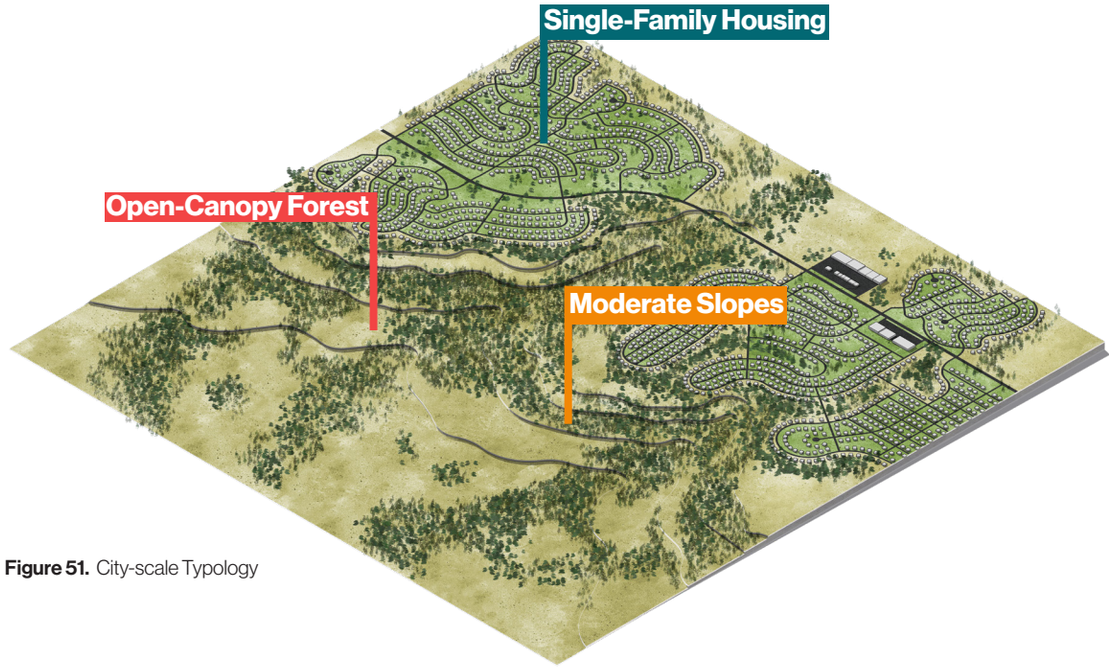


Figure 51. City-scale Typology

Overview

The city-scale typology (fig. 51) emulates the leading edge of development as urban areas expand into previously undeveloped, wildland vegetation. This typology is intentionally broad, drawing from the most common features of individual neighborhoods along the wildland-urban interface to construct a generalized arrangement of built and natural landscape features.

The city-scale typology consists of single-family detached housing in an urban form that falls between traditional and curvilinear. The overall density is low, with homes on large plots of land. Access is rated as moderate, due to vegetation in close proximity to roads and inadequate access to main thoroughfares. The city lies atop a hill, with adjacent slopes between 10 and 20 percent.

The adjacent open space is characterized by open canopy forest with moderate levels of eastern redcedar encroachment. The city is bordered by substantial ladder fuels and exhibits numerous woody fingers within developments, though eastern redcedar presence within these interior spaces is low.

Risk Profile

Natural Landscape

The city-scale typology lies adjacent to open canopy forest, which may facilitate easy fire ignition in grassy areas before allowing transition to intense crown fire in its trees. The moderate presence of eastern redcedar in this neighboring landscape may further intensify fires and carry embers downwind into the city from ladder fuels near the development.

The city's proximity to relatively steep slopes further heightens wildfire risk, as slope significantly influences fire behavior. Increased slope contributes to higher fire intensity and rate of spread, raising the likelihood that adjacent structures will sustain damage.

Woody fingers within the city form connections between interior development and exterior landscapes through channels of unbroken combustible vegetation. This interconnected vegetation may carry fire deep into developments, increasing overall community exposure.

Built Landscape

The built landscape of the city-scale typology contributes significantly to its risk. Moderate access and egress limit ease of movement, and the lower density may make the city more difficult to defend during wildfires. Woody fingers near carry fire inside the development, which could block roads and endanger residents and responders during evacuation or emergency response.

The low-density urban form of the city exposes a large perimeter to wildfire risk. This density makes mitigation more difficult because mitigation strategies must be spread over a large area, thus requiring more resources to implement and maintain. Denser developments are easier to defend due to their compact form, requiring fewer resources. However, the city's low density may also reduce fire spread within neighborhoods and decrease the likelihood of urban conflagration should structures ignite.

Neighborhood Typology 1: Mixed Suburban Fringe

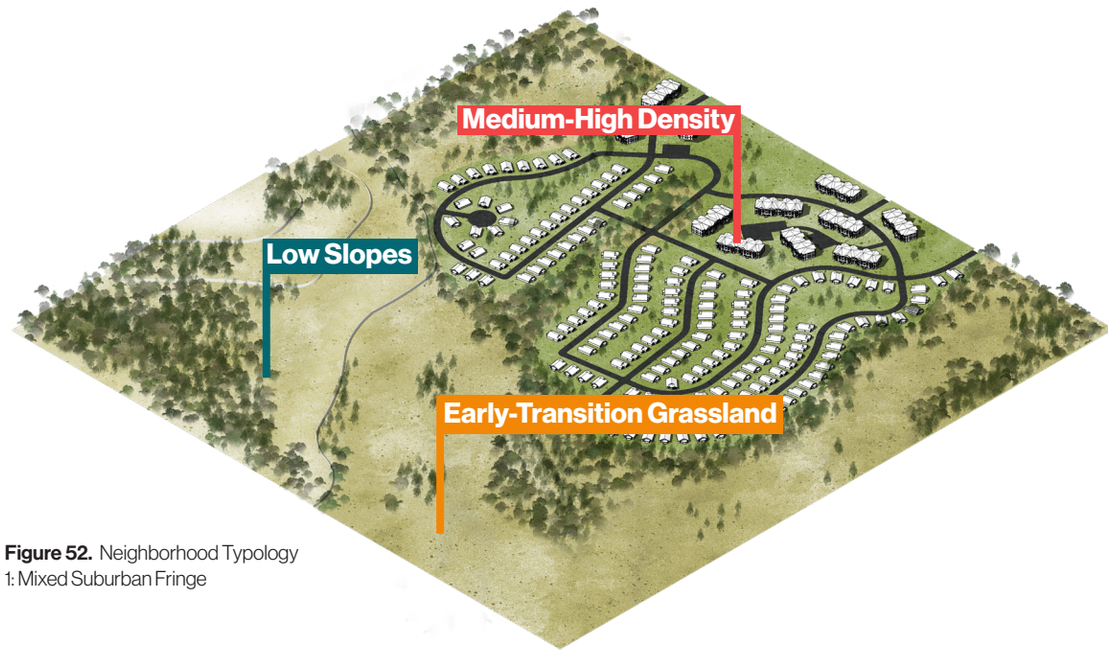


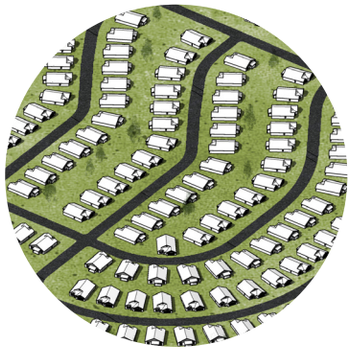
Figure 52. Neighborhood Typology 1: Mixed Suburban Fringe

Overview

The "Mixed Suburban Fringe" neighborhood is typified by a variety of land uses and housing types (fig. 52). Urban form is neither curvilinear nor traditional but falls between the two categories. Density is medium to high, due to single family homes on small lots and multi-family apartment buildings. Access is good, with multiple entry and exit points to the neighborhood.

This typology lies in a bottomland landscape position with low slopes, meaning topography rises on a single side. The surrounding vegetation is dominated by grasses and forbs interspersed with pockets of woody species, though eastern redcedar presence is low within these pockets. Significant ladder fuels are present, as are fingers of woody vegetation which stretch into the interior of the neighborhood.

Mixed Suburban Fringe is named as such because it lies on the outermost edge of suburban development. Like most neighborhoods that fall within the wildland-urban interface, this typology is being pressed against undeveloped, combustible land by development pressure and urban expansion.



Risk Profile

Natural Landscape

Mixed Suburban Fringe neighborhoods face significant exposure to wildfire from the adjacent savanna/early transition vegetation. Though eastern red cedar presence is low, the grasses that dominate the ecosystem ignite easily and carry fire quickly during high wind and extreme fire weather events.

The presence of many ladder fuels adjacent to the neighborhood may allow lower intensity grass fires to climb into tree canopies and loft embers deep into the neighborhood, endangering structures up to a mile away.

This typology also contains woody fingers, areas of interior vegetation that connect to larger areas of vegetation outside the neighborhood, which may carry flames inside of the development. Homes that are not directly exposed to wildfire threat from exterior wildlands may be exposed through these interior channels.

Built Landscape

The medium to high density development pattern of the Mixed Suburban Fringe typology may make it easier to mitigate wildfire threat and defend during wildfires events. However, it's density may also be its downfall. Denser neighborhoods can initially be easier to defend from wildfires due to less land area requiring fewer resources, though results can be catastrophic if structures ignite.

Small lot sizes and low structure separation can facilitate rapid structure-to-structure spread during extreme fire weather, which can quickly overwhelm fire crews and lead to an urban conflagration.

Neighborhood access and egress within the typology is good, with multiple neighborhood access points and minimal vegetation near roads. This means that residents and emergency responders have appropriate freedom of movement during wildfire events.

Neighborhood Typology 2: Intermix Estates

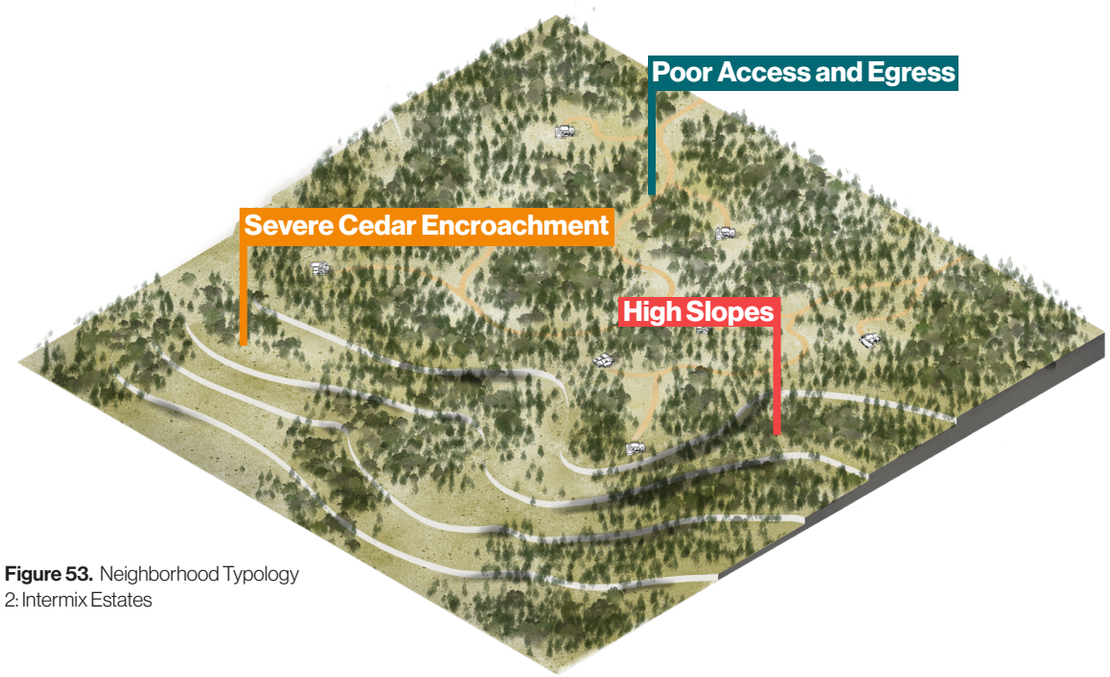


Figure 53. Neighborhood Typology 2: Intermix Estates

Overview

"The Intermix Estates" typology features large single-family detached homes on very large lots, characterized by an undefined urban form and winding roads (fig. 53). This lack of a clear layout contributes to the neighborhood's poor access and egress, which is exacerbated by the presence of dense vegetation immediately adjacent to roads.

The typology lies in the hilltop landscape position, with one side sloping downward from the development at slopes of 10 to 20 percent. The neighborhood's surrounding vegetation is composed of open-canopy forests or grassland in mid-transition to woody domination. This vegetation exhibits severe eastern redcedar encroachment, as do the many ladder fuels, and significant interior woody fingers. The neighborhood is nearly indistinguishable from the neighboring open space due to the prevalence of woody species.

Like many neighborhoods in the Great Plains, Intermix Estates neighborhood likely has not experienced regular prescribed burns. This has allowed eastern redcedar and other woody species to flourish. Intermix Estates is named for its position in the WUI "intermix" and the large, estate style homes dotting the landscape.

Risk Profile

Natural Landscape

Intermix Estates lies in a landscape that has nearly fully transitioned to eastern redcedar forest. The prevalence of eastern redcedar in this neighborhood poses an elevated risk of high-intensity, fast moving fires.

In contrast, the neighboring open-canopy forest exhibits a lower degree of eastern redcedar encroachment compared to Intermix Estates. However, the combination of grasses and woody species in this landscape may create conditions conducive to easy fire ignition and subsequent spread into the densely forested neighborhood.

Similarly, the neighborhood's close proximity to steep slopes increases its susceptibility to wildfires. Slopes accelerate rates of fire spread and intensity, meaning structures adjacent to these slopes are at a greater risk of damage from wildfire events.

Built Landscape

The very low density and lack of defined urban form of Intermix Estates pose significant challenges for firefighters during wildfire events. While the likelihood of structure-to-structure spread is low, the fragmented development pattern makes defending structures challenging. Rather than defending a single perimeter around a neighborhood, firefighters must defend each home separately which can quickly exhaust resources.

Additionally, the undefined layout of the development has a substantial impact on access and egress. Poor sightlines around corners, limited connections to major roads, and vegetation in close proximity to exit points may create challenges for evacuating residents. Firefighters may also find the neighborhood hard to access during fires.

Neighborhood Typology 3: The American Dream

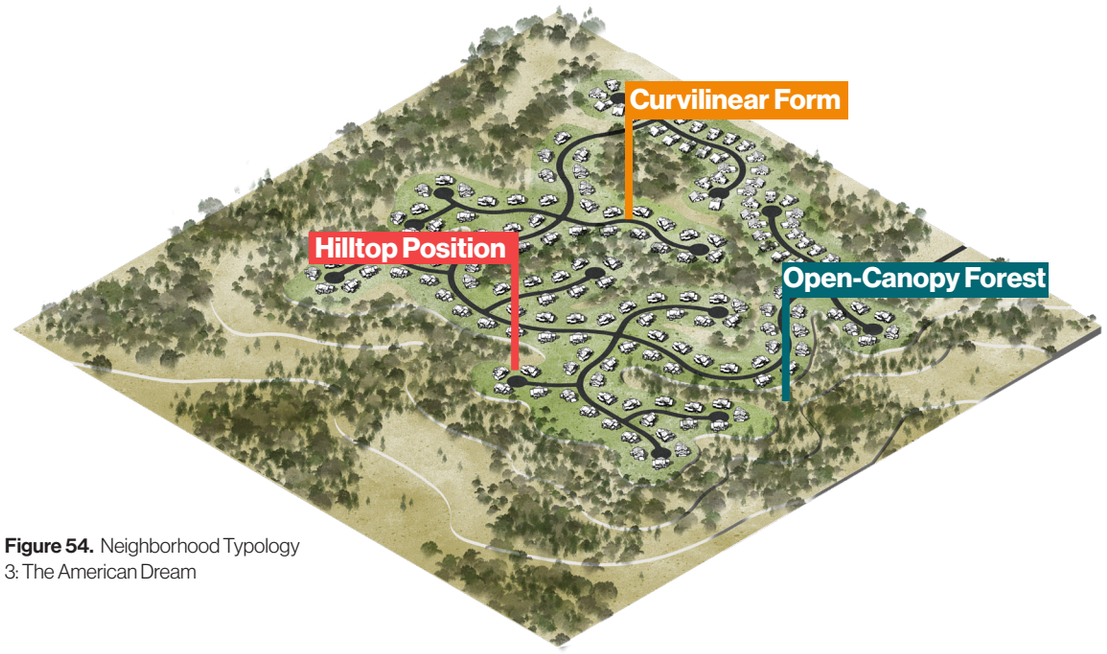


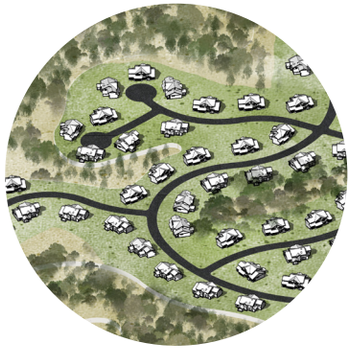
Figure 54. Neighborhood Typology 3: The American Dream

Overview

"The American Dream" typology is characterized by a mix of single-family detached and single-family attached housing at medium to low density (fig. 54). This neighborhood's winding, curvilinear form and the presence of considerable vegetation near roadways reduces safe access and egress for emergency personnel and evacuations. These winding roads result in nearly every home having direct exposure to combustible vegetation.

Situated in the hilltop landscape position, The American Dream occupies a flat area of land atop downward slopes between 0 and 10 percent. The vegetation adjacent to the development is composed of open-canopy forest interspersed with pockets of tallgrass prairie. This landscape exhibits moderate eastern redcedar encroachment, and homes are adjacent to many ladder fuels. The neighborhood also has numerous woody fingers with moderate levels of woody encroachment.

"The American Dream" is named for the prevalence of large homes on large lots in an idyllic suburban setting. The neighborhood's winding form is common among many new suburban developments.



Risk Profile

Natural Landscape

The proximity of The American Dream to the open-canopy forest landscape type increases the neighborhood's vulnerability to fast-spreading, high-intensity fires. The significant presence of both grasses and woody species means that fires can easily ignite, spread, and intensify in ladder fuels adjacent to homes.

While the slopes adjacent to The American Dream are relatively low; even modest slopes can have significant impact on fire behavior. Homes positioned on the upper side of slopes, directly exposed to combustible vegetation, may encounter elevated rates of fire spread and heightened fire intensity.

The presence of eastern redcedar, both within and outside the development, adds another layer of risk. Cedar presence in open space may allow lower intensity grass fires to transition to violent crown fires.

Built Landscape

While the urban form of The American Dream offers homeowners a sense of separation from their neighbors, the sinuous nature of its roads creates multiple fingers of woody vegetation. These features could act as pathways for flames during wildfire events. Additionally, the curvilinear layout of the arrangement of the neighborhood reduces access for emergency personnel and may make evacuation more difficult.

Like Mixed Suburban Fringe, The American Dream's form could significantly influence structure survival during wildland fires. The dispersed placement of homes within the neighborhood might pose initial challenges for firefighters to as resources could be stretched thin across the area. However, large structural separation means structure-to-structure spread is less likely.

Structure Typology 1: Single-Family

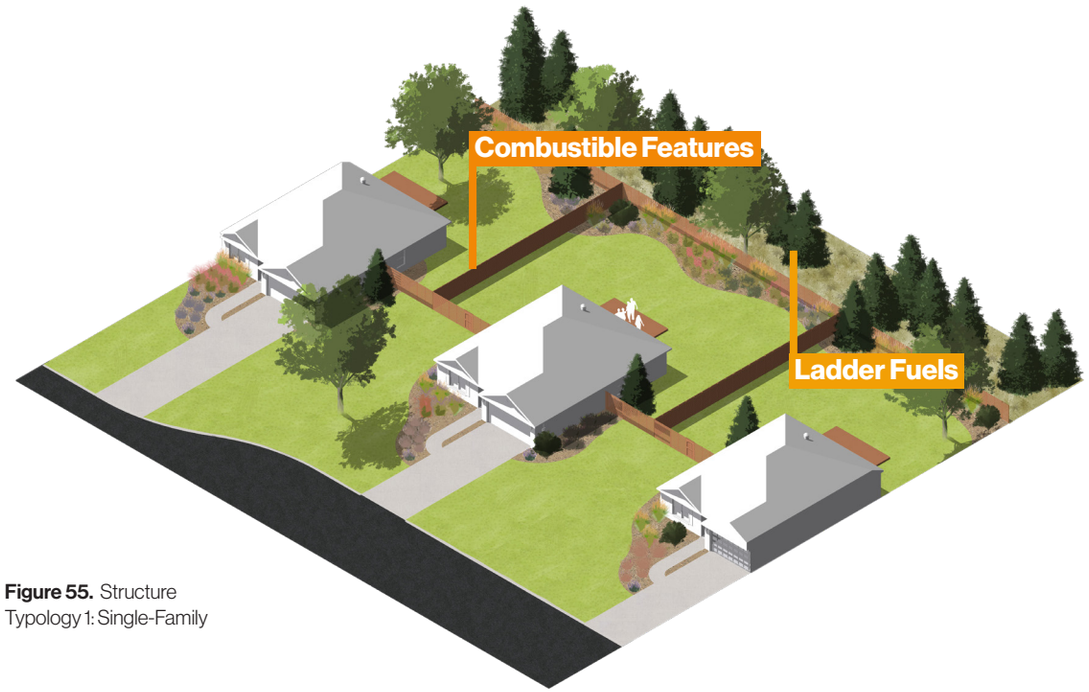


Figure 55. Structure Typology 1: Single-Family

The single-family typology is composed of a single-family home on a large lot (fig. 55). This home lies adjacent to wildland vegetation in the rear and has additional development on both sides and front. The site around the structure contains numerous landscape elements, including ornamental plant beds, a wooden deck, and a wooden perimeter fence around the backyard.

Each of these elements contributes to the home's wildfire risk. The vegetation to the rear has considerable cedar encroachment mixed with grasses, allowing wildfire to easily ignite before intensifying in ladder fuels. Vegetation and landscape material adjacent to the structure may trap embers and ignite nearby walls. Wooden landscape features, such as decking and fencing, may bridge combustible vegetation and the home.

Due to the suburban setting of this home, its residents are unlikely to have taken previous mitigation actions and may be unaware of their high wildfire risk. However, this doesn't mean that people don't want to make changes. Despite a lack of wildfire risk awareness among many Great Plains residents, most are willing to make changes to reduce the chance of wildfire affecting their homes or properties.

Structure Typology 2: Multi-Family

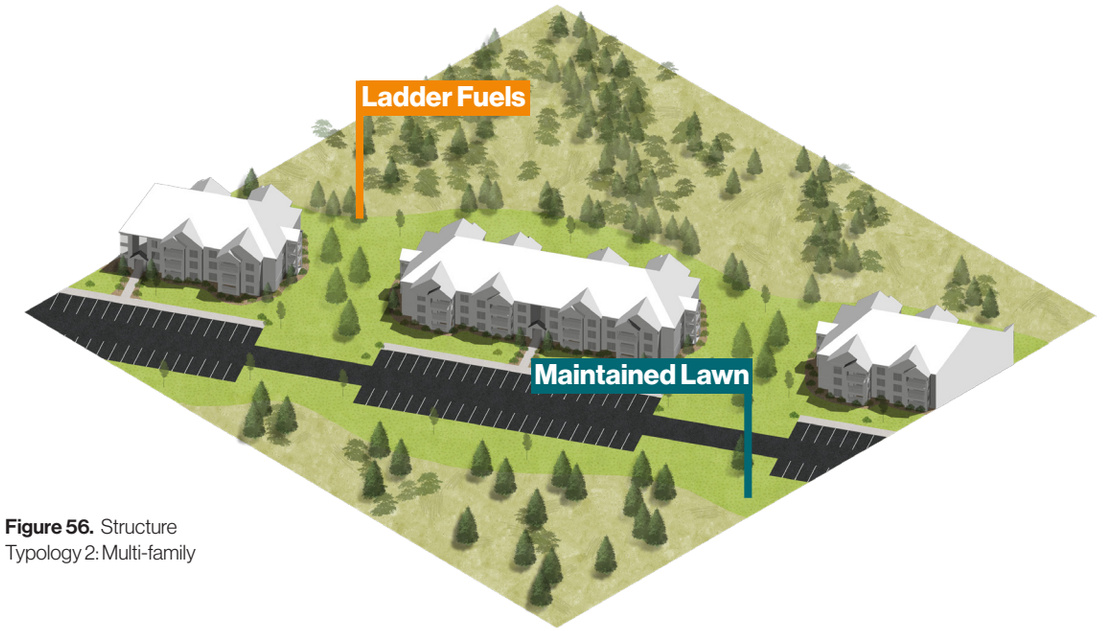


Figure 56. Structure Typology 2: Multi-family

The multi-family typology represents a typical apartment building found within Neighborhood Typology 1 (Fig. 56). This building houses numerous residents and contains multiple individual housing units. Due to the population density in multi-family settings and the danger structure ignition poses to dozens of people and their homes, mitigating wildfire risk is extraordinarily important.

The multi-family typology is set adjacent to open-canopy woodland, where tracts of grass are interspersed with large swaths of trees. This landscape has considerable eastern redcedar encroachment and many ladder fuels which can intensify fires. However, the large maintained lawn that surrounds the building provides considerable protection from surface fire.

Though the multi-family typology has fewer landscape features which may contribute to increased wildfire risk, it has challenges unique to multi-family settings. Since residents have little to no control over outdoor spaces adjacent to their homes, tenants must rely on their landlords to perform mitigation actions. Despite this lack of ability to protect themselves, residents likely support mitigation near their homes.

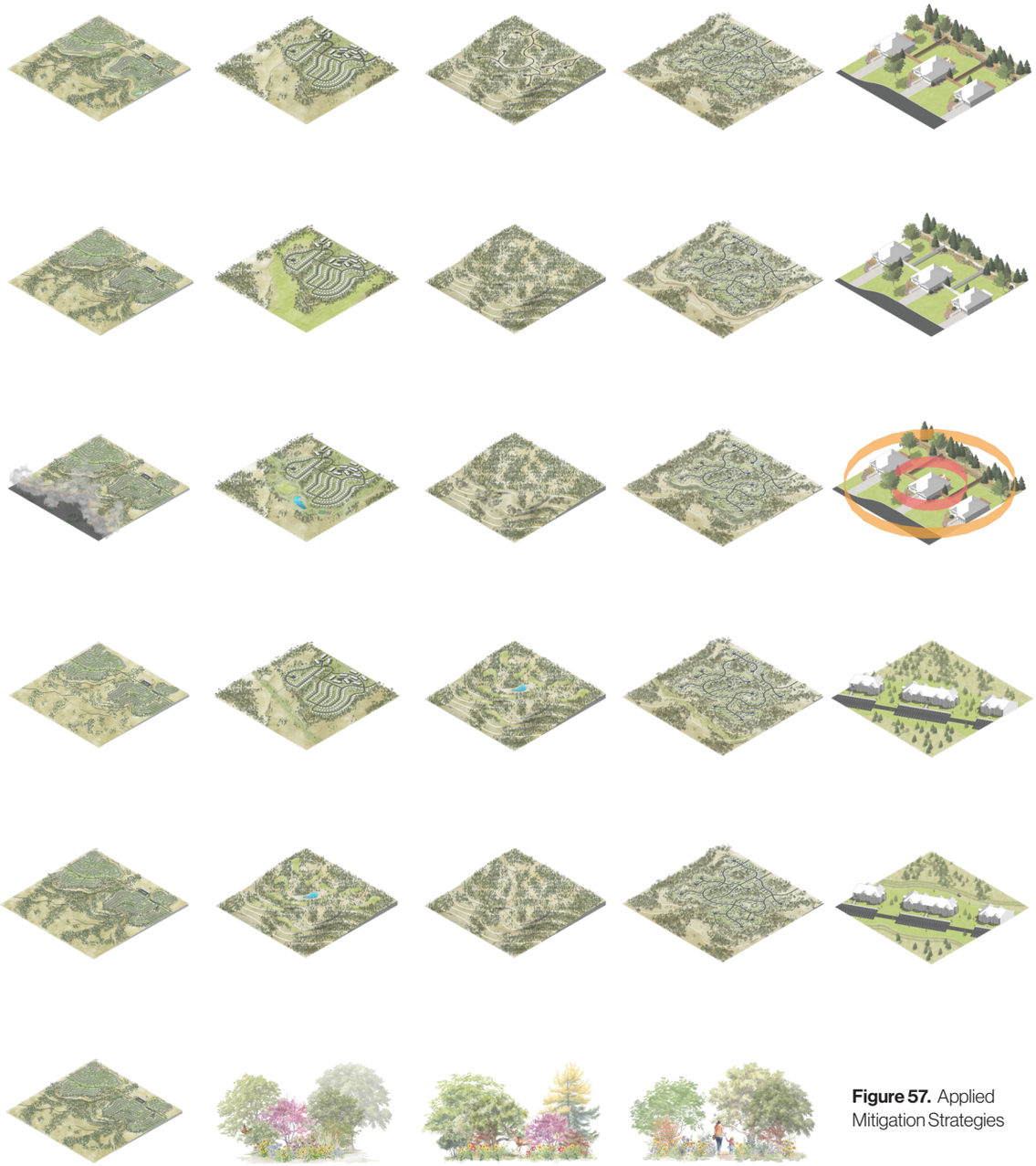


Figure 57. Applied Mitigation Strategies

Strategy Application

Introduction

The following section applies the top five wildfire mitigation strategies to the typologies identified in the previous section. These strategies, as selected by wildfire experts from across the Great Plains, represent the most effective methods of mitigating wildfire risk at each scale (fig. 57). Each strategy includes an overview of the technique, the challenges involved in strategy implementation and effectiveness, and additional considerations experts noted are most important when implementing strategies at each scale.

Though the following strategies are presented as standalone techniques, multiple strategies should be implemented across scales for the most effective mitigation impact. Simultaneous, broad sweeping mitigation at the city, neighborhood, and structure levels ensures redundancy in the mitigation process. While these methods are each useful by themselves, they are most effective when considered as a part of a mitigation package.

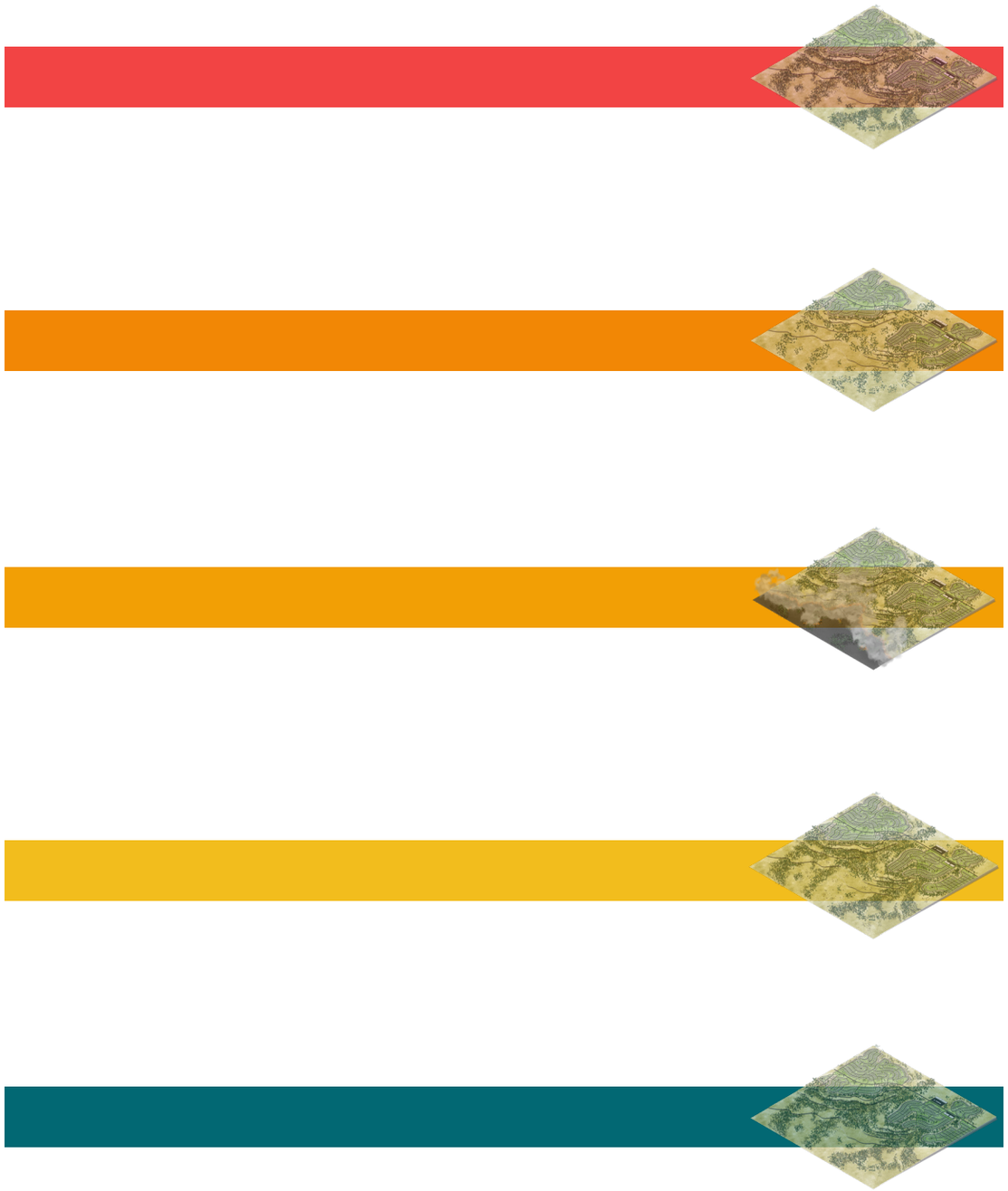


Figure 58. City-scale Mitigation Strategies

The City Scale

Introduction

Wildfire mitigation at the city scale often focuses on large-scale vegetation management, land use guidelines, and development restrictions (fig. 58). These mitigation strategies aim to reduce the likelihood of wildfires occurring near cities and decreasing their impacts if they do. Vegetation management at this scale disrupts the connectivity of combustible plant material and aims to reduce the presence of highly combustible invasive or nuisance species.

Land use guidelines and development restrictions create a framework for future city growth with considerations for wildfire mitigation and often prohibit new construction from occurring in areas at high risk of wildfires, such as slopes, ridges, and areas adjacent to large tracts of wildland vegetation (Gude, Rasker, and van den Noort 2008).

In Great Plains landscapes, city-scale mitigation strategies should focus on intercepting wildfires before they reach interface communities. The easy ignition and high spread rate of wind-driven grass fires give communities little time to respond to the threat, meaning mitigation that halts wildfire spread is critical to protect exposed cities. Experts noted that vegetation management is the most effective method to achieve mitigation at this scale.

Expert Preferred Strategies

- Nuisance Species Control
- Selective Thinning
- Prescribed Burning
- Targeted Grazing
- Cutting Firebreaks*
- Improved Conditions Monitoring

Additional Considerations

- Ease of Maintenance
- Nuisance Species Control
- Ecological Function
- Public Access
- Aesthetics

*Shown in neighborhood scale

Invasive/nuisance species control

Overview

Managing invasive and nuisance species is the most impactful measure communities can take to reduce their wildfire risk according to wildfire experts (fig. 59). These species are often less fire adapted than their desirable counterparts, meaning they ignite easily and burn with high intensity. These undesirable species are typically found in areas where prescribed fire has been excluded for long periods of time which, unfortunately, are often in close proximity to homes and development.

In the Great Plains, the primary nuisance species is eastern redcedar. Though eastern redcedar is native to much of the region, it has grown well beyond its typical habitat. Under historic fire regimes, eastern redcedar would have been restricted to areas that burned less frequently such as valleys and riparian corridors. However, the long term absence of fire has allowed eastern redcedar to colonize vast tracts of open prairie. The increased presence of eastern redcedar creates challenges for mitigation in communities across the region. Though young eastern redcedar are relatively easy to manage with regular mowing or seasonal burns, established plants must be removed manually or with high intensity prescribed fire (Ulrish 2019). Since removal can be difficult, the best way to mitigate risk from eastern redcedar is to prevent its establishment altogether (Ratajczak et al. 2016).

Many of the following strategies focus on the management of eastern redcedar across the Great Plains. Though this single species is not solely responsible for increased wildfire risk in the region, it may be the greatest contributing factor and the easiest variable to manage. While lengthened fire seasons and volatile fire weather are impossible to control, risk from eastern redcedar can be mitigated with traditional land management methods.

Additional Considerations

Ease of Maintenance

Managing eastern redcedar is straightforward when performed at regular intervals. However, considerably more effort is required to convert colonized prairie back into grassland. Once this is done, regular burns or mechanical disturbance are required to keep eastern redcedar from reestablishing.

Ecological Function

Removing eastern redcedar reduces competition for desirable prairie species and increases groundwater availability. Similarly, eastern redcedar removal can vastly improve wildlife habitat.

Aesthetics/Visual Quality

Eastern redcedar can be a visually appealing species when planted intentionally and maintained. However, eastern redcedar dominated woodlands become overgrown and thick with vegetation which may reduce the visual quality of the landscape.

Challenges

Eastern redcedar and other woody species are difficult and costly to remove once established.

Landowners and residents may appreciate the aesthetic value of eastern redcedar woodlands despite the increased wildfire risk.

Eastern redcedar is widespread and well-established across the region. Large-scale management projects will require immense coordination among private landowners and governments.

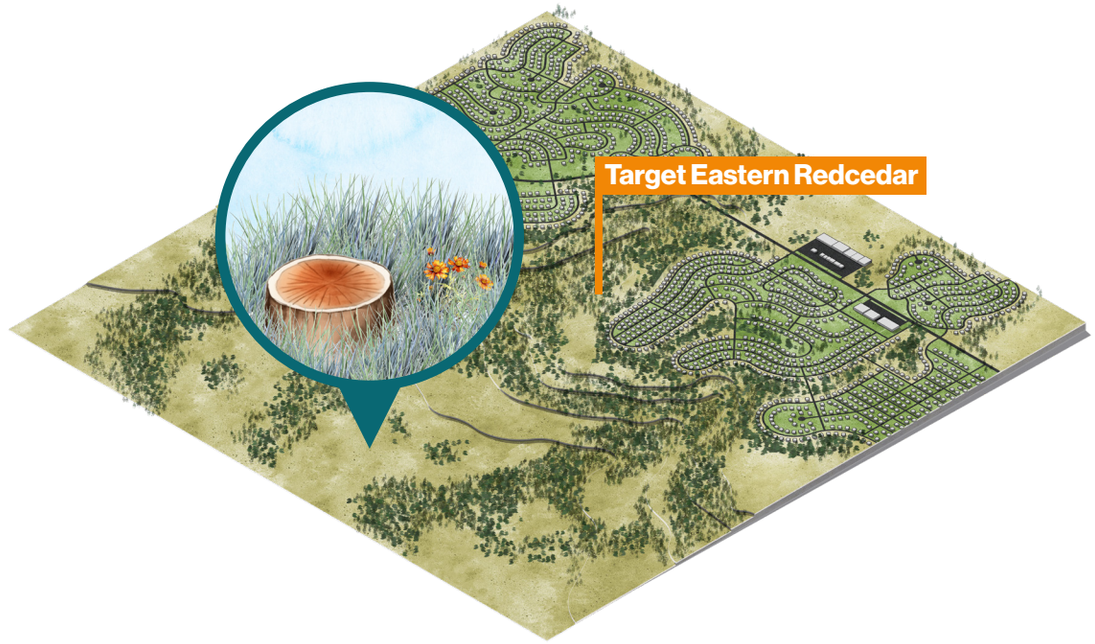


Figure 59. City-scale Invasive/Nuisance Species Control
Eastern redcedar will not resprout from stumps after removal, meaning trees can be removed with a simple cut.

Selective thinning

Overview

Selective thinning aims to reduce the amount of combustible biomass available during wildfires by removing trees and thinning forests (fig. 60). Typically, thinning does not focus on removing a specific species but rather a general "opening-up" of a forest ecosystem (Westover 2021). In the case of Great Plains ecosystems, thinning likely involves specifically targeting problem species such as eastern redcedar. Eastern redcedar forms large clumping stands that can burn intensely during wildfires. Thinning also has ecological benefits, such as improving wildlife habitat, forest health, and soil quality.

The city typology borders an open canopy forest ecosystem in the middle stages of woodland transition, where pockets of tallgrass prairie lie among large stands of woody species-- including significant stands of eastern redcedar. The mixture of grasses and eastern redcedar may allow fires to ignite and spread quickly, then transition to intense crown fires before reaching the city's edge.

Eastern redcedar near cities can be thinned to mitigate this risk and reduce fire spread and intensity, though thinning requires considerable time and money to achieve meaningful results. The Nebraska Forest Service estimates that mechanical thinning redcedar costs range from $120 to $1000 per acre, depending on density, ecosystem, and topography (Nebraska Conservation Roundtable 2016).

Additional Considerations

Ease of Maintenance

Eastern redcedar does not resprout from the stump once its foliage has been removed, meaning mechanical removal is straightforward, though considerable effort is required to contain its spread. Regular burning or mowing is needed to ensure seeds don't sprout where trees were removed.

Ecological Function

Though eastern redcedar is native to the Great Plains, its overabundance is caused by altering natural processes. Removing cedar promotes biodiversity and creates habitat for native species.

Aesthetics/Visual Quality

Removing eastern redcedar may drastically change the visual quality of many Great Plains landscapes. However, thinning may also restore desirable views and allow showy native species to grow where cedar once dominated.

Challenges

Selective thinning of eastern redcedar requires continual work due to the speed with which they spread, grow, and establish.

Thinning could significantly alter the landscape's aesthetic character, which may be undesirable to some residents.

Selective thinning is most effective when followed by prescribed fire, meaning it is often a multistep process.

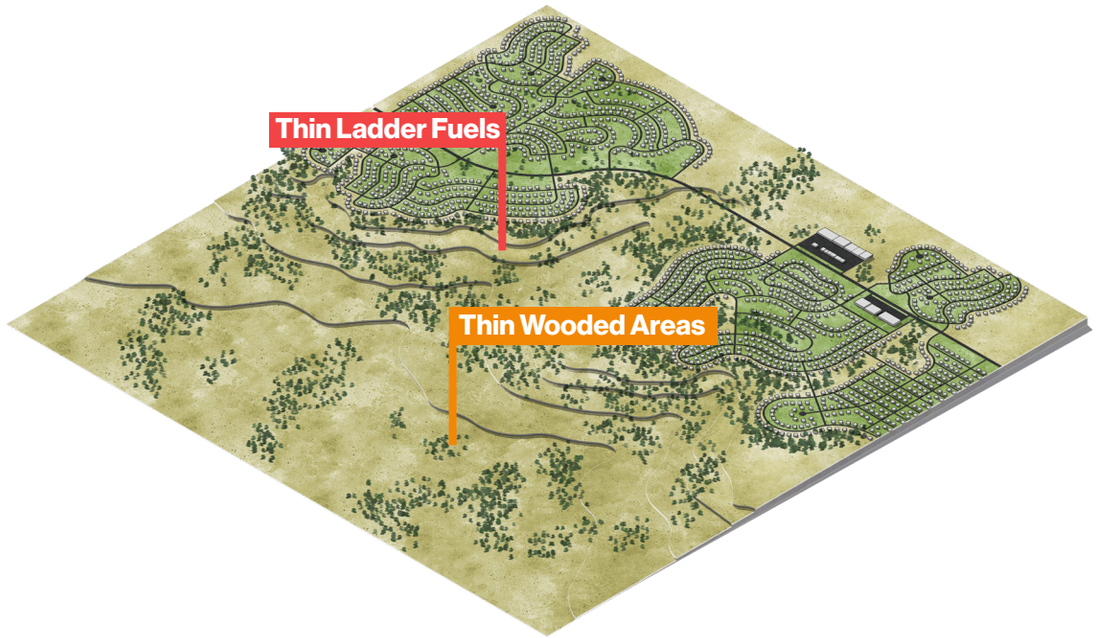


Figure 60. City-scale Selective Thinning
Eastern redcedar removal costs in the Southern Plains are often much higher than the Northern Plains due to the increased presence of the species (Ulrish 2019).

Prescribed burning

Overview

Burning has been used to manage landscapes across the Great Plains for thousands of years. However, the use of fire has become increasingly rare in the region due to concerns about safety, air pollution, and liability (Harr et al. 2014; Little 2020). The lack of fire disrupts a crucial process in maintaining balance within the ecosystem and allows undesirable species to flourish in its absence. Species poorly adapted to fire are no longer restricted to areas that rarely burn and have taken hold across the Great Plains (Missouri Department of Conservation n.d.).

Prescribed fire is likely one of the most efficient ways to reduce wildfire risk in the Great Plains, but it is not a magic bullet. Its effectiveness largely depends on the degree of eastern redcedar encroachment and the level of plant establishment. Burning in established eastern redcedar-dominated woodlands could risk spreading fire beyond intended boundaries. Ideally, prescribed fire must occur before eastern redcedars reach a 1-inch stem diameter at 4.5 feet above ground level and occupy less than 10% of the land area. Once encroachment crosses this threshold, prescribed burning becomes more complex and large trees must be removed prior to burning. Additionally, prescribed fire may be unsuitable for clearing nuisance species from woodlands, where intense crown fire in redcedar can kill desirable species (Nebraska Conservation Roundtable 2016).

Moreover, prescribed fire requires careful planning and coordination with neighboring landowners and favorable weather conditions to ensure a safe and successful burn. Despite its limitations, prescribed fire remains an effective method to manage wildfire risk in many areas across the region (fig. 61).

Additional Considerations

Ecological Function

Fire is an essential ecological process in many regions of the Great Plains. Reintroducing fire at regular intervals promotes ecological health by emulating naturally occurring fires that were once allowed to burn across the region.

Invasive/Nuisance Species Control

Prescribed fire effectively controls non-fire adapted species when they are less established. Both eastern redcedar, which is common in grasslands, and Japanese honeysuckle, common in woodland understories, are effectively controlled with the regular application of prescribed fire (Munger 2002).

Aesthetics/Visual Quality

Grass fires are dynamic processes that are a visual experience in and of themselves, but their visual impact extends beyond the immediate burn. Fires can be timed to select for specific kinds of plants by encouraging the growth of grasses or forbs leading to visual interest in the landscape (Towne and Craine 2016).

Challenges

Prescribed fire may be viewed negatively by significant portions of the population and landowners may be hesitant to burn near developed areas.

Prescribed burning is highly weather-dependent, and its use requires careful coordination and preparation.

Overuse of prescribed fire can lead to loss of biodiversity and establishment of monocultural landscapes, potentially increasing fire risk.

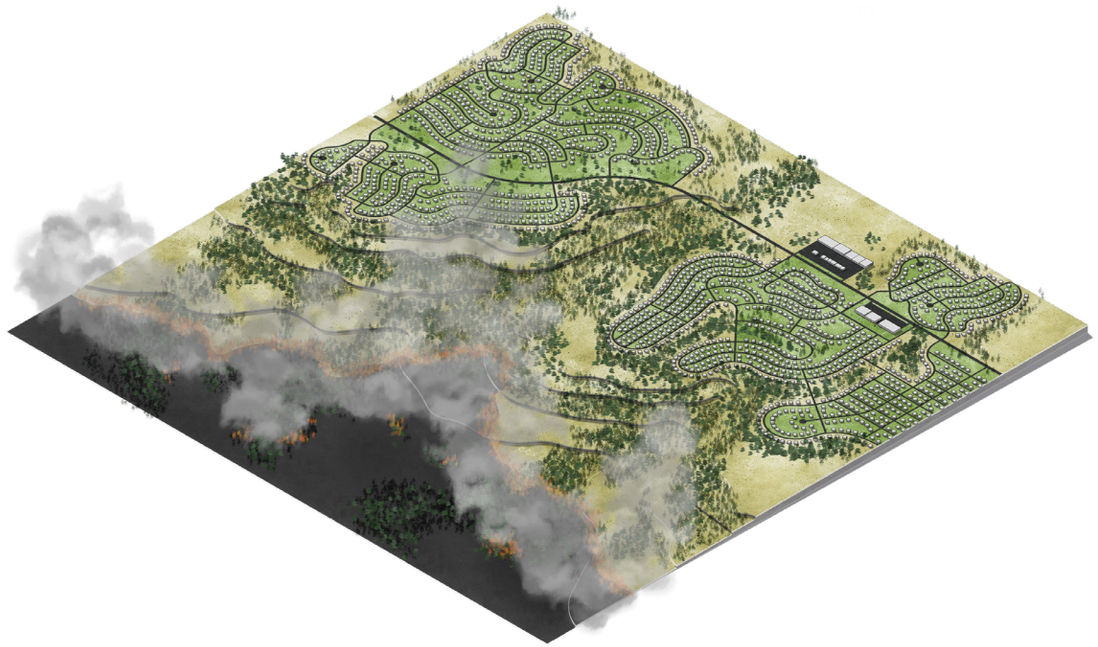


Figure 61. City-scale Prescribed Burning
Prescribed burns must consider weather conditions and require careful coordination among landowners, local governments, and fire agencies.

Targeted livestock grazing

Overview

Targeted livestock grazing to reduce fuel loads has recently gained popularity in fire-prone regions. Cattle, sheep, or goats- confined to a targeted area- consume combustible vegetation and reduce the availability of fuels during wildfires. This grazing can significantly lower fuel loads and create effective, miles-long, firebreaks. Grazing is most beneficial for managing fine fuels, such as grasses, which are prevalent across the Great Plains (fig. 62). Livestock graze these fuels to a specified length before relocation to the next targeted area (USDA Agricultural Research Service 2020).

While sheep and cattle effectively reduce herbaceous fuels, they show limited effectiveness in controlling woody species due to their inability to digest toxins in woody plant tissue. However, goats can digest monoterpenes found in eastern redcedar, making them particularly effective in controlling young trees. Despite its potential year-round use, targeted grazing typically occurs in the spring when grasses are most palatable and nutritious to grazing livestock. This timing maximizes wildfire risk reduction and creates value for ranchers who receive increased animal production in exchange for their animals' work reducing fuel loads (Taylor, n.d.).

Targeted grazing has been implemented in both urban and rural areas across the West, with demonstrated success in reducing wildfire spread (Hupp and Sukach 2021; Rao 2020; USDA Agricultural Research Service 2020). Additionally, the practice may receive greater support from residents of nearby developments than wildfire mitigation methods involving mechanical, prescribed fire, or chemical means of vegetation management.

Additional Considerations

Ecological Function

Targeted grazing produces fewer emissions than prescribed burns, less disturbance than mechanical vegetation removal, and less pollution than chemical vegetation management (Taylor n.d.).

Invasive/Nuisance Species Control

Grazing is used to control invasive annual grasses, such as cheatgrass and medusahead, in the western United States. Though invasive grasses are less prevalent in the Great Plains, goats may be effective at controlling the spread of eastern redcedar in grasslands (Taylor n.d.).

Ease of Maintenance

Though targeted grazing requires yearly application, its implementation is fairly straightforward. Land managers identify areas to target and ranchers move their livestock to the specified location. Targeted grazing typically occurs over a month before livestock are moved elsewhere (USDA Agricultural Research Service 2020).

Challenges

Overgrazing can damage ecosystems and lead to the establishment of monocultures and invasive species.

Targeted grazing is ineffective in established timber and slash, where livestock cannot eat large trees.

Targeted grazing requires yearly prescription, and the availability and distribution of forage is weather dependent.

Figure 62. City-scale Livestock Grazing

Targeted grazing is limited in its effectiveness when stands of eastern redcedar are already established. However, some species are capable of consuming small trees.

Improved conditions monitoring

Overview

Wildfire conditions monitoring is crucial for professionals and communities to assess and predict wildfire risk. This information is collected with a variety of instruments which monitor variables contributing to the likelihood of wildfire ignition and spread. These instruments include remote weather stations, which gather data on atmospheric conditions and fuel moisture levels; meteorological models which predict favorable fire weather conditions; and aerial and satellite imagery which can quantify fuel characteristics. These findings are frequently confirmed through the use of ground-based observations by wildfire experts (National Park Service n.d.; Heath 2023; National Oceanic and Atmospheric Administration n.d.).

Though these methods are effective in monitoring and predicting weather favorable for wildfire, they can be improved by expanding current systems employing emerging technologies (fig. 63). Remote weather stations can be placed more frequently to provide greater understanding of localized conditions. Additional sensors, such as soil moisture probes, can be added throughout the landscape to provide a high-fidelity assessment of fuel loads.

Emerging technologies, such as drones and artificial intelligence, can augment existing systems and spur future improvements. Drones allow for fast, efficient, and cost effective observations of large landscape areas when manned aircraft are unavailable. Drones may also be fitted with cameras and sensors capable of analyzing microclimatic conditions and identifying possible sources of ignition. Finally, artificial intelligence and machine learning can be employed to aggregate and interpret data from multiple instruments. Predictive machine learning models may be able to identify high risk locations and conditions with extreme accuracy.

Additional Considerations

Ease of Maintenance

As with any technology, the instruments used to monitor conditions require routine updates and maintenance. However, internet-based systems may be able to self-report malfunctions and perform updates automatically.

Ecological Function

Data collection tools used to monitor fire conditions may be useful in monitoring general ecosystem health. Increased weather station coverage, soil moisture probes, and aerial imagery could aid in ecosystem research.

Aesthetics/Visual Quality

Conditions monitoring tools have minimal impact to the aesthetic value of the landscape. Emerging technologies such as drones and probes reduce the need for significant permanent infrastructure.

Challenges

New technology is often expensive to implement and communities may be wary of investing in technology that is not already widely used.

Internet-based systems may require significant infrastructure to move, store, and process data, though existing cellular networks may be suitable.

Specialists must be trained to operate and maintain high-tech data collection instruments.

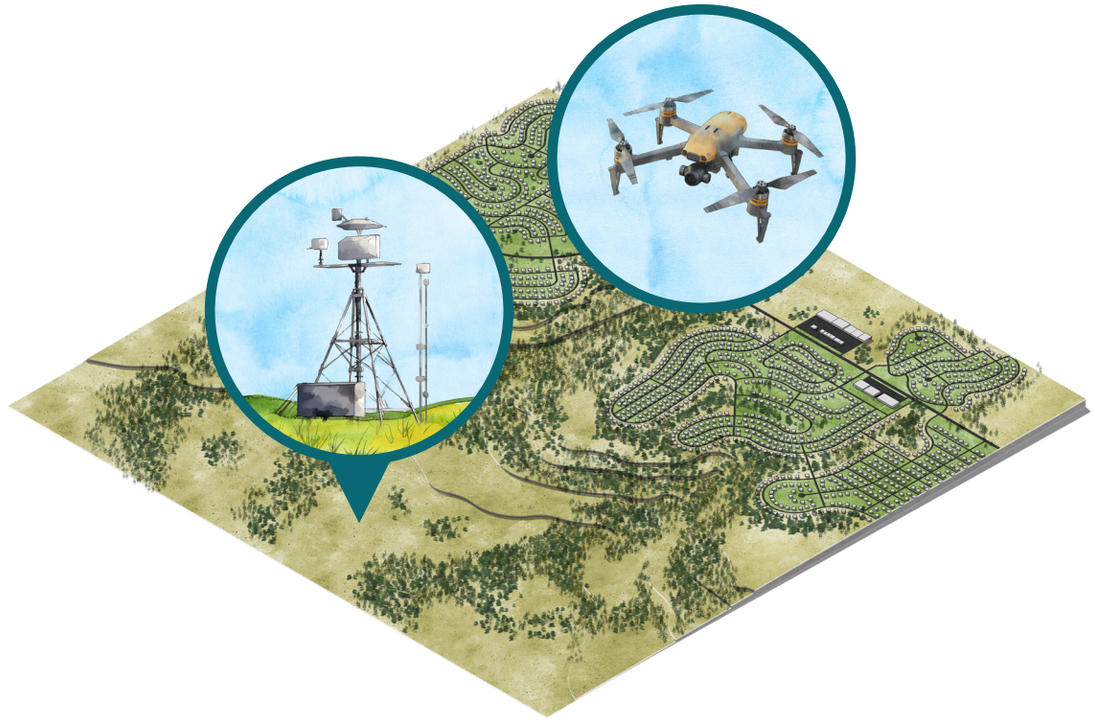


Figure 63. City-scale Improved Conditions Monitoring

Emerging technologies, such as drones and artificial intelligence, can be integrated into wildfire conditions monitoring to augment data from weather stations and climate models.

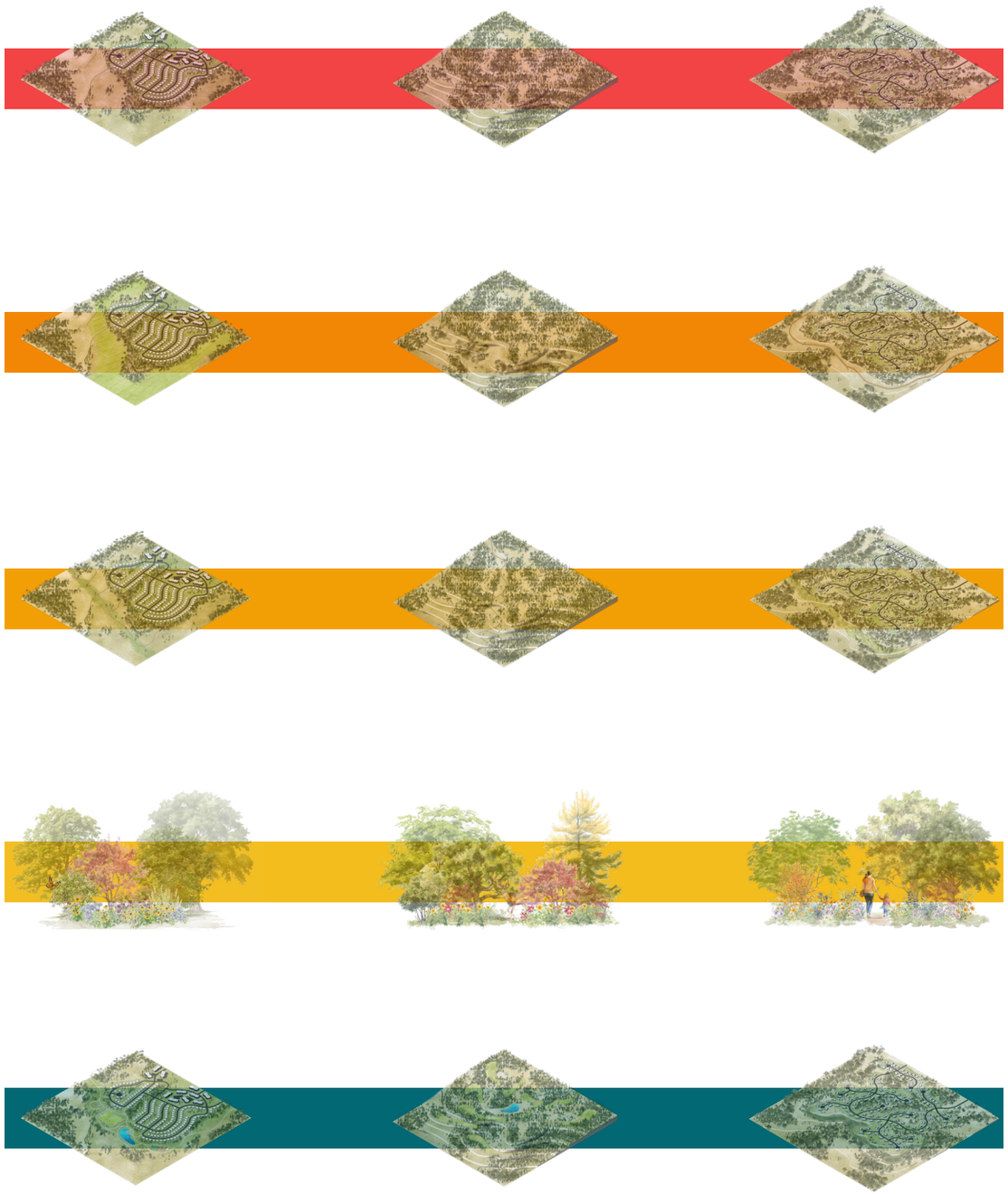


Figure 64. Neighborhood-scale Strategy Application

The Neighborhood Scale

Introduction

Wildfire mitigation at the neighborhood scale attempts to reduce wildfire exposure to entire developments (fig. 64). This is often achieved through development guidelines or restrictions, landscape and urban design methods, and vegetation management on adjacent lands. Interior vegetation and urban form also play a significant role in wildfire risk at this scale and should be considered when mitigating risk.

Notably, risk mitigation at the neighborhood scale is critical in dense developments where homes are located on small lots. The low separation between structures allows fires to spread easily and quickly once buildings ignite, which may overwhelm emergency responders (FEMA Mitigation Assessment Team 2023a). Though denser developments can be more easily defended from initial ignition, consequences are high once ignition occurs, making neighborhood-scale mitigation essential. The necessity of wildfire mitigation in grassland WUI neighborhoods was demonstrated by the Marshall Fire, during which over 1000 homes were destroyed (FEMA Mitigation Assessment Team 2023b).

Like all scales, wildfire risk mitigation is achieved most effectively when neighborhoods are designed with wildfires in mind. However, existing neighborhoods can considerably reduce risk with modifications to the built and natural environment.

Expert Preferred Strategies

- Access/Egress
- Selective Thinning*
- Nuisance Species Control*
- Cutting Firebreaks
- Utility Easement Clearance
- Landscape Planting Standards
- Managed Greenbelts

Additional Considerations

- Ease of Maintenance
- Aesthetics
- Productive Landscapes
- Nuisance Species Control
- Public Access

*Shown in city scale

Neighborhood scale mitigation strategies

Access and Egress

Strategy Overview

Sufficient access and egress routes are critical for residents and emergency responders in the event of a wildfire. Residents must be able to evacuate efficiently, and emergency personnel should have easy access for emergency response. The absence of adequate access and egress paths can heighten the risk to individuals and structures. Debris obstructing roadways, insufficient traffic capacity, poor road design, and flammable vegetation near roads can all impede the ability to enter or exit a neighborhood (Susskin 2023; FEMA Mitigation Assessment Team 2023a).

In the West's fire-prone regions, access and egress regulations have recently gained traction (Fire Safe Marin 2021b). These regulations frequently mandate the minimum clearance of vegetation along roadways, road surfacing, consideration for fire apparatus maneuvers, road markings, and address signage. Access and egress requirements are included in the International Wildland-Urban Interface Code; however, governments must adopt and adapt them to local conditions(International Code Council 2021) .

Ensuring that communities have adequate ability to escape harm is especially important in the Great Plains, where fires ignite and spread quickly. Unlike many fires in the timber-dominated western United States, grass fires often give residents little to no time to prepare for evacuation. Wind-driven grass fires may spread hundreds of yards in just a few minutes, requiring Great Plains communities to react and move quickly. Emergency personnel must be able to rapidly position themselves to defend structures and provide aid to those who need it.

The following examples use typical Great Plains wildland-urban interface layouts to demonstrate the application of strategies to improve access and egress.

Neighborhood Typology 1

Access and Egress

Higher Volume Roads

Access and egress to Typology 1 is good. The neighborhood contains multiple access points, little combustible vegetation near roads, and considerable space for maneuvering emergency equipment. However, the medium to high-density development within the neighborhood may overwhelm minor roads during emergency evacuation and response.

During emergencies requiring evacuation, smaller roads may be quickly overwhelmed with levels of traffic well beyond their intended capacity. This is especially true in neighborhoods with denser development patterns, where many people occupy a relatively small space. The flood of vehicles that occurs when everyone evacuates simultaneously can lead to traffic jams, reducing people's ability to escape and impeding emergency response access (FEMA Mitigation Assessment Team 2023a).

The likelihood of traffic jams occurring during emergency evacuations can be reduced by designing streets and transportation infrastructure capable of handling large volumes of vehicles, providing multiple exits from neighborhoods, and improving wayfinding. Though Typology 1 already has multiple access points, streets near apartment buildings can be widened to accommodate large traffic volumes (fig. 66).

Since widened, higher volume routes are often unpopular among residents and dangerous for pedestrians, streets should be designed to augment neighborhood access while providing benefit to the community. Additional lanes can be used as bike and bus lanes under normal circumstances but be adapted to evacuation lanes during emergencies (fig. 65).

Additional Considerations

Nuisance Species Control
Though eastern red cedar encroachment is low along access routes, continuous work will be needed to ensure its presence remains low. Regular mowing will keep trees from establishing.

Aesthetics/Visual Quality
Though increased pavement may detract from the visual quality of the neighborhood, streetscape elements such as ornamental plantings, seating, lighting, and paving patterns can help enhance the aesthetic quality of the development.

Public Access
Widened roads may be able to accommodate alternative modes of transit with the addition of bike lanes and multi-use paths. Bike lanes allow cyclists to remain separated from vehicles and can be converted to an additional lane of traffic during emergency evacuations.

Challenges

Residents may not support increased pavement and higher traffic volumes, despite benefits during evacuations.

Governments may be unwilling to invest in infrastructure that is infrequently utilized.

Road design requires anticipating traffic volumes during evacuation events., which may be difficult to gauge without prior examples.

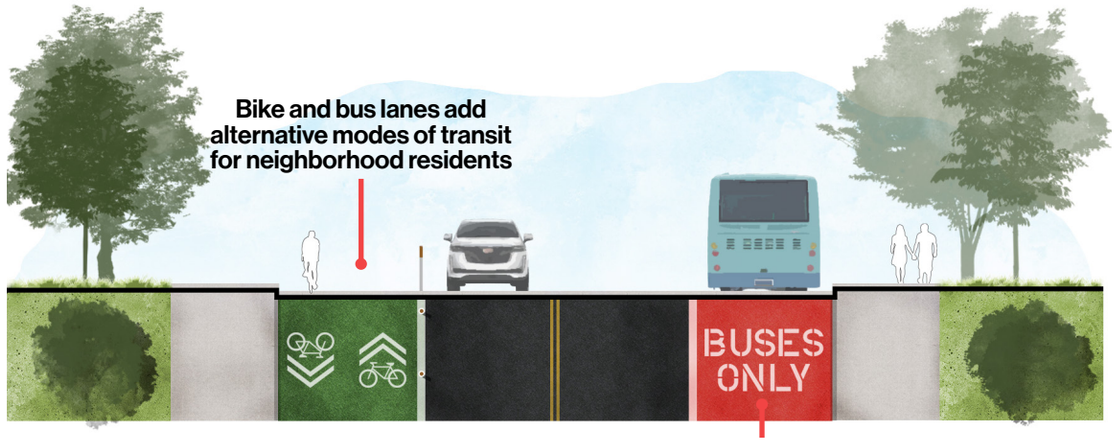


Figure 65. Adaptable Road Section

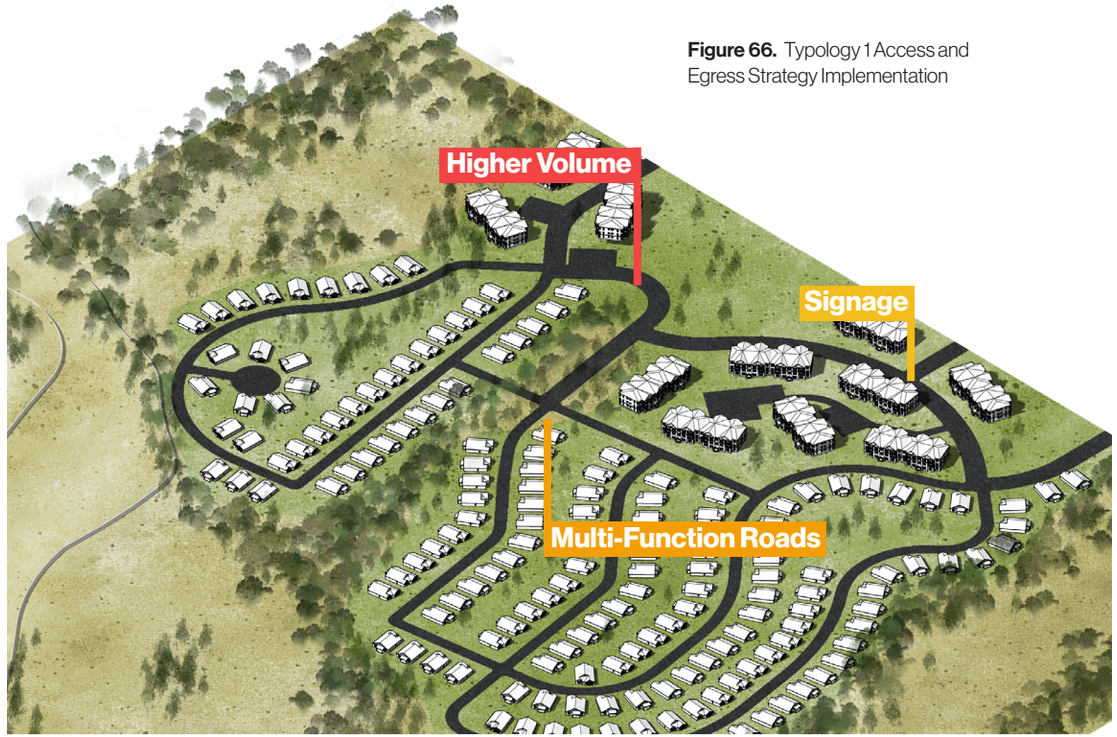


Figure 66. Typology 1 Access and Egress Strategy Implementation

Neighborhood Typology 2

Access and Egress

Emergency Maneuverability

The accessibility of Typology 2 has been rated as "poor" due to the proximity of woody vegetation to main access roads and the lack of connectivity to main thoroughfares. This poses a serious threat to the safety of residents, as blocked routes and impeded movement can make evacuation during emergencies challenging. Access to the neighborhood's exit points is limited by the lack of connection between the area's main roads, which means each home can only access a single exit. Moreover, the dirt roads in the neighborhood may become impassable during severe weather conditions and may not be suitable for some types of fire apparatuses.

Addressing these issues will significantly improve the safety of the residents. Clearing combustible vegetation along roads, connecting and paving interior routes, and accommodating emergency vehicles are crucial. Maintaining a combustible-free buffer zone of at least 10 feet adjacent to roadways, with larger distances preferable, will facilitate safer access and egress and employ roads as firebreaks (International Code Council 2021).

Connecting interior roads will provide residents and emergency personnel with two points of entry and exit during emergencies. Paving these roads will ensure fire department vehicles have access regardless of weather or road conditions, and equipping each driveway and home with turnarounds and turnouts for emergency vehicles will allow them to maneuver quickly and safely (International Code Council 2021). These features eliminate the need for large vehicles to reverse long distances or park on unstable ground along driveways (fig.s 67-68).

Additional Considerations

Ease of Maintenance

Prescribed fire along roadways is likely the easiest and most cost-effective way to maintain suitable levels of access and egress, though regular mowing will be necessary between burns.

Invasive/Nuisance Species Control

Studies have suggested that goats may be effective at controlling eastern red cedar growth, though prescribed fire is likely still the most effective method of controlling the conifer's spread. Manual removal and mastication will be necessary to remove existing, established plants.

Aesthetics/Visual Quality

Maintaining visual quality is of high importance in residential settings. Utilizing deciduous, broadleaf trees and shrubs spaced at moderate distances may reduce flammability adjacent to roads, while ensuring the neighborhood maintains its aesthetic character.

Challenges

Removing combustible species near roads requires considerable time, effort, money, and ongoing maintenance.

Residents may be unwilling to alter the visual quality of their neighborhood by removing trees near routes.

Altering or adding roads requires engineering, site preparation, and construction, which are costly and time-consuming.

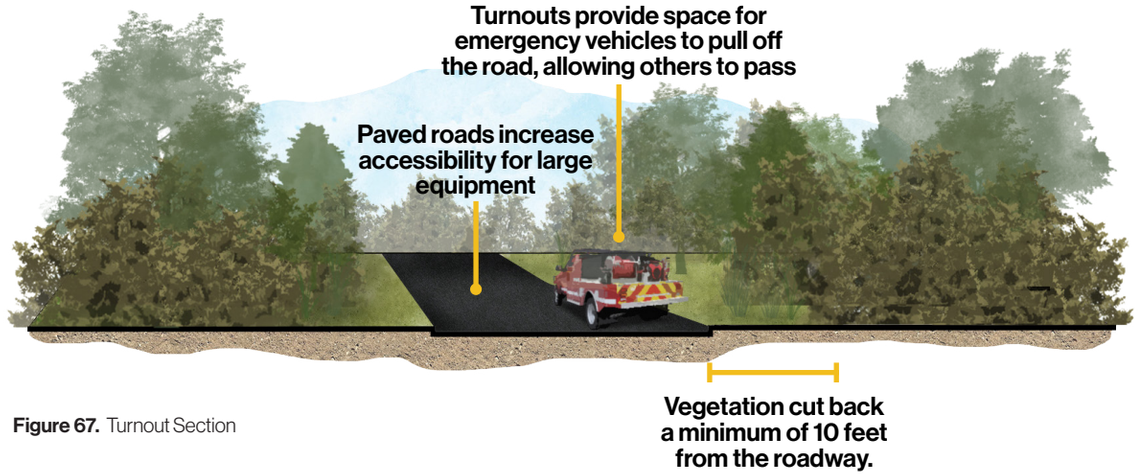


Figure 67. Turnout Section

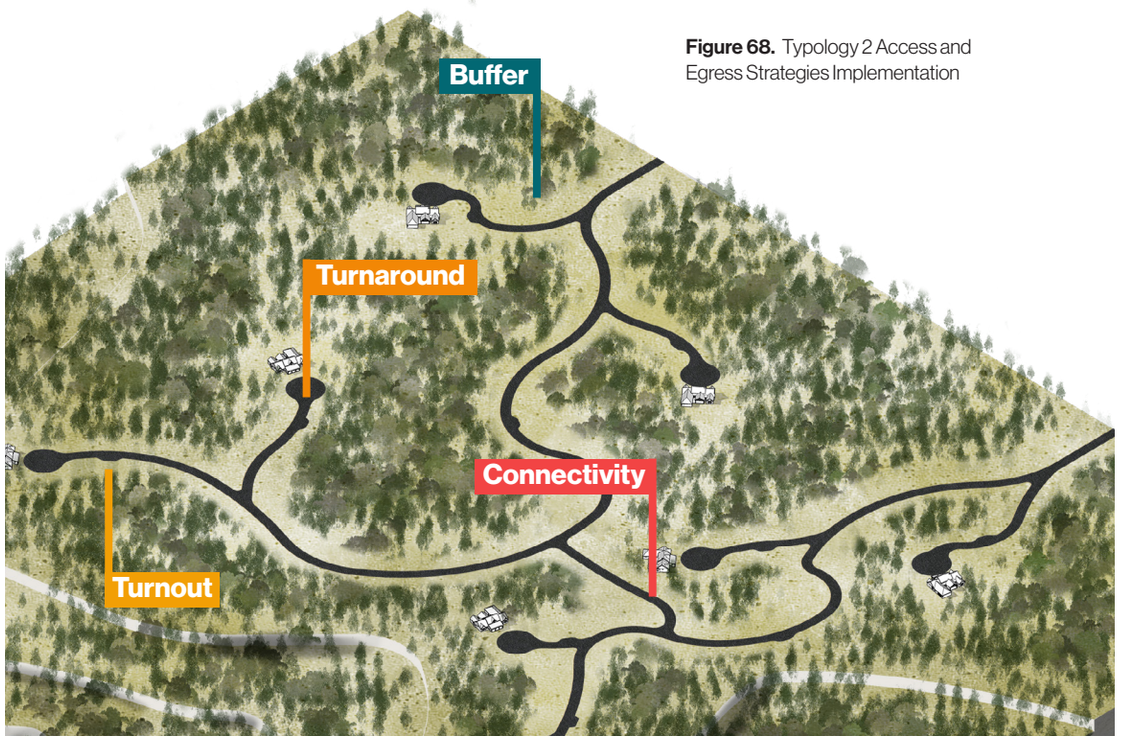


Figure 68. Typology 2 Access and Egress Strategies Implementation

Neighborhood Typology 3

Access and Egress

Enhanced Connectivity

Access to Typology 3 is "moderate" due to the neighborhood's curvilinear layout and the proximity of combustible vegetation to access and egress routes. Additionally, many homes lie at the end of long dead-end roads, which could become blocked or congested with traffic during a wildfire. Despite having multiple access points, each dead-end practically restricts many homes to a single route out of the neighborhood. Notably, Typology 3 already includes features to accommodate large emergency vehicles.

The neighborhood's existing development and topography significantly affect the ability to retrofit strategies that enhance accessibility. Ideally, dead-end roads would be converted to through streets, and an additional neighborhood access point would be added. However, some basic methods can significantly improve neighborhood access without major modifications to the development.

Regularly trimming combustible vegetation adjacent to roadways and removing flammable woody vegetation within 10 feet of the road can significantly improve access. Additionally, signage should be installed at intersections to guide evacuees and responders during emergencies (fig.s 69-70).

Additional Considerations

Ease of Maintenance

Regular mowing of buffers along roads is likely the easiest way to ensure fuels remain low along access and egress routes. When mowing is difficult, stone can be used as ground cover to reduce plant growth; however, seasonal maintenance will still be required.

Invasive/Nuisance Species Control

The removal of eastern redcedar adjacent to access routes should be prioritized. Initial removal will need to be performed manually, followed by regular mowing to prevent the establishment of new plants.

Aesthetics/Visual Quality

Less flammable native species can be used to maintain the neighborhood's aesthetic appeal. Residents note that trees most frequently contribute to the visual quality of their homes, so native high-moisture content trees can be placed in areas where more flammable vegetation has been removed.

Challenges

Existing development and topography restrict the ability to improve access by adding new roads and exit routes.

Homeowners may be resistant to changes in the landscape. Many residents likely appreciate the aesthetic value of their neighborhood.

Effective methods of removing and combating woody vegetation, such as prescribed fire, may not be tolerated close to suburban homes.

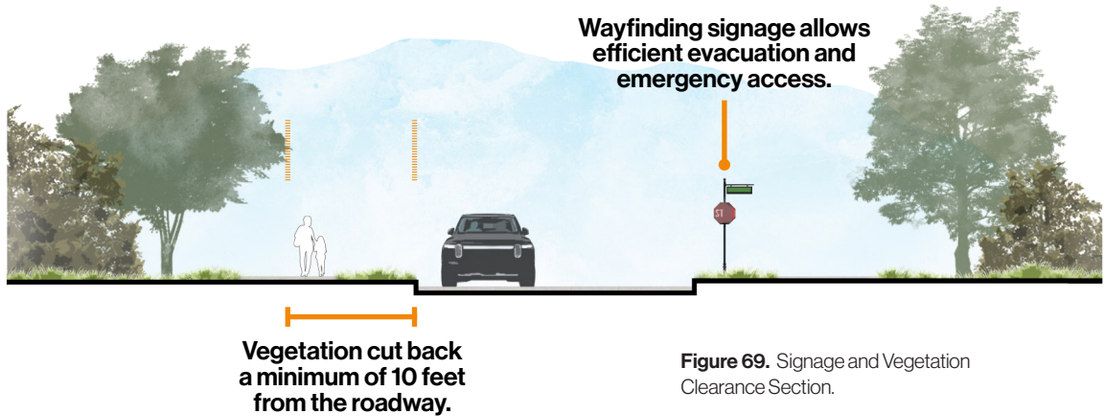


Figure 69. Signage and Vegetation Clearance Section.

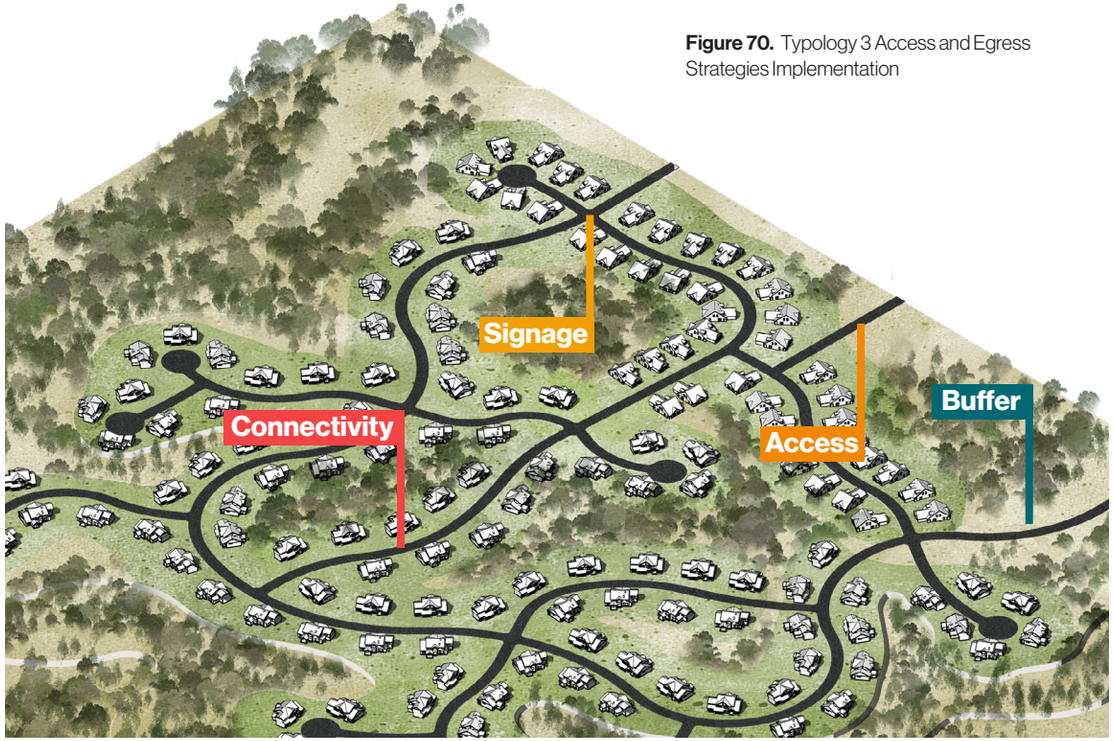


Figure 70. Typology 3 Access and Egress Strategies Implementation

Neighborhood scale mitigation strategies

Utility easement clearing

Strategy Overview

Electrical transmission lines are increasingly involved in wildfire ignitions as development expands and infrastructure ages. A downed PG&E line, which failed after years of neglect, sparked California's 2018 Camp Fire, an Xcel Energy power line disconnected by high winds was one of two ignition sources responsible for igniting Colorado's 2021 Marshall Fire, and a damaged Hawaiian Electric line set off 2023's fire that burned through Lahaina, Maui.

Damaged transmission infrastructure is linked to numerous fires throughout the West, which have resulted in dozens of deaths and billions of dollars in damage and legal settlements (Dougherty and Johnson 2023; Solis 2022; Worth, Pinchin, and Sullivan 2020). Above-ground utilities are vulnerable to damage during high winds, which are, unfortunately, also dangerous conditions for wildfire ignition. Ensuring electrical infrastructure does not ignite wildfires is of interest to both the public and utility corporations operating the lines.

Though burying electrical lines underground is the most effective method of reducing the likelihood that electrical infrastructure will ignite wildfires, burying equipment can be costly and slow. PG&E estimates that burying one mile of electrical line costs as much as $5 million (Simon 2023). Though not as effective at removing the risk as burying lines, clearing easements under transmission lines can considerably reduce wildfire risk near the wildland-urban interface and be performed relatively quickly (Kalthoff 2023).

Vegetation management near transmission corridors often involves maintaining adequate clearance between brush and lines to reduce the likelihood of outages caused by limbs falling on power lines. However, increased fires ignited by downed lines and flashovers, an electrical arc from line to ground, have encouraged electric utilities to manage vegetation through mowing or selective thinning to reduce ignition risk (Seattle City Light 2023). This vegetation management entails clearing swaths of land where vegetation is controlled, and construction is restricted.

Typically, this land sits unused, but governments have begun utilizing the open space for public access (Macdonald 2018). Colorado's 2022 "Powerline Trails Act" puts these corridors to work as recreation amenities, requiring utilities to notify local governments when transmission corridors expand to allow for trail planning. These trails provide public access and recreation, easy access for maintenance crews, and can serve as permanent vegetation clearance underneath transmission lines.

Neighborhood Typology 1

Utility Easement Clearing

Multi-Use Trail

The low slopes of Typology 1 and the neighborhood's considerable density create an opportunity to incorporate a powerline trail as a part of a larger city-wide or regional transit network. A trail provides residents in the neighborhood with recreation and transportation opportunities, and provides vegetation management underneath the transmission corridor.

Hard surface trails are frequently located under transmission lines. Significant parts of Denver's Cherry Creek Trail and portions of Florida's Marjorie Harris Carr Cross Florida Greenway utilize transmission easements in their routes. These multi-use trails allow various activities, such as running, walking, and bicycling, to occur along their lengths (Macdonald 2018). Multi-use trails are very popular among residents in adjacent neighborhoods. Respondents in one survey identified access and fitness as the most significant benefits of living near the route. Trails also provide social space for communities and allow residents to interact with nature in an otherwise urban or suburban setting (Headwaters Economics 2012).

Though relatively narrow, the hard surface of these trails can also serve as firebreaks during wildfires. Developing mitigation infrastructure that provides community value beyond wildfire risk reduction could encourage communities to invest in mitigation when they may otherwise be hesitant (fig.s 71-72).

Additional Considerations

Ease of Maintenance

Since utility companies must ensure easements remain clear of vegetation, maintenance of a multi-use trail is minimal. However, routine maintenance must be performed at regular intervals depending on the trail material.

Aesthetics/Visual Quality

The presence of a trail may provide a significant boost to the visual quality of the neighborhood. Trails allow area residents to experience the surrounding landscape in a more interactive way, thus integrating the landscape's aesthetic benefits with the neighborhood.

Public Access

A multi-use trail provides recreation and transportation benefits to the broader community. Power easement trails allow area residents to utilize space that often sits unused. These trails can link neighborhoods across cities, allowing for greater interaction among residents.

Challenges

Easements frequently lie on private land, meaning public access would need to be secured before the construction of trails within the corridors.

Construction of trails requires considerable planning, design, and implementation work.

Reducing the availability of grass fuels under transmission corridors could be challenging. Though selecting for forbs is possible, continuous management of grass fuels will be necessary.

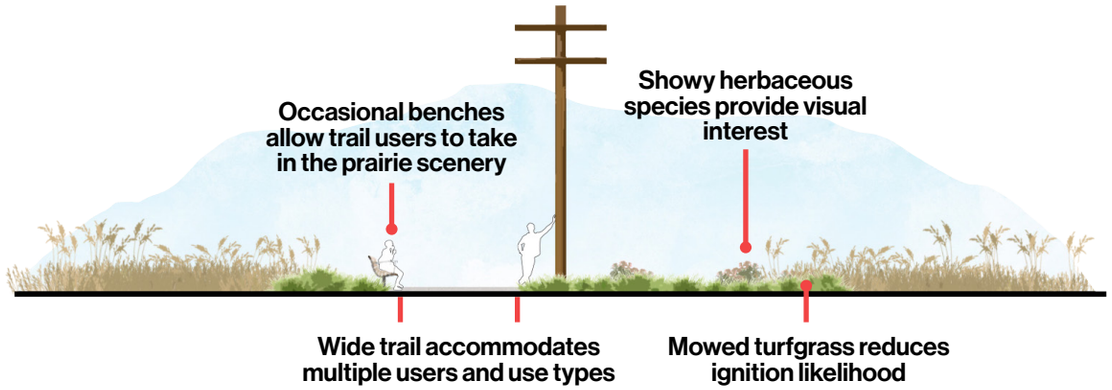


Figure 71. Multi-Use Trail Corridor Section.

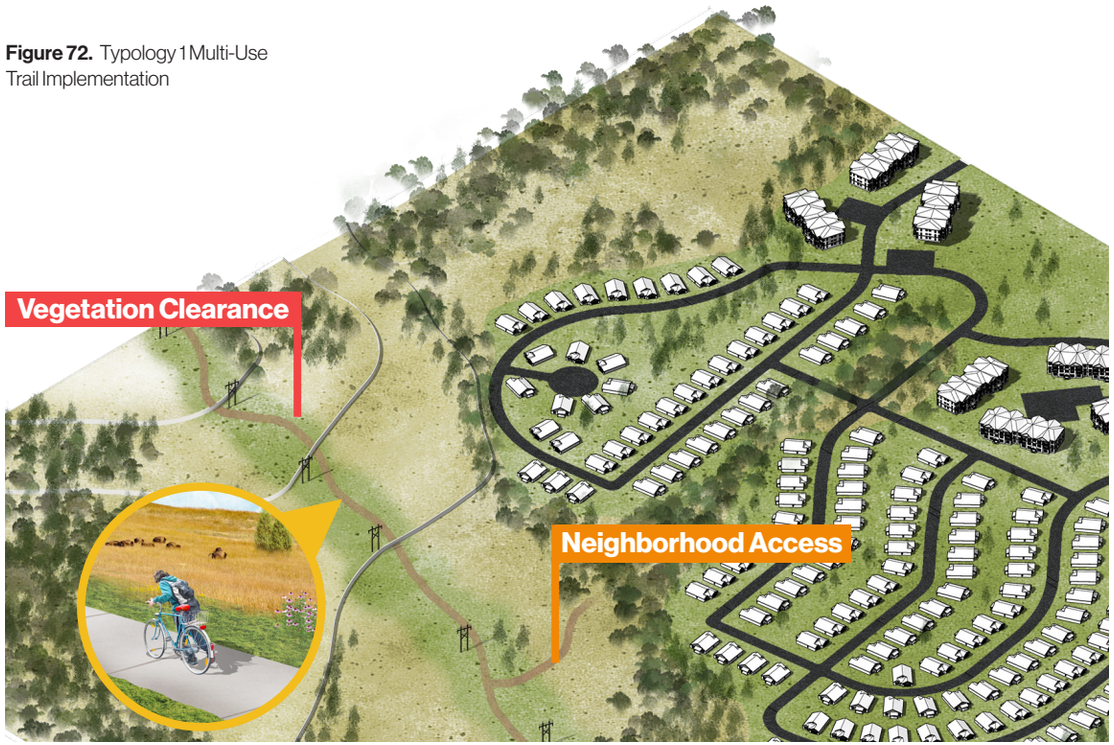


Figure 72. Typology 1 Multi-Use Trail Implementation

Neighborhood Typology 2

Utility Easement Clearing

Mountain Bike/Hiking Trails

Though residential density within Typology 2 is low, the neighborhood's high slopes and dense forests provide opportunities to incorporate recreational amenities not frequently found in the Great Plains, such as mountain biking and hiking trails (fig.s 73-74).

Transmission corridors on high slopes are often used as mountain biking and hiking trails in regions with more varied topography, such as the Powerline Trail in South Lake Tahoe, California, and The Electrician Trail in Templestow, Australia (Trailforks 2015, 2022). Including such a trail would provide considerable recreation value for the neighborhood, surrounding community, and the larger region. However, due to the large amount of private land across the Great Plains, public access agreements would need to be secured for powerline trails to be feasible on a large scale.

Vegetation clearance along the transmission corridor also acts as a firebreak within the development's cedar woodlands, allowing the easement to serve multiple purposes simultaneously. The corridor functions as maintenance access, ignition reduction, firebreak, and recreation amenity with little additional effort or cost.

Additional Considerations

Ease of Maintenance

Though utility companies are responsible for ensuring clearance below power lines, mountain biking and hiking trails require regular upkeep. Trails must be cleared of debris and regular maintenance is needed to ensure continued function and safety.

Aesthetics/Visual Quality

Clearing swaths of forested area in Typology 2 could significantly impact the visual quality of the neighborhood. Steps should be taken to reduce aesthetic impact, such as screening the easement from nearby homes with broadleaf trees and less flammable plant species.

Public Access

Mountain biking and hiking trails could be a substantial public asset to cities and regions within the Great Plains. The varied topography of Typology 2 provides elevation change not common in the Great Plains. These trails provide recreation for nearby residents as well as drawing use from bikers and hikers around the region.

Challenges

Nearby landowners may be uncomfortable with public trails near their homes.

Planning, design, implementation, and maintenance are costly and may be difficult due to Typology 2's terrain and vegetation coverage.

Communities may be unwilling to accept the liability involved with higher intensity hiking and biking trails.

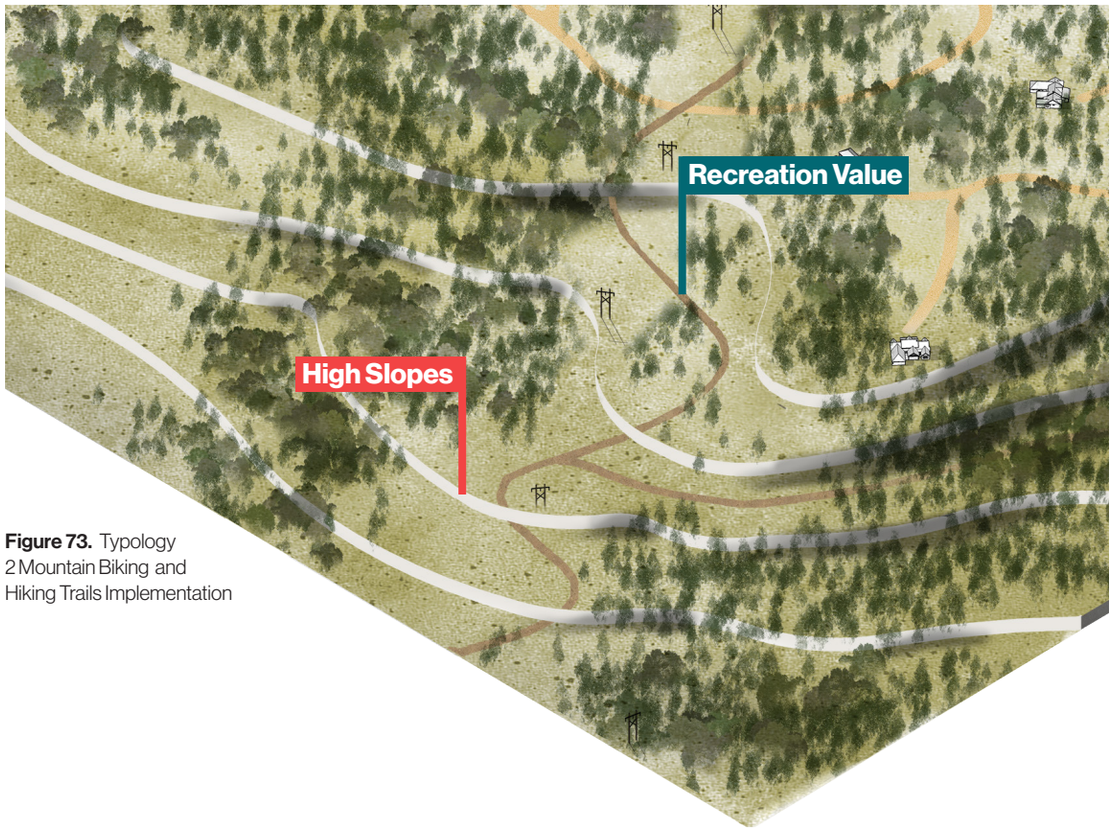
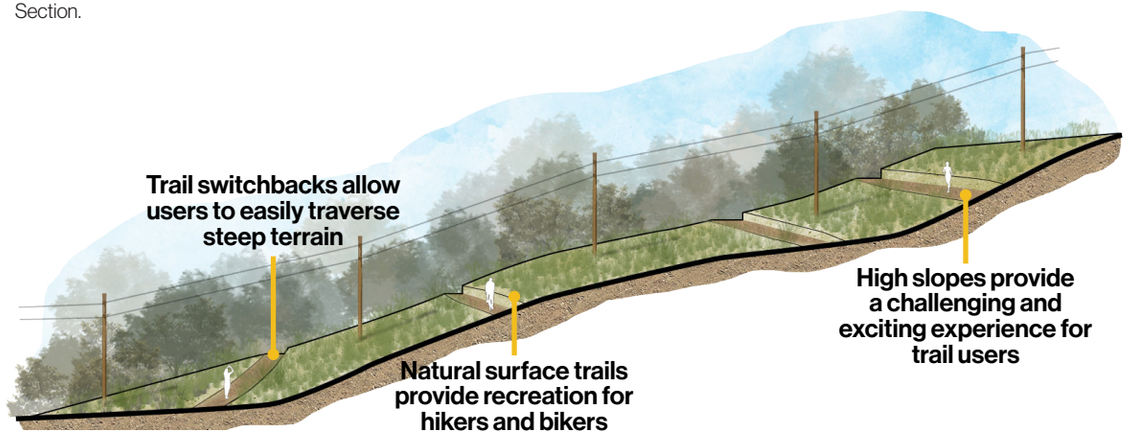


Figure 73. Typology 2 Mountain Biking and Hiking Trails Implementation

Figure 74. Mountain Biking and Hiking Trails Section.



Neighborhood Typology 3

Utility Easement Clearing

Conservation Easement

In addition to reducing wildfire ignition risk, acting as firebreaks, and providing recreation amenities, transmission corridors can be valuable conservation areas. Since the corridors require routine maintenance to ensure woody species remain clear of the easement, herbaceous prairie species find a refuge free of competition from eastern redcedar (Kalthoff 2023; Sheridan, Orzell, and Bridges 1999). Though grasses can ignite and carry fire, forbs (herbaceous flowering species) are much less likely to ignite due to their high moisture content. The growth of these species can be encouraged through intentional cultivation and prescribed burns or mechanical clearing timed to select for specific species (fig. 75).

A study conducted in 1999 found that powerline easements were frequently home to rare species not found elsewhere in the ecosystem. The authors posit that mechanical clearance used to reduce woody vegetation mimics natural disturbances, often absent from fire-excluded landscapes. This disturbance encourages the growth of species that may be unable to survive in heavily wooded environments (Sheridan, Orzell, and Bridges 1999).

The ecosystem benefits of cleared transmission corridors are especially valuable in landscapes that have transitioned to cedar forests, where prairie ecosystems may be rare. These stretches of low-lying vegetation perform myriad services, protecting communities from wildfire and augmenting human and natural systems (fig. 76).

Additional Considerations

Ease of Maintenance

Once woody species have been removed, maintaining a conservation easement necessitates regular efforts to prevent the regrowth of undesirable plants. However, once native prairie species are established maintenance should be minimal and require seasonal disturbance.

Aesthetics/Visual Quality

Though removing trees and introducing a conservation easement would disrupt the pattern of the landscape, the increased presence of prairie plant species provides greater visual interest through biodiversity and the presence of showy plant species,

Public Access

A trail can be routed through the easement to provide public access and educational opportunities within a naturalized setting. The easement's proximity to neighborhood allows for the integration of interpretive information targeted at children and families.

Challenges

Utility workers accessing electrical infrastructure may damage or disturb signification portions of the easement.

Lack of consistent upkeep could allow invasive species to reestablish, both increasing wildfire risk and harming the conservation easement.

Though less flammable than conifers, native prairie species will still carry fire. Higher moisture species should be considered when choosing plants.

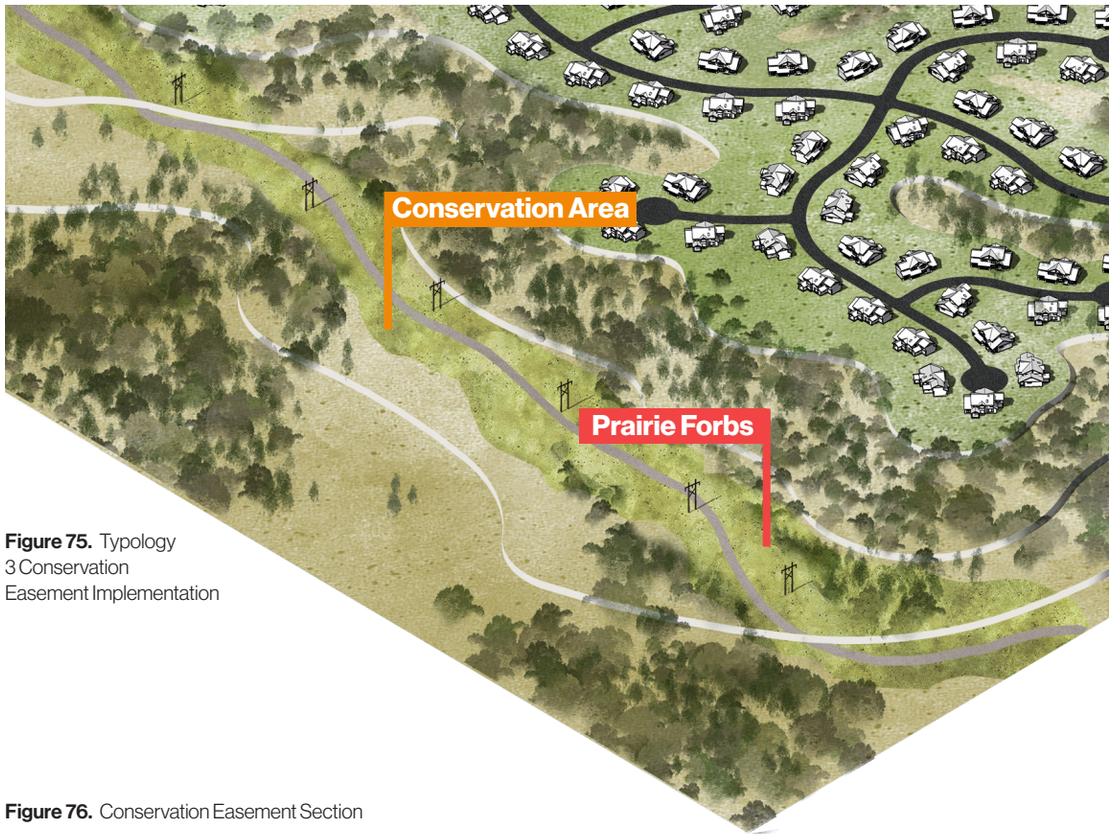
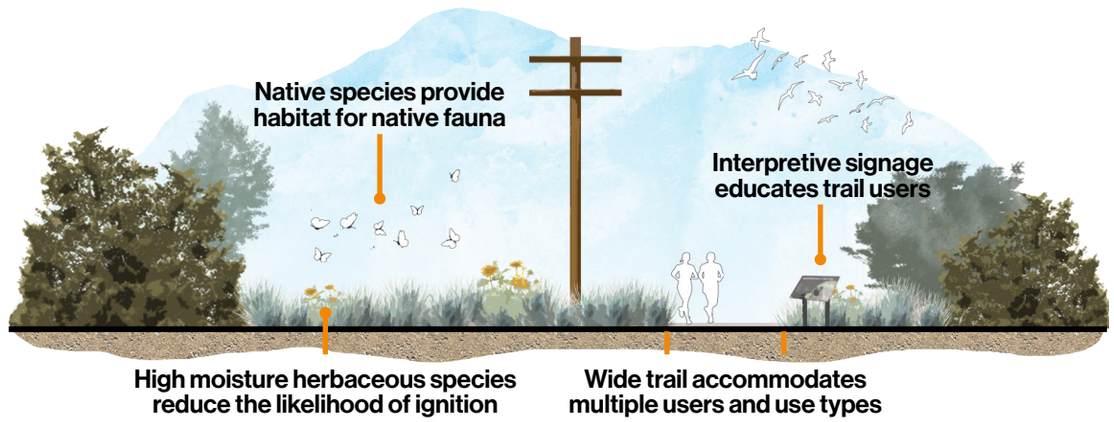


Figure 75. Typology 3 Conservation Easement Implementation

Figure 76. Conservation Easement Section



Neighborhood scale mitigation strategies

Cutting firebreaks

Strategy Overview

Firebreaks are one of the most common methods of mitigating wildfire risk to exposed communities. At their most basic, they are strips of land where vegetation is reduced or removed to slow or stop the spread of fire. Firebreaks can be intentionally constructed through plowing, bulldozing, grading, and mowing, or may be naturally occurring breaks in fuels such as creeks or canyons. Existing roads and trails can serve as firebreaks as well. Firebreak creation is frequently used in the Great Plains to contain prescribed burns and manage wildfires on a short-term basis, though their use as long-term protection from wildfire is less common (Oklahoma State University Extension 2017).

However, creating permanent firebreaks to protect entire neighborhoods is an increasingly common practice in many fire-exposed communities in the West (South County Project n.d.; Bernard 2023). These permanent breaks are often constructed as shaded fuel breaks, which selectively thin vegetation within a strip of land rather than remove vegetation entirely. Shaded fuel breaks retain the landscape's visual quality due to minimized vegetation clearance. They may also improve forest health through enhanced moisture retention, thus further reducing wildfire risk. Despite their strengths, they are generally less effective at stopping flames than traditional firebreaks and must be much wider to provide adequate protection (Oregon State University, n.d.).

Shaded fuel breaks may be useful in Great Plains landscapes where fire has been excluded for decades. Though eastern redcedar is a common colonizer in these locations, hardwood species are also frequently present. Prioritizing the removal of eastern redcedar along targeted strips of land while retaining some or all hardwood species minimizes the impact on the aesthetic qualities of wooded neighborhoods while significantly reducing wildfire risk.

In Great Plains communities with low levels of woody encroachment, shaded fuel breaks are ineffective. The basic concept of thinning, rather than removing, vegetation is challenging in a grassland ecosystem where continuous fine fuels dominate. Wholesale vegetation clearance with mechanical methods is likely the most straightforward method of firebreak creation in these ecosystems; however, exposed soil can facilitate the growth of invasive species, degrade soil health, and decrease habitat quality.

Establishing green or vegetative firebreaks can prevent these impacts while providing long-term wildfire mitigation and ecological benefits. Green firebreaks utilize high-moisture to inhibit fire spread while maintaining or improving environmental health (Natural Resource Conservation Service 2006). These firebreaks can also be planted with productive species like alfalfa to provide economic benefits while reducing wildfire risk.

Neighborhood Typology 1

Cutting Firebreaks

Green Firebreak

Typology 1, characterized by its low slopes and bottomland position, presents an opportunity to implement a green firebreak (fig. 78). This strategy mitigates wildfire risk to the neighborhood by providing a large buffer of high-moisture, low-growing plant species. Non-productive vegetation, such as clover, buffalograss, fescues, and coneflower can be planted in these areas to combat fire spread, as can productive species like alfalfa (fig. 77) (Natural Resource Conservation Service 2006).

The rich soils and higher moisture found in bottomland sites may increase the long-term viability of a green firebreak, potentially reducing overall maintenance or irrigation requirements. Although these species may still carry fire under severe conditions, they burn less intensely and more slowly than grasses or coniferous woody species that may otherwise be present.

Furthermore, the urban form of Typology 1 offers additional advantages in wildfire mitigation. The compactness of the typology increases the effectiveness of firebreaks by allowing a single firebreak to encircle the entire development, protecting it from all angles. In contrast, dispersed developments require much larger neighborhood-scale firebreaks, or firebreaks for each individual structure. This approach requires considerably more investment in its implementation and maintenance (Natural Resource Conservation Service 2006; United States Department of Homeland Security 2023).

Additional Considerations

Ease of Maintenance

Since green firebreaks can be maintained by farmers and landowners, they require little maintenance from municipalities and nearby communities. However, farmers should be continuously incentivized to plant low-flammability species.

Aesthetics/Visual Quality

Though green firebreaks planted with agricultural crops may detract from the prairie aesthetic many appreciate, they also provide the opportunity to plant showy productive species such as sunflower. Green firebreaks can also be constructed with non-productive showy species such as echinacea.

Productive Landscapes

Productive crops can be used in green firebreaks. Legumes, such as alfalfa and soybeans, can provide protection from wildfire while providing revenue for farmers. This may help incentivize communities to install green firebreaks.

Challenges

Though less flammable than grasses and conifers, high moisture forbs will still burn during droughts and outside of growing seasons.

Coordination between farmers and landowners is necessary to ensure continued maintenance of firebreaks.

Large amounts of land across the Great Plains is unsuitable for cultivation, meaning green firebreaks are only effective where crops can be grown, such as the bottomlands of Typology 1.

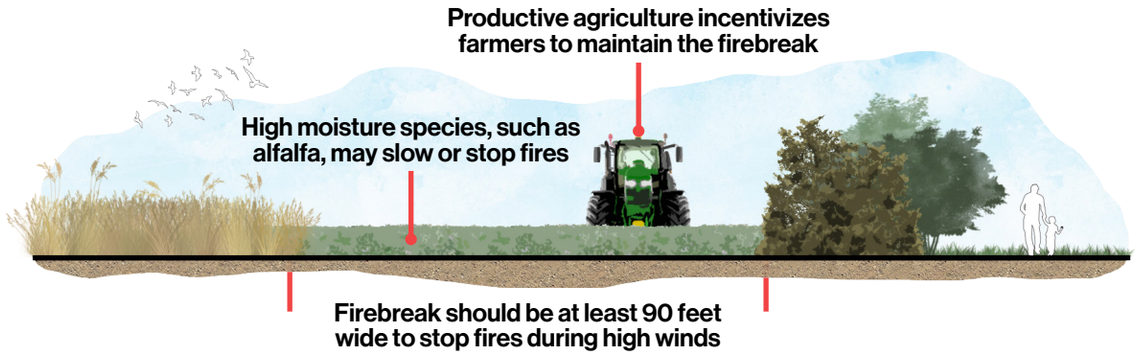
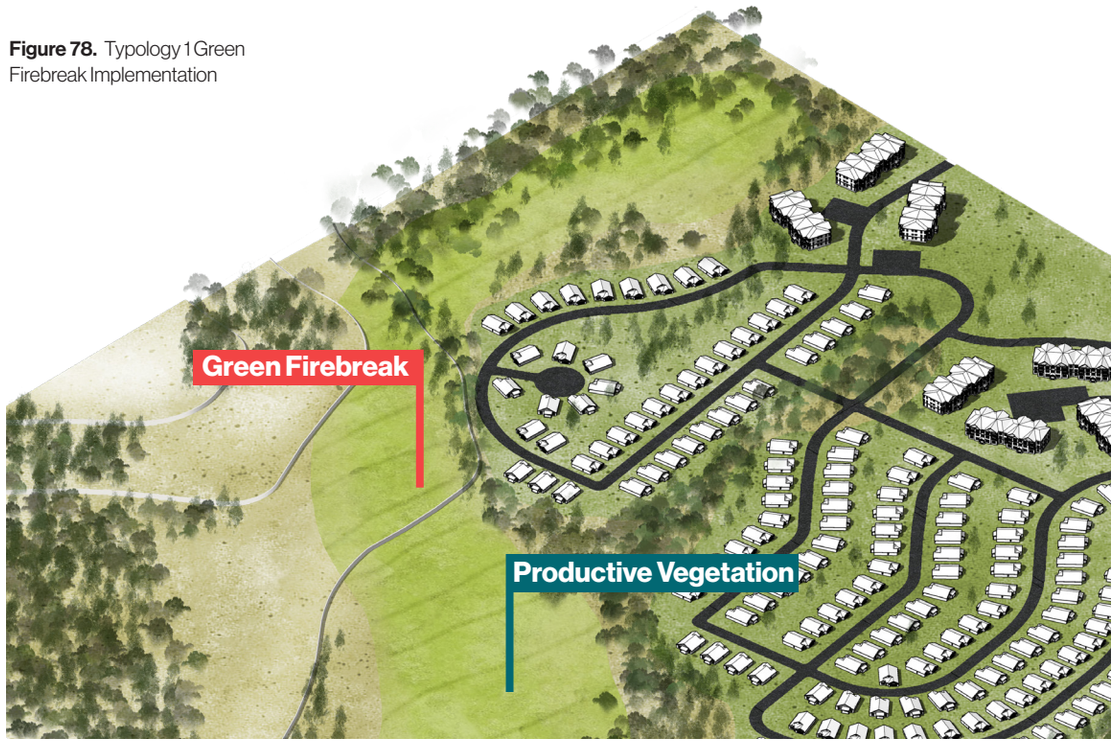


Figure 77. Green Firebreak Section

Figure 78. Typology 1 Green Firebreak Implementation



Neighborhood Typology 2

Cutting Firebreaks

Shaded Fuel Break

The slopes and wooded character of Typology 2 allow a shaded fuel break to be used to reduce neighborhood wildfire risk (fig. 79). Residents within the neighborhood likely appreciate the visual qualities of their forested landscape, so maintaining a similar aesthetic is of high priority. This can be achieved by selectively thinning or removing eastern redcedar along the fuel break while allowing hardwood species to remain in place. Though hardwood species still burn under the correct conditions, decreasing the prevalence of cedar decreases overall fire intensity and increases moisture, thus reducing the likelihood that hardwood species will ignite. Notably, not all cedar must be removed for the fuel break to be effective. The presence of deciduous species, and minimized overlap between individual cedar trees, can be adequate to reduce fire spread. This mixture of species is also beneficial in retaining a naturalized look to the landscape (Oregon State University, n.d.).

Since fuel breaks allow some vegetation to remain in place, they must be considerably larger than traditional firebreaks used in similar conditions (fig. 80). Fuel breaks on hills must also account for the effect of slope on fire intensity and spread. A fuel break on a 20 percent slope, which occur frequently in Typology 2, must be 210 feet wide to be effective. Trees within the fuel break must also be spaced based on slope, requiring a minimum of 10 feet of separation on slopes found in the neighborhood (Natural Resource Conservation Service 2020). Though implementation requires considerable upfront effort, it is often more cost-effective than the land clearance that occurs with traditional firebreaks. Maintenance demands of shaded fuel breaks depend on the level and speed of plant growth, though the establishment of hardwood species may slow the spread of cedar within the fuel break (Oregon State University, n.d.).

Additional Considerations

Aesthetics/Visual Quality

Shaded fuel breaks minimize the visual impact to the landscape by retaining some woody species. Clearing the area of undesirable species, such as honeysuckle and eastern redcedar, also provides greater visibility within forested area.

Public Access

The increased vegetation clearance within shaded fuel breaks makes them attractive locations for public amenities such as trails. These locations provide interaction with a forest ecosystem, which are rare across the Great Plains.

Nuisance Species Control

Shaded fuel breaks control undesirable species through selective thinning. This must be done through work intensive manual removal. However, competition from the desirable trees that are allowed to remain reduce the ability of nuisance species to regrow within the selectively thinned area.

Challenges

Inadequate spacing or poor construction may allow fires to jump the fuel break during high winds or extreme fire weather events.

Though fuelbreaks can be installed for long-term use, their effective life span is determined by ongoing seasonal maintenance.

Initial installation is work intensive, requiring manual selective thinning of trees within the fuel break.

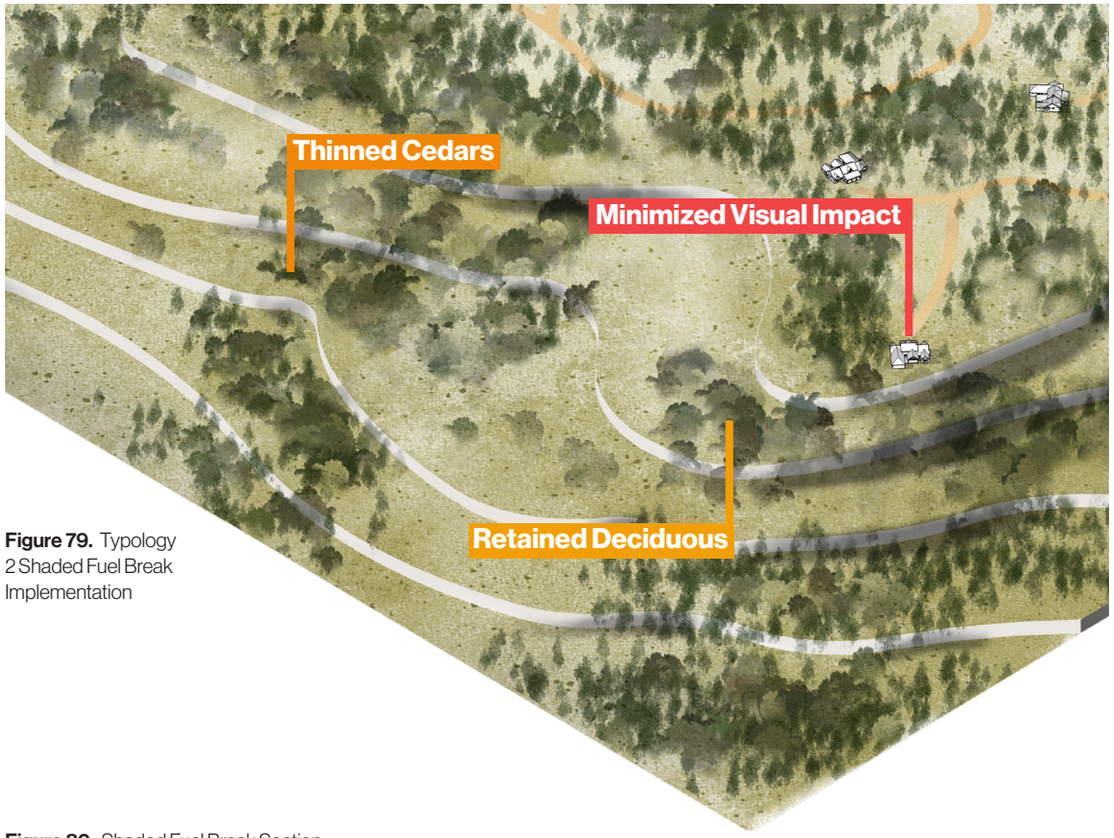
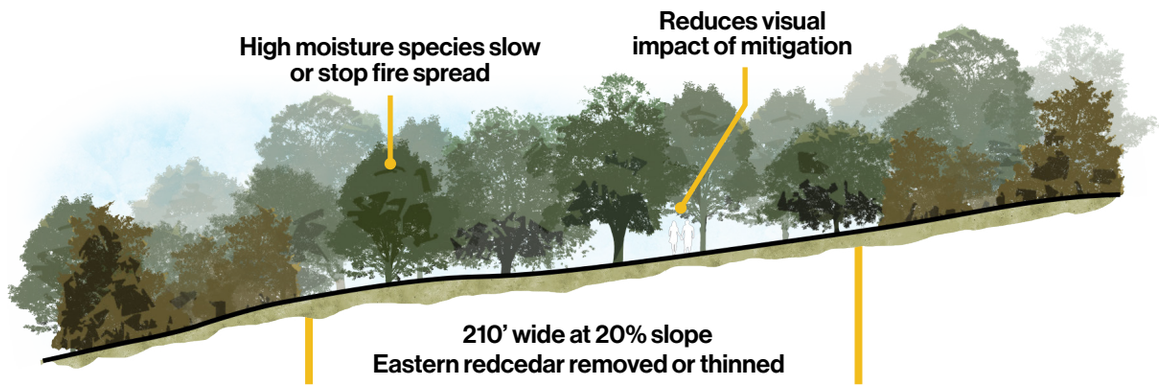


Figure 79. Typology 2 Shaded Fuel Break Implementation

Figure 80. Shaded Fuel Break Section



Neighborhood Typology 3

Cutting Firebreaks

Traditional Fire Break

Typology 3 demonstrates the application of traditional firebreaks, which rely on the nearly complete clearance of combustible vegetation within a designated strip of land (fig. 81). This clearance process is achieved through various methods, with mechanical methods used most frequently. Mechanical clearance uses bulldozers, graders, mowers, or tractors to reduce fuels within the targeted area. These techniques are particularly effective in grass-dominated landscapes where vegetation removal is straightforward. Mechanical clearance is also widespread in woody ecosystems, though its use requires considerably more effort since trees must be removed from the firebreak after being felled (Oklahoma State University Extension 2017).

Additionally, existing topographic and infrastructural features can serve as effective firebreaks. These features, such as roads, trails, ravines, and creeks, can offer incidental wildfire mitigation to exposed communities and should be considered for integration when constructing built firebreaks. Intentionally routing new roads around the perimeter of developments may also provide adequate protection from wildfire (fig. 82) (Texas A&M Agrilife Extension n.d.).

Like shaded fuel breaks, firebreaks must be built with consideration of topography and vegetation. Firebreaks in areas with considerable eastern redcedar encroachment must be much wider than firebreaks in grassy fields. Maintaining firebreaks requires seasonal maintenance to remove vegetation, reduce the establishment of invasive species, and prevent erosion (Texas A&M Forest Service n.d.).

Additional Considerations

Ease of Maintenance

Fire breaks within partially wooded areas are work-intensive to implement. However, once undesirable species are cleared, regular prescribed burns or mowing can be used to control the regrowth of nuisance plants.

Aesthetics/Visual Quality

Since neighborhoods of Typology 3 lie atop a hill, the visual impact of a traditional fire break can be minimized by placing it below the line of sight from houses within the neighborhood. This approach minimizes the aesthetic impact to the open-canopy woodland aesthetic that residents likely appreciate.

Nuisance Species Control

Since fire breaks remove nearly all combustible vegetation within a swath of land, they are extremely effective at removing nuisance species. However, this lack of vegetation also allows for nonnative species to colonize areas where vegetation has been removed.

Challenges

Traditional fire breaks can lead to significant alterations to the visual character of the landscape which may be unpopular among residents.

Areas cleared of vegetation may allow invasive or nuisance species to establish in the absence of competition.

Permanently installed fire breaks require considerable initial investment and continuous upkeep to ensure they remain functional.

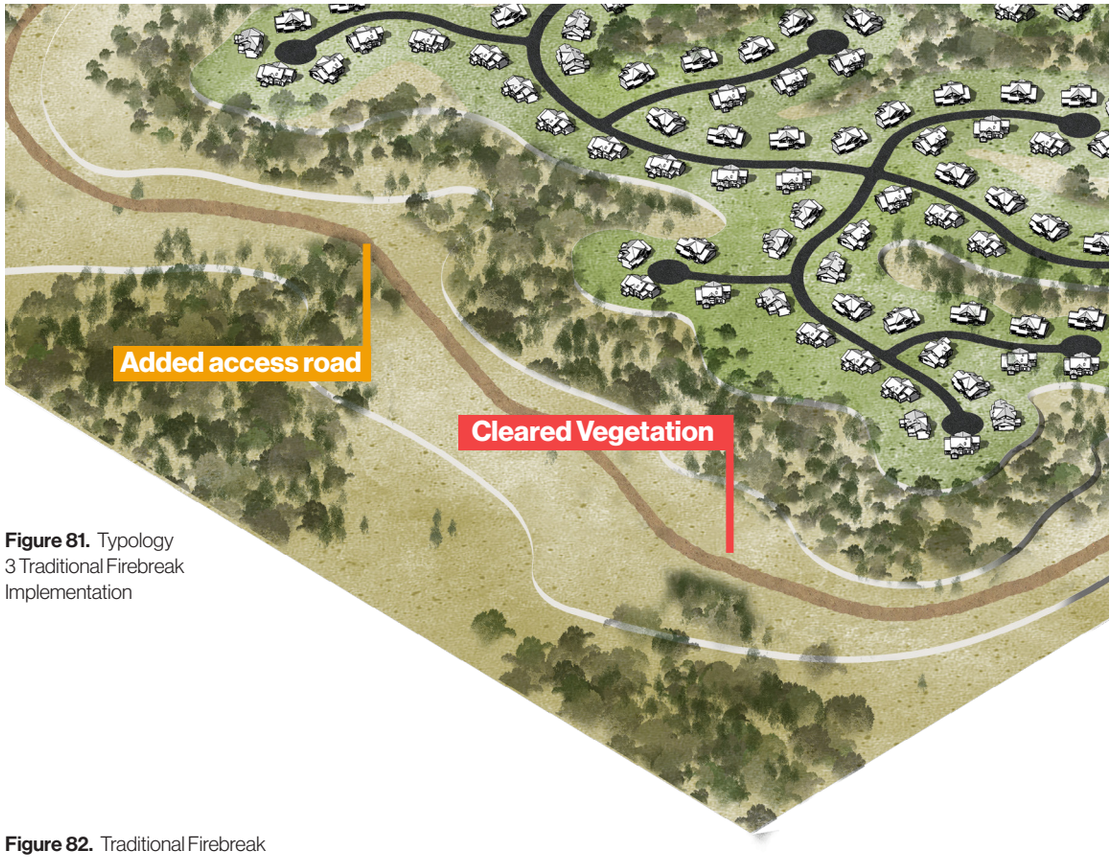
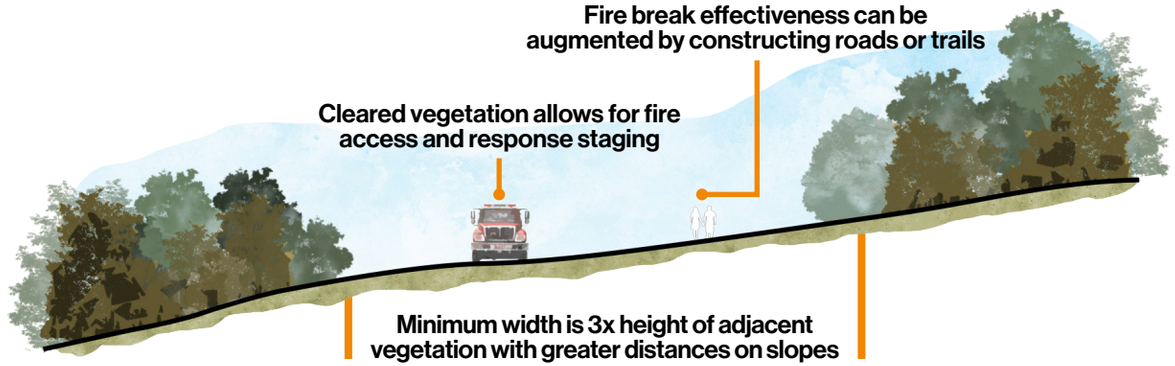


Figure 81. Typology 3 Traditional Firebreak Implementation

Figure 82. Traditional Firebreak Section.



Step #	Plant Characteristic Description		If Yes, Go To #	Points
1. Type of Plant	Tree Trees can provide shade, windbreak, energy savings, wildlife habitat, & erosion control.		2	
	Shrub or Woody Groundcover Shrubs are typically 2-12 feet tall and have a hard, woody stem. Woody groundcovers are low to the ground, but still have a hard, woody stem & branches.		2	
	Vine Vines can be herbaceous or woody, but require a trellis, plant, or building for support.		15	
	Herbaceous Ornamental or Grass Herbaceous plants are usually low-growing annuals or perennials, without a woody stem.		16	
2	Conifer and/or Evergreen Conifers have needle-like or scale-like leaves, and include pines, spruces, junipers & cedars. Evergreen plants retain their leaves throughout the year, and include Rhododendron & Azalea.		3	
	Broadleaf and/or Deciduous Broadleaf plants have wider leaves (ex.: maples, oaks, Forsythia, and Butterfly Bush.) Deciduous plants drop their leaves once each year.	For trees, go to: For shrubs, go to:	9 11	
3	Resinous Resinous plants produce resin, typically giving off a pungent odor when the leaves are crushed. These include pines, spruces, junipers and cedars.		4	
	Non-Resinous or Less Resinous Plants with less resin will usually give off less of a pungent odor when crushed.		5	
4	Less Firewise - Resinous plants are highly flammable and should not be used in close proximity to structures. Place 4 points in the far right column and go to:		5	4
5	Conifer sheds large amounts of leaves or needles (many pine species)		6	
	Conifer does not regularly shed leaves or needles		7	
6	Less Firewise - Shed needles need to periodically be removed from roofs and the ground around structures. Place 2 points in the far right column and go to:		7	2
7	Branches are less than 4 feet above the ground. This includes almost all shrubs.		8	
	Branches are more than 4 feet above the ground		9	
8	Less Firewise - Trees should be pruned and dead/low-hanging branches removed to be Firewise. Place 1 point in the far right column and go to:		11	1
9	Trunk has papery bark or loose fibers		10	
	Trunk does not have papery bark or loose fibers		18	
10	Less Firewise - Papery bark or loose fibers can act as ladder fuels; proper placement is necessary. Place 1 point in the far right column and go to:		18	
11	Plant has fine texture Texture is a term to describe the overall appearance of a plant from a distance. From a distance of about 10-15 feet, it is not easy to distinguish individual leaves or branches. (Examples: Boxwood, Spirea, junipers)		12	
	Plant has medium texture From a distance of about 10-15 feet, some individual leaves and branches can be distinguished on the outer part of the shrub, but not the inner part. (Examples: some azaleas and hollies)		13	
	Plant has coarse texture From a distance of about 10-15 feet, it is easy to distinguish individual leaves and branches. Examples include Hydrangea, Beauty-berrry, and and Witch Hazel.		13	
12	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		13	2
13	Plant is very dense These shrubs are so dense that it is difficult to place your hand in the shrub and touch a main stem. They have dense branching, and include plants like Boxwood and junipers.		14	
	Plant is moderately dense These shrubs are dense enough that you can't clearly see through them, but it is reasonably easy to place your hand in the shrub and touch a main stem.		18	
	Plant is sparsely dense Plants have an open branching pattern, making it easy to see through the shrub. Examples include American Beauty-berry and some hydrangeas.		18	
14	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		18	2
15	Less Firewise - Vines can be flammable, and are problematic in that they add fuel directly to a structure, or act as ladder fuels. Place 2 points in the far right column and go to:		18	
16	Grass, more than 8 inches tall		17	
	All other herbaceous ornamentals, or mowed/green grass		18	
17	Less Firewise - Grass that is tall, dead, and/or dormant (yellow or brown in color) is extrememly flammable and carries fire rapidly. Place 6 points in the far right column and go to:		18	
18	Plant retains dead leaves for more than two months of the year		19	
	Plant does not usually retain dead leaves, except when shedding leaves		20	
19	Less Firewise - Plants with dead foliage are highly flammable, because of the low moisture content of the leaves and fine twigs. Place 3 points in the far right column and go to:		20	
20	**Note:** Make sure leaves are not poisonous before touching them			
	Leaves have a waxy coating These plants have a very distinctive waxy coating on the leaf. (Ex.: Wax Myrtle, Gallberry, & Rhododendron)		21	
	Leaves do not have a waxy coating		22	
21	Less Firewise - Proper placement and maintenance are necessary. Place 1 point in the far right column and go to:		22	1
22	Species is seriously susceptible to disease, pests, and/or drought All plants can get diseases, but plants seriously susceptible to disease or drought are likely to be stressed and have less vigorous growth. When this happens, the foliage has a lower moisture content and a greater number of dead leaves are retained.		23	
	Species is not seriously susceptible to disease, pests, and/or drought		24	
23	Less Firewise - Make a note of, and routinely monitor for, diseases or pests. Obtain proper diagnosis and treatment of problems. Select plants that are native and/or well-adapted to local climate conditions. Place 1 point in the far right column and go to:		24	
24	FINISHED - Total all the points in the far right column and compare this number to the table below, to get the flammability rating of this plant.			
		Total Points:		12

Total Points	Flammability Rating
0 - 1	Low Flammability
2 - 4	Moderate Flammability
5 - 8	High Flammability
9+	Very High Flammability

Eastern redcedar

Juniperus virginiana

Score: **12, very high flammability**

Figure 83. Flammability Key

This flammability key, from Firewise Maryland, can be used to determine how plant characteristics contribute to overall flammability.

Neighborhood scale mitigation strategies

Landscape planting standards

Strategy Overview

Landscape planting standards that manage plant selection within communities can be an effective method to reduce the risk of wildfire while ensuring neighborhoods remain aesthetically pleasing. Maintaining the visual quality of neighborhoods may be an important part of securing support for wildfire mitigation from residents within established neighborhoods. Plant selection in exposed communities should focus on species less likely to ignite or intensify flames while still augmenting the visual quality of the neighborhood. Implementing neighborhood-wide landscape standards ensures that each resident shares in reducing wildfire risk to the broader community. Since structure-to-structure spread is common in urban conflagrations caused by wildfire, reducing the likelihood of ignition to each structure within the development is crucial.

Though the selection of high-moisture plant species is the most obvious way to reduce wildfire risk from ornamental landscapes, numerous other factors contribute to plant flammability. These factors include resin content, branching structure, leaf type, texture, and density (Idaho Firewise 2017d). Species with high resin content, such as eastern redcedar, are highly flammable due to volatile oils within their sap. Similarly, conifers with needles or scales are typically more flammable than deciduous species. Species with low growing branches and dense structure are more likely to act as ladder fuels and intensify flames, and fine textured fuels (such as grasses) ignite and carry fire easily (Carter et al., n.d.).

A plant flammability key can be used to determine flammability characteristics of individual species. Flammability keys provide a methodical analysis of factors relating to combustibility by scoring each plant in a series of steps. Plants with higher scores are more flammable. Though flammability keys are not as rigorous as more scientific methods of analyzing flammability, they can efficiently identify inappropriate plants for use in ornamental landscapes. The use of a plant flammability key is demonstrated in figure 83 with eastern redcedar. Predictably, eastern redcedar scores very highly indicating its extreme flammability.

The following pages develop plant palettes for each of the three neighborhood-scale typologies using the plant flammability key. These palettes attempt to honor the aesthetic character of the neighborhoods and reduce wildfire risk by suggesting low flammability plants that are visually appropriate for each neighborhood. Flammability keys for each of the selected species are located in Appendices 9-11.

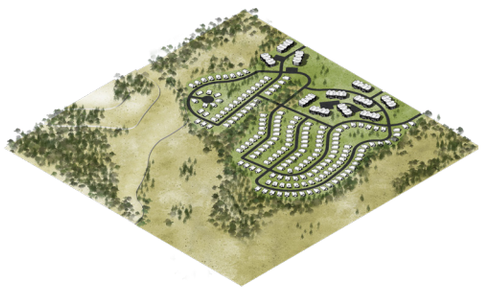
Neighborhood Typology 1

Landscape Planting Standards

Bottomland

Plant selection in Typology 1 attempts to maintain the neighborhood's bottomland prairie aesthetic while reducing wildfire risk (fig. 84). The selected plants are adapted to higher moisture environments that are often present in bottomland settings. Each selected plant is native to the Great Plains, though they are not necessarily present throughout the full extent of the region (table 6). However, with standard levels of care typical in residential settings, each species should easily establish and require minimal maintenance.

Chinkapin oak, slippery elm, and box elder serve as primary shade trees within the neighborhood, while eastern redbud provides understory interest. Corralberry and red twig dogwood provide high-moisture, showy elements to residential landscapes and public plantings. Showy perennials, such as showy milkweed, purple coneflower, smooth blue aster, and black-eyed susan provide pops of color throughout the neighborhood and provide valuable pollinator habitat. Finally, side-oats grama and Indiangrass are used sparingly to acknowledge the neighborhood's grassland setting. These grasses should be planted individually or in small groupings, among higher-moisture content species, and away from structures to reduce the likelihood of ignition.



Additional Considerations

Ease of Maintenance

Native species generally require less maintenance than non-native ornamental species and are better adapted to the conditions of the prairie. Similarly, many native species will readily reseed and fill plantings over time.

Productive Landscapes

Though this plant selection does not include productive species, productive plants can be excellent additions to residential plantings. The bottomland setting is especially well-suited for fruit bearing species such as raspberry and blueberry. These species are often high-moisture and fire resistant.

Nuisance Species Control

Ensuring the health of desirable species and facilitating their growth may make it harder for invasive or nuisance species to establish.

Challenges

Like all plants, native species often take a few years to establish, especially if grown from seed. Residents may be unwilling to wait for full establishment.

Native plantings are often "messier" than ornamental plantings. Some nearby residents may be unhappy with the unkempt look of native species, especially in winter months.

Though these species are less likely to burn, they will still ignite under the correct conditions. However, their risk is considerably lower than many species.

Figure 84. Typology 1 Landscape Standards

Common name	Scientific name	Flammability rating
Chinkapin oak	*Quercus muhlenbergii*	**3- moderate**
Slippery elm	*Ulmus rubra*	**0- low**
Boxelder	*Acer negundo*	**1- low**
Eastern redbud	*Cercis canadensis*	**1- low**
Coralberry	*Symphoricarpos orbiculatus*	**1- low**
Red twig dogwood	*Cornus sericea*	**1- low**
Showy milkweed	*Asclepias speciosa*	**0- low**
Purple coneflower	*Echinacea purpurea*	**3- moderate**
Black-eyed susan	*Rudbeckia hirta*	**0- low**
Smooth blue aster	*Symphyotrichum laeve*	**0- low**
Side-oats grama	*Bouteloua curtipendula*	**9- very high**
Indiangrass	*Sorghastrum nutans*	**9- very high**

Table 6. Typology 1 Plant List

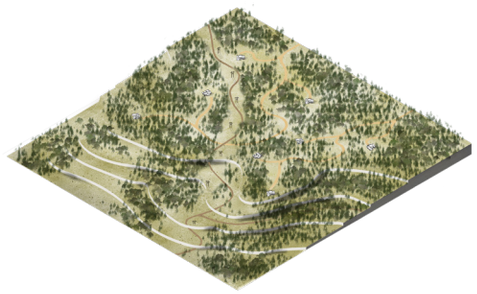
Neighborhood Typology 2

Landscape Standards

Woodland

Planting standards and selections in Typology 2 honor the wooded character of the landscape (fig. 85). These plants are more tolerant of the extensive shade likely found throughout the typology. With the exception of Siberian larch, each plant selected is native to the Great Plains region (table 7).

Siberian larch was selected to emulate the coniferous woodlands which currently comprise most vegetation in the neighborhood. Though Siberian larch is still a highly flammable coniferous species, its needles are very small and shed seasonally, and its thick bark is highly resistant to ignition. This species can be used sparingly to ensure the woodland character is maintained. Thornless honeylocust and post oak provide shade in residential settings across the typology, while eastern redbud adds interest to the landscape. Downy serviceberry, roughleaf dogwood, winged sumac, and fragrant sumac augment the aesthetics of home plantings. Woodland sunflower, wild bergamot, Canadian columbine, and Great Solomon's seal add pops of color the neighborhood while providing habitat for native pollinators. Finally, northern sea oats and switchgrass honor the prairie, though these grass species should be used sparingly.



Additional Considerations

Ease of Maintence

Most species included in this selection require minimal maintenance. However, Siberian larch should be trimmed routinely to maintain four feet of clearance from its lower branches to the ground. Grasses should also be cut back annually to allow for fresh growth.

Aesthetics/Visual Quality

Though the primary goal of this plant selection is to reduce wildfire risk to the neighborhood, visual quality is a high priority. The selected species provide year-round interest with colors, textures, and smells. These experiences will evolve through the seasons and augment the neighborhood's aesthetic resources.

Nuisance Species Control

Since the woods of Typology 2 have a considerable presence of nuisance species, this plant selection attempts to emulate the neighborhood's existing character while reducing the presence of undesirable plants.

Challenges

Considerable shade in Typology 2 limits plant selection to species more tolerant of low light conditions. Most species in this selection are tolerant of part-sun but are unable to survive in full shade conditions.

Plant establishment may be difficult due to the high presence of existing mature plants. Considerable work must be done to ensure initial plan health.

Figure 85. Typology 2 Landscape Standards

Common name	Scientific name	Flammability rating
Siberian larch	*Larix sibirica*	**7- high**
Thornless honeylocust	*Ulmus rubra*	**0- low**
Post oak	*Quercus stellata*	**1- low**
Eastern redbud	*Cercis canadensis*	**1- low**
Downy serviceberry	*Amelanchier arborea*	**1- low**
Roughleaf dogwood	*Cornus drummondii*	**1- low**
Winged sumac	*Rhus copallinum*	**2- moderate**
Fragrant sumac	*Rhus aromatica*	**1- low**
Woodland sunflower	*Helianthus divaricatus*	**0- low**
Wild bergamot	*Monarda fistulosa*	**0- low**
Canadian columbine	*Aquilegia canadensis*	**0- low**
Great solomon's seal	*Polygonatum biflorum*	**0- low**
Northern sea oats	*Chasmanthium latifolium*	**9- very high**
Switchgrass	*Panicum virgatum*	**9- very high**

Table 7. Typology 2 Plant List

Neighborhood Typology 3

Landscape Standards

Hilltop

Planting standards for Typology 3 are inspired by the hilltop prairies found across the Great Plains (fig. 86). The selected species are fairly drought tolerant and thrive in full sun (table 8). All selected species are native to the region, though they may not be naturally present in all areas. However, with regular care, they are all capable of thriving across the plains.

Bur oak, chinkapin oak, and black locust are utilized for their proven hardiness in the region. Bur oak and chinkapin oak are renown for their abilities to withstand the harsh conditions of the prairie, while black locust is well adapted to the plains. Staghorn sumac, eastern wahoo, and blue false indigo provide seasonal interest to both residential and prairie landscapes with brilliant blooms and striking fall colors. New England aster, plains zinnia, prairie blazing star, and lanceleaf coreposis create textural variation and a naturalized aesthetic while providing respite for native fauna. Little bluestem and prairie dropseed will thrive in Typology 3, however, they should be used sparingly in small groupings and planted away from structures.

Additional Considerations

Ease of Maintenance

Each species in this plant selection is adapted to the conditions of the Great Plains, however, some higher moisture species will require regular irrigation to thrive. The hilltop position of Typology 3 means runoff quickly flows to lower areas.

Aesthetics/Visual Quality

Species in this selection, such as eastern wahoo and staghorn sumac provide brilliant fall colors, while wildflowers provide interest from spring into late summer. These species may also attract native pollinators which can augment the aesthetics of the landscape.

Public Access

Though not an explicit goal of this planting selection, the use of showy native species provides excellent opportunities to incorporate public access and environmental education into neighborhood spaces.

Challenges

The hilltop position of Typology 3 exposes species to more intense environmental stresses such as wind, erosion, and drought.

The effect of slope on fire intensity must be considered when placing plants. Higher flammability species should be placed away from slopes.

Residents may be unwilling to alter the suburban character of their neighborhood with species that are less "clean" than ornamental plants.

Figure 86. Typology 3 Landscape Standards

Common name	Scientific name	Flammability rating
Bur oak	*Quercus macrocarpa*	**3- moderate**
Chinkapin oak	*Quercus muhlenbergii*	**3- moderate**
Black locust	*Robinia pseudoacacia*	**0- low**
Staghorn sumac	*Rhus typhina*	**1- low**
Eastern wahoo	*Euonymus atropurpureus*	**1- low**
Blue false indigo	*Baptisia australis*	**3- low**
New England aster	*Aster novae-angliae*	**0- low**
Plains zinnia	*Zinnia grandiflora*	**0- low**
Prairie blazing star	*Liatris pycnostachya*	**3- moderate**
Lanceleaf coreopsis	*Coreopsis lanceolata*	**0- low**
Little bluestem	*Schizachyrium scoparium*	**9- very high**
Prairie dropseed	*Sporobolus heterolepus*	**9- very high**

Table 8. Typology 3 Plant List

Neighborhood scale mitigation strategies

Managed greenbelts

Strategy Overview

Greenbelts are strips of public, vegetated land that encircle communities, ensuring open space is available in urbanized settings. These greenbelts help protect sensitive ecosystems, provide ecosystem services to nearby communities, and provide recreation to city-dwellers. Historically, greenbelts have been used to control urban sprawl and increase the quality of life for both urban and rural residents. The practice of designating space for greenbelt preservation gained popularity in 19th century England and has remained a popular land-use planning practice since (London Green Belt Council 2022). Greenbelts are in use globally, with prominent examples in London, Toronto, Boston, and Tehran.

Though preserving open space for public use has been planning best practice for over a century, interest in greenbelts and the services they provide has grown under climate change. Greenbelts influence urban climates by reducing the urban heat island effect, increasing moisture availability, reducing air pollution, improving stream health, and managing stormwater and flooding (Canada in a Changing Climate n.d.). Recently, their effectiveness as buffers against wildfire has also been considered.

The Greenbelt Alliance, a Bay Area non-profit, has conducted extensive research into the effectiveness of greenbelts in wildfire risk mitigation. The group's publication "The Critical Role of Greenbelts in Wildfire Resilience" includes case studies from across the United States where greenbelts successfully protected communities from wildfire. Through this research, the group developed greenbelt typologies and recommendations for their implementation. These typologies include greenbelts as public open space, agricultural land, greenbelts within subdivisions and neighborhoods, and recreational greenways such as bike paths, sports fields, and golf courses. In implementing these strategies, the group recommends intentional placement of greenbelts to mitigate wildfire risk and the incorporation of greenbelt wildfire buffers into new developments (Greenbelt Alliance 2021).

Though the primary aim of greenbelts has historically been to preserve open space, the lack of development alone is inadequate to provide protection from wildfire. Boulder County's Marshall Fire was carried by highly combustible native grasses through public open space before igniting homes adjacent to preserved land. As such, vegetation selection is crucial in greenbelt planning and design. Greenbelts should be comprised of high-moisture species less likely to ignite when exposed to flames.

In the Great Plains, where native grasses are the primary carriers of fire and the dominant vegetation type, ecosystem conscious greenbelt construction may be challenging. Native grasses must be managed in a way that reduces wildfire risk, which often reduces the ecosystem services they provide. Management of greenbelts planted with native grasses likely involves irrigation and mowing to ensure fuel loads remain low. In settings where native species are inappropriate, parks and recreational facilities with irrigated turfgrass and deciduous tree species can effectively reduce wildfire risk to adjacent communities while providing valuable amenities.

Neighborhood Typology 1

Managed Greenbelts

Public Park

The moderately dense development patterns and low slopes of Typology 1 allow for the implementation of a greenbelt and public park (fig. 87). The park provides recreation to residents of the community while decreasing wildfire risk from the adjacent prairie landscape. The proximity of the park to large populations within the neighborhood ensures that the park receives consistent use while providing green space to residents, such as apartment dwellers, who may otherwise lack access to natural spaces.

Though public parks and open space aren't frequently designed with wildfire mitigation in mind, they have shown consistent success in protecting communities from approaching wildfires. The Greenbelt Alliance notes numerous examples of parks successfully intercepting wildfires across California and Colorado (Greenbelt Alliance 2021). Though research has not been conducted on which park aspects are most important in reducing wildfire risk, it can be assumed that high-moisture plant species, irrigated open spaces, roads, trails, and an absence of undesirable species all play a role in risk reduction.

Utilizing public parks and greenbelts as wildfire buffers offers the opportunity to incorporate wildfire mitigation in a non-invasive way which adds value for the surrounding community (fig. 88). Municipalities may be more likely to invest in wildfire mitigation strategies if they can serve multiple purposes and augment the lives of their citizens. Parks and recreation departments, who typically manage these spaces, can be valuable partners in mitigating wildfire risk since their work manages human interaction with natural spaces.

Additional Considerations

Aesthetics/Visual Quality

Though the introduction of a park reduces the prevalence of the native prairie landscape, park features and landscape design should provide aesthetic interest to the community.

Nuisance Species Control

Since the construction of the park requires considerable landscape alterations most, if not all, eastern redcedar will be removed adjacent to the neighborhood. The consistent maintenance required in public parks reduces the likelihood that eastern redcedar will recolonize near the community.

Public Access

The presence of a park can be a valuable public asset to nearby communities. Parks provide myriad benefits including space for recreation, improved ecosystem services, and greater community interaction.

Challenges

Park planning and construction requires acquiring land from adjacent landowners who may be unwilling to sell to municipalities.

Park upkeep is costly and requires ongoing maintenance and investment from governments.

Parks may raise property values. In worst case scenarios, property owners may be unable to afford their homes and be forced to move.

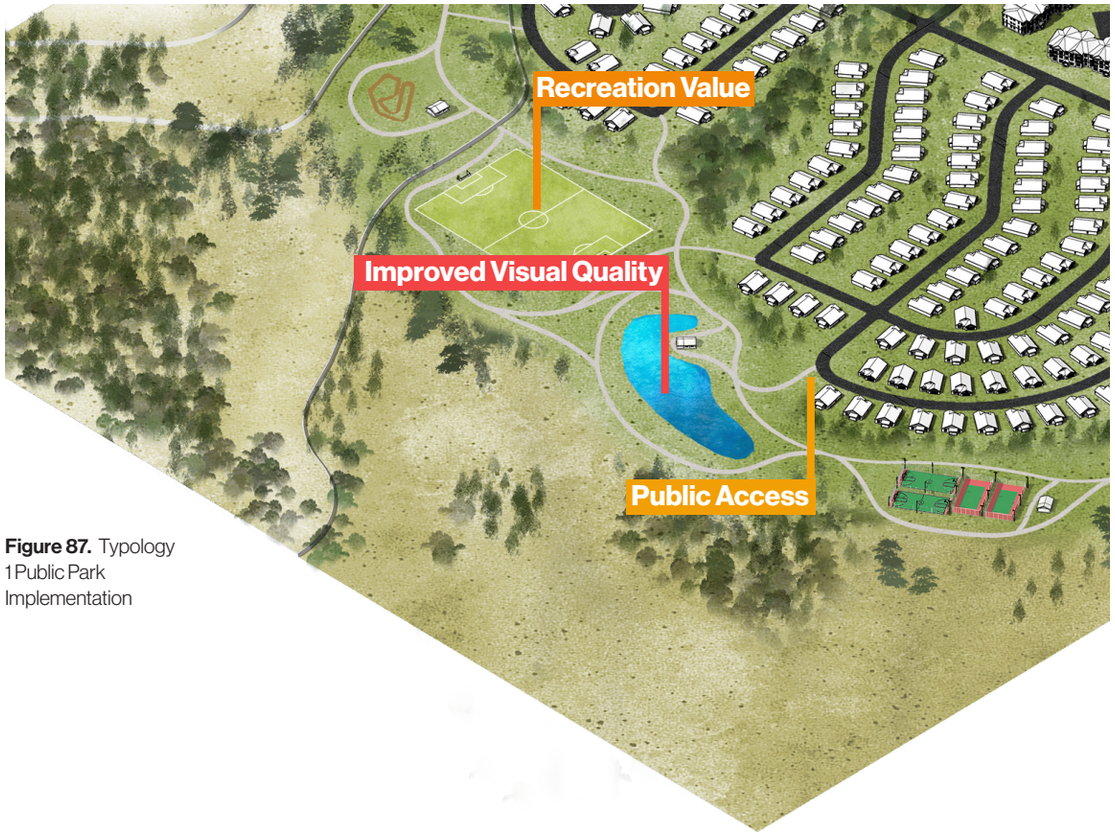
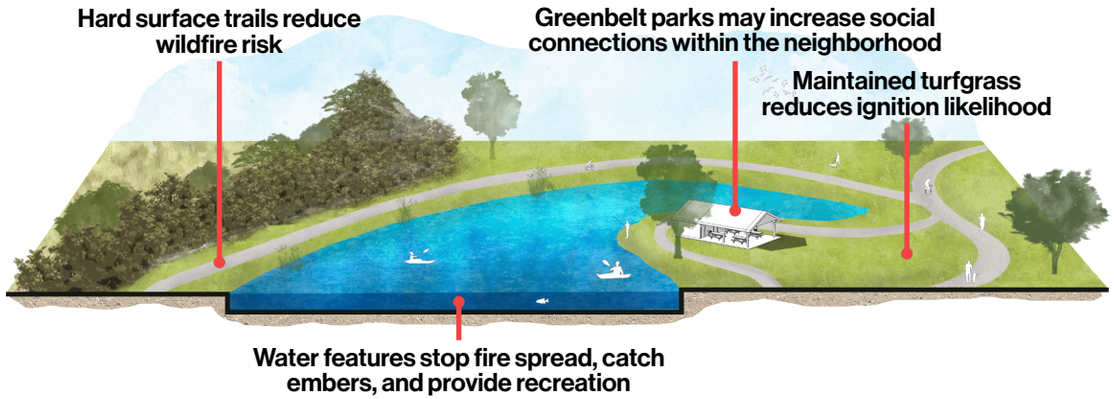


Figure 87. Typology 1 Public Park Implementation

Figure 88. Public Park Section



Managed Greenbelts

Interior Greenbelts

The high slopes of Typology 2 considerably restrict the ability to incorporate greenbelts on the exterior of the neighborhood, however, the benefits of greenbelts extend to interior community spaces as well (Greenbelt Alliance 2021). Interior greenbelts aim to disrupt fuel continuity and prevent fire spread within neighborhoods (fig. 90). This is especially important in eastern redcedar dominated communities, such as Typology 2, where fires may burn and spread with extreme intensity.

Greenbelts within neighborhoods create opportunity to provide amenities, such as parks, trails, sports fields, and water features to area residents. In Typology 2, the system of interior greenbelts includes a small pond, trails, and a 9-hole private golf course. Each of these features effectively reduces the likelihood of fire spread by removing highly combustible vegetation and introducing managed landscapes (fig. 89). Though golf courses are often counter to ecological goals, the highly degraded landscape of Typology 2 provides opportunity to integrate a course with minimal ecological damage. To maintain the wooded characteristic of the neighborhood, some eastern redcedar and many deciduous woody stands have been incorporated into the greenbelt system.

Interior greenbelts can also be useful staging areas for emergency responders during disaster response. Cleared or less-flammable vegetation within the greenbelt provide safe locations where responders can coordinate a response or defend structures.

Additional Considerations

Ease of Maintenance

Implementation and maintenance of interior greenbelts can be costly and time consuming. However, routine maintenance of trails and the golf course should keep unwanted species at bay.

Aesthetics/Visual Quality

Though constructing interior greenbelts may impact the aesthetic characteristics of the neighborhood, areas cleared of trees provide greater visibility across the landscape. Since Typology 2 lies atop a hill, this increased visibility can be used to create scenic viewsheds of the surrounding prairies.

Public Access

The neighborhood within Typology 2 is very low density, meaning programmatic elements within the greenbelts may receive little use. To increase visitorship, residents may choose to allow public use of the golf course for a small fee.

Challenges

Implementation requires manual removal of large swaths of woody species.

Golf courses require constant upkeep and large amounts of water. Communities may be unable to afford maintenance and excessive irrigation runoff may damage ecosystems.

Residents may be unwilling to allow public access to their neighborhood.

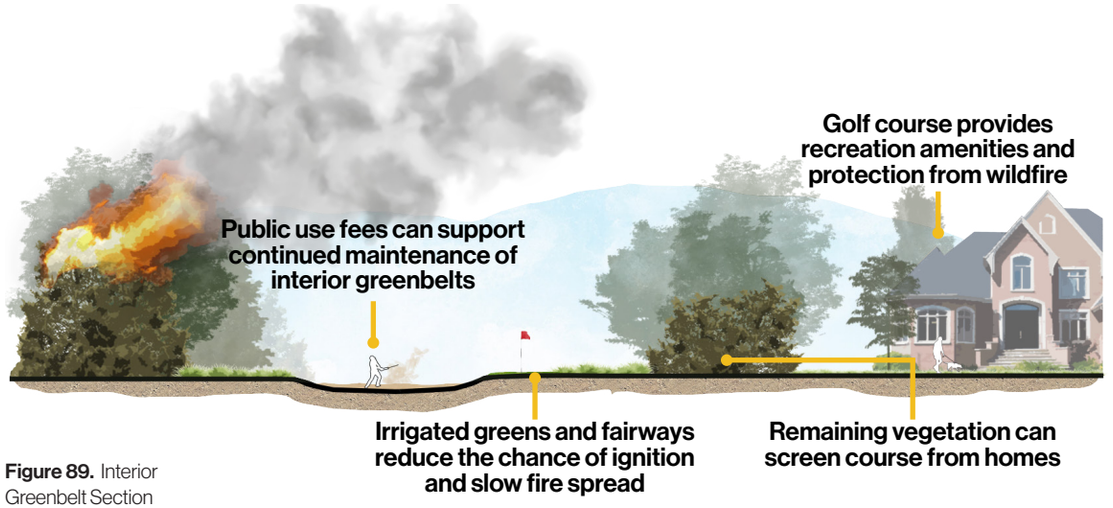


Figure 89. Interior Greenbelt Section

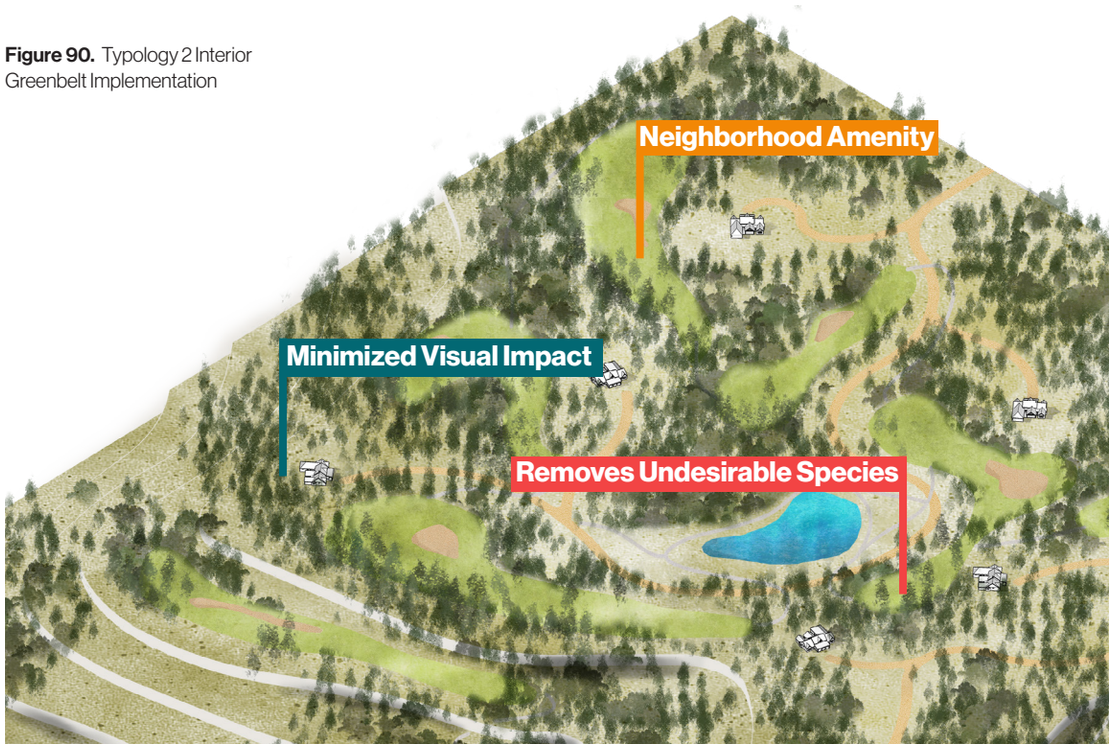


Figure 90. Typology 2 Interior Greenbelt Implementation

Neighborhood Typology 3

Managed Greenbelts

Community Gardens

The suburban character of Typology 3 and its adjacency to slopes allows for the construction of terraced community gardens to reduce wildfire risk (fig. 91). These gardens provide residents the opportunity to interact with natural systems and foster a sense of ownership over their neighborhood. Community gardens reinforce social connections within the community while providing enriching activities for neighborhood families. Within these gardens, high moisture species, such as vegetables, fruit trees, and showy forbs provide considerable wildfire risk reduction while increasing the visual quality of the neighborhood.

Though implementing terraced gardens may be difficult, the placement of wildfire mitigation strategies on slopes considerably reduces wildfire risk to adjacent structures. Since slopes intensify fire behavior, removing or reducing the presence of highly combustible species decreases the likelihood that wildfire will result in structure ignition. Likewise, increasing the presence of high-moisture species may slow or stop wildfire spread altogether. As added benefit, the infrastructure necessary to support community gardens, such as irrigation systems, can be used to suppress wildfire should one occur on adjacent slopes (fig. 92).

Large-scale agricultural buffers have demonstrated consistent success in mitigating wildfire risk across the West and are demonstrated on previous pages, however, the slopes of Typology 3 restrict agricultural interventions to micro-scale strategies. Research has suggested that smaller plantings of perennial crops, such as grape and banana, can slow wildfire spread in Mediterranean climates (Fu et al. 2023). Though bananas are inappropriate for use in the Great Plains, other perennial species may offer similar protection in small plantings.

Additional Considerations

Ease of Maintenance

Since community gardens are often community-controlled assets, maintenance of these spaces require little intervention from municipalities. Community members can be tasked with ensuring garden areas remain clear of undesirable species.

Aesthetics/Visual Quality

Community gardens can be implemented with little aesthetic impact to the landscape. Productive and showy species planted in the gardens can augment the visual quality of the landscape by introducing a variety of textures, forms and colors to the neighborhood.

Productive Landscapes

Produce harvested from the gardens can be distributed among residents or sold at local farmers markets, and neighborhood children can learn about agricultural processes and crop production.

Challenges

Constructing garden plots on hillsides could be logistically challenging and require substantial upfront investment.

Management of atypical garden species, such as fruit trees and grapevines, may be difficult for inexperienced gardeners.

Continued wildfire mitigation requires consistent use and substantial investments of time and money from neighborhood residents.

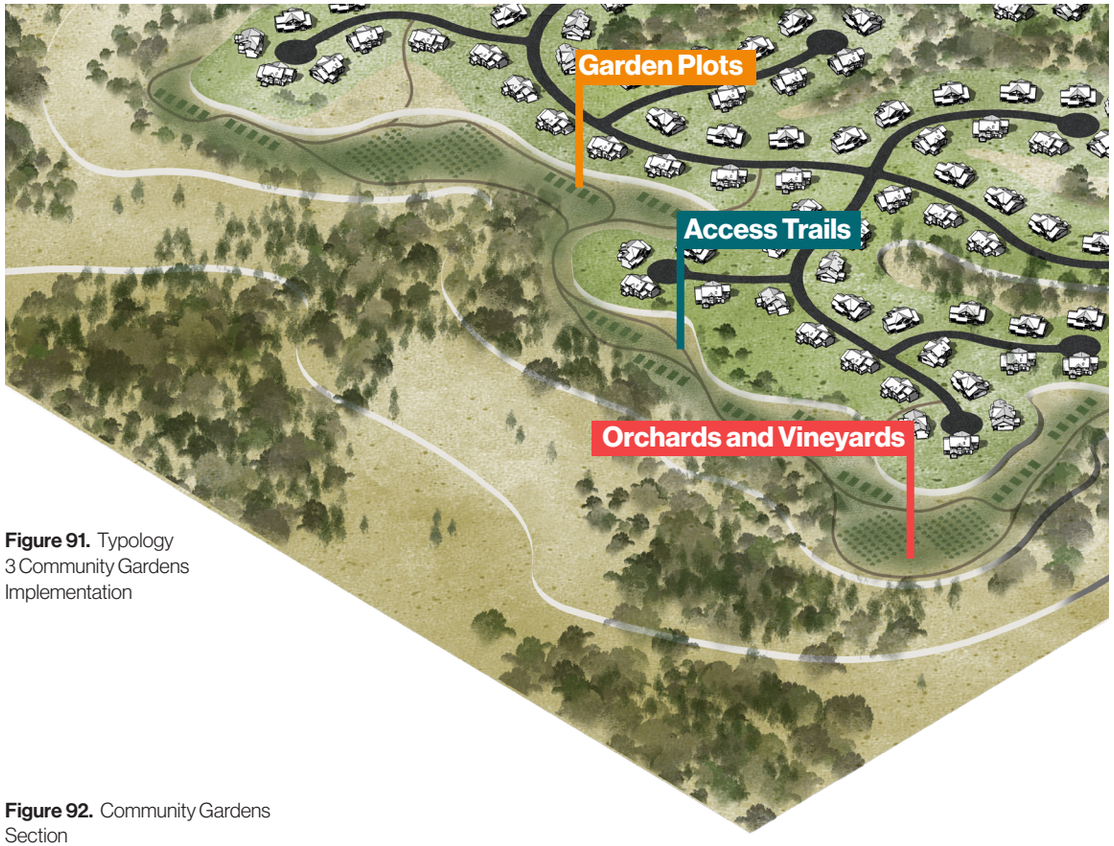


Figure 91. Typology 3 Community Gardens Implementation

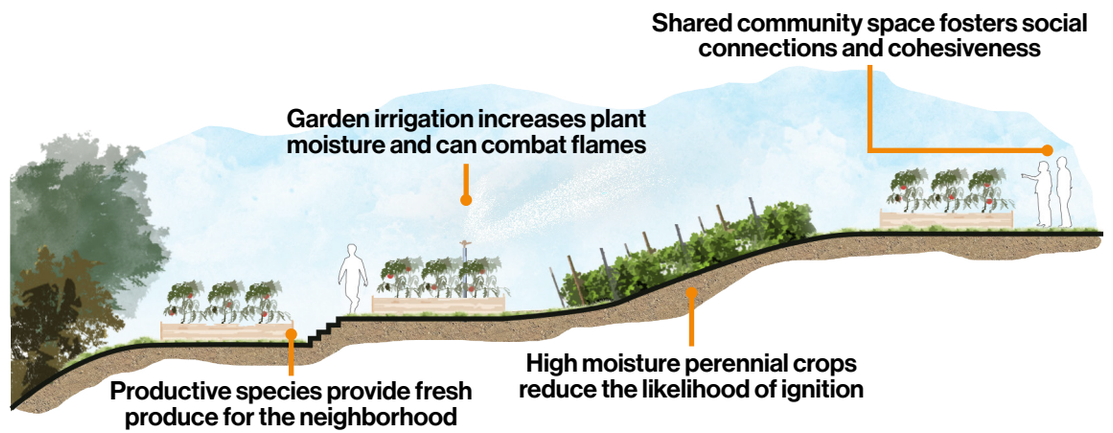


Figure 92. Community Gardens Section

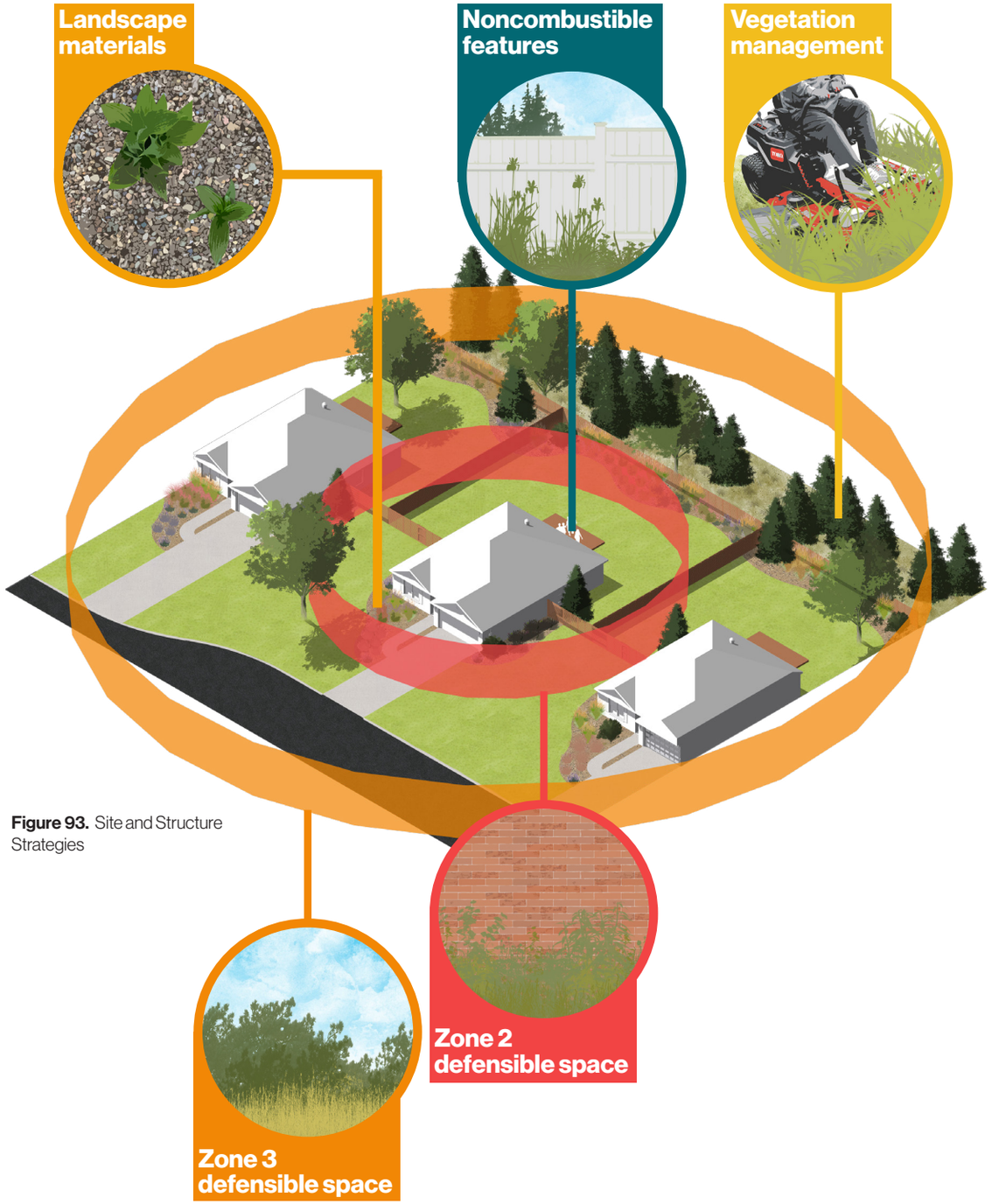


Figure 93. Site and Structure Strategies

Site and Structure Scale Strategies

Introduction

Homes are the structures most often affected by wildfires and comprise most land use within the wildland-urban interface (Donovan et al. 2020). Ensuring individual residences are prepared to handle wildfires can considerably decrease losses along the WUI. Typically, wildfire mitigation at the structure level focuses on creating defensible space and managing the home ignition zone (HIZ), which extends 100 feet from the structure in all directions (fig. 93).

Reducing flammability within this zone minimizes the likelihood that a wildfire will transition to structures and decreases the chance of structure-to-structure spread. Structures in this zone ignite from direct contact with flames, radiant heat, or wind-blown embers—mitigation strategies in the HIZ attempt to reduce risk from each of these threats (FEMA 2023). Creating defensible space, an area with minimal combustible vegetation and landscaping materials, ensures that the HIZ is less flammable than its surroundings.

Though effective in reducing wildfire risk, maintaining defensible space within the 100-foot HIZ may be difficult in denser suburban neighborhoods where zones overlap. Coordination between neighbors and communities is necessary to implement defensible space successfully (NFPA n.d.). The following section applies expert-supported mitigation strategies to the single-family and multi-family structures found in the Great Plains landscape typologies.

Expert Preferred Strategies

- Defensible Space Zone 3
- Noncombustible Landscape
- Defensible Space Zone 2
- Noncombustible Materials
- Vegetation Management

Additional Considerations

- Ease of Maintenance
- Cost of Implementation
- Aesthetics
- Ease of Implementation
- Nuisance Species Control

Defensible space

Overview

Defensible space zone 2

Defensible space zone 2 lies 5 to 30 feet from a structure. Landowners should remove dead plants, dried leaves, and overhanging branches from this area. Trees should be pruned to a minimum of 10 feet above the ground and be spaced at least 10 feet apart. Lawns and plant beds should be well maintained and adequately irrigated, and flammable vegetation should be kept short. (Idaho Firewise 2017a; United States Forest Service n.d.; Cal Fire n.d.) These strategies are relatively easy for the average landowner to implement, though they do require seasonal maintenance (fig.s 94-95).

Defensible space zone 3

Defensible space zone 3 lies 30-100 feet from the exterior walls of the building. Landowners should clear this zone of dried plant material, ensure combustible grasses are kept short, and reduce the density of eastern redcedar and other coniferous species through pruning or removal.

Landowners should also ensure adequate vertical separation between vegetation to reduce grass fires' likelihood of transitioning to more intense crown fires. Vertical separation between low-growing species and tree branches should be a minimum of three times the height of the low-growing species (United States Forest Service n.d.).

Though basic principles of defensible space remain the same for large multi-family structures, the radius of the defensible space must be much larger to accommodate the larger building footprint (fig. 95).

Additional Considerations

Ease of Maintenance

Ensuring defensible space remains capable of reducing wildfire risk requires routine maintenance. Undesirable plant species must be prevented from establishing and vegetation should be managed throughout the year.

Cost of Implementation

The cost of defensible space implementation likely depends how vegetation needs to be managed. Defensible space will be more costly to implement in lots with considerable woody coverage, whereas defensible space creation in grassy lots could be relatively affordable.

Aesthetics/Visual Quality

Defensible space may alter the aesthetic character of residential landscapes by removing woody species and altering the visual forms of vegetation. However, this can be offset by choosing less flammable species such as those featured on pages 124-129.

Challenges

Landowners have little incentive to perform defensible space modifications if they believe their wildfire risk to be low. Municipalities can encourage defensible space creation through wildfire education, outreach, and grant programs.

Defensible space often overlaps between structures, meaning residents must rely on neighbors to ensure their home is protected. Neighborhood-scale mitigation strategies can account for this problem.

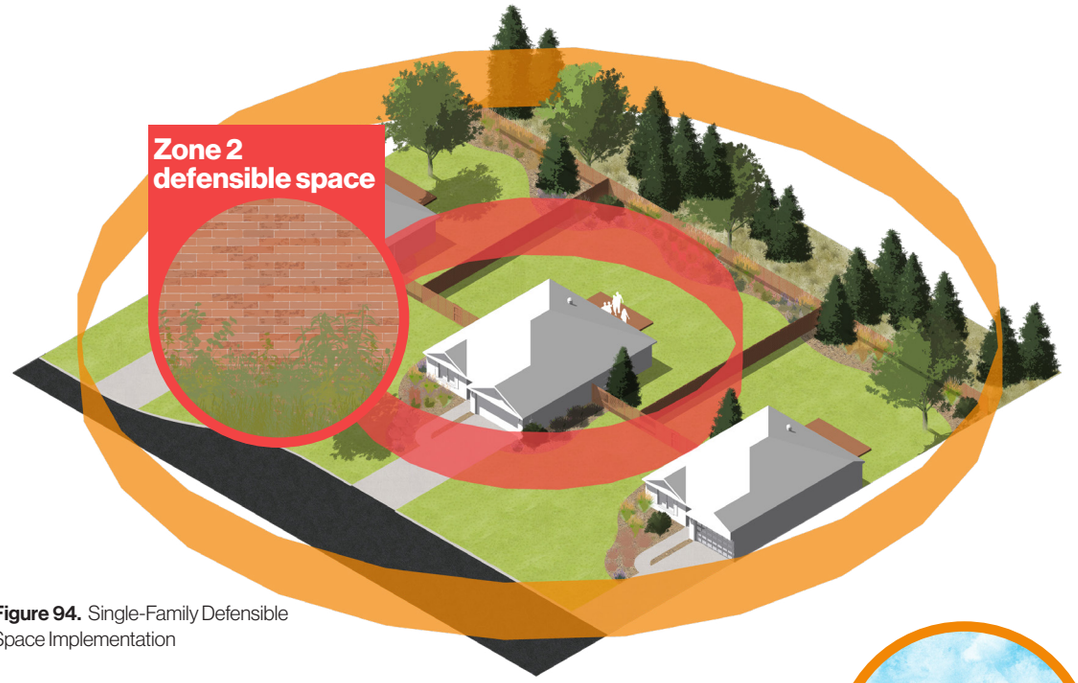


Figure 94. Single-Family Defensible Space Implementation

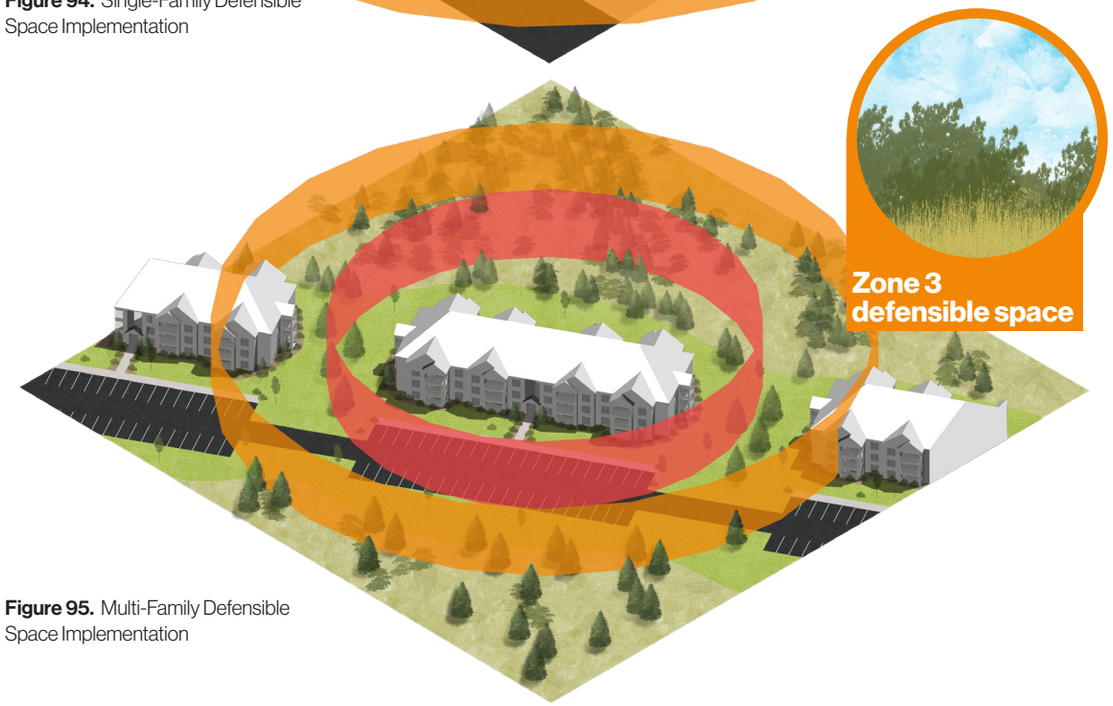


Figure 95. Multi-Family Defensible Space Implementation

Landscape materials

Overview

Landscape materials often act as fuels during wildfires. Dry mulch in plant beds may catch smoldering embers and ignite nearby plants, lawn furniture, and structures. This can be prevented by using non-combustible mulch material such as decomposed granite, coarse pumice, limestone chips, or pea gravel in plant beds (Fire Safe Marin 2021; Idaho Firewise 2017b).

Rock mulches provide a durable and attractive replacement for traditional wood mulch while being non-combustible (fig. 96). Additionally, rock mulch is lower maintenance, more affordable, and less erosion-prone than conventional wood mulch (Davey n.d.). Rock mulches may also be sourced locally from native stone, reducing the overall environmental impact of the landscape.

Installing hardscape materials such as stone pavers or concrete walks in residential yards and gardens can also reduce the ability of fire to spread close to homes. In multi-family settings, paved parking lots and access roads can be effective modes of halting wildfire spread (fig. 97). Where possible, paved surfaces can be placed between structures and wildlands to intercept flames before they come into contact with buildings.

Additional Considerations

Ease of Maintenance

Stone and hardscape material often require less maintenance than their alternatives. Stone mulches must be routinely cleared of dead plant material and weeds should be removed regularly. Hardscape walks and drives will require regular upkeep to fill cracks and ensure longevity.

Cost of Implementation

Stone and hardscape can be costly and difficult to implement for the average landowner. Stone is more expensive than most wood mulch and pavement is expensive to install. However, the increased longevity of stone and pavement may offset some of the initial costs of implementation.

Aesthetics/Visual Quality

Stone and hardscape elements invariably alter the visual quality of the landscape. In many landscapes, however, they can be pleasing aesthetic additions. In low-water landscapes, these features can augment aesthetics.

Challenges

Owners may be hesitant to move away from traditional landscape materials since many have been in widespread use for decades.

Though stone mulches have many benefits, they lack the organic contributions to the soil offered by wood mulches. Additionally, stone mulches may stress plants due to their higher heat retention.

Figure 96. Single-Family Landscape Material Implementation

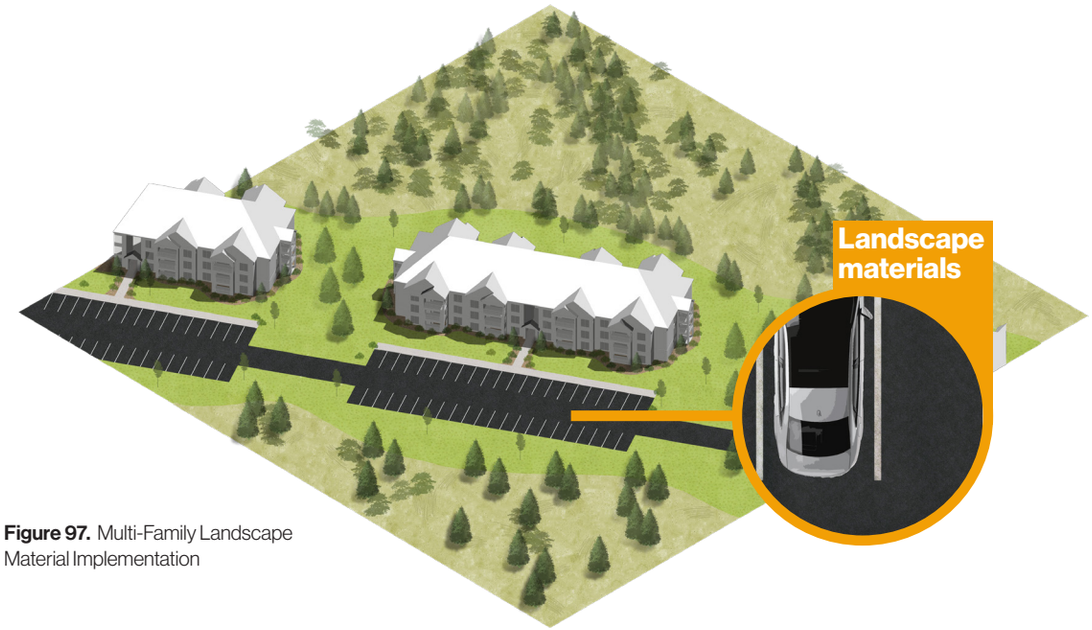


Figure 97. Multi-Family Landscape Material Implementation

Noncombustible features

Overview

Wooden decks and fences may ignite and carry flames to structures during wildfires. This risk can be mitigated by opting for non- or less-combustible materials (Idaho Firewise 2017a). Polymer or composite materials offer greater ignition resistance than wood, although they may burn more intensely if ignited due to their high plastic content.

Constructing decks with PVC, metal, or hardscape materials like brick and tile provides nearly non-combustible options; however, these options are more expensive and more challenging to construct (DeGroot 2014). In cases where deck construction with alternative materials is not feasible, a concrete or hardscape patio may be preferable. Similarly, wooden fences can be replaced with vinyl fences and masonry walls to reduce flamability. These fence materials may also intercept wind-blown embers before they reach the home ignition zone, further reducing wildfire risk (fig.s 98-99) (FEMA 2023).

Additional Considerations

Ease of Maintenance

Non- or less-combustible features are often lower maintenance than their more combustible, traditional alternatives. Metal and stone landscape features may last decades with basic maintenance, such as cleaning, painting, and repairing cracks.

Cost of Implementation

For certain features, such as decks or patios, concrete and stone may be more affordable than wood construction. Similarly, concrete or paver patios may require less ongoing maintenance than wooden decks, reducing long-term costs associated with maintenance.

Aesthetics/Visual Quality

Concrete, stone, PVC, and metal landscape features come in a variety of shapes, sizes, and finishes. Landowners can choose from a vast selection of concrete stains, paver styles, metal materials, and PVC colors. Additionally, many companies offer selections that mimic the look of wood.

Challenges

Neighborhoods and homeowners associations may have regulations that mandate certain materials be used to construct fences, decks, and other landscape features.

Owners may be hesitant to use a material they are unfamiliar with. Maintenance requirements for new materials may differ from what residents are used to.

Some upfront costs for certain features, such as fences, will be higher when built with less flammable materials.

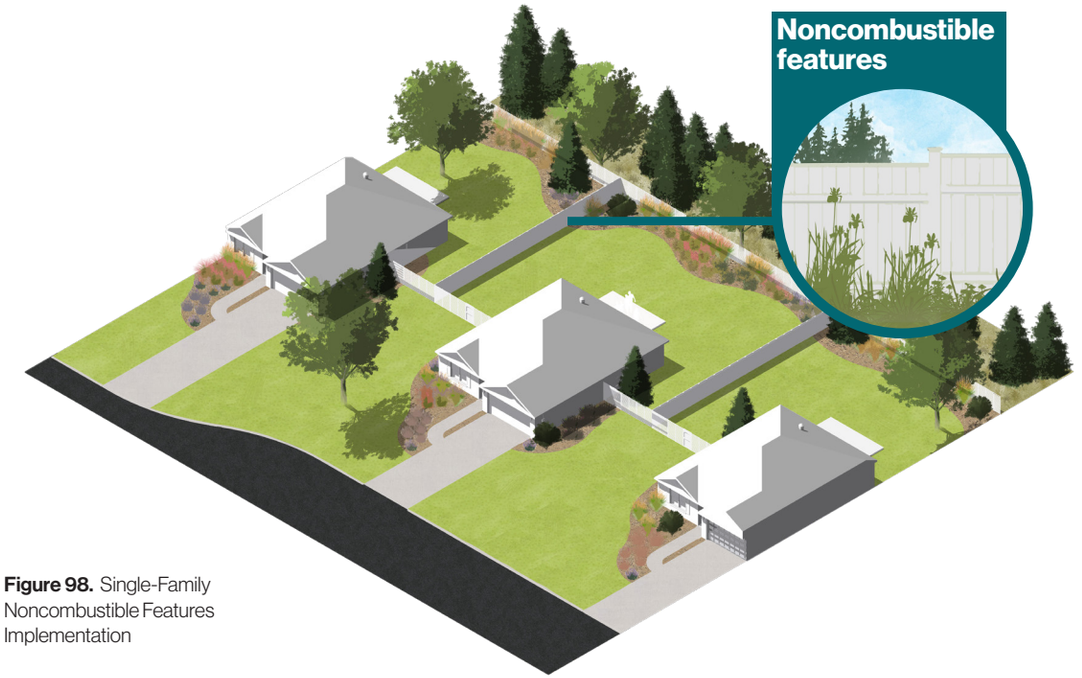


Figure 98. Single-Family Noncombustible Features Implementation

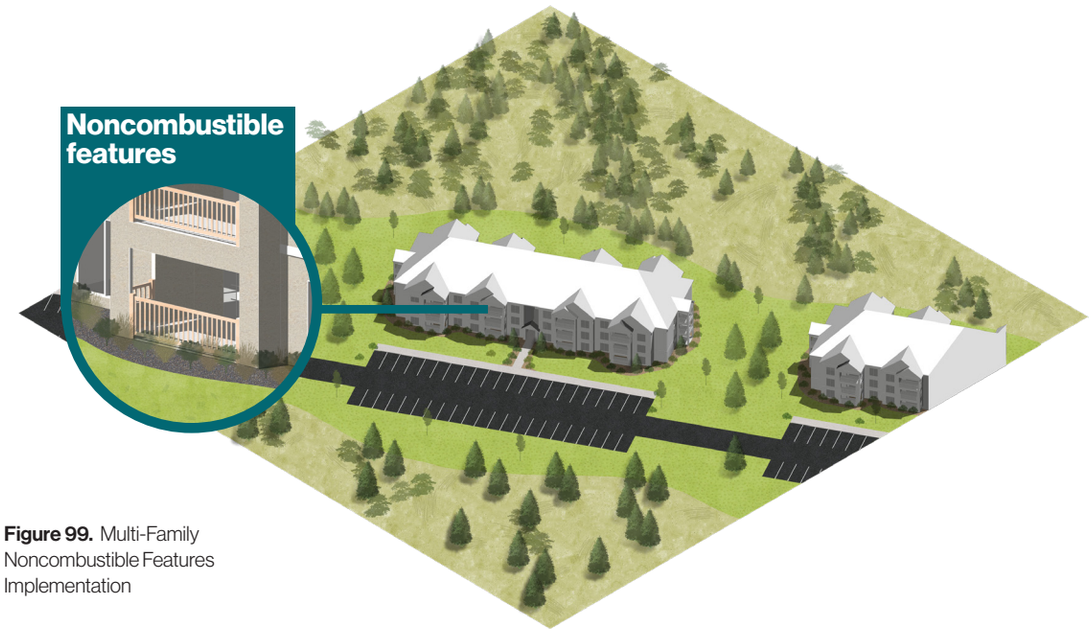


Figure 99. Multi-Family Noncombustible Features Implementation

Vegetation management

Overview

Managing native vegetation within and adjacent to the home ignition zone can significantly reduce wildfire risk. A path of continuous vegetation between home landscaping and adjacent wildlands can provide a channel for fire to enter the home ignition zone. To mitigate the risk of structure fire, steps should be taken to reduce the likelihood of fire entering the HIZ and minimize its impacts if it does. Native grasses near structures should be kept below 4 inches, and ladder fuels should be thinned. Reducing the availability of ladder fuels makes it less likely that a low-intensity grass fire will become a high-intensity crown fire in the canopy of trees. Likewise, overlap between tree crowns should be minimized to reduce spread if trees ignite (Cal Fire n.d.).

Vegetation near structures should be healthy and regularly irrigated since green vegetation is much less likely to burn. Coniferous species should be avoided in foundation plantings alongside structures, and grasses should be cut back seasonally. High-moisture or drought-resistant plants such as broadleaf trees and native forbs are much less likely to ignite and should be prioritized when designing residential plantings (fig.s 100-101) (FEMA 2023).

Additional Considerations

Ease of Maintenance

Tall vegetation should be regularly cut back. In growing seasons, this may mean weekly mowing to ensure vegetation remains below 4 inches in height. Similarly, woody species should be pruned seasonally to keep branches from reaching over adjacent structures.

Cost of Implementation

Like the creation of defensible space, the cost of initial vegetation management will vary based on what vegetation is present. Pruning branches, reducing ladder fuels, and managing undesirable woody species will be much more costly than trimming grasses and irrigating herbaceous plants. Though initial implementation may be costly, ongoing costs should be considerably lower.

Aesthetics/Visual Quality

Managing vegetation can increase the overall visual quality of residential landscapes. Thinned vegetation increases visibility and allows sunlight to reach the ground, encouraging the growth of diverse species.

Challenges

Vegetation management adjacent to structures may have to occur on lands owned by a private third-party. Coordination between landowners may be difficult to achieve.

Residents of multi-family structures have little control over how the surrounding landscape is managed, meaning owners must take initiative to reduce risk to their occupants.

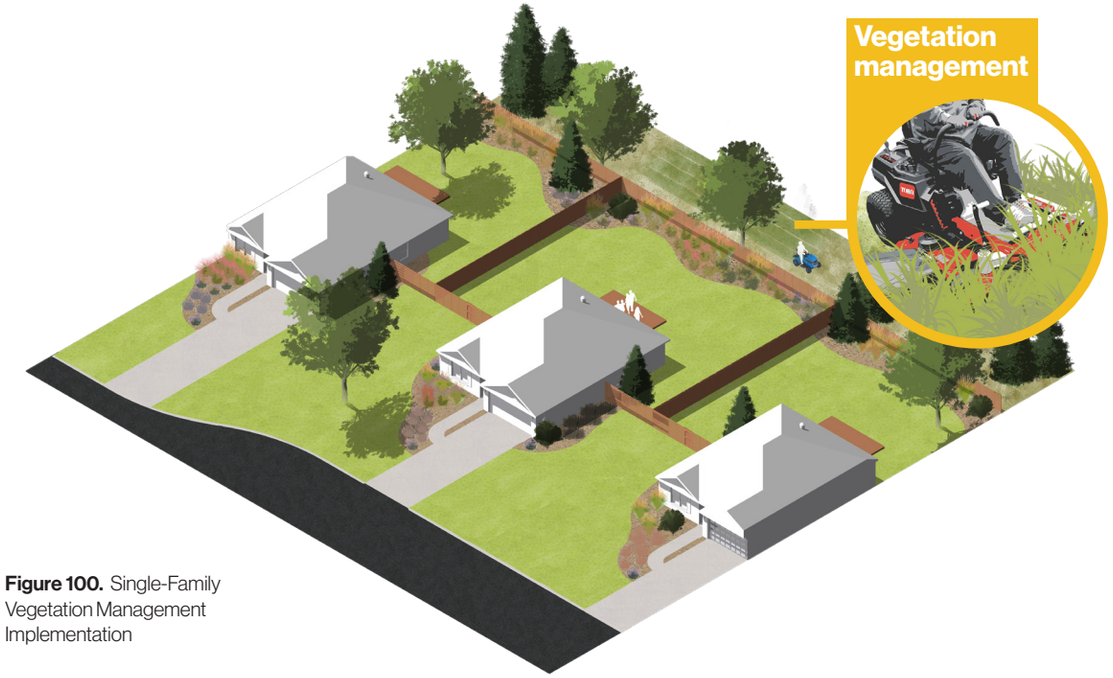


Figure 100. Single-Family Vegetation Management Implementation

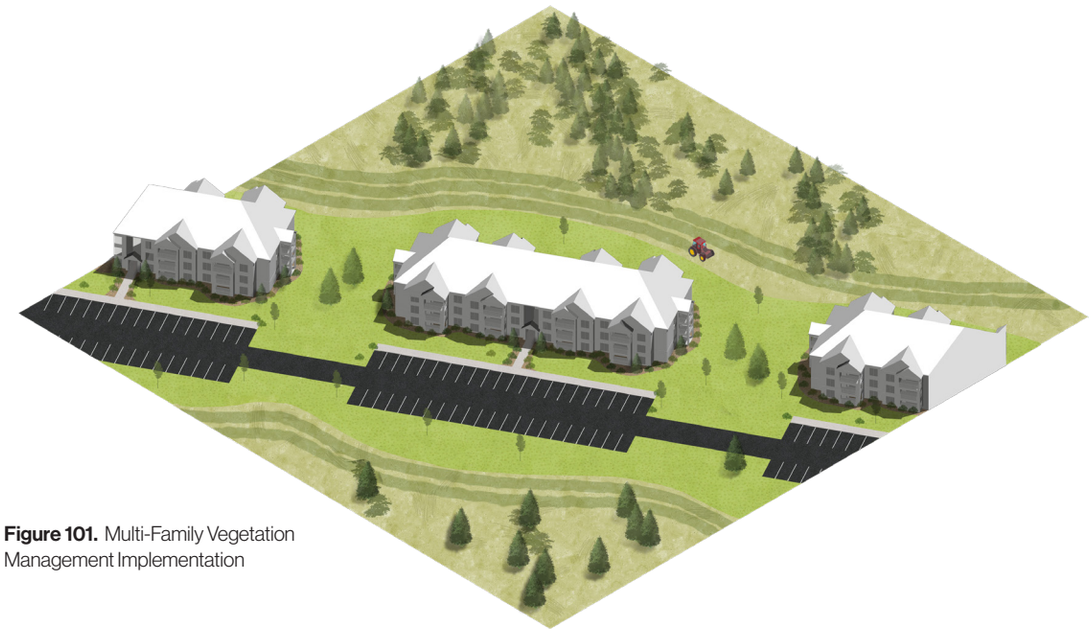


Figure 101. Multi-Family Vegetation Management Implementation

VI Conclusion

Key Results

This study developed conceptual mitigation strategies for Great Plains communities informed by the mitigation preferences of wildfire experts within the region, resident risk perceptions, and the study of the wildland-urban interface of Manhattan, Kansas. This research utilized qualitative observation of WUI characteristics and statistical analysis of the results to determine common development patterns within the study site.

Next, the study employed survey instruments to collect the wildfire risk perceptions of Manhattan, Kansas-area residents and the wildfire mitigation preferences of professionals across the Great Plains. A study of mitigation strategies used in other fire-prone areas informed questions used in the survey. Finally, results from each study objective were used to apply conceptual mitigation strategies to generalized Great Plains landscape typologies. These techniques successfully address the research question, "How can design, planning, and land management strategies mitigate Great Plains wildfire risk at the city, neighborhood, and individual household scales?"

The results of the research reveal varied perceptions among survey participants. Rural residents are more likely to be aware of wildfire risk and have taken actions to mitigate their risk. Conversely, residents who identify as living in urban areas are less likely to have taken action to protect themselves or their property. These findings imply that residents living along the WUI, which is often urbanized, are less likely to be aware of their exposure to wildfire. However, residents who live in more rural WUI areas, which often fall within the "intermix" category, may have already taken risk reduction actions and have greater awareness of their wildfire risk. Despite the discrepancy in risk awareness, most survey area residents believe Great Plains communities are at risk of wildfire. Likewise, respondents overwhelmingly support actions to reduce wildfire risk at the city, neighborhood, and individual site and structure scales.

The resident survey findings also carry significant findings regarding mitigation strategy design and implementation. Notably, Most residents live where they do, in part, because of the aesthetic features of the landscape. Of these residents, respondents prefer the aesthetic qualities of trees over grasses, meaning that strategies focusing on reducing woody fuels may be unpopular with residents. These findings conflict with many mitigation techniques that focus on reducing the presence of eastern redcedar and other woody ladder fuels and indicate that mitigation near residential areas should be done with minimal disturbance to the visual qualities of the landscape.

Findings from the expert survey revealed preferences for mitigation techniques that prioritized vegetation management across the city, neighborhood, and individual structure/site scales. Strategies focused on managing existing combustible vegetation comprised at least three of the top five mitigation strategies at each scale. Similarly, ease of maintenance was the most important additional aspect to consider at each scale.

Like mitigation preference, risk perception among expert respondents is consistent, with 80% agreeing that wildfires are a growing threat in the Great Plains. Likewise, 80% agree that a fire similar to the 2023 Lahaina, Maui Fire is possible in the region, while 55.1% of residents surveyed agree that such an event is possible. This finding highlights a gap in risk perception among experts and residents.

Discussion and Implications

Wildfire mitigation is possible in the Great Plains using established mitigation strategies. However, adjustments must be made to suit the region. Most notably, strategies focused on vegetation management look significantly different than in the West. Though woody species, such as trees and shrubs, burn at disproportionately high rates across much of the region, grass remains the primary carrier of wildfire in the Great Plains. Effectively reducing wildfire threat from grasses requires near-constant effort due to their high growth rates. Seasonal use of mechanical, chemical, targeted grazing, or prescribed fire methods is necessary to reduce fuel loads. This maintenance is not easy in an ecosystem where native grasses are fire-adapted.

Though grasses currently comprise the most significant threat, eastern redcedar encroachment significantly complicates wildfire mitigation in the region. Fire is often absent from landscapes near residential areas, leading to a rapid transition from a prairie ecosystem to a conifer woodland. Though this transition to woody dominance may make "traditional" mitigation strategies used in the forested landscapes of the West more effective, the increased fire intensity in conifer stands drastically increases risk to the WUI and, subsequently, increases the need for mitigation. Like managing threat from grasses, reducing wildfire threat in established stands of eastern redcedar requires considerable effort. Manual or mechanical removal of eastern redcedar is often necessary, requiring high initial investments of money and effort.

Ultimately, the combination of both highly combustible grasses and the increasing presence of woody fuels presents the most pressing threat to interface communities. Woody fuels in areas where fire has been absent for decades allow fast-moving, lower-intensity grass fires to transition to high-intensity forest fires close to development. This complex relationship necessitates that wildfire mitigation occurs across scales. City-scale interventions reduce the likelihood of ignition and reduce fire intensity, neighborhood-scale interventions mitigate the impact on communities and reduce spread if a wildfire occurs, and structure-scale mitigation prepares homes to manage the effects of wildfire.

Though wildfire mitigation is possible in the Great Plains, the feasibility of its application is more complicated due to the region's high rates of private land ownership. Wildfire mitigation across much of the West is conducted on public land administered by federal, state, or local agencies; however, the prevalence of private land ownership of Great Plains wildlands means that mitigation must involve private stakeholders who may have no incentive to reduce wildfire risk. Successful large-scale mitigation will require coordination between private and public

stakeholders, and potential incentives or penalties for those reluctant to participate.

Findings from both the expert and resident surveys also carry interesting implications for wildfire mitigation in the Great Plains. Development and built environment mitigation techniques were frequently rated as the least effective strategies by Great Plains wildfire experts. Limiting development in high-risk areas and alterations to urban form, such as clustering or spreading out structures, were rated poorly compared to strategies focused on reducing fuel levels. This is contrary to findings in fire science literature, which have frequently found landscape position, urban form, and density to be the most significant factors in determining structure survival during wildfires (Alexandre, Stewart, Keuler, et al. 2016; Alexandre, Stewart, Mockrin, et al. 2016). Notably, clustering structures to reduce wildfire exposure received the lowest effectiveness rating from experts despite being recommended practice in emerging fire-resiliency planning and design literature (Syphard et al. 2012).

Similarly, managing the space from 0 to 5 feet of a structure with landscape and vegetation modification was among the lowest-rated mitigation methods at the structure scale despite being the most critical zone for reducing home ignition (Syphard and Keeley 2019; Knapp et al. 2021) These discrepancies highlight a significant information gap between wildfire literature and practitioners.

Finally, despite wildfire risk within the study site being comparable to the rural areas of the broader survey area, none of the resident survey respondents residing within the study site identified as living in a rural setting. This suggests that residents within the study site may be exposed to high levels of risk without adequate awareness of the wildfire threat.

Notably, residents within the study area, despite facing similar levels of risk, are less likely to have taken preparedness or mitigation actions than their rural counterparts. These findings underscore the potential lack of preparedness and awareness among residents in wildland-urban interface communities in the Great Plains. While public outreach and education are crucial for increasing awareness, implementing effective mitigation measures can significantly reduce the risk faced by these communities. Mitigation will become crucial as the Great Plains wildfire threat grows and communities rapidly expand into combustible wildlands, just as neighborhoods in the study site have (fig. 102).

Figure 102. Study Site Growth Through Time

Limitations

Though Manhattan, Kansas lies within the Great Plains region, numerous factors contributing to fire behavior and urban development may not be universal across the region. Identified landscape typologies and proposed mitigation strategies may be less relevant in communities with different topography, vegetation, urban form, etc. Similarly, risk varies considerably across the region, meaning the need for mitigation strategies is not universal.

Additionally, a lack of past research into wildfire behavior and risk in the Great Plains provides a sparse, directly-related theoretical basis for research. Most wildfire research in the United States focuses on ecosystems of the West, with very little research examining wildfire variables in the Great Plains. Therefore, the foundational basis for this project primarily employs findings from across the West– though some recent region-specific research has been used. Since fire dynamics are dependent on landscape factors, fire behavior in Western states may not directly transfer to the Great Plains region. This limitation highlights a research gap for future study.

Respondents to the expert survey in Objective 3b were primarily fire personnel and emergency management officials. Though input from these professionals is extraordinarily valuable, the opinions of designers, planners, and land managers may have been underrepresented in this study. The application of mitigation strategies in Chapter V was directly informed by survey results, meaning this research may not be adequately representative of the diversity of opinions within wildfire-related industries.

Future Study

Though this study analyzed numerous aspects of wildfire mitigation in the Great Plains, it also left many questions unanswered and revealed topics for future study. Among these are the disconnect between wildfire research and implementation, typological analysis of WUI areas across the region, and broader exploration of wildfire perceptions of Great Plains residents.

Wildfire practitioners who are involved in regular wildfire mitigation, suppression, design, and planning work ranked vegetation management strategies as more effective in mitigating risk than development-based strategies, which is counter to emerging fire science literature. Future research should focus on how information flow between practitioners and researchers can be improved.

Though this study began the analysis of WUI communities in the Great Plains, the results cannot be extrapolated beyond the study site. To better understand WUI communities across the region, more research should be conducted into the built and natural landscape features along the interface region-wide. This knowledge will allow communities to identify vulnerable locations and work toward the implementation of highly specific, research-informed mitigation strategies.

Finally, more research must be done on wildfire risk perceptions of Great Plains residents. This research surveyed a small population of residents in Manhattan, Kansas, but more understanding of resident perceptions across the region will allow wildfire practitioners to educate and mitigate more effectively.

References

Abatzoglou, John T., and A. Park Williams. 2016. “Impact of Anthropogenic Climate Change on Wildfire across Western US Forests.” Proceedings of the National Academy of Sciences 113, no. 42 (October): 11770–75. https://doi.org/10.1073/pnas.1607171113.

Ager, Alan A., Palaiologos Palaiologou, Cody R. Evers, Michelle A. Day, Chris Ringo, and Karen Short. 2019. “Wildfire Exposure to the Wildland Urban Interface in the Western US.” Applied Geography 111, no. October (October): 102059. https://doi.org/10.1016/j.apgeog.2019.102059.

Alexandre, Patricia, Susan I. Stewart, Nicholas S. Keuler, Murray K. Clayton, Miranda H. Mockrin, Avi Bar-Massada, Alexandra D. Syphard, and Volker C. Radeloff. 2016. “Factors Related to Building Loss Due to Wildfires in the Conterminous United States.” Ecological Applications 26, no. 7: 2323–38. https://doi.org/10.1002/eap.1376.

Alexandre, Patricia, Susan Stewart, Miranda Mockrin, Nicholas Keuler, Alexandra Syphard, Avi Bar-Massada, Murray Clayton, and Volker Radeloff. 2016. “The Relative Impacts of Vegetation, Topography and Spatial Arrangement on Building Loss to Wildfires in Case Studies of California and Colorado.” Landscape Ecology 31, no. January (January): 415–30. https://doi.org/10.1007/s10980-015-0257-6.

Allen, Matthew S., and Michael W. Palmer. 2011. “Fire History of a Prairie/Forest Boundary: More than 250 Years of Frequent Fire in a North American Tallgrass Prairie.” Journal of Vegetation Science 22, no. 3: 436–44. https://doi.org/10.1111/j.1654-1103.2011.01278.x.

Armbrust, Ryan. 2018. “Eastern Redcedar Expansion: Perspective, Response, and Strategy.” Kansas Forest Service.

Bernard, Cornell. 2023. “How Massive Wildfire Break around This Bay Area City Could Protect Thousands of Homes.” ABC7 San Francisco. May 8, 2023. https://abc7news.com/california-wildfire-fire-buffer-zone-novato-marin-county/13216480/.

Blocksome, Carol. 2015. “Prescribed Burning Notebook.” Kansas State University. https://www.ksfire.org/education/docs/BurnBook_Winter_2015-2016%20WITH%20COVERS.pdf.

Cal Fire. n.d. “Defensible Space.” Ready for Wildfire. Accessed February 8, 2024. https://www.readyforwildfire.org/prepare-for-wildfire/get-ready/defensible-space/.

Calkin, David E., Jack D. Cohen, Mark A. Finney, and Matthew P. Thompson. 2014. “How Risk Management Can Prevent Future Wildfire Disasters in the Wildland-Urban Interface.” Proceedings of the National Academy of Sciences 111, no. 2 (January): 746–51. https://doi.org/10.1073/pnas.1315088111.

Canada in a Changing Climate. n.d. “Ecosystem Services Provided by Ontario’s Greenbelt.” Accessed March 16, 2024. https://changingclimate.ca/map/ecosystem-services-provided-by-ontarios-greenbelt/.

Carter, S, N Goeckner, C Julian, L Langelo, I Shonle, and C Dennis. n.d. “Low-Flammability Landscape Plants.”

Davey. n.d. “Landscaping Pros and Cons of Rocks Vs. Mulch.” Accessed February 8, 2024. https://blog.davey.com/landscaping-pros-and-cons-of-rocks-vs-mulch/.

DeGroot, Paul. 2014. “How to Build a Fire Resistant Deck.” Fine Homebuilding. July 11, 2014. https://www.finehomebuilding.com/project-guides/decks/decks-that-stand-up-to-wildfire.

Donovan, Victoria M., Carissa L. Wonkka, and Dirac Twidwell. 2017. “Surging Wildfire Activity in a Grassland Biome.” Geophysical Research Letters 44, no. 12: 5986–93. https://doi.org/10.1002/2017GL072901.

Donovan, Victoria M., Carissa L. Wonkka, David A. Wedin, and Dirac Twidwell. 2020. “Land-Use Type as a Driver of Large Wildfire Occurrence in the U.S. Great Plains.” Remote Sensing 12, no. 11 (January): 1869. https://doi.org/10.3390/rs12111869.

Dougherty, Michael T, and Curtis Johnson. 2023. “Marshall Fire Investigative Summary and Review.” Boulder County.

Evers, Cody R., Alan A. Ager, Max Nielsen-Pincus, Palaiologos Palaiologou, and Ken Bunzel. 2019. “Archetypes of Community Wildfire Exposure from National Forests of the Western US.” Landscape and Urban Planning 182, no. February (February): 55–66. https://doi.org/10.1016/j.landurbplan.2018.10.004.

FEMA Mitigation Assessment Team. 2023a. “Best Practices for Wildfire-Resilient Subdivision Planning.” United States Department of Homeland Security.

———. 2023b. “Marshall Fire: Building Performance, Observations, Recommendations, and Technical Guidance.” United States Department of Homeland Security. https://www.fema.gov/sites/default/files/documents/fema_p2320-marshall-fire-mat-report-appendices.pdf.

———. 2023c. “Marshall Fire Mitigation Assessment Team: Homeowner’s Guide to Reducing Wildfire Risk Through Defensible Space.” United States Department of Homeland Security. https://www.fema.gov/sites/default/files/documents/fema_marshall-fire-mat-homeowners-guide-defensible-space.pdf.

Fire Safe Marin. 2021a. “How to Use Fire-Resistant Mulch - Fire Safe Marin.” June 1, 2021. https://firesafemarin.org/create-a-fire-smart-yard/mulch/.

———. 2021b. “Safe Evacuation Routes.” June 1, 2021. https://firesafemarin.org/programs/safe-evacuation-routes/.

Fu, Xiao, Abigail Lidar, Michael Kantar, and Barath Raghavan. 2023. “Edible Fire Buffers: Mitigation of Wildfire with Multifunctional Landscapes.” PNAS Nexus 2, no. 10 (October): pgad315. https://doi.org/10.1093/pnasnexus/pgad315.

Gao, Peng, Adam J. Terando, John A. Kupfer, J. Morgan Varner, Michael C. Stambaugh, Ting L. Lei, and J. Kevin Hiers. 2021. “Robust Projections of Future Fire Probability for the Conterminous United States.” Science of The Total Environment 789, no. October (October): 147872. https://doi.org/10.1016/j.scitotenv.2021.147872.

Greenbelt Alliance. 2021. “The Critical Role of Greenbelts in Wildfire Resilience.” https://www.greenbelt.org/.

Gude, Patricia, Ray Rasker, and Jeff van den Noort. 2008. “Potential for Future Development on Fire-Prone Lands.” Journal of Forestry 106, no. 4 (June): 198–205. https://doi.org/10.1093/jof/106.4.198.

Hanberry, Brice B. 2020. “Classifying Large Wildfires in the United States by Land Cover.” Remote Sensing 12, no. 18 (September): 2966. https://doi.org/10.3390/rs12182966.

Harr, Ryan, Lois Wright Morton, Shannon Rusk, David Engle, James Miller, and Diane Debinski. 2014. “Landowners’ Perceptions of Risk in Grassland Management: Woody Plant Encroachment and Prescribed Fire.” Ecology and Society 19, no. 2 (May). https://doi.org/10.5751/ES-06404-190241.

Headwaters Economics. 2012. “Multiuse Trails: Benefits and Concerns of Residents and Property Owners.” Headwaters Economics. 2012. https://headwaterseconomics.org/trail/32-multiuse-trails-benefits-and-concerns/.

Heath, Jessica. 2023. “New Drone Research Advances Wildfire Monitoring.” UC Davis. August 28, 2023. https://www.ucdavis.edu/climate/news/new-drone-research-advances-wildfire-monitoring.

Hupp, Erica, and Chris Sukach. 2021. “Hazardous Fuels Reduction with Sheep Near Reno’s Arrowcreek Community.” April 29, 2021. https://www.fs.usda.gov/wps/portal/fsinternet3/cs/detail/htnf/news-events/.

Idaho Firewise. 2017a. “Fire Resistant Homes.” March 8, 2017. https://idahofirewise.org/firewise-homes/firewise-building-materials/.

———. 2017b. “Fire Resistant Landscapes.” March 8, 2017. https://idahofirewise.org/firewise-landscapes/.

———. 2017c. “Landscape Design.” March 8, 2017. https://idahofirewise.org/firewise-landscapes/firewise-landscape-design/.

———. 2017d. “Plant Materials.” March 8, 2017. https://idahofirewise.org/firewise-landscapes/firewise-plant-materials/.

International Code Council. 2021. “International Wildland-Urban Interface Code.” ICC Digital Codes. 2021. https://codes.iccsafe.org/content/IWUIC2021P1/preface.

Jolly, W. Matt, Mark A. Cochrane, Patrick H. Freeborn, Zachary A. Holden, Timothy J. Brown, Grant J. Williamson, and David M. J. S. Bowman. 2015. “Climate-Induced Variations in Global Wildfire Danger from 1979 to 2013.” Nature Communications 6, no. July (July): 7537. https://doi.org/10.1038/ncomms8537.

Jones, Matthew, Adam Smith, Richard Betts, Josep Canadell, I. Colin Prentice, and Corinne Le Quere. 2020. “Climate Change Increases the Risk of Wildfires.” ScienceBrief.org. https://www.preventionweb.net/files/73797_wildfiresbriefingnote.pdf.

Kalthoff, John. 2023. “Vegetation Management: The Utility’s Role in Wildfire Mitigation.” Smart Energy International. July 31, 2023. https://www.smart-energy.com/industry-sectors/energy-grid-management/the-utilitys-role-in-wildfire-mitigation/.

Kansas Forest Service. 2023. “Kansas Wildfire Risk Assessment Portal.” 2023. https://kansaswildfirerisk.org/.

Knapp, Eric E., Yana S. Valachovic, Stephen L. Quarles, and Nels G. Johnson. 2021. “Housing Arrangement and Vegetation Factors Associated with Single-Family Home Survival in the 2018 Camp Fire, California.” Fire Ecology 17, no. 1 (October): 25. https://doi.org/10.1186/s42408-021-00117-0.

Little, Jenn. 2020. “EPA Region 7 Research Spotlight: Studying Fire in the Flint Hills.” Overviews and Factsheets. Missouri. August 28, 2020. https://www.epa.gov/ks/epa-region-7-research-spotlight-studying-fire-flint-hills.

London Green Belt Council. 2022. “History of the Green Belt.” 2022. https://londongreenbeltcouncil.org.uk/history-of-the-london-green-belt/.

Macdonald, Stuart. 2018. “Power Lines along Trails.” American Trails. October 16, 2018. https://www.americantrails.org/resources/power-lines-along-trails.

Missouri Department of Conservation. n.d. “Eastern Red Cedar.” Accessed February 4, 2024. https://mdc.mo.gov/discover-nature/field-guide/eastern-red-cedar.

National Oceanic and Atmospheric Administration. n.d. “Fire Weather Tools.” Accessed March 16, 2024. https://www.noaa.gov/noaa-wildfire/fire-weather-tools.

National Park Service. n.d. “Wildland Fire Monitoring.” Accessed March 16, 2024. https://www.nps.gov/articles/wildland-fire-monitoring.htm.

Natural Resource Conservation Service. 2006. “Firebreak- Code 394.” Natural Resource Conservation Service. https://efotg.sc.egov.usda.gov/references/Delete/2011-10-8/Archived_394_Final_111005.pdf.

———. 2020. “Fuel Break Forestland- Code 383.” Natural Resource Conservation Service. https://efotg.sc.egov.usda.gov/api/CPSFile/20901/383_PS_CA_Fuel_Break-Forestland_05-2020.

Nebraska Conservation Roundtable. 2016. “Eastern Redcedar in Nebraska: Problems and Opportunities.” Nebraska Forest Service. https://nfs.unl.edu/publications/downloads/Cedar%20Issue%20Paper%20July%202016%20w%20signatures.pdf.

NFPA. n.d. “Reducing Wildfire Risks in the Home Ignition Zone.” NFPA. Accessed February 8, 2024. https://idahofirewise.org/wp-content/uploads/2019/12/ReducingWildfireRisksHIZ.pdf.

Noble, Brynn. 2023. “Early Detection of Wildfire Risk in the Great Plains: Merging Machine Learning, Landscape Metrics, and Rich Data Sources.” Kansas State University.

Oklahoma State University Extension. 2017. “Firebreaks for Prescribed Burning.” March 1, 2017. https://extension.okstate.edu/fact-sheets/firebreaks-for-prescribed-burning.html.

Oregon State University. n.d. “Firebreaks and Shaded Fuelbreaks.” Oregon State University. https://ir.library.oregonstate.edu/downloads/q237hs27w#:~:text=Fires%20can%20burn%20through%20the,intensity%20and%20rate%20of%20spread.&text=Effective%20shaded%20fuelbreaks%20need%20to%20be%20much%20wider%20than%20firebreaks.&text=Need%20to%20be%20retreated%20aproximately%20every%2010%20years%20depending%20on%20site%20productivity.

Price, Owen, and Ross Bradstock. 2014. “Countervailing Effects of Urbanization and Vegetation Extent on Fire Frequency on the Wildland Urban Interface: Disentangling Fuel and Ignition Effects.” Landscape and Urban Planning 130, no. October (October): 81–88. https://doi.org/10.1016/j.landurbplan.2014.06.013.

“Quantitative Wildfire Risk Assessment Considerations.” 2023. Interagency Fuel Treatment Decision Support System. https://iftdss.firenet.gov/firenetHelp/help/pageHelp/content/30-tasks/qwra/risk/qwraconsiderations.htm?TocPath=Cycle%7CStrategic%20Planning%7CRisk%20Assessment%7C____5.

Radeloff, Volker C., David P. Helmers, H. Anu Kramer, Miranda H. Mockrin, Patricia M. Alexandre, Avi Bar-Massada, Van Butsic, et al. 2018. “Rapid Growth of the US Wildland-Urban Interface Raises Wildfire Risk.” Proceedings of the National Academy of Sciences 115, no. 13 (March): 3314–19. https://doi.org/10.1073/pnas.1718850115.

Rao. 2020. “Benefits of Cattle Grazing for Reducing Fire Fuels and Hazard.” UC Berkeley Rausser College of Natural Resources. September 11, 2020. https://nature.berkeley.edu/news/2020/09/benefits-cattle-grazing-reducing-fire-fuels-and-fire-hazard.

Ratajczak, Zak, John M. Briggs, Doug G. Goodin, Lei Luo, Rhett L. Mohler, Jesse B. Nippert, and Brian Obermeyer. 2016. “Assessing the Potential for Transitions from Tallgrass Prairie to Woodlands: Are We Operating Beyond Critical Fire Thresholds?” Rangeland Ecology & Management 69, no. 4 (July): 280–87. https://doi.org/10.1016/j.rama.2016.03.004.

Ratajczak, Zak, Jesse B. Nippert, John M. Briggs, and John M. Blair. 2014. “Fire Dynamics Distinguish Grasslands, Shrublands and Woodlands as Alternative Attractors in the Central Great Plains of North America.” Journal of Ecology 102, no. 6: 1374–85. https://doi.org/10.1111/1365-2745.12311.

Schlickman, Emily, and Brett Milligan. 2023. Design By Fire: Resitance, Co-Creation, and Retreat in the Pyrocene. Routledge.

Seattle City Light. 2023. “Wildfire Risk Reduction Strategy.” https://www.seattle.gov/documents/departments/citylight/environment/wildfireriskreductionstrategy.pdf.

Sheridan, P.M., Steve Orzell, and Edwin Bridges. 1999. “Powerline Easements as Refugia for State Rare Seepage and Pineland Plant Taxa.” The Sixth International Symposium on Environmental Concerns in Rights-Of-Way Management, January (January), 451–60.

Simon, Matt. 2023. “Burying Power Lines Prevents Wildfires. But There’s a Cost.” Wired, September 1, 2023. https://www.wired.com/story/the-high-stakes-calculus-of-preventing-wildfires-by-burying-power-lines/.

Skidmore, Owings and Merrill. 2021. “Designing Communities for Wildfire Resilience.” Skidmore, Owings and Merrill. https://www.som.com/wp-content/uploads/2021/09/Designing-Communities-for-Wildfire-Resilience_reduced_FINAL-1632896152.pdf.

Solis, Nathan. 2022. “Former PG&E Executives Agree to $117-Million Settlement over California Wildfires.” Los Angeles Times. September 29, 2022. https://www.latimes.com/california/story/2022-09-29/former-pg-e-executives-announce-117-million-settlement-over-california-wildfires.

South County Project. n.d. “South County Shaded Fuel Break.” SouthCountyProject.Org. Accessed February 6, 2024. https://www.southcountyproject.org/.

Susskin, Jonah. 2023. Playbook-for-the-Pyrocene-Design-Strategies-for-Fire-Prone-Communities.Pdf. SWA Group. https://swacdn.s3.amazonaws.com/wp-content/uploads/2023/09/13195714/Playbook-for-the-Pyrocene-Design-Strategies-for-Fire-Prone-Communities.pdf.

Syphard, Alexandra D., Teresa J. Brennan, and Jon E. Keeley. 2014. “The Role of Defensible Space for Residential Structure Protection during Wildfires.” International Journal of Wildland Fire 23, no. 8: 1165. https://doi.org/10.1071/WF13158.

Syphard, Alexandra D., and Jon E. Keeley. 2019. “Factors Associated with Structure Loss in the 2013–2018 California Wildfires.” Fire 2, no. 3 (September): 49. https://doi.org/10.3390/fire2030049.

Syphard, Alexandra, Jon E. Keeley, Avi Bar Massada, Teresa J. Brennan, and Volker C. Radeloff. 2012. “Housing Arrangement and Location Determine the Likelihood of Housing Loss Due to Wildfire.” PLOS ONE 7, no. 3 (March): e33954. https://doi.org/10.1371/journal.pone.0033954.

Taylor, Charles A. n.d. “Targeted Grazing to Manage Fire Risk.” https://bof.fire.ca.gov/media/8861/2-d-i-targeted-grazing-handbook_chpt12.pdf.

Texas A&M Agrilife Extension. n.d. “Firebreaks.” Texas A&M Agrilife Extension. Accessed February 6, 2024. https://agrilife.org/rxburn/planning-a-burn/firebreaks/.

Texas A&M Forest Service. n.d. “Permanent Firebreaks.” Texas A&M Forest Service. Accessed February 6, 2024. https://tfsweb.tamu.edu/uploadedFiles/TFSMain/Manage_Forest_and_Land/Landowner_Assistance/Stewardship(1)/Permanent_Firebreaks.pdf.

"The National Strategy." 2014. https://www.forestsandrangelands.gov/documents/strategy/strategy/CSPhaseIIINationalStrategyApr2014.pdf.

Troy, Austin, Jason Moghaddas, David Schmidt, J. Shane Romsos, David B. Sapsis, William Brewer, and Tadashi Moody. 2022. "An Analysis of Factors Influencing Structure Loss Resulting from the 2018 Camp Fire." International Journal of Wildland Fire 31, no. 6 (May): 586–98. https://doi.org/10.1071/WF21176.

Ulrish, Linda. 2019. "Redcedar Trees a Complex Social-Ecological Issue." 2019. https://ianr.unl.edu/growing/redcedar-trees-complex-social-ecological-issue.

"Understand Risk." n.d. Wildfire Risk to Communities. Accessed September 8, 2023. https://wildfirerisk.org/understand-risk/.

United States Forest Service. n.d. "What Is Defensible Space?" Accessed February 8, 2024. https://www.fs.usda.gov/detail/osfnf/home/?cid=stelprdb5211501.

USDA Agricultural Research Service. 2020. "Targeted Grazing for Wildfire Fuel Breaks." USDA Climate Hubs. 2020. https://www.climatehubs.usda.gov/hubs/northwest/topic/targeted-grazing-wildfire-fuel-breaks#:~:text=Cattle%20grazing%20can%20be%20used,for%20firefighters%20to%20combat%20wildfires.

USDA Forest Service Northern Research Station. 2023. "Understanding the Wildland Urban Interface (1990-2020)." ArcGIS StoryMaps. September 20, 2023. https://storymaps.arcgis.com/stories/6b2050a0ded0498c863ce30d73460c9e.

Westover, Robert. 2021. "Thinning the Forest for the Trees." US Forest Service. August 19, 2021. https://www.fs.usda.gov/features/thinning-forest-trees.

"What Are the Flint Hills?" 2023. Flint Hills Discovery Center. 2023. https://www.flinthillsdiscovery.org/594/What-are-the-Flint-Hills.

Williams, A. Park, John T. Abatzoglou, Alexander Gershunov, Janin Guzman-Morales, Daniel A. Bishop, Jennifer K. Balch, and Dennis P. Lettenmaier. 2019. "Observed Impacts of Anthropogenic Climate Change on Wildfire in California." Earth's Future 7, no. 8: 892–910. https://doi.org/10.1029/2019EF001210.

Worth, Kate, Karen Pinchin, and Lucie Sullivan. 2020. "'Deflect, Delay, Defer': Decade of Pacific Gas & Electric Wildfire Safety Pushback Preceded Disasters." FRONTLINE. September 18, 2020. https://www.pbs.org/wgbh/frontline/article/pge-california-wildfire-safety-pushback/.

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Burnt Flint Hills Rangeland in the Distance. Retrieved September 15, 2023. https://www.epa.gov/sites/default/files/2020-08/burnt_rangeland_distance_ks_burns_story.png

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Hutchmacher, Mike. 2016. *Untitled photograph of firefighters battling the Anderson Creek Fire near Medicine Lodge, Kansas.* Retrieved October 21, 2023. https://okcfox.com/news/local/gallery/wind-speeds-increasing-friday-as-oklahoma-fight-wildfire-now-15-contained?photo=6

Rader, Bo. 2017. U*ntitled photograph of firefighters battling the Starbuck Fire near Protection, Kansas.* Retrieved October 21, 2023. https://www.cnn.com/2017/03/06/us/wildfires-oklahoma-texas-kansas-colorado-florida/index.html

Heying, Travis. 2021. *Untitled photograph of deer in a flaming field in Ness County, Kansas.* Retrieved October 21, 2023. https://nebraska.tv/newsletter-daily/kansas-forest-service-revises-acreage-burned-in-wildfires

Mulburn, Sandra. 2022. *Untitled photograph of a destroyed home in the aftermath of the Cottonwood Complex Fires.* Retrieved October 21, 2023. https://www.hutchnews.com/story/news/2022/03/06/buhler-hutchinson-fires-cottonwood-complex-continue-burn-reno-county-highland-blue-spruce/9402307002/

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Short, Karen C.; Finney, Mark A.; Vogler, Kevin C.; Scott, Joe H.; Gilbertson-Day, Julie W.; Grenfell, Isaac C. 2020. *Spatial Datasets of Probabilistic Wildfire Risk Components for the United States (270m).* Image Service Layer. https://doi.org/10.2737/RDS-2016-0034-2

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Kansas Data Access and Support Center. 2021. *2021 NG911 Imagery.* Image Service Layer. https://services.kgs.ku.edu/arcgis7/services/IMAGERY_STATEWIDE/NG911_Imagery_2021/ImageServer

Riley County GIS. 2021. *MUA Comp Plan Boundary.* Shapefile. https://gis.rileycountyks.gov/

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Kansas Forest Service. 2023. *Wildfire Risk Assessment Portal, Wildfire Risk.* Raster Layer. https://wrap.kansaswildfirerisk.org/Map/Public/#whats-your-risk

Riley County GIS. 2021. *MUA Comp Plan Boundary.* Shapefile. https://gis.rileycountyks.gov/

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Susskin, Jonah. 2023. *Playbook for the Pyrocene: Design Strategies for Fire-Prone Communities*. Book Cover. https://www.swagroup.com/stories/playbook-for-the-pyrocene/

Tan, P.Y. and P.H. Verburg. 2023. *Landscape and Urban Planning.* Journal Cover. https://www.sciencedirect.com/journal/landscape-and-urban-planning/vol/238/suppl/C

Conard, Susan and Stefan Doerr. 2020. *International Journal of Wildland Fire.* Journal Cover. https://www.iawfonline.org/international-journal-wildland-fire-ijwf/

Community Wildfire Planning Center. 2022. *Wildland-Urban Interface Planning Guide.* Document Cover. https://opr.ca.gov/docs/20220817-Complete_WUI_Planning_Guide.pdf

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Facebook Inc. 2015. *Facebook Blue Wordmark and No Background.* Logo. https://commons.wikimedia.org/wiki/File:Facebook_New_Logo_(2015).svg#/media/File:Facebook_Logo_(2015)_light.svg

Nextdoor. 2023. *Lime Logo*. Logo. https://about.nextdoor.com/us-media/

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U.S. Census Bureau. 2010. *Tiger2010 Zip Codes.* Feature Layer. https://services1.arcgis.com/q2CglofYX6ACNEeu/arcgis/rest/services/Zip_Codes/FeatureServer

Riley County GIS. 2021. *MUA Comp Plan Boundary.* Shapefile. https://gis.rileycountyks.gov/

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Commission for Environmental Cooperation (CEC). 2021. *Ecological Regions of North American, Level I.* Feature Layer. http://www.cec.org/north-american-environmental-atlas/terrestrial-ecoregions-level-i/

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Kansas Data Access and Support Center. 2021. *2021 NG911 Imagery.* Image Service Layer. https://services.kgs.ku.edu/arcgis7/services/IMAGERY_STATEWIDE/NG911_Imagery_2021/ImageServer

Federal Emergency Management Agency. 2022. *USA Structures.* Feature Layer. https://www.arcgis.com/home/item.html?id=0ec8512ad21e4bb987d7e848d14e7e24.

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Kansas Data Access and Support Center. 2021. *2021 NG911 Imagery.* Image Service Layer. https://services.kgs.ku.edu/arcgis7/services/IMAGERY_STATEWIDE/NG911_Imagery_2021/ImageServer

Federal Emergency Management Agency. 2022. *USA Structures*. Feature Layer. https://www.arcgis.com/home/item.html?id=0ec8512ad21e4bb987d7e848d14e7e24.

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Kansas Data Access and Support Center. 2021. *2021 NG911* Imagery. Image Service Layer. https://services.kgs.ku.edu/arcgis7/services/IMAGERY_STATEWIDE/NG911_Imagery_2021/ImageServer

Federal Emergency Management Agency. 2022. *USA Structures*. Feature Layer. https://www.arcgis.com/home/item.html?id=0ec8512ad21e4bb987d7e848d14e7e24.

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Kansas Data Access and Support Center. 2021. *2021 NG911* Imagery. Image Service Layer. https://services.kgs.ku.edu/arcgis7/services/IMAGERY_STATEWIDE/NG911_Imagery_2021/ImageServer

Federal Emergency Management Agency. 2022. *USA Structures*. Feature Layer. https://www.arcgis.com/home/item.html?id=0ec8512ad21e4bb987d7e848d14e7e24.

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Kansas Data Access and Support Center. 2021. *2021 NG911 Imagery*. Image Service Layer. https://services.kgs.ku.edu/arcgis7/services/IMAGERY_STATEWIDE/NG911_Imagery_2021/ImageServer

Federal Emergency Management Agency. 2022. *USA Structures.* Feature Layer. https://www.arcgis.com/home/item.html?id=0ec8512ad21e4bb987d7e848d14e7e24.

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Kansas Data Access and Support Center. 2021. *2021 NG911 Imagery.* Image Service Layer. https://services.kgs.ku.edu/arcgis7/services/IMAGERY_STATEWIDE/NG911_Imagery_2021/ImageServer

Federal Emergency Management Agency. 2022. *USA Structures.* Feature Layer. https://www.arcgis.com/home/item.html?id=0ec8512ad21e4bb987d7e848d14e7e24.

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Figure 59. Ochsner, Landon. 2024. *City-scale Invasive/Nuisance Species Control*. Illustration.

Figure 60. Ochsner, Landon. 2024. *City-scale Selective Thinning.* Illustration.

Figure 61. Ochsner, Landon. 2024. *City-scale Prescribed Burning.* Illustration.

Figure 62. Ochsner, Landon. 2024. *City-scale Livestock Grazing.* Illustration.

Figure 63. Ochsner, Landon. 2024. *City-scale Improved Conditions Monitoring.* Illustration.

Figure 64. Ochsner, Landon. 2024. *Neighborhood-scale Strategy Application.* Graphic.

Figure 65. Ochsner, Landon. 2024. *Adaptable Road Section.* Illustrative Section.

Figure 66. Ochsner, Landon. 2024. *Typology 1 Access and Egress Strategy Implementation.* Illustration.

Figure 67. Ochsner, Landon. 2024. *Turnout Section.* Illustrative Section.

Figure 68. Ochsner, Landon. 2024. *Typology 2 Access and Egress Strategies Implementation.* Illustration.

Figure 69. Ochsner, Landon. 2024. *Signage and Vegetation Clearance Section.* Illustrative Section.

Figure 70. Ochsner, Landon. 2024. *Typology 3 Access and Egress Strategies Implementation*. Illustration.

Figure 71. Ochsner, Landon. 2024. *Multi-Use Trail Corridor Section.* Illustrative Section.

Figure 72. Ochsner, Landon. 2024. *Typology 1 Multi-Use Trail Implementation.* Illustration.

Figure 73. Ochsner, Landon. 2024. *Typology 2 Mountain Biking and Hiking Trails Implementation.* Illustration.

Figure 74. Ochsner, Landon. 2024. *Typology 2 Mountain Biking and Hiking Trails Section.* Illustrative Section.

Figure 75. Ochsner, Landon. 2024. *Typology 3 Conservation Easement Implementation.* Illustration.

Figure 76. Ochsner, Landon. 2024. *Conservation Easement Section.* Illustrative Section.

Figure 77. Ochsner, Landon. 2024. *Green Firebreak Section.* Illustrative Section.

Figure 78. Ochsner, Landon. 2024. *Typology 1 Green Firebreak Implementation.* Illustration.

Figure 79. Ochsner, Landon. 2024. *Typology 2 Shaded Fuel Break Implementation.* Illustration.

Figure 80. Ochsner, Landon. 2024. *Shaded Fuel Break Section.* Illustrative Section.

Figure 81. Ochsner, Landon. 2024. *Typology 3 Traditional Firebreak Implementation.* Illustration.

Figure 82. Ochsner, Landon. 2024. *Traditional Firebreak Section.* Illustrative Section.

Figure 83. Firewise Maryland. *Plant Flammability Key.* Dichotomous Key. Retrieved March 1, 2024. https://dnr.maryland.gov/forests/Documents/fire/Firewise_PlantFlammabilityKey.pdf

Figure 84. Ochsner, Landon. 2024. *Typology 1 Landscape Standards.* Photomontage.

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Figure 86. Ochsner, Landon. 2024. *Typology 3 Landscape Standards.* Photomontage.

Figure 87. Ochsner, Landon. 2024. *Typology 1 Public Park Implementation.* Illustration.

Figure 88. Ochsner, Landon. 2024. *Public Park Section.* Illustrative Section.

Figure 89. Figure 89. Ochsner, Landon. 2024. *Interior Greenbelt Section.* Illustrative Section.

Figure 90. Ochsner, Landon. 2024. Typology 2 *Interior Greenbelt Implementation.* Illustration.

Figure 91. Ochsner, Landon. 2024. Typology 3 *Community Gardens Implementation.* Illustration.

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Figure 93. Ochsner, Landon. 2024. *Site and Structure Strategies.* Graphic.

Figure 94. Ochsner, Landon. 2024. *Single-Family Defensible Space Implementation.* Illustration.

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Figure 96. Ochsner, Landon. 2024. *Single-Family Landscape Material Implementation.* Illustration.

Figure 97. Ochsner, Landon. 2024. *Multi-Family Landscape Material Implementation.* Illustration.

Figure 98. Ochsner, Landon. 2024. *Single-Family Noncombustible Features Implementation.* Illustration.

Figure 99. Figure 99. Ochsner, Landon. 2024. *Multi-Family Noncombustible Features Implementation.* Illustration.

Figure 100. Figure 100. Ochsner, Landon. 2024. *Single-Family Vegetation Management Implementation.* Illustration.

Figure 101. Ochsner, Landon. 2024. *Multi-Family Vegetation Management Implementation.* Illustration.

Figure 102. Ochsner, Landon. 2024. *Study Site Growth Through Time.* Map.

Google Earth. 1991. *Untitled image of Study Site in Manhattan, Kansas.* Retrieved February 28, 2024. https://www.google.com/maps/place/39%C2%B010'22.9%22N+96%C2%B038'28.0%22W/@39.173036,-96.6436839,1195m/data=!3m2!1e3!4b1!4m4!3m3!8m2!3d39.173036!4d-96.641109?entry=ttu

Google Earth. 2005. *Untitled image of Study Site in Manhattan, Kansas.* Retrieved February 28, 2024. https://www.google.com/maps/place/39%C2%B010'22.9%22N+96%C2%B038'28.0%22W/@39.173036,-96.6436839,1195m/data=!3m2!1e3!4b1!4m4!3m3!8m2!3d39.173036!4d-96.641109?entry=ttu

Google Earth. 2010. *Untitled image of Study Site in Manhattan, Kansas.* Retrieved February 28, 2024. https://www.google.com/maps/place/39%C2%B010'22.9%22N+96%C2%B038'28.0%22W/@39.173036,-96.6436839,1195m/data=!3m2!1e3!4b1!4m4!3m3!8m2!3d39.173036!4d-96.641109?entry=ttu

Google Earth. 2022. *Untitled image of Study Site in Manhattan, Kansas.* Retrieved February 28, 2024. https://www.google.com/maps/place/39%C2%B010'22.9%22N+96%C2%B038'28.0%22W/@39.173036,-96.6436839,1195m/data=!3m2!1e3!4b1!4m4!3m3!8m2!3d39.173036!4d-96.641109?entry=ttu

Figure 103. Ochsner, Landon. 2024. *Resident Survey Neighborhood Divisions.* Map.

Kansas Data Access and Support Center. 2021. *2021 NG911 Imagery.* Image Service Layer. https://services.kgs.ku.edu/arcgis7/services/IMAGERY_STATEWIDE/NG911_Imagery_2021/ImageServer

Riley County GIS. 2021. *MUA Comp Plan Boundary.* Shapefile. https://gis.rileycountyks.gov/

Figure 104. Ochsner, Landon. 2024. *Study Site WUI Classification.* Map.

Kansas Data Access and Support Center. 2021. *2021 NG911 Imagery.* Image Service Layer. https://services.kgs.ku.edu/arcgis7/services/

Federal Emergency Management Agency. 2022. *USA Structures.* Feature Layer. https://www.arcgis.com/home/item.html?id=0ec8512ad21e4bb987d7e848d14e7e24.

Spatial Analysis for Conservation and Sustainability (SILVIS LAB). 2023. *The Global Wildland-Urban Interface- 2020.* Dataset. https://silvis.forest.wisc.edu/globalwui/

Figure 105. Ochsner, Landon. 2024. *Study Site Combustible Landcover.* Map.

Kansas Data Access and Support Center. 2021. *2021 NG911 Imagery.* Image Service Layer. https://services.kgs.ku.edu/arcgis7/services/

Federal Emergency Management Agency. 2022. *USA Structures*. Feature Layer. https://www.arcgis.com/home/item.html?id=0ec8512ad21e4bb987d7e848d14e7e24.

Multi-Resolution Land Characteristics Consortium. 2021. *National Landcover Database.* Database. https://www.mrlc.gov/data?f%5B0%5D=category%3ALand%20Cover

Figure 106. Ochsner, Landon. 2024. *Study Site Wildfire Risk*. Map.

Kansas Data Access and Support Center. 2021. *2021 NG911 Imagery.* Image Service Layer. https://services.kgs.ku.edu/arcgis7/services/

Federal Emergency Management Agency. 2022. *USA Structures*. Feature Layer. https://www.arcgis.com/home/item.html?id=0ec8512ad21e4bb987d7e848d14e7e24.

Kansas Forest Service. 2023. *Wildfire Risk Assessment Portal, Wildfire Risk.* Raster Layer. https://wrap.kansaswildfirerisk.org/Map/Public/#whats-your-risk

Figure 107. Ochsner, Landon. 2024. *Study Site Slope.* Map.

ESRI. 2024. *Terrain: Slope Map.* Image Service Layer. https://elevation.arcgis.com/arcgis/services/WorldElevation/Terrain/ImageServer

Appendix

Appendix I
Typological Classification Manual

Land Use
Land use of the structure closest to the given point.

Single Family Detached- One structure intended to house a single family.
Single Family Attached- One structure intended to house multiple families. Units have common walls but are not apartments. These include duplex and triplex structures.
Multifamily- Apartment buildings with multiple units. Typically multiple stories with smaller units.
Open Space- No developed adjacent land use.

Density
Density of the structure/lot closest to the given point.

Very Low- Very large lots with few structures.
Low- Large lots with single-family attached with considerable space between structures.
Medium- Smaller lots with single-family attached or detached land use with some space between structures
High- Smaller lots with multifamily structures or single-family attached with little to no space between structures.

Urban Form
Density of the structure/lot closest to the given point.

Traditional- Orthogonal street layout typifying a traditional grid system.
Curvilinear- Meandering street layout typified by sweeping curves and cul-de-sacs.
Combination- Includes elements of both traditional and curvilinear neighborhoods
Undefined- Little or no identifiable organizational scheme.

Access/Egress
Access and egress points must intersect major thoroughfares.

Poor- Single exit point from the neighborhood or combustible vegetation on both sides of the exits.
Moderate- Two neighborhood exit points or combustible vegetation on a single side of the exit
Good- >2 neighborhood exit points and no combustible vegetation near exits

Slope
Slope at a given point.

Landscape Position
Position of the closest structure to the given point.

Bottomland- Lies at the bottom of a hill. Sloped up on one side and flat on the other.
Valley- Lies at the bottom of a hill. Sloped up on both sides.
Midslope- Lies in the middle of a hill. The land slopes up on one side and down on the other.
Hilltop- Lies at the top of a hill. The land slopes down on one side and is flat on the other.
Ridgeline- Lies at the top of a hill. The land slopes down on both sides of the given point.

Adjacent Land Use
The closest significant land use to the given point outside the neighborhood study area within a ¼ mile. If no land use outside ¼ mile radius, then development category is used.

Open Space- Undeveloped land with natural vegetation. Includes land used for cattle grazing. May or may not be maintained with prescribed burns. Does not include areas intentionally maintained as parks.
Agriculture- Planted cropland regularly used for agricultural cultivation.
Park- Open space intentionally maintained for public access.
Developed- Land with infrastructure, including roads, residential developments, and commercial areas. Little to no 'natural' vegetation

Adjacent Vegetation Type
The closest, most significant vegetation type to the given point outside the neighborhood study area. Does not include ladder fuels.

Closed Canopy Forest/Transitioned Grassland- Dense forested areas with no discernible separation between tree stands
Open Canopy Forest/Mid-Transition Grassland- Pockets of dense woodlands separated by space between stands.
Woodland Savanna or Scrub/Early-Transition Grassland- Pockets of trees or shrubs scattered amongst grasslands. Primarily herbaceous species.
Tallgrass Prairie- Grass-dominated areas with mature grasses >18" in height.
Agriculture- Planted cropland regularly used for agricultural cultivation.
N/A- Developed without significant vegetation.

Adjacent Cedar Encroachment
The severity of eastern red cedar (ERC) encroachment in the identified adjacent land use and vegetation types, determined using NG911 imagery. Does include ladder fuels.

Severe- Vegetation type dominated by ERC; ERC is the primary species.
Moderate- Significant ERC encroachment, but ERC is not the dominant species. Large stands of ERC may be present with significant linkages.
Low- Some ERC may be present but do not form significant stands or linkages.
None- ERC is not significant

Ladder Fuels

The presence of trees or shrubs between the development and combustible open space. These woody species may loft embers downwind and allow grass fires to climb higher. Trees may not be the dominant vegetation type, but often form along the WUI threshold between grasslands and development.

Draw a line from the given point to the nearest land use outside the neighborhood study area. Determine ladder fuel designation based on the threshold between development and open space.

Many- Continuous or dense strips of woody species between development and open space.
Few- Patchy areas of woody species between development and open space.
None- No ladder fuels present. Development meets shorter fuels, such as grasses, directly.

Interior Vegetation

Vegetation within a 300' radius of the given point that lies within the neighborhood study area.

Grassy Fingers- Combustible grass-dominated vegetation linked to larger combustible tracts outside the neighborhood study area. Often lie along drainages, streams, and trail systems.

Woody Fingers- Combustible woody-dominated vegetation linked to larger combustible tracts outside the neighborhood study area. Often lie along drainages and trail systems.

Grassy Islands- Combustible grass-dominated vegetation pockets separated from larger combustible vegetation tracts. May be found near urban parks.

Woody Islands- Combustible woody-dominated vegetation pockets separated from larger combustible vegetation tracts. May be found near urban parks.

Interior Cedar Encroachment

The severity of eastern red cedar (ERC) encroachment in the identified adjacent land use and vegetation types, determined using NG911 imagery. Does include ladder fuels.

Severe- Vegetation type dominated by ERC; ERC is the primary species.

Moderate- Significant ERC encroachment, but ERC is not the dominant species. Large stands of ERC may be present with significant linkages.

Low- Some ERC may be present but do not form significant stands or linkages.

None- ERC is not significant

Appendix II
Resident Survey

Resident Survey

Q19 **Project Title:** Heartburn: Mitigating Wildfire Risk to Interface Communities in America's Heartland

Introduction:
You are invited to participate in a research study. This survey is research conducted to aid in the development of wildfire mitigation strategies in Great Plains communities.

Purpose of the Research:
The purpose of this survey is to research perceptions and preferred mitigation strategies of residents of the Great Plains. Information collected during this survey will help guide the development of conceptual wildfire mitigation strategies tailored to Great Plains communities' specific landscape conditions and needs.

Length of Study:
Approximately five (5) minutes

Contact Details for Problems/Questions: Landon Ochsner, Graduate Student, Landscape Architecture and Regional and Community Planning (landonop@ksu.edu). Hyung Jin Kim, Associate Professor, Landscape Architecture and Regional and Community Planning, 1102 Seaton Hall, Kansas State University, Manhattan, KS 66506 (785) 532-5961 (hyungjin@ksu.edu).
IRB Chair Contact Information: Lisa Rubin, Chair, Committee on Research Involving Human Subjects, 203 Fairchild Hall, Kansas State University, Manhattan, KS 66506, (785) 532-3224. Brad Woods, Associate Vice President for Research Compliance, 203 Fairchild Hall, Kansas State University, Manhattan, KS 66506, (785) 532-3224.
Study Procedures:
Your participation involves completing an electronic survey consisting of multiple choice, preference scales, and short-answer questions.

Confidentiality:
All responses will be kept confidential and anonymous. Only the research team will have access to the collected data. Your responses will not be distributed or used for future research studies.

Voluntary Participation:
Participation in this survey is entirely voluntary. You may choose not to participate, skip questions, or exit the survey at any time without penalty. Anticipated Benefits: This study will aid in the creation of a framework for wildfire mitigation in Great Plains communities. Communities and individuals may use this framework to mitigate wildfire risk to people and property.

By continuing with this survey, you acknowledge that you understand the information provided, are over the age of 18, and agree to participate voluntarily.

Q30 What is your age?

- ○ 17 or younger (1)
- ○ 18-64 (2)
- ○ 65 or older (3)

Q1 What is your zip code?

- ○ 66502 (1)
- ○ 66503 (2)
- ○ 66506 (3)
- ○ My zip code is not listed, specify (4) _____

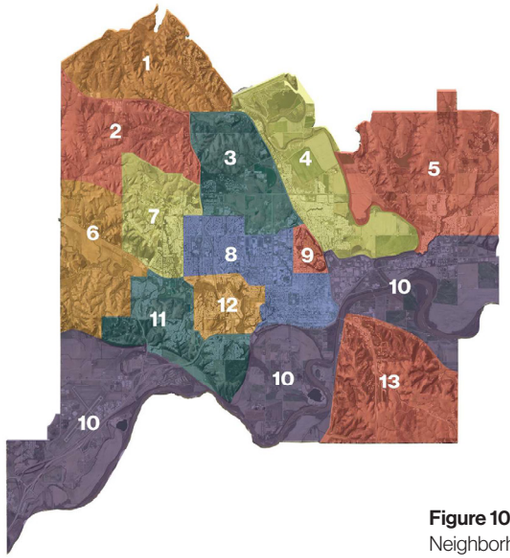

Figure 103. Resident Survey Neighborhood Divisions

Q24 Above is a map of the Manhattan, Kansas urban area divided into separate areas labeled with numbers. Please select number of the area where your home is located.

- 1 (1)
- 2 (2)
- 3 (3)
- 4 (4)
- 5 (5)
- 6 (6)
- 7 (7)
- 8 (8)
- 9 (9)
- 10 (10)
- 11 (11)
- 12 (12)
- 13 (13)
- My home/neighborhood is not displayed (14)
- Unsure/Prefer not to answer (15)

The following questions ask about the Great Plains region of the United States, pictured above in blue. Manhattan lies within this region.

Q5 Please select your level of agreement with the following statements:

I think a wildfire similar to the fire that occurred in Maui, Hawaii in 2023 is possible in the Great Plains, where Manhattan is located.

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q4 I think communities in the Great Plains are at risk of wildfire.

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q6 What experience do you have with wildfire in the Great Plains? (select all that apply)

- Been directly impacted by wildfire due to evacuation, injury, or property loss (1)
- Know others who have been directly impacted by wildfire due to evacuation, injury, or property loss (2)
- Seen a wildfire from a distance but have not been directly impacted by wildfire (3)
- Have knowledge of wildfire events occurring in the Great Plains (4)
- Do not have any prior experience with wildfire in the Great Plains (5)

Q7 How long have you lived in your current residence?

- Less than 1 year (1)
- 2-5 years (2)
- 6-10 years (3)
- 11-20 years (4)
- More than 20 years (5)

Q8 What best describes the setting of your home?

- Within the city (1)
- On the edge of the city (2)
- Close to the city but not in it (3)
- In the country or a rural area (4)

Q9 Please select your level of agreement with the following statement:

I live where I do, in part, because of the visual quality or aesthetic features of the natural landscape around my home.

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Display This Question:

If Please select your level of agreement with the following statement: I live where I do, in part, b... = Somewhat agree

Or Please select your level of agreement with the following statement: I live where I do, in part, b... = Strongly agree

Q10 Please select the features you find most contribute to the landscape's aesthetic value or visual quality in your community. (select all that apply)

- [ ] Native grasses or prairie areas (1)
- [ ] Woods or forested areas (2)
- [ ] Topographic features (hills, ridges, valleys, etc.) (3)
- [ ] Expansive views (4)
- [ ] Wildlife (5)
- [ ] Natural water features (creeks, streams, ponds, lakes etc.) (6)

Q11 Please select your level of agreement with the following statements:

I think wildfire could be a threat to my neighborhood.

- ○ Strongly disagree (1)
- ○ Somewhat disagree (2)
- ○ Neither agree nor disagree (3)
- ○ Somewhat agree (4)
- ○ Strongly agree (5)

Q12 I think my community is prepared to handle a wildfire.

- ○ Strongly disagree (1)
- ○ Somewhat disagree (2)
- ○ Neither agree nor disagree (3)
- ○ Somewhat agree (4)
- ○ Strongly agree (5)

Q13 I have taken steps to reduce my personal wildfire risk.

- ○ Strongly disagree (1)
- ○ Somewhat disagree (2)
- ○ Neither agree nor disagree (3)
- ○ Somewhat agree (4)
- ○ Strongly agree (5)

Q14 Have you ever discussed wildfire risk with your neighbors or friends?

- ○ No (1)
- ○ Yes (2)

Q15 Do you know where to find information about your wildfire risk?

- ○ No (1)
- ○ Yes (2)

Q16 Please select your level of agreement with the following statements.

I support city-wide or regional efforts to reduce the risk of wildfire spreading to Manhattan and surrounding areas.

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q17 It is important that my neighborhood is made safer from wildfires while still being a pleasant place to live.

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q18 I am willing to make changes to my home or yard to make it safer from wildfires, such as using different types of plants, landscaping materials, and landscape designs.

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q20 This study surveys wildfire perceptions and preferred mitigation strategies of residents and professionals residing and working within the Great Plains. Information collected during this survey will help guide the development of conceptual mitigation strategies tailored to Great Plains communities' specific landscape conditions and needs.

If you want to learn more about the wildfire threat to your community and the steps you can take to
protect yourself, visit https://wildfirerisk.org/ or contact your state forest service.

If you would like to receive a copy of this report when it is completed, please contact Landon Ochsner
(landonop@ksu.edu) or Hyung Jin Kim, Ph.D (hyungjin@ksu.edu).

Appendix III
Expert Survey

Expert Survey

Project Title:
Heartburn: Mitigating Wildfire Risk to Interface Communities in America's Heartland

Introduction:
You are invited to participate in a research study. This survey is research conducted to aid in the development of wildfire mitigation strategies in Great Plains communities.

Purpose of the Research:
The purpose of this survey is to research perceptions and preferred mitigation strategies of professionals residing and working within the Great Plains. Information collected during this survey will help guide the development of mitigation strategies tailored to Great Plains communities' specific landscape conditions and needs.

Length of Study:
Approximately ten (10) minutes

Contact Details for Problems/Questions:

Landon Ochsner, Graduate Student, Landscape Architecture and Regional and Community Planning (landonop@ksu.edu).

Hyung Jin Kim, Associate Professor, Landscape Architecture and Regional and Community Planning, 1102 Seaton
Hall, Kansas State University, Manhattan, KS 66506 (785) 532-5961 (hyungjin@ksu.edu).

IRB Chair Contact Information:
Lisa Rubin, Chair, Committee on Research Involving Human Subjects, 203 Fairchild Hall, Kansas State University,
Manhattan, KS 66506, (785) 532-3224.

Brad Woods, Associate Vice President for Research Compliance, 203 Fairchild Hall, Kansas State University,
Manhattan, KS 66506, (785) 532-3224.

Study Procedures:
Your participation involves completing an electronic survey consisting of multiple choice, preference scales, and short-answer questions.

Confidentiality:
All responses will be kept confidential and anonymous. Only the research team will have access to the collected data. Your responses will not be distributed or used for future research studies.

Voluntary Participation:
Participation in this survey is entirely voluntary. You may choose not to participate, skip questions, or exit the survey at any time without penalty.

Anticipated Benefits:
This study will aid in the creation of a framework for wildfire mitigation in Great Plains communities. Communities and individuals may use this framework to mitigate wildfire risk to people and property.

By continuing with this survey, you acknowledge that you understand the information provided and agree to participate voluntarily.

Q1 What industry do you work in?

- ○ Academic/Research (1)
- ○ Design/Planning (2)
- ○ Natural Resources/Forestry (3)
- ○ Public Administration/Emergency Management (4)
- ○ Fire Agency (State/Local) (5)
- ○ Other (please specify) (6) _____

Q4 What state are you currently employed in?

_____

Q5 How long have you been employed in your current industry?

- Less than one year (1)
- 1-4 years (2)
- 5-9 years (3)
- 10+ years (4)

Q29
This questionnaire asks about the Great Plains. For the remainder of this survey, the "Great Plains" describes the blue area pictured above.

Q6 Please rate your level of agreement with the following statements:

Wildfires are a growing threat in the Great Plains

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q7 A wildfire similar to the fire that occured in Maui, Hawaii in 2023 is possible in the Great Plains.

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q8 Wildland-urban interface communities in the Great Plains should work to mitigate wildfire risk.

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q9 What is the current level of wildfire risk you believe is faced by the community or communities in which you work?

- Very Low (1)
- Low (2)
- Moderate (3)
- High (4)
- Very High (5)

Q10 Does the community in which you work have wildfire mitigation measures in place (e.g. fuels thinning programs, defensible space requirements, community wildfire protection plans, land use/development/zoning regulations, FireWise programs, etc.)?

- No (1)
- Yes (2)
- Unsure (3)

Display This Question:

If Does the community in which you work have wildfire mitigation measures in place (e.g. fuels thinn... = Yes

Q13 What wildfire mitigation measures does your community currently have in place?

_____

Q23 The following questions survey your preference for wildfire mitigation strategies for exposed communities (WUI areas) at three different scales: city-wide and regional, neighborhood and subdivision, and individual homes and structures. Each scale is presented separately, beginning with city-wide and regional on the next page.

Q14 How effective do you think the following actions would be at mitigating wildfire risk to exposed Great Plains communities at the **city-wide and regional scale**?

	Not effective at all (1)	Slightly effective (2)	Moderately effective (3)	Very effective (4)	Extremely effective (5)	Unsure (6)
Cutting permanent/seasonal firebreaks (1)	○	○	○	○	○	○
Selective thinning of combustible vegetation (2)	○	○	○	○	○	○
Invasive/nuisance species management (3)	○	○	○	○	○	○
Prescribed burning to reduce combustible material (4)	○	○	○	○	○	○
Livestock grazing to reduce combustible material (5)	○	○	○	○	○	○
Limiting development near high risk areas, such as slopes and ridges (6)	○	○	○	○	○	○
Improved fire weather/conditions monitoring (7)	○	○	○	○	○	○
Utility easement clearing to reduce ignitions from power lines (8)	○	○	○	○	○	○
Windbreaks to trap embers and slow wind and fire spread (9)	○	○	○	○	○	○
Others, please specify. Separate multiple answers with a comma. (10)	○	○	○	○	○	○

Q15 Beyond reducing wildfire risk, which aspects do you believe are most important when developing wildfire mitigation strategies at the **city-wide and regional scale**? (select all that apply)

- [ ] Aesthetics / visual quality (1)
- [ ] Public access (recreation, sports facilities, trails, etc.) (2)
- [ ] Preserving/promoting ecological function (prioritizing native species) (3)
- [ ] Promoting economic activity (4)
- [ ] Productive landscapes (agriculture, community gardens, etc.) (5)
- [ ] Ease of maintenance (6)
- [ ] Invasive/nuisance species control (7)
- [ ] Other, please specify (8) _____

Q16 How effective do you think the following actions would be at mitigating wildfire risk to exposed **neighborhoods and subdivisions** in the Great Plains?

	Not effective at all (1)	Slightly effective (2)	Moderately effective (3)	Very effective (4)	Extremely effective (5)	Unsure (6)
Cutting permanent/seasonal firebreaks (1)	○	○	○	○	○	○
Creating managed greenbelts/buffer areas between neighborhoods and wildlands (2)	○	○	○	○	○	○
Creating managed greenbelts/buffer areas within neighborhoods to reduce fire spread (3)	○	○	○	○	○	○
Creating agricultural/farmed buffers between development and wildlands (4)	○	○	○	○	○	○
Selective thinning of combustible vegetation near neighborhoods (5)	○	○	○	○	○	○
Invasive/nuisance species management (6)	○	○	○	○	○	○
Prescribed burning near neighborhoods (7)	○	○	○	○	○	○
Livestock grazing to reduce combustible material near neighborhoods (8)	○	○	○	○	○	○
Landscape planting standards regarding the use of low-fire hazard plants (9)	○	○	○	○	○	○

Landscape planting standards regarding ornamental vegetation spacing (10)	○	○	○	○	○	○
Land-use/zoning regulations limiting future development near high-risk areas such as slopes and ridges (11)	○	○	○	○	○	○
Clustering structures closely together to reduce community wildfire exposure (12)	○	○	○	○	○	○
Spreading out structures to reduce structure-to-structure spread (13)	○	○	○	○	○	○
Ensuring access and egress for evacuation and emergency personnel (14)	○	○	○	○	○	○
Utility easement clearing to reduce ignitions from downed power lines (15)	○	○	○	○	○	○
Windbreaks to trap embers and slow wind and fire spread (16)	○	○	○	○	○	○
Others, please specify. Separate multiple answers with a comma. (17)	○	○	○	○	○	○

Q24 Beyond reducing wildfire risk, which aspects do you believe are most important when developing wildfire mitigation strategies at the **neighborhood and subdivision scale**? (select all that apply)

- ☐ Aesthetics / visual quality (1)
- ☐ Public access (recreation, sports facilities, trails, etc.) (2)
- ☐ Preserving/promoting ecological function (prioritizing native species) (3)
- ☐ Promoting economic activity (4)
- ☐ Productive landscapes (agriculture, community gardens, etc.) (5)
- ☐ Ease of maintenance (6)
- ☐ Invasive/nuisance species control (7)
- ☐ Other, please specify (8) _____

Q18 How effective do you think the following actions would be at mitigating wildfire risk to individual homes and structures exposed to wildfire risk in the Great Plains?

	Not effective at all (1)	Slightly effective (2)	Moderately effective (3)	Very effective (4)	Extremely effective (5)	Unsure (6)
Creating defensible space within 5 feet of a structures (1)	○	○	○	○	○	○
Creating defensible space from 5 feet to 30 feet of a structure (2)	○	○	○	○	○	○
Creating defensible space from 30 feet to 100 feet of a structure (3)	○	○	○	○	○	○
Using hardscape materials such as pavers and gravel instead of mulch (4)	○	○	○	○	○	○
Using noncombustible materials for fences, gates, and outdoor furniture (5)	○	○	○	○	○	○
Hardening exposed areas with landforms or masonry walls to reduce fire spread (6)	○	○	○	○	○	○
Landscape planting standards regarding the use of low-fire hazard plants (7)	○	○	○	○	○	○
Landscape planting standards regarding ornamental vegetation spacing (8)	○	○	○	○	○	○
Invasive/nuisance species management near structures (9)	○	○	○	○	○	○
Keeping native vegetation short through mowing or other means (10)	○	○	○	○	○	○
Regular irrigation of ornamental landscaping (11)	○	○	○	○	○	○
Others, please specify. Separate multiple answers with a comma. (12)	○	○	○	○	○	○

Q25 Beyond reducing wildfire risk, which aspects do you believe are most important when developing wildfire mitigation strategies at the **individual home and structure scale**? (select all that apply)

- ☐ Aesthetics / visual quality (1)
- ☐ Cost of implementation (2)
- ☐ Preserving/promoting ecological function (prioritizing native species) (3)
- ☐ Ease of implementation (4)
- ☐ Ease of maintenance (5)
- ☐ Invasive/nuisance species control (6)
- ☐ Other, please specify (7) _____

Q21 Are there any innovative, emerging, or unconventional methods, perhaps ‘out there’ ideas, that you believe hold potential and would like to see considered for wildfire mitigation in exposed Great Plains communities or elsewhere?

_____

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Q22 Do you have any additional comments on wildfire mitigation in the Great Plains?

_____

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Appendix IV
Study Site Maps

Figure 104. Study Site WUI Classification

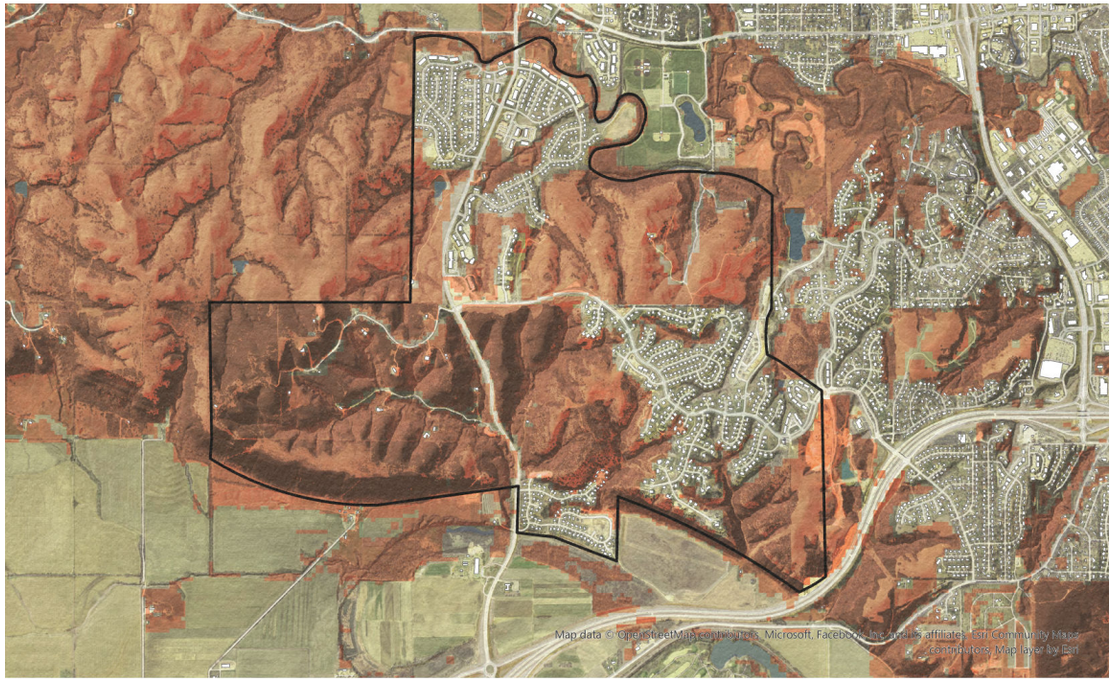

Figure 105. Study Site Combustible Landcover

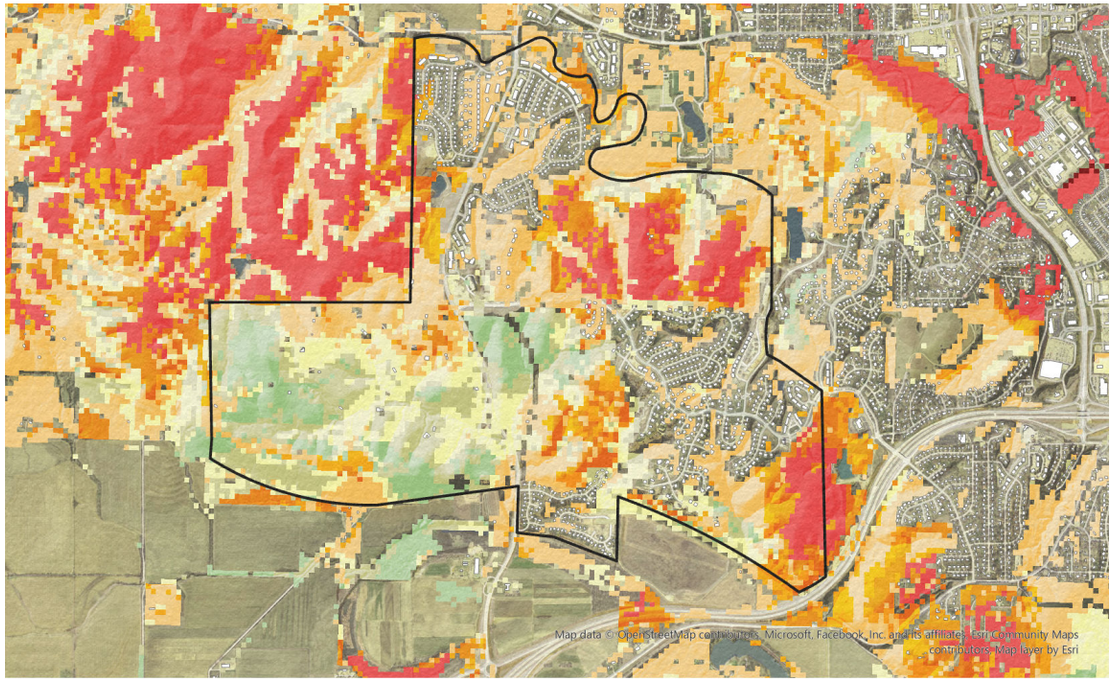

Figure 106. Study Site Wildfire Risk

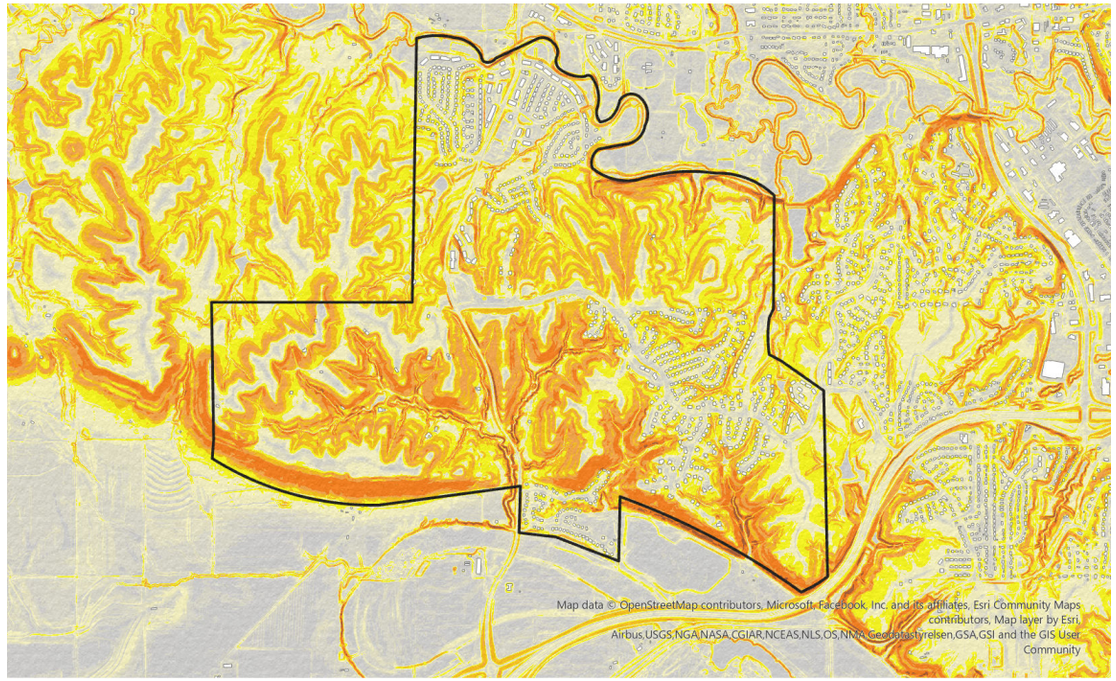

Figure 107. Study Site Slope

Appendix V
Resident Survey Urban vs. Rural Independent Samples T-test

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means							
						Significance				95% Confidence Interval of the Difference	
		F	Sig.	t	df	One-Sided p	Two-Sided p	Mean Difference	Std. Error Difference	Lower	Upper
Q11	Equal variances assumed	.760	.385	-2.729	180	.003	.007	-.599	.220	-1.033	-.166
	Equal variances not assumed			-2.740	86.322	.004	.007	-.599	.219	-1.034	-.165
Q12	Equal variances assumed	.296	.587	.684	180	.247	.495	.136	.199	-.257	.530
	Equal variances not assumed			.673	83.054	.251	.503	.136	.203	-.267	.540
Q13	Equal variances assumed	1.479	.226	-3.900	180	<.001	<.001	-.817	.210	-1.231	-.404
	Equal variances not assumed			-4.027	91.230	<.001	<.001	-.817	.203	-1.221	-.414
Q14	Equal variances assumed	69.026	<.001	-5.352	180	<.001	<.001	-.336	.063	-.460	-.212
	Equal variances not assumed			-4.372	62.665	<.001	<.001	-.336	.077	-.490	-.183
Q15	Equal variances assumed	4.991	.027	-1.265	180	.104	.208	-.097	.076	-.247	.054
	Equal variances not assumed			-1.214	79.475	.114	.228	-.097	.080	-.255	.062
Q16	Equal variances assumed	.093	.761	-1.111	176	.134	.268	-.171	.154	-.474	.133
	Equal variances not assumed			-1.153	93.538	.126	.252	-.171	.148	-.465	.123
Q17	Equal variances assumed	.069	.793	-1.000	176	.159	.319	-.170	.170	-.506	.166
	Equal variances not assumed			-1.005	87.660	.159	.317	-.170	.169	-.507	.166
Q18	Equal variances assumed	.261	.610	-.444	176	.329	.658	-.081	.183	-.442	.280
	Equal variances not assumed			-.447	88.036	.328	.656	-.081	.182	-.442	.280
Q7	Equal variances assumed	2.284	.132	-1.099	182	.137	.273	-.242	.220	-.676	.192
	Equal variances not assumed			-1.143	95.131	.128	.256	-.242	.212	-.662	.178
Q8	Equal variances assumed	1.864	.174	-24.136	181	<.001	<.001	-1.949	.081	-2.108	-1.790
	Equal variances not assumed			-24.394	90.020	<.001	<.001	-1.949	.080	-2.108	-1.790
Q9	Equal variances assumed	5.753	.017	-3.891	182	<.001	<.001	-.819	.210	-1.234	-.404
	Equal variances not assumed			-4.190	102.630	<.001	<.001	-.819	.195	-1.206	-.431
Q5	Equal variances assumed	1.322	.252	-.225	183	.411	.822	-.046	.204	-.448	.356
	Equal variances not assumed			-.216	80.993	.415	.830	-.046	.213	-.469	.378
Q4	Equal variances assumed	4.624	.033	-2.389	183	.009	.018	-.387	.162	-.707	-.067
	Equal variances not assumed			-2.734	117.743	.004	.007	-.387	.142	-.668	-.107
Q24	Equal variances assumed	18.284	<.001	-.869	185	.193	.386	-.499	.574	-1.632	.634
	Equal variances not assumed			-.748	68.277	.229	.457	-.499	.668	-1.832	.833

Table 9. Resident Survey
Urban-Rural T-test

Appendix VI
Resident Survey Study Site vs. Study Area Independent samples T-test

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means							
						Significance				95% Confidence Interval of the Difference	
		F	Sig.	t	df	One-Sided p	Two-Sided p	Mean Difference	Std. Error Difference	Lower	Upper
Q11	Equal variances assumed	1.965	.163	-.842	180	.200	.401	-.434	.516	-1.452	.584
	Equal variances not assumed			-.884	6.544	.204	.408	-.434	.491	-1.613	.745
Q12	Equal variances assumed	.906	.343	.733	180	.232	.464	.337	.460	-.570	1.245
	Equal variances not assumed			.629	6.350	.276	.551	.337	.536	-.956	1.631
Q13	Equal variances assumed	3.059	.082	.284	180	.388	.777	.143	.503	-.850	1.136
	Equal variances not assumed			.383	6.953	.357	.713	.143	.373	-.740	1.026
Q14	Equal variances assumed	13.861	<.001	1.362	180	.087	.175	.211	.155	-.095	.518
	Equal variances not assumed			6.830	174.000	<.001	<.001	.211	.031	.150	.273
Q15	Equal variances assumed	40.308	<.001	1.758	180	.040	.080	.309	.176	-.038	.655
	Equal variances not assumed			8.812	174.000	<.001	<.001	.309	.035	.239	.378
Q16	Equal variances assumed	.967	.327	1.173	176	.121	.243	.446	.380	-.304	1.196
	Equal variances not assumed			.737	5.129	.247	.493	.446	.605	-1.097	1.989
Q17	Equal variances assumed	.398	.529	.657	176	.256	.512	.277	.422	-.556	1.110
	Equal variances not assumed			.458	5.162	.333	.666	.277	.606	-1.265	1.820
Q18	Equal variances assumed	1.822	.179	-1.086	176	.140	.279	-.490	.452	-1.382	.401
	Equal variances not assumed			-2.161	6.702	.035	.069	-.490	.227	-1.032	.051
Q7	Equal variances assumed	.730	.394	.570	182	.285	.570	.292	.513	-.720	1.304
	Equal variances not assumed			.622	6.586	.278	.555	.292	.470	-.834	1.418
Q8	Equal variances assumed	2.496	.116	.952	181	.171	.342	.366	.384	-.392	1.124
	Equal variances not assumed			1.696	7.817	.065	.129	.366	.216	-.134	.866
Q9	Equal variances assumed	.054	.816	.404	182	.343	.687	.206	.509	-.799	1.210
	Equal variances not assumed			.359	6.372	.366	.732	.206	.574	-1.179	1.591
Q5	Equal variances assumed	.009	.926	.086	183	.466	.932	.038	.445	-.841	.917
	Equal variances not assumed			.082	7.594	.468	.936	.038	.462	-1.038	1.115
Q4	Equal variances assumed	.029	.864	-.663	183	.254	.508	-.238	.359	-.946	.470
	Equal variances not assumed			-.782	7.935	.229	.457	-.238	.304	-.941	.465
Q24	Equal variances assumed	15.667	<.001	-2.678	185	.004	.008	-3.307	1.235	-5.743	-.871
	Equal variances not assumed			-12.702	178.000	<.001	<.001	-3.307	.260	-3.821	-2.793
Q8X	Equal variances assumed	25.099	<.001	1.647	202	.051	.101	.255	.155	-.050	.560
	Equal variances not assumed			8.172	195.000	<.001	<.001	.255	.031	.194	.317

Table 10. Resident Survey
Study Site-Study Area T-test

Appendix VII
Question 21 Expert Feedback

Q21 - Are there any innovative, emerging, or unconventional methods, perhaps 'out there' ideas, that you believe hold potential and would like to see considered for wildfire mitigation in exposed Great Plains communities or elsewhere?

State highways continue to take larger amounts of land for easements. These land would otherwise be being utilized for farming and ranching, and as such is utilized and maintained. In the state of Oklahoma they are mowing less frequently and usually when they do mow they are not maintaining the additional space that they have taken which leads to excess fuels being built up along roadways. Fire is able to travel vast distances quickly. We need to reduce land grabs, increase productive tax generating use of our land, and at the same time reduce the expense to taxpayers. A smaller footprint on all highways utilizing only what is actually needed will go a long ways towards a reduction in fire spread do to unwanted, and unnecessary maintenance costs.

Continued emphasis on prescribed fire to reduce fuel loading and control invasive species. Cheapest possible option

There really aren't and probably never will be. Sorry to rain on the parade but there has not been any relevant research related to fire and the interface in a couple of decades. It has all been studied before many times. Those in risk management science know that your either remove the risk or remove people from exposure to the risk. Nobody has the political will to do the latter. We have always had wildland fires year round, the size/number/complexity were far worse pre-climate everything, and people aren't interested. No politician at any level ever reads so-called research. This is a people problem not a forest or grassland problem.

Defensible space is still the easiest and most affordable for the individual, neighborhood, and community.

We need to remind folks that defensive space is not just for the mountains. outbuildings, windbreaks/shelter belts, and seasonal Ag debris (corn shucks, tumble weeks) are all very flammable for 4-6 months of an average year in the great plains, sometimes longer during droughts. If it's not green, or white (covered with snow) it will burn, that message needs to be reiterated to residents, we have to look no further than the December 30th, 2021 Marshall fire in Colorado to see what wind and seasonal dead vegetation can do. in a matter of hours a wildland fire driven by winds of up to 100 mph, burned over 1000 homes.

I've seen policies in California that place concrete patios adjacent to buildings as a way of ensuring defensible space. This seems promising, if not a bit extreme. Likewise, not allowing tall wooden decks in particularly risky areas kind of seems like a no brainer from a policy perspective. Not sure how the politics would go on that one. Pave everything? (kidding)

Historically the plains are used as a resource with little consequence due to wind farms, solar farms and oil and gas sites being in remote areas. With increased demand for energy and increased urban sprawl, these two land uses are at odds. Locally we have seen numerous ignitions from solar farms, this has led to a requirement of noncombustible ground cover w/ in 20ft of panels especially as subdivisions are now being built within 1/4mi of one of these solar farms.

KS needs a region specific planting guide similar to the Oregon guidebook that I now use as a reference when I speak locally.

Any approach to mitigation must be supported at all levels of government, it does no good for a community to want to mitigate wildfire if the state refuses to provide grant programs. It does no good for the state to offer money if local officials scoff at the idea that wildfire is a threat. A whole community approach is necessary and should be focused on the interventions of engineering, education, economic incentives, enforcement of codes, and then as a last resort - emergency response.

Site surveys with aerial devices such as drones to help identify troubled areas. As well as using drones during emergency events to help plan as the event unfolds. This would also help with the placement of emergency vehicles throughout the event.

For best results, measures need to be taken throughout a neighborhood, not just on individual properties. Anything is better than nothing, but once a fire starts burning structures, it is spreading structure-to-structure, so individual measures become less effective.

Tax credits for homeowners in the WUI who properly prepare and maintain their defensible space around structures. 200' easements along major escape routes that can be maintained by the county.

Creating 100' conifer-free buffers along public roadways, which are burned prior to wildfire season. Creates huge fuel breaks for backburning and stopping wildfires.

Not innovation or emerging or unconventional but to successfully reduce wildfire risk requires collaboration between political subdivisions, private landowners and state / federal agencies.

In my opinion, it has already been covered, but a combination of all aspects within this survey are important, and are area-specific to detail. A combination of fuels management (thinning AND prescribed fire!), building construction guidelines, and public education are imperative to wildfire preparedness.

Appendix VIII
Question 22 Expert Feedback

Q22 - Do you have any additional comments on wildfire mitigation in the Great Plains?

Our city has undergrounded most of our utilities since the 1950s. I don't believe standard power lines are a large issue here. Very large transmission lines are still above ground in our region and may pose a risk. Our city is actively pursuing sustainable landscapes, especially with reference to irrigation needs. These policies come with tradeoffs and decisions regarding our policy priorities that are not necessarily being openly discussed. These include: soil health vs. covering everything with rock mulch. Xeric landscaping vs. fire risk. Xeric landscaping vs. urban tree health. Xeric landscaping vs. urban heat island. And, as you bring up, Xeric landscaping vs wildfire (or other fire) risk.

When we see wildfires move from wildlands across the urban interface, as we saw in Maui recently, the Marshall Fire in Louisville, CO a few winters ago, and Santa Rosa, CA a number of years ago, it is clear that there are risks here that are probably not being looked at as clearly as they should be. I believe all three of these incidents happened during high wind events. Indeed, just the memory of smoke during the devastating fires in Colorado wildlands in the late summer and fall of 2020 are enough to have triggered most residents of our town to voluntarily stop using charcoal grills or doing any outdoor burning of any sort when winds are high. These memories are fresh among our residents and compliance with fireworks bans and fire bans is taken very seriously. We have $1,000 fines for fireworks within city limits and large signs reminding folks of this go up around July 4th and New Year's every year.

On the other hand, short grass prairie poses a much lesser risk to homes and structures than do tallgrass prairie, shrubland or forests experiencing drought. So while we certainly have risks, they may not be as large of risks as communities higher up in the foothills to the west of us or communities in dry forests or on slopes. [redacted] is generally quite flat. Right now, our city is working very hard to allow residences to be built at slightly higher densities. This supports our transportation goals, our climate goals, and our housing affordability and housing type choice goals. There has been no conversation throughout this somewhat long and exhausting process of fire risk.

Our urban planners feel that TOO much of urban design in our community, and likely nationwide right now is dictated by ever-larger fire trucks and ever stricter access requirements by our fire department. We actively try to reduce the amount of land in our urban areas that is dedicated to cars (roads, parking, etc.), but our fire department demands more and more. This is helpful for accessing individual sites, and for creating large swaths of imflammable areas (i.e. parking lots and roads) between buildings, but at what cost. We are building urban areas that are less walkable, less pleasant to occupy, and generally less livable because of the possibility of a catastrophic fire. More work NEEDS to be done to integrate these two perspectives and find common ground, so to speak.

The example of the 2021 Marshall Fire on the Colorado Front Range suggests control of wildfires with similar fuel and weather characteristics can't really be slowed with construction or site management methods. High winds and dry open space grasslands were a severe combination in that case. Long term regional zoning and development regulations is likely the most effective strategy to mitigate risk in case like that.

Particularly in neighborhoods and subdivisions, creating defensible space >30' from structures becomes challenging because that is the neighbor or neighbor's neighbor's property. Risk must be evaluated and mitigated at the community level to be effective and efficient. It is still critical to take individual actions to protect lives and structures, but community-level action becomes much more important.

The Great Plains historically not been thought of as a fire prone area. Its good to see the passion of others to promote that we do live in a high fire danger area. Our fires are not months long like in a forest but we can have just as much damage/destruction in a 2 day fire.

WUI fire modeling still has a long way to go. 2022 COAL Fuelscape redesignating developed areas as having the ability to burn has helped with this but is not yet usable in FlaMap or IFTDSS yet. Without the ability to readily model WUI ignitions/impacts to communities and effects that fuel treatments will have it can be difficult to justify mitigation costs to stakeholders.

The Great Plains is likely one of the most difficult ecosystems in which to mitigate wildfire. Unlike the timbered west, a mitigation project to remove or reduce grass may be effective only until the next growing season has ended. Further, because emergency response is so efficient at extinguishing undesirable fires, many people have the mistaken notion that wildfire is less dangerous on the prairie than in other locals. - It cannot be lost in this discussion that fire is a natural part of the ecosystem and is required for the ecosystem to function. Fire has burned the prairie since long before man walked here and man will not keep fire out. Our only choice is to choose when and how fires burn through prescribed burning or let fire make the choice.

Wildfire is one of the only natural disasters that society often times tries to eradicate, which is unreasonable. Instead, we should compare it to a blizzard, or any other natural event that we prepare for. Then when it does happen, it passes by with less impact. A cooperative effort amongst government and private organizations, the public, etc to mitigate wildfire risk so important. Here in our area, we categorize most of our wildfires as "high risk, short duration" events that hit quickly without much warning, regardless of the time of year. The traditional "fire season" of the summer months is not our only risk, and in fact, we see more threat from grass fires in the shoulder seasons and even winter.

Appendix IX: Typology 1 Plant Selection

Step #	Plant Characteristic Description	If Yes, Go To #	Points
1. Type of Plant	Tree Trees can provide shade, windbreak, energy savings, wildlife habitat, & erosion control.	2	
	Shrub or Woody Groundcover Shrubs are typically 2-12 feet tall and have a hard, woody stem. Woody groundcovers are low to the ground, but still have a hard, woody stem & branches.	2	
	Vine Vines can be herbaceous or woody, but require a trellis, plant, or building for support.	15	
	Herbaceous Ornamental or Grass Herbaceous plants are usually low-growing annuals or perennials, without a woody stem.	16	
2	Conifer and/or Evergreen Conifers have needle-like or scale-like leaves, and include pines, spruces, junipers & cedars. Evergreen plants retain their leaves throughout the year, and include Rhododendron & Azalea.	3	
	Broadleaf and/or Deciduous — For trees, go to:	9	
	Broadleaf plants have wider leaves (ex.: maples, oaks, Forsythia, and Butterfly Bush.) Deciduous plants drop their leaves once each year. — For shrubs, go to:	11	
3	Resinous Resinous plants produce resin, typically giving off a pungent odor when the leaves are crushed. These include pines, spruces, junipers and cedars.	4	
	Non-Resinous or Less Resinous Plants with less resin will usually give off less of a pungent odor when crushed.	5	
4	Less Firewise - Resinous plants are highly flammable and should not be used in close proximity to structures. Place 4 points in the far right column and go to:	5	
5	Conifer sheds large amounts of leaves or needles (many pine species)	6	
	Conifer does not regularly shed leaves or needles	7	
6	Less Firewise - Shed needles need to periodically be removed from roofs and the ground around structures. Place 2 points in the far right column and go to:	7	
7	Branches are less than 4 feet above the ground. This includes almost all shrubs.	8	
	Branches are more than 4 feet above the ground	9	
8	Less Firewise - Trees should be pruned and dead/low-hanging branches removed to be Firewise. Place 1 point in the far right column and go to:	11	
9	Trunk has papery bark or loose fibers	10	
	Trunk does not have papery bark or loose fibers	18	
10	Less Firewise - Papery bark or loose fibers can act as ladder fuels; proper placement is necessary. Place 1 point in the far right column and go to:	18	
11	Plant has fine texture Texture is a term to describe the overall appearance of a plant from a distance. From a distance of about 10-15 feet, it is not easy to distinguish individual leaves or branches. (Examples: Boxwood, Spirea, junipers)	12	
	Plant has medium texture From a distance of about 10-15 feet, some individual leaves and branches can be distinguished on the outer part of the shrub, but not the inner part. (Examples: some azaleas and hollies)	13	
	Plant has coarse texture From a distance of about 10-15 feet, it is easy to distinguish individual leaves and branches. Examples include Hydrangea, Beauty-berrry, and and Witch Hazel.	13	
12	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:	13	
13	Plant is very dense These shrubs are so dense that it is difficult to place your hand in the shrub and touch a main stem. They have dense branching, and include plants like Boxwood and junipers.	14	
	Plant is moderately dense These shrubs are dense enough that you can't clearly see through them, but it is reasonably easy to place your hand in the shrub and touch a main stem.	18	
	Plant is sparsely dense Plants have an open branching pattern, making it easy to see through the shrub. Examples include American Beauty-berry and some hydrangeas.	18	
14	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:	18	
15	Less Firewise - Vines can be flammable, and are problematic in that they add fuel directly to a structure, or act as ladder fuels. Place 2 points in the far right column and go to:	18	
16	Grass, more than 8 inches tall	17	
	All other herbaceous ornamentals, or mowed/green grass	18	
17	Less Firewise - Grass that is tall, dead, and/or dormant (yellow or brown in color) is extrememly flammable and carries fire rapidly. Place 6 points in the far right column and go to:	18	
18	Plant retains dead leaves for more than two months of the year	19	
	Plant does not usually retain dead leaves, except when shedding leaves	20	
19	Less Firewise - Plants with dead foliage are highly flammable, because of the low moisture content of the leaves and fine twigs. Place 3 points in the far right column and go to:	20	3
20	**Note:** Make sure leaves are not poisonous before touching them		
	Leaves have a waxy coating These plants have a very distinctive waxy coating on the leaf. (Ex.: Wax Myrtle, Gallberry, & Rhododendron)	21	
	Leaves do not have a waxy coating	22	
21	Less Firewise - Proper placement and maintenance are necessary. Place 1 point in the far right column and go to:	22	
22	Species is seriously susceptible to disease, pests, and/or drought All plants can get diseases, but plants seriously susceptible to disease or drought are likely to be stressed and have less vigorous growth. When this happens, the foliage has a lower moisture content and a greater number of dead leaves are retained.	23	
	Species is not seriously susceptible to disease, pests, and/or drought	24	
23	Less Firewise - Make a note of, and routinely monitor for, diseases or pests. Obtain proper diagnosis and treatment of problems. Select plants that are native and/or well-adapted to local climate conditions. Place 1 point in the far right column and go to:	24	
24	FINISHED - Total all the points in the far right column and compare this number to the table below, to get the flammability rating of this plant.		
	Total Points:		3

Total Points	Flammability Rating
0 - 1	Low Flammability
2 - 4	Moderate Flammability
5 - 8	High Flammability
9+	Very High Flammability

Chinkapin oak

Quercus muehlenbergii

Score: **3, moderate flammability**

Great Plains Native

Step #	Plant Characteristic Description	If Yes, Go To #	Points
1. Type of Plant	Tree Trees can provide shade, windbreak, energy savings, wildlife habitat, & erosion control.	2	
	Shrub or Woody Groundcover Shrubs are typically 2-12 feet tall and have a hard, woody stem. Woody groundcovers are low to the ground, but still have a hard, woody stem & branches.	2	
	Vine Vines can be herbaceous or woody, but require a trellis, plant, or building for support.	15	
	Herbaceous Ornamental or Grass Herbaceous plants are usually low-growing annuals or perennials, without a woody stem.	16	
2	Conifer and/or Evergreen Conifers have needle-like or scale-like leaves, and include pines, spruces, junipers & cedars. Evergreen plants retain their leaves throughout the year, and include Rhododendron & Azalea.	3	
	Broadleaf and/or Deciduous — For trees, go to:	9	
	Broadleaf plants have wider leaves (ex.: maples, oaks, Forsythia, and Butterfly Bush.) Deciduous plants drop their leaves once each year. — For shrubs, go to:	11	
3	Resinous Resinous plants produce resin, typically giving off a pungent odor when the leaves are crushed. These include pines, spruces, junipers and cedars.	4	
	Non-Resinous or Less Resinous Plants with less resin will usually give off less of a pungent odor when crushed.	5	
4	Less Firewise - Resinous plants are highly flammable and should not be used in close proximity to structures. Place 4 points in the far right column and go to:	5	
5	Conifer sheds large amounts of leaves or needles (many pine species)	6	
	Conifer does not regularly shed leaves or needles	7	
6	Less Firewise - Shed needles need to periodically be removed from roofs and the ground around structures. Place 2 points in the far right column and go to:	7	
7	Branches are less than 4 feet above the ground. This includes almost all shrubs.	8	
	Branches are more than 4 feet above the ground	9	
8	Less Firewise - Trees should be pruned and dead/low-hanging branches removed to be Firewise. Place 1 point in the far right column and go to:	11	
9	Trunk has papery bark or loose fibers	10	
	Trunk does not have papery bark or loose fibers	18	
10	Less Firewise - Papery bark or loose fibers can act as ladder fuels; proper placement is necessary. Place 1 point in the far right column and go to:	18	
11	Plant has fine texture Texture is a term to describe the overall appearance of a plant from a distance. From a distance of about 10-15 feet, it is not easy to distinguish individual leaves or branches. (Examples: Boxwood, Spirea, junipers)	12	
	Plant has medium texture From a distance of about 10-15 feet, some individual leaves and branches can be distinguished on the outer part of the shrub, but not the inner part. (Examples: some azaleas and hollies)	13	
	Plant has coarse texture From a distance of about 10-15 feet, it is easy to distinguish individual leaves and branches. Examples include Hydrangea, Beauty-berrry, and and Witch Hazel.	13	
12	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:	13	
13	Plant is very dense These shrubs are so dense that it is difficult to place your hand in the shrub and touch a main stem. They have dense branching, and include plants like Boxwood and junipers.	14	
	Plant is moderately dense These shrubs are dense enough that you can't clearly see through them, but it is reasonably easy to place your hand in the shrub and touch a main stem.	18	
	Plant is sparsely dense Plants have an open branching pattern, making it easy to see through the shrub. Examples include American Beauty-berry and some hydrangeas.	18	
14	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:	18	
15	Less Firewise - Vines can be flammable, and are problematic in that they add fuel directly to a structure, or act as ladder fuels. Place 2 points in the far right column and go to:	18	
16	Grass, more than 8 inches tall	17	
	All other herbaceous ornamentals, or mowed/green grass	18	
17	Less Firewise - Grass that is tall, dead, and/or dormant (yellow or brown in color) is extrememly flammable and carries fire rapidly. Place 6 points in the far right column and go to:	18	
18	Plant retains dead leaves for more than two months of the year	19	
	Plant does not usually retain dead leaves, except when shedding leaves	20	
19	Less Firewise - Plants with dead foliage are highly flammable, because of the low moisture content of the leaves and fine twigs. Place 3 points in the far right column and go to:	20	
20	**Note:** Make sure leaves are not poisonous before touching them		
	Leaves have a waxy coating These plants have a very distinctive waxy coating on the leaf. (Ex.: Wax Myrtle, Gallberry, & Rhododendron)	21	
	Leaves do not have a waxy coating	22	
21	Less Firewise - Proper placement and maintenance are necessary. Place 1 point in the far right column and go to:	22	
22	Species is seriously susceptible to disease, pests, and/or drought All plants can get diseases, but plants seriously susceptible to disease or drought are likely to be stressed and have less vigorous growth. When this happens, the foliage has a lower moisture content and a greater number of dead leaves are retained.	23	
	Species is not seriously susceptible to disease, pests, and/or drought	24	
23	Less Firewise - Make a note of, and routinely monitor for, diseases or pests. Obtain proper diagnosis and treatment of problems. Select plants that are native and/or well-adapted to local climate conditions. Place 1 point in the far right column and go to:	24	
24	FINISHED - Total all the points in the far right column and compare this number to the table below, to get the flammability rating of this plant.		
	Total Points:		0

Total Points	Flammability Rating
0 - 1	Low Flammability
2 - 4	Moderate Flammability
5 - 8	High Flammability
9+	Very High Flammability

Slippery elm

Ulmus Rubra

Score: **0, low flammability**

Great Plains Native

Step #	Plant Characteristic Description		If Yes, Go To #	Points
1. Type of Plant	Tree Trees can provide shade, windbreak, energy savings, wildlife habitat, & erosion control.		2	
	Shrub or Woody Groundcover Shrubs are typically 2-12 feet tall and have a hard, woody stem. Woody groundcovers are low to the ground, but still have a hard, woody stem & branches.		2	
	Vine Vines can be herbaceous or woody, but require a trellis, plant, or building for support.		15	
	Herbaceous Ornamental or Grass Herbaceous plants are usually low-growing annuals or perennials, without a woody stem.		16	
2	Conifer and/or Evergreen Conifers have needle-like or scale-like leaves, and include pines, spruces, junipers & cedars. Evergreen plants retain their leaves throughout the year, and include Rhododendron & Azalea.		3	
	Broadleaf and/or Deciduous Broadleaf plants have wider leaves (ex.: maples, oaks, Forsythia, and Butterfly Bush.) Deciduous plants drop their leaves once each year.	For trees, go to: For shrubs, go to:	9 11	
3	Resinous Resinous plants produce resin, typically giving off a pungent odor when the leaves are crushed. These include pines, spruces, junipers and cedars.		4	
	Non-Resinous or Less Resinous Plants with less resin will usually give off less of a pungent odor when crushed.		5	
4	Less Firewise - Resinous plants are highly flammable and should not be used in close proximity to structures. Place 4 points in the far right column and go to:		5	
5	Conifer sheds large amounts of leaves or needles (many pine species)		6	
	Conifer does not regularly shed leaves or needles		7	
6	Less Firewise - Shed needles need to periodically be removed from roofs and the ground around structures. Place 2 points in the far right column and go to:		7	
7	Branches are less than 4 feet above the ground. This includes almost all shrubs.		8	
	Branches are more than 4 feet above the ground		9	
8	Less Firewise - Trees should be pruned and dead/low-hanging branches removed to be Firewise. Place 1 point in the far right column and go to:		11	1
9	Trunk has papery bark or loose fibers		10	
	Trunk does not have papery bark or loose fibers		18	
10	Less Firewise - Papery bark or loose fibers can act as ladder fuels; proper placement is necessary. Place 1 point in the far right column and go to:		18	
11	Plant has fine texture Texture is a term to describe the overall appearance of a plant from a distance. From a distance of about 10-15 feet, it is not easy to distinguish individual leaves or branches. (Examples: Boxwood, Spirea, junipers)		12	
	Plant has medium texture From a distance of about 10-15 feet, some individual leaves and branches can be distinguished on the outer part of the shrub, but not the inner part. (Examples: some azaleas and hollies)		13	
	Plant has coarse texture From a distance of about 10-15 feet, it is easy to distinguish individual leaves and branches. Examples include Hydrangea, Beauty-berrry, and and Witch Hazel.		13	
12	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		13	
13	Plant is very dense These shrubs are so dense that it is difficult to place your hand in the shrub and touch a main stem. They have dense branching, and include plants like Boxwood and junipers.		14	
	Plant is moderately dense These shrubs are dense enough that you can't clearly see through them, but it is reasonably easy to place your hand in the shrub and touch a main stem.		18	
	Plant is sparsely dense Plants have an open branching pattern, making it easy to see through the shrub. Examples include American Beauty-berry and some hydrangeas.		18	
14	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		18	
15	Less Firewise - Vines can be flammable, and are problematic in that they add fuel directly to a structure, or act as ladder fuels. Place 2 points in the far right column and go to:		18	
16	Grass, more than 8 inches tall		17	
	All other herbaceous ornamentals, or mowed/green grass		18	
17	Less Firewise - Grass that is tall, dead, and/or dormant (yellow or brown in color) is extrememly flammable and carries fire rapidly. Place 6 points in the far right column and go to:		18	
18	Plant retains dead leaves for more than two months of the year		19	
	Plant does not usually retain dead leaves, except when shedding leaves		20	
19	Less Firewise - Plants with dead foliage are highly flammable, because of the low moisture content of the leaves and fine twigs. Place 3 points in the far right column and go to:		20	
20	**Note:** Make sure leaves are not poisonous before touching them			
	Leaves have a waxy coating These plants have a very distinctive waxy coating on the leaf. (Ex.: Wax Myrtle, Gallberry, & Rhododendron)		21	
	Leaves do not have a waxy coating		22	
21	Less Firewise - Proper placement and maintenance are necessary. Place 1 point in the far right column and go to:		22	
22	Species is seriously susceptible to disease, pests, and/or drought All plants can get diseases, but plants seriously susceptible to disease or drought are likely to be stressed and have less vigorous growth. When this happens, the foliage has a lower moisture content and a greater number of dead leaves are retained.		23	
	Species is not seriously susceptible to disease, pests, and/or drought		24	
23	Less Firewise - Make a note of, and routinely monitor for, diseases or pests. Obtain proper diagnosis and treatment of problems. Select plants that are native and/or well-adapted to local climate conditions. Place 1 point in the far right column and go to:		24	
24	FINISHED - Total all the points in the far right column and compare this number to the table below, to get the flammability rating of this plant.			
		Total Points:		1

Total Points	Flammability Rating
0 - 1	Low Flammability
2 - 4	Moderate Flammability
5 - 8	High Flammability
9+	Very High Flammability

Box elder

Acer negundo

Score: **1, low flammability**

Great Plains Native

Step #	Plant Characteristic Description		If Yes, Go To #	Points
1. Type of Plant	Tree Trees can provide shade, windbreak, energy savings, wildlife habitat, & erosion control.		2	
	Shrub or Woody Groundcover Shrubs are typically 2-12 feet tall and have a hard, woody stem. Woody groundcovers are low to the ground, but still have a hard, woody stem & branches.		2	
	Vine Vines can be herbaceous or woody, but require a trellis, plant, or building for support.		15	
	Herbaceous Ornamental or Grass Herbaceous plants are usually low-growing annuals or perennials, without a woody stem.		16	
2	Conifer and/or Evergreen Conifers have needle-like or scale-like leaves, and include pines, spruces, junipers & cedars. Evergreen plants retain their leaves throughout the year, and include Rhododendron & Azalea.		3	
	Broadleaf and/or Deciduous Broadleaf plants have wider leaves (ex.: maples, oaks, Forsythia, and Butterfly Bush.) Deciduous plants drop their leaves once each year.	For trees, go to: For shrubs, go to:	9 11	
3	Resinous Resinous plants produce resin, typically giving off a pungent odor when the leaves are crushed. These include pines, spruces, junipers and cedars.		4	
	Non-Resinous or Less Resinous Plants with less resin will usually give off less of a pungent odor when crushed.		5	
4	Less Firewise - Resinous plants are highly flammable and should not be used in close proximity to structures. Place 4 points in the far right column and go to:		5	
5	Conifer sheds large amounts of leaves or needles (many pine species)		6	
	Conifer does not regularly shed leaves or needles		7	
6	Less Firewise - Shed needles need to periodically be removed from roofs and the ground around structures. Place 2 points in the far right column and go to:		7	
7	Branches are less than 4 feet above the ground. This includes almost all shrubs.		8	
	Branches are more than 4 feet above the ground		9	
8	Less Firewise - Trees should be pruned and dead/low-hanging branches removed to be Firewise. Place 1 point in the far right column and go to:		11	1
9	Trunk has papery bark or loose fibers		10	
	Trunk does not have papery bark or loose fibers		18	
10	Less Firewise - Papery bark or loose fibers can act as ladder fuels; proper placement is necessary. Place 1 point in the far right column and go to:		18	
11	Plant has fine texture Texture is a term to describe the overall appearance of a plant from a distance. From a distance of about 10-15 feet, it is not easy to distinguish individual leaves or branches. (Examples: Boxwood, Spirea, junipers)		12	
	Plant has medium texture From a distance of about 10-15 feet, some individual leaves and branches can be distinguished on the outer part of the shrub, but not the inner part. (Examples: some azaleas and hollies)		13	
	Plant has coarse texture From a distance of about 10-15 feet, it is easy to distinguish individual leaves and branches. Examples include Hydrangea, Beauty-berrry, and and Witch Hazel.		13	
12	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		13	
13	Plant is very dense These shrubs are so dense that it is difficult to place your hand in the shrub and touch a main stem. They have dense branching, and include plants like Boxwood and junipers.		14	
	Plant is moderately dense These shrubs are dense enough that you can't clearly see through them, but it is reasonably easy to place your hand in the shrub and touch a main stem.		18	
	Plant is sparsely dense Plants have an open branching pattern, making it easy to see through the shrub. Examples include American Beauty-berry and some hydrangeas.		18	
14	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		18	
15	Less Firewise - Vines can be flammable, and are problematic in that they add fuel directly to a structure, or act as ladder fuels. Place 2 points in the far right column and go to:		18	
16	Grass, more than 8 inches tall		17	
	All other herbaceous ornamentals, or mowed/green grass		18	
17	Less Firewise - Grass that is tall, dead, and/or dormant (yellow or brown in color) is extrememly flammable and carries fire rapidly. Place 6 points in the far right column and go to:		18	
18	Plant retains dead leaves for more than two months of the year		19	
	Plant does not usually retain dead leaves, except when shedding leaves		20	
19	Less Firewise - Plants with dead foliage are highly flammable, because of the low moisture content of the leaves and fine twigs. Place 3 points in the far right column and go to:		20	
20	**Note:** Make sure leaves are not poisonous before touching them			
	Leaves have a waxy coating These plants have a very distinctive waxy coating on the leaf. (Ex.: Wax Myrtle, Gallberry, & Rhododendron)		21	
	Leaves do not have a waxy coating		22	
21	Less Firewise - Proper placement and maintenance are necessary. Place 1 point in the far right column and go to:		22	
22	Species is seriously susceptible to disease, pests, and/or drought All plants can get diseases, but plants seriously susceptible to disease or drought are likely to be stressed and have less vigorous growth. When this happens, the foliage has a lower moisture content and a greater number of dead leaves are retained.		23	
	Species is not seriously susceptible to disease, pests, and/or drought		24	
23	Less Firewise - Make a note of, and routinely monitor for, diseases or pests. Obtain proper diagnosis and treatment of problems. Select plants that are native and/or well-adapted to local climate conditions. Place 1 point in the far right column and go to:		24	
24	FINISHED - Total all the points in the far right column and compare this number to the table below, to get the flammability rating of this plant.			
		Total Points:		1

Total Points	Flammability Rating
0 - 1	Low Flammability
2 - 4	Moderate Flammability
5 - 8	High Flammability
9+	Very High Flammability

Eastern redbud

Cercis canadensis

Score: **1, low flammability**

Great Plains Native

Step #	Plant Characteristic Description		If Yes, Go To #	Points
1. Type of Plant	Tree Trees can provide shade, windbreak, energy savings, wildlife habitat, & erosion control.		2	
	Shrub or Woody Groundcover Shrubs are typically 2-12 feet tall and have a hard, woody stem. Woody groundcovers are low to the ground, but still have a hard, woody stem & branches.		2	
	Vine Vines can be herbaceous or woody, but require a trellis, plant, or building for support.		15	
	Herbaceous Ornamental or Grass Herbaceous plants are usually low-growing annuals or perennials, without a woody stem.		16	
2	Conifer and/or Evergreen Conifers have needle-like or scale-like leaves, and include pines, spruces, junipers & cedars. Evergreen plants retain their leaves throughout the year, and include Rhododendron & Azalea.		3	
	Broadleaf and/or Deciduous Broadleaf plants have wider leaves (ex.: maples, oaks, Forsythia, and Butterfly Bush.) Deciduous plants drop their leaves once each year.	For trees, go to: For shrubs, go to:	9 11	
3	Resinous Resinous plants produce resin, typically giving off a pungent odor when the leaves are crushed. These include pines, spruces, junipers and cedars.		4	
	Non-Resinous or Less Resinous Plants with less resin will usually give off less of a pungent odor when crushed.		5	
4	Less Firewise - Resinous plants are highly flammable and should not be used in close proximity to structures. Place 4 points in the far right column and go to:		5	
5	Conifer sheds large amounts of leaves or needles (many pine species)		6	
	Conifer does not regularly shed leaves or needles		7	
6	Less Firewise - Shed needles need to periodically be removed from roofs and the ground around structures. Place 2 points in the far right column and go to:		7	
7	Branches are less than 4 feet above the ground. This includes almost all shrubs.		8	
	Branches are more than 4 feet above the ground		9	
8	Less Firewise - Trees should be pruned and dead/low-hanging branches removed to be Firewise. Place 1 point in the far right column and go to:		11	1
9	Trunk has papery bark or loose fibers		10	
	Trunk does not have papery bark or loose fibers		18	
10	Less Firewise - Papery bark or loose fibers can act as ladder fuels; proper placement is necessary. Place 1 point in the far right column and go to:		18	
11	Plant has fine texture Texture is a term to describe the overall appearance of a plant from a distance. From a distance of about 10-15 feet, it is not easy to distinguish individual leaves or branches. (Examples: Boxwood, Spirea, junipers)		12	
	Plant has medium texture From a distance of about 10-15 feet, some individual leaves and branches can be distinguished on the outer part of the shrub, but not the inner part. (Examples: some azaleas and hollies)		13	
	Plant has coarse texture From a distance of about 10-15 feet, it is easy to distinguish individual leaves and branches. Examples include Hydrangea, Beauty-berrry, and and Witch Hazel.		13	
12	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		13	
13	Plant is very dense These shrubs are so dense that it is difficult to place your hand in the shrub and touch a main stem. They have dense branching, and include plants like Boxwood and junipers.		14	
	Plant is moderately dense These shrubs are dense enough that you can't clearly see through them, but it is reasonably easy to place your hand in the shrub and touch a main stem.		18	
	Plant is sparsely dense Plants have an open branching pattern, making it easy to see through the shrub. Examples include American Beauty-berry and some hydrangeas.		18	
14	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		18	
15	Less Firewise - Vines can be flammable, and are problematic in that they add fuel directly to a structure, or act as ladder fuels. Place 2 points in the far right column and go to:		18	
16	Grass, more than 8 inches tall		17	
	All other herbaceous ornamentals, or mowed/green grass		18	
17	Less Firewise - Grass that is tall, dead, and/or dormant (yellow or brown in color) is extrememly flammable and carries fire rapidly. Place 6 points in the far right column and go to:		18	
18	Plant retains dead leaves for more than two months of the year		19	
	Plant does not usually retain dead leaves, except when shedding leaves		20	
19	Less Firewise - Plants with dead foliage are highly flammable, because of the low moisture content of the leaves and fine twigs. Place 3 points in the far right column and go to:		20	
20	**Note:** Make sure leaves are not poisonous before touching them			
	Leaves have a waxy coating These plants have a very distinctive waxy coating on the leaf. (Ex.: Wax Myrtle, Gallberry, & Rhododendron)		21	
	Leaves do not have a waxy coating		22	
21	Less Firewise - Proper placement and maintenance are necessary. Place 1 point in the far right column and go to:		22	
22	Species is seriously susceptible to disease, pests, and/or drought All plants can get diseases, but plants seriously susceptible to disease or drought are likely to be stressed and have less vigorous growth. When this happens, the foliage has a lower moisture content and a greater number of dead leaves are retained.		23	
	Species is not seriously susceptible to disease, pests, and/or drought		24	
23	Less Firewise - Make a note of, and routinely monitor for, diseases or pests. Obtain proper diagnosis and treatment of problems. Select plants that are native and/or well-adapted to local climate conditions. Place 1 point in the far right column and go to:		24	
24	FINISHED - Total all the points in the far right column and compare this number to the table below, to get the flammability rating of this plant.			
		Total Points:		1

Total Points	Flammability Rating
0 - 1	Low Flammability
2 - 4	Moderate Flammability
5 - 8	High Flammability
9+	Very High Flammability

Coralberry

Symphorocarpus orbiculatus

Score: **1, low flammability**

Great Plains Native

Step #	Plant Characteristic Description		If Yes, Go To #	Points
1. Type of Plant	Tree Trees can provide shade, windbreak, energy savings, wildlife habitat, & erosion control.		2	
	Shrub or Woody Groundcover Shrubs are typically 2-12 feet tall and have a hard, woody stem. Woody groundcovers are low to the ground, but still have a hard, woody stem & branches.		2	
	Vine Vines can be herbaceous or woody, but require a trellis, plant, or building for support.		15	
	Herbaceous Ornamental or Grass Herbaceous plants are usually low-growing annuals or perennials, without a woody stem.		16	
2	Conifer and/or Evergreen Conifers have needle-like or scale-like leaves, and include pines, spruces, junipers & cedars. Evergreen plants retain their leaves throughout the year, and include Rhododendron & Azalea.		3	
	Broadleaf and/or Deciduous Broadleaf plants have wider leaves (ex.: maples, oaks, Forsythia, and Butterfly Bush.) Deciduous plants drop their leaves once each year.	For trees, go to: For shrubs, go to:	9 11	
3	Resinous Resinous plants produce resin, typically giving off a pungent odor when the leaves are crushed. These include pines, spruces, junipers and cedars.		4	
	Non-Resinous or Less Resinous Plants with less resin will usually give off less of a pungent odor when crushed.		5	
4	Less Firewise - Resinous plants are highly flammable and should not be used in close proximity to structures. Place 4 points in the far right column and go to:		5	
5	Conifer sheds large amounts of leaves or needles (many pine species)		6	
	Conifer does not regularly shed leaves or needles		7	
6	Less Firewise - Shed needles need to periodically be removed from roofs and the ground around structures. Place 2 points in the far right column and go to:		7	
7	Branches are less than 4 feet above the ground. This includes almost all shrubs.		8	
	Branches are more than 4 feet above the ground		9	
8	Less Firewise - Trees should be pruned and dead/low-hanging branches removed to be Firewise. Place 1 point in the far right column and go to:		11	1
9	Trunk has papery bark or loose fibers		10	
	Trunk does not have papery bark or loose fibers		18	
10	Less Firewise - Papery bark or loose fibers can act as ladder fuels; proper placement is necessary. Place 1 point in the far right column and go to:		18	
11	Plant has fine texture Texture is a term to describe the overall appearance of a plant from a distance. From a distance of about 10-15 feet, it is not easy to distinguish individual leaves or branches. (Examples: Boxwood, Spirea, junipers)		12	
	Plant has medium texture From a distance of about 10-15 feet, some individual leaves and branches can be distinguished on the outer part of the shrub, but not the inner part. (Examples: some azaleas and hollies)		13	
	Plant has coarse texture From a distance of about 10-15 feet, it is easy to distinguish individual leaves and branches. Examples include Hydrangea, Beauty-berrry, and and Witch Hazel.		13	
12	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		13	
13	Plant is very dense These shrubs are so dense that it is difficult to place your hand in the shrub and touch a main stem. They have dense branching, and include plants like Boxwood and junipers.		14	
	Plant is moderately dense These shrubs are dense enough that you can't clearly see through them, but it is reasonably easy to place your hand in the shrub and touch a main stem.		18	
	Plant is sparsely dense Plants have an open branching pattern, making it easy to see through the shrub. Examples include American Beauty-berry and some hydrangeas.		18	
14	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		18	
15	Less Firewise - Vines can be flammable, and are problematic in that they add fuel directly to a structure, or act as ladder fuels. Place 2 points in the far right column and go to:		18	
16	Grass, more than 8 inches tall		17	
	All other herbaceous ornamentals, or mowed/green grass		18	
17	Less Firewise - Grass that is tall, dead, and/or dormant (yellow or brown in color) is extrememly flammable and carries fire rapidly. Place 6 points in the far right column and go to:		18	
18	Plant retains dead leaves for more than two months of the year		19	
	Plant does not usually retain dead leaves, except when shedding leaves		20	
19	Less Firewise - Plants with dead foliage are highly flammable, because of the low moisture content of the leaves and fine twigs. Place 3 points in the far right column and go to:		20	
20	**Note:** Make sure leaves are not poisonous before touching them			
	Leaves have a waxy coating These plants have a very distinctive waxy coating on the leaf. (Ex.: Wax Myrtle, Gallberry, & Rhododendron)		21	
	Leaves do not have a waxy coating		22	
21	Less Firewise - Proper placement and maintenance are necessary. Place 1 point in the far right column and go to:		22	
22	Species is seriously susceptible to disease, pests, and/or drought All plants can get diseases, but plants seriously susceptible to disease or drought are likely to be stressed and have less vigorous growth. When this happens, the foliage has a lower moisture content and a greater number of dead leaves are retained.		23	
	Species is not seriously susceptible to disease, pests, and/or drought		24	
23	Less Firewise - Make a note of, and routinely monitor for, diseases or pests. Obtain proper diagnosis and treatment of problems. Select plants that are native and/or well-adapted to local climate conditions. Place 1 point in the far right column and go to:		24	
24	FINISHED - Total all the points in the far right column and compare this number to the table below, to get the flammability rating of this plant.			
		Total Points:		1

Total Points	Flammability Rating
0 - 1	Low Flammability
2 - 4	Moderate Flammability
5 - 8	High Flammability
9+	Very High Flammability

Red twig dogwood

Cornus sericea

Score: **1, low flammability**

Great Plains Native

Step #	Plant Characteristic Description		If Yes, Go To #	Points
1. Type of Plant	Tree Trees can provide shade, windbreak, energy savings, wildlife habitat, & erosion control.		2	
	Shrub or Woody Groundcover Shrubs are typically 2-12 feet tall and have a hard, woody stem. Woody groundcovers are low to the ground, but still have a hard, woody stem & branches.		2	
	Vine Vines can be herbaceous or woody, but require a trellis, plant, or building for support.		15	
	Herbaceous Ornamental or Grass Herbaceous plants are usually low-growing annuals or perennials, without a woody stem.		16	
2	Conifer and/or Evergreen Conifers have needle-like or scale-like leaves, and include pines, spruces, junipers & cedars. Evergreen plants retain their leaves throughout the year, and include Rhododendron & Azalea.		3	
	Broadleaf and/or Deciduous Broadleaf plants have wider leaves (ex.: maples, oaks, Forsythia, and Butterfly Bush.) Deciduous plants drop their leaves once each year.	For trees, go to: For shrubs, go to:	9 11	
3	Resinous Resinous plants produce resin, typically giving off a pungent odor when the leaves are crushed. These include pines, spruces, junipers and cedars.		4	
	Non-Resinous or Less Resinous Plants with less resin will usually give off less of a pungent odor when crushed.		5	
4	Less Firewise - Resinous plants are highly flammable and should not be used in close proximity to structures. Place 4 points in the far right column and go to:		5	
5	Conifer sheds large amounts of leaves or needles (many pine species)		6	
	Conifer does not regularly shed leaves or needles		7	
6	Less Firewise - Shed needles need to periodically be removed from roofs and the ground around structures. Place 2 points in the far right column and go to:		7	
7	Branches are less than 4 feet above the ground. This includes almost all shrubs.		8	
	Branches are more than 4 feet above the ground		9	
8	Less Firewise - Trees should be pruned and dead/low-hanging branches removed to be Firewise. Place 1 point in the far right column and go to:		11	
9	Trunk has papery bark or loose fibers		10	
	Trunk does not have papery bark or loose fibers		18	
10	Less Firewise - Papery bark or loose fibers can act as ladder fuels; proper placement is necessary. Place 1 point in the far right column and go to:		18	
11	Plant has fine texture Texture is a term to describe the overall appearance of a plant from a distance. From a distance of about 10-15 feet, it is not easy to distinguish individual leaves or branches. (Examples: Boxwood, Spirea, junipers)		12	
	Plant has medium texture From a distance of about 10-15 feet, some individual leaves and branches can be distinguished on the outer part of the shrub, but not the inner part. (Examples: some azaleas and hollies)		13	
	Plant has coarse texture From a distance of about 10-15 feet, it is easy to distinguish individual leaves and branches. Examples include Hydrangea, Beauty-berrry, and and Witch Hazel.		13	
12	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		13	
13	Plant is very dense These shrubs are so dense that it is difficult to place your hand in the shrub and touch a main stem. They have dense branching, and include plants like Boxwood and junipers.		14	
	Plant is moderately dense These shrubs are dense enough that you can't clearly see through them, but it is reasonably easy to place your hand in the shrub and touch a main stem.		18	
	Plant is sparsely dense Plants have an open branching pattern, making it easy to see through the shrub. Examples include American Beauty-berry and some hydrangeas.		18	
14	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		18	
15	Less Firewise - Vines can be flammable, and are problematic in that they add fuel directly to a structure, or act as ladder fuels. Place 2 points in the far right column and go to:		18	
16	Grass, more than 8 inches tall		17	
	All other herbaceous ornamentals, or mowed/green grass		18	
17	Less Firewise - Grass that is tall, dead, and/or dormant (yellow or brown in color) is extrememly flammable and carries fire rapidly. Place 6 points in the far right column and go to:		18	
18	Plant retains dead leaves for more than two months of the year		19	
	Plant does not usually retain dead leaves, except when shedding leaves		20	
19	Less Firewise - Plants with dead foliage are highly flammable, because of the low moisture content of the leaves and fine twigs. Place 3 points in the far right column and go to:		20	
20	**Note:** Make sure leaves are not poisonous before touching them			
	Leaves have a waxy coating These plants have a very distinctive waxy coating on the leaf. (Ex.: Wax Myrtle, Gallberry, & Rhododendron)		21	
	Leaves do not have a waxy coating		22	
21	Less Firewise - Proper placement and maintenance are necessary. Place 1 point in the far right column and go to:		22	
22	Species is seriously susceptible to disease, pests, and/or drought All plants can get diseases, but plants seriously susceptible to disease or drought are likely to be stressed and have less vigorous growth. When this happens, the foliage has a lower moisture content and a greater number of dead leaves are retained.		23	
	Species is not seriously susceptible to disease, pests, and/or drought		24	
23	Less Firewise - Make a note of, and routinely monitor for, diseases or pests. Obtain proper diagnosis and treatment of problems. Select plants that are native and/or well-adapted to local climate conditions. Place 1 point in the far right column and go to:		24	
24	FINISHED - Total all the points in the far right column and compare this number to the table below, to get the flammability rating of this plant.			
		Total Points:		0

Total Points	Flammability Rating
0 - 1	Low Flammability
2 - 4	Moderate Flammability
5 - 8	High Flammability
9+	Very High Flammability

Showy milkweed

Ascelipas speciosa

Score: **0, low flammability**

Great Plains Native

Step #	Plant Characteristic Description		If Yes, Go To #	Points
1. Type of Plant	Tree Trees can provide shade, windbreak, energy savings, wildlife habitat, & erosion control.		2	
	Shrub or Woody Groundcover Shrubs are typically 2-12 feet tall and have a hard, woody stem. Woody groundcovers are low to the ground, but still have a hard, woody stem & branches.		2	
	Vine Vines can be herbaceous or woody, but require a trellis, plant, or building for support.		15	
	Herbaceous Ornamental or Grass Herbaceous plants are usually low-growing annuals or perennials, without a woody stem.		16	
2	Conifer and/or Evergreen Conifers have needle-like or scale-like leaves, and include pines, spruces, junipers & cedars. Evergreen plants retain their leaves throughout the year, and include Rhododendron & Azalea.		3	
	Broadleaf and/or Deciduous Broadleaf plants have wider leaves (ex.: maples, oaks, Forsythia, and Butterfly Bush.) Deciduous plants drop their leaves once each year.	For trees, go to: For shrubs, go to:	9 11	
3	Resinous Resinous plants produce resin, typically giving off a pungent odor when the leaves are crushed. These include pines, spruces, junipers and cedars.		4	
	Non-Resinous or Less Resinous Plants with less resin will usually give off less of a pungent odor when crushed.		5	
4	Less Firewise - Resinous plants are highly flammable and should not be used in close proximity to structures. Place 4 points in the far right column and go to:		5	
5	Conifer sheds large amounts of leaves or needles (many pine species)		6	
	Conifer does not regularly shed leaves or needles		7	
6	Less Firewise - Shed needles need to periodically be removed from roofs and the ground around structures. Place 2 points in the far right column and go to:		7	
7	Branches are less than 4 feet above the ground. This includes almost all shrubs.		8	
	Branches are more than 4 feet above the ground		9	
8	Less Firewise - Trees should be pruned and dead/low-hanging branches removed to be Firewise. Place 1 point in the far right column and go to:		11	
9	Trunk has papery bark or loose fibers		10	
	Trunk does not have papery bark or loose fibers		18	
10	Less Firewise - Papery bark or loose fibers can act as ladder fuels; proper placement is necessary. Place 1 point in the far right column and go to:		18	
11	Plant has fine texture Texture is a term to describe the overall appearance of a plant from a distance. From a distance of about 10-15 feet, it is not easy to distinguish individual leaves or branches. (Examples: Boxwood, Spirea, junipers)		12	
	Plant has medium texture From a distance of about 10-15 feet, some individual leaves and branches can be distinguished on the outer part of the shrub, but not the inner part. (Examples: some azaleas and hollies)		13	
	Plant has coarse texture From a distance of about 10-15 feet, it is easy to distinguish individual leaves and branches. Examples include Hydrangea, Beauty-berrry, and and Witch Hazel.		13	
12	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		13	
13	Plant is very dense These shrubs are so dense that it is difficult to place your hand in the shrub and touch a main stem. They have dense branching, and include plants like Boxwood and junipers.		14	
	Plant is moderately dense These shrubs are dense enough that you can't clearly see through them, but it is reasonably easy to place your hand in the shrub and touch a main stem.		18	
	Plant is sparsely dense Plants have an open branching pattern, making it easy to see through the shrub. Examples include American Beauty-berry and some hydrangeas.		18	
14	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		18	
15	Less Firewise - Vines can be flammable, and are problematic in that they add fuel directly to a structure, or act as ladder fuels. Place 2 points in the far right column and go to:		18	
16	Grass, more than 8 inches tall		17	
	All other herbaceous ornamentals, or mowed/green grass		18	
17	Less Firewise - Grass that is tall, dead, and/or dormant (yellow or brown in color) is extrememly flammable and carries fire rapidly. Place 6 points in the far right column and go to:		18	
18	Plant retains dead leaves for more than two months of the year		19	
	Plant does not usually retain dead leaves, except when shedding leaves		20	
19	Less Firewise - Plants with dead foliage are highly flammable, because of the low moisture content of the leaves and fine twigs. Place 3 points in the far right column and go to:		20	3
20	**Note:** Make sure leaves are not poisonous before touching them			
	Leaves have a waxy coating These plants have a very distinctive waxy coating on the leaf. (Ex.: Wax Myrtle, Gallberry, & Rhododendron)		21	
	Leaves do not have a waxy coating		22	
21	Less Firewise - Proper placement and maintenance are necessary. Place 1 point in the far right column and go to:		22	
22	Species is seriously susceptible to disease, pests, and/or drought All plants can get diseases, but plants seriously susceptible to disease or drought are likely to be stressed and have less vigorous growth. When this happens, the foliage has a lower moisture content and a greater number of dead leaves are retained.		23	
	Species is not seriously susceptible to disease, pests, and/or drought		24	
23	Less Firewise - Make a note of, and routinely monitor for, diseases or pests. Obtain proper diagnosis and treatment of problems. Select plants that are native and/or well-adapted to local climate conditions. Place 1 point in the far right column and go to:		24	
24	FINISHED - Total all the points in the far right column and compare this number to the table below, to get the flammability rating of this plant.			
		Total Points:		3

Total Points	Flammability Rating
0 - 1	Low Flammability
2 - 4	Moderate Flammability
5 - 8	High Flammability
9+	Very High Flammability

Purple coneflower

Echinacea purpurea

Score: **3, moderate flammability**

Great Plains Native

Step #	Plant Characteristic Description	If Yes, Go To #	Points
1. Type of Plant	Tree Trees can provide shade, windbreak, energy savings, wildlife habitat, & erosion control.	2	
	Shrub or Woody Groundcover Shrubs are typically 2-12 feet tall and have a hard, woody stem. Woody groundcovers are low to the ground, but still have a hard, woody stem & branches.	2	
	Vine Vines can be herbaceous or woody, but require a trellis, plant, or building for support.	15	
	Herbaceous Ornamental or Grass Herbaceous plants are usually low-growing annuals or perennials, without a woody stem.	16	
2	Conifer and/or Evergreen Conifers have needle-like or scale-like leaves, and include pines, spruces, junipers & cedars. Evergreen plants retain their leaves throughout the year, and include Rhododendron & Azalea.	3	
	Broadleaf and/or Deciduous — For trees, go to:	9	
	Broadleaf plants have wider leaves (ex.: maples, oaks, Forsythia, and Butterfly Bush.) Deciduous plants drop their leaves once each year. — For shrubs, go to:	11	
3	Resinous Resinous plants produce resin, typically giving off a pungent odor when the leaves are crushed. These include pines, spruces, junipers and cedars.	4	
	Non-Resinous or Less Resinous Plants with less resin will usually give off less of a pungent odor when crushed.	5	
4	Less Firewise - Resinous plants are highly flammable and should not be used in close proximity to structures. Place 4 points in the far right column and go to:	5	
5	Conifer sheds large amounts of leaves or needles (many pine species)	6	
	Conifer does not regularly shed leaves or needles	7	
6	Less Firewise - Shed needles need to periodically be removed from roofs and the ground around structures. Place 2 points in the far right column and go to:	7	
7	Branches are less than 4 feet above the ground. This includes almost all shrubs.	8	
	Branches are more than 4 feet above the ground	9	
8	Less Firewise - Trees should be pruned and dead/low-hanging branches removed to be Firewise. Place 1 point in the far right column and go to:	11	
9	Trunk has papery bark or loose fibers	10	
	Trunk does not have papery bark or loose fibers	18	
10	Less Firewise - Papery bark or loose fibers can act as ladder fuels; proper placement is necessary. Place 1 point in the far right column and go to:	18	
11	Plant has fine texture Texture is a term to describe the overall appearance of a plant from a distance. From a distance of about 10-15 feet, it is not easy to distinguish individual leaves or branches. (Examples: Boxwood, Spirea, junipers)	12	
	Plant has medium texture From a distance of about 10-15 feet, some individual leaves and branches can be distinguished on the outer part of the shrub, but not the inner part. (Examples: some azaleas and hollies)	13	
	Plant has coarse texture From a distance of about 10-15 feet, it is easy to distinguish individual leaves and branches. Examples include Hydrangea, Beauty-berrry, and and Witch Hazel.	13	
12	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:	13	
13	Plant is very dense These shrubs are so dense that it is difficult to place your hand in the shrub and touch a main stem. They have dense branching, and include plants like Boxwood and junipers.	14	
	Plant is moderately dense These shrubs are dense enough that you can't clearly see through them, but it is reasonably easy to place your hand in the shrub and touch a main stem.	18	
	Plant is sparsely dense Plants have an open branching pattern, making it easy to see through the shrub. Examples include American Beauty-berry and some hydrangeas.	18	
14	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:	18	
15	Less Firewise - Vines can be flammable, and are problematic in that they add fuel directly to a structure, or act as ladder fuels. Place 2 points in the far right column and go to:	18	
16	Grass, more than 8 inches tall	17	
	All other herbaceous ornamentals, or mowed/green grass	18	
17	Less Firewise - Grass that is tall, dead, and/or dormant (yellow or brown in color) is extrememly flammable and carries fire rapidly. Place 6 points in the far right column and go to:	18	
18	Plant retains dead leaves for more than two months of the year	19	
	Plant does not usually retain dead leaves, except when shedding leaves	20	
19	Less Firewise - Plants with dead foliage are highly flammable, because of the low moisture content of the leaves and fine twigs. Place 3 points in the far right column and go to:	20	
20	**Note:** Make sure leaves are not poisonous before touching them		
	Leaves have a waxy coating These plants have a very distinctive waxy coating on the leaf. (Ex.: Wax Myrtle, Gallberry, & Rhododendron)	21	
	Leaves do not have a waxy coating	22	
21	Less Firewise - Proper placement and maintenance are necessary. Place 1 point in the far right column and go to:	22	
22	Species is seriously susceptible to disease, pests, and/or drought All plants can get diseases, but plants seriously susceptible to disease or drought are likely to be stressed and have less vigorous growth. When this happens, the foliage has a lower moisture content and a greater number of dead leaves are retained.	23	
	Species is not seriously susceptible to disease, pests, and/or drought	24	
23	Less Firewise - Make a note of, and routinely monitor for, diseases or pests. Obtain proper diagnosis and treatment of problems. Select plants that are native and/or well-adapted to local climate conditions. Place 1 point in the far right column and go to:	24	
24	FINISHED - Total all the points in the far right column and compare this number to the table below, to get the flammability rating of this plant.		
	Total Points:		0

Total Points	Flammability Rating
0 - 1	Low Flammability
2 - 4	Moderate Flammability
5 - 8	High Flammability
9+	Very High Flammability

Black-eyed Susan

Rudbeckia hirta

Score: **0, low flammability**

Great Plains Native

Step #	Plant Characteristic Description	If Yes, Go To #	Points
1. Type of Plant	Tree Trees can provide shade, windbreak, energy savings, wildlife habitat, & erosion control.	2	
	Shrub or Woody Groundcover Shrubs are typically 2-12 feet tall and have a hard, woody stem. Woody groundcovers are low to the ground, but still have a hard, woody stem & branches.	2	
	Vine Vines can be herbaceous or woody, but require a trellis, plant, or building for support.	15	
	Herbaceous Ornamental or Grass Herbaceous plants are usually low-growing annuals or perennials, without a woody stem.	16	
2	Conifer and/or Evergreen Conifers have needle-like or scale-like leaves, and include pines, spruces, junipers & cedars. Evergreen plants retain their leaves throughout the year, and include Rhododendron & Azalea.	3	
	Broadleaf and/or Deciduous — For trees, go to:	9	
	Broadleaf plants have wider leaves (ex.: maples, oaks, Forsythia, and Butterfly Bush.) Deciduous plants drop their leaves once each year. — For shrubs, go to:	11	
3	Resinous Resinous plants produce resin, typically giving off a pungent odor when the leaves are crushed. These include pines, spruces, junipers and cedars.	4	
	Non-Resinous or Less Resinous Plants with less resin will usually give off less of a pungent odor when crushed.	5	
4	Less Firewise - Resinous plants are highly flammable and should not be used in close proximity to structures. Place 4 points in the far right column and go to:	5	
5	Conifer sheds large amounts of leaves or needles (many pine species)	6	
	Conifer does not regularly shed leaves or needles	7	
6	Less Firewise - Shed needles need to periodically be removed from roofs and the ground around structures. Place 2 points in the far right column and go to:	7	
7	Branches are less than 4 feet above the ground. This includes almost all shrubs.	8	
	Branches are more than 4 feet above the ground	9	
8	Less Firewise - Trees should be pruned and dead/low-hanging branches removed to be Firewise. Place 1 point in the far right column and go to:	11	
9	Trunk has papery bark or loose fibers	10	
	Trunk does not have papery bark or loose fibers	18	
10	Less Firewise - Papery bark or loose fibers can act as ladder fuels; proper placement is necessary. Place 1 point in the far right column and go to:	18	
11	Plant has fine texture Texture is a term to describe the overall appearance of a plant from a distance. From a distance of about 10-15 feet, it is not easy to distinguish individual leaves or branches. (Examples: Boxwood, Spirea, junipers)	12	
	Plant has medium texture From a distance of about 10-15 feet, some individual leaves and branches can be distinguished on the outer part of the shrub, but not the inner part. (Examples: some azaleas and hollies)	13	
	Plant has coarse texture From a distance of about 10-15 feet, it is easy to distinguish individual leaves and branches. Examples include Hydrangea, Beauty-berrry, and and Witch Hazel.	13	
12	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:	13	
13	Plant is very dense These shrubs are so dense that it is difficult to place your hand in the shrub and touch a main stem. They have dense branching, and include plants like Boxwood and junipers.	14	
	Plant is moderately dense These shrubs are dense enough that you can't clearly see through them, but it is reasonably easy to place your hand in the shrub and touch a main stem.	18	
	Plant is sparsely dense Plants have an open branching pattern, making it easy to see through the shrub. Examples include American Beauty-berry and some hydrangeas.	18	
14	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:	18	
15	Less Firewise - Vines can be flammable, and are problematic in that they add fuel directly to a structure, or act as ladder fuels. Place 2 points in the far right column and go to:	18	
16	Grass, more than 8 inches tall	17	
	All other herbaceous ornamentals, or mowed/green grass	18	
17	Less Firewise - Grass that is tall, dead, and/or dormant (yellow or brown in color) is extrememly flammable and carries fire rapidly. Place 6 points in the far right column and go to:	18	
18	Plant retains dead leaves for more than two months of the year	19	
	Plant does not usually retain dead leaves, except when shedding leaves	20	
19	Less Firewise - Plants with dead foliage are highly flammable, because of the low moisture content of the leaves and fine twigs. Place 3 points in the far right column and go to:	20	
20	**Note:** Make sure leaves are not poisonous before touching them		
	Leaves have a waxy coating These plants have a very distinctive waxy coating on the leaf. (Ex.: Wax Myrtle, Gallberry, & Rhododendron)	21	
	Leaves do not have a waxy coating	22	
21	Less Firewise - Proper placement and maintenance are necessary. Place 1 point in the far right column and go to:	22	
22	Species is seriously susceptible to disease, pests, and/or drought All plants can get diseases, but plants seriously susceptible to disease or drought are likely to be stressed and have less vigorous growth. When this happens, the foliage has a lower moisture content and a greater number of dead leaves are retained.	23	
	Species is not seriously susceptible to disease, pests, and/or drought	24	
23	Less Firewise - Make a note of, and routinely monitor for, diseases or pests. Obtain proper diagnosis and treatment of problems. Select plants that are native and/or well-adapted to local climate conditions. Place 1 point in the far right column and go to:	24	
24	FINISHED - Total all the points in the far right column and compare this number to the table below, to get the flammability rating of this plant.		
	Total Points:		0

Total Points	Flammability Rating
0 - 1	Low Flammability
2 - 4	Moderate Flammability
5 - 8	High Flammability
9+	Very High Flammability

Smooth blue aster

Symphyotrichum laeve

Score: **0, low flammability**

Great Plains Native

Step #	Plant Characteristic Description		If Yes, Go To #	Points
1. Type of Plant	Tree Trees can provide shade, windbreak, energy savings, wildlife habitat, & erosion control.		2	
	Shrub or Woody Groundcover Shrubs are typically 2-12 feet tall and have a hard, woody stem. Woody groundcovers are low to the ground, but still have a hard, woody stem & branches.		2	
	Vine Vines can be herbaceous or woody, but require a trellis, plant, or building for support.		15	
	Herbaceous Ornamental or Grass Herbaceous plants are usually low-growing annuals or perennials, without a woody stem.		16	
2	Conifer and/or Evergreen Conifers have needle-like or scale-like leaves, and include pines, spruces, junipers & cedars. Evergreen plants retain their leaves throughout the year, and include Rhododendron & Azalea.		3	
	Broadleaf and/or Deciduous Broadleaf plants have wider leaves (ex.: maples, oaks, Forsythia, and Butterfly Bush.) Deciduous plants drop their leaves once each year.	For trees, go to: For shrubs, go to:	9 11	
3	Resinous Resinous plants produce resin, typically giving off a pungent odor when the leaves are crushed. These include pines, spruces, junipers and cedars.		4	
	Non-Resinous or Less Resinous Plants with less resin will usually give off less of a pungent odor when crushed.		5	
4	Less Firewise - Resinous plants are highly flammable and should not be used in close proximity to structures. Place 4 points in the far right column and go to:		5	
5	Conifer sheds large amounts of leaves or needles (many pine species)		6	
	Conifer does not regularly shed leaves or needles		7	
6	Less Firewise - Shed needles need to periodically be removed from roofs and the ground around structures. Place 2 points in the far right column and go to:		7	
7	Branches are less than 4 feet above the ground. This includes almost all shrubs.		8	
	Branches are more than 4 feet above the ground		9	
8	Less Firewise - Trees should be pruned and dead/low-hanging branches removed to be Firewise. Place 1 point in the far right column and go to:		11	
9	Trunk has papery bark or loose fibers		10	
	Trunk does not have papery bark or loose fibers		18	
10	Less Firewise - Papery bark or loose fibers can act as ladder fuels; proper placement is necessary. Place 1 point in the far right column and go to:		18	
11	Plant has fine texture Texture is a term to describe the overall appearance of a plant from a distance. From a distance of about 10-15 feet, it is not easy to distinguish individual leaves or branches. (Examples: Boxwood, Spirea, junipers)		12	
	Plant has medium texture From a distance of about 10-15 feet, some individual leaves and branches can be distinguished on the outer part of the shrub, but not the inner part. (Examples: some azaleas and hollies)		13	
	Plant has coarse texture From a distance of about 10-15 feet, it is easy to distinguish individual leaves and branches. Examples include Hydrangea, Beauty-berrry, and and Witch Hazel.		13	
12	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		13	
13	Plant is very dense These shrubs are so dense that it is difficult to place your hand in the shrub and touch a main stem. They have dense branching, and include plants like Boxwood and junipers.		14	
	Plant is moderately dense These shrubs are dense enough that you can't clearly see through them, but it is reasonably easy to place your hand in the shrub and touch a main stem.		18	
	Plant is sparsely dense Plants have an open branching pattern, making it easy to see through the shrub. Examples include American Beauty-berry and some hydrangeas.		18	
14	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		18	
15	Less Firewise - Vines can be flammable, and are problematic in that they add fuel directly to a structure, or act as ladder fuels. Place 2 points in the far right column and go to:		18	
16	Grass, more than 8 inches tall		17	
	All other herbaceous ornamentals, or mowed/green grass		18	
17	Less Firewise - Grass that is tall, dead, and/or dormant (yellow or brown in color) is extrememly flammable and carries fire rapidly. Place 6 points in the far right column and go to:		18	6
18	Plant retains dead leaves for more than two months of the year		19	
	Plant does not usually retain dead leaves, except when shedding leaves		20	
19	Less Firewise - Plants with dead foliage are highly flammable, because of the low moisture content of the leaves and fine twigs. Place 3 points in the far right column and go to:		20	3
20	**Note:** Make sure leaves are not poisonous before touching them			
	Leaves have a waxy coating These plants have a very distinctive waxy coating on the leaf. (Ex.: Wax Myrtle, Gallberry, & Rhododendron)		21	
	Leaves do not have a waxy coating		22	
21	Less Firewise - Proper placement and maintenance are necessary. Place 1 point in the far right column and go to:		22	
22	Species is seriously susceptible to disease, pests, and/or drought All plants can get diseases, but plants seriously susceptible to disease or drought are likely to be stressed and have less vigorous growth. When this happens, the foliage has a lower moisture content and a greater number of dead leaves are retained.		23	
	Species is not seriously susceptible to disease, pests, and/or drought		24	
23	Less Firewise - Make a note of, and routinely monitor for, diseases or pests. Obtain proper diagnosis and treatment of problems. Select plants that are native and/or well-adapted to local climate conditions. Place 1 point in the far right column and go to:		24	
24	FINISHED - Total all the points in the far right column and compare this number to the table below, to get the flammability rating of this plant.			
		Total Points:		9

Total Points	Flammability Rating
0 - 1	Low Flammability
2 - 4	Moderate Flammability
5 - 8	High Flammability
9+	Very High Flammability

Side-oats grama

Bouteloua curtipendula

Score: **9, low flammability**

Great Plains Native

Step #	Plant Characteristic Description		If Yes, Go To #	Points
1. Type of Plant	Tree Trees can provide shade, windbreak, energy savings, wildlife habitat, & erosion control.		2	
	Shrub or Woody Groundcover Shrubs are typically 2-12 feet tall and have a hard, woody stem. Woody groundcovers are low to the ground, but still have a hard, woody stem & branches.		2	
	Vine Vines can be herbaceous or woody, but require a trellis, plant, or building for support.		15	
	Herbaceous Ornamental or Grass Herbaceous plants are usually low-growing annuals or perennials, without a woody stem.		16	
2	Conifer and/or Evergreen Conifers have needle-like or scale-like leaves, and include pines, spruces, junipers & cedars. Evergreen plants retain their leaves throughout the year, and include Rhododendron & Azalea.		3	
	Broadleaf and/or Deciduous Broadleaf plants have wider leaves (ex.: maples, oaks, Forsythia, and Butterfly Bush.) Deciduous plants drop their leaves once each year.	For trees, go to: For shrubs, go to:	9 11	
3	Resinous Resinous plants produce resin, typically giving off a pungent odor when the leaves are crushed. These include pines, spruces, junipers and cedars.		4	
	Non-Resinous or Less Resinous Plants with less resin will usually give off less of a pungent odor when crushed.		5	
4	Less Firewise - Resinous plants are highly flammable and should not be used in close proximity to structures. Place 4 points in the far right column and go to:		5	
5	Conifer sheds large amounts of leaves or needles (many pine species)		6	
	Conifer does not regularly shed leaves or needles		7	
6	Less Firewise - Shed needles need to periodically be removed from roofs and the ground around structures. Place 2 points in the far right column and go to:		7	
7	Branches are less than 4 feet above the ground. This includes almost all shrubs.		8	
	Branches are more than 4 feet above the ground		9	
8	Less Firewise - Trees should be pruned and dead/low-hanging branches removed to be Firewise. Place 1 point in the far right column and go to:		11	
9	Trunk has papery bark or loose fibers		10	
	Trunk does not have papery bark or loose fibers		18	
10	Less Firewise - Papery bark or loose fibers can act as ladder fuels; proper placement is necessary. Place 1 point in the far right column and go to:		18	
11	Plant has fine texture Texture is a term to describe the overall appearance of a plant from a distance. From a distance of about 10-15 feet, it is not easy to distinguish individual leaves or branches. (Examples: Boxwood, Spirea, junipers)		12	
	Plant has medium texture From a distance of about 10-15 feet, some individual leaves and branches can be distinguished on the outer part of the shrub, but not the inner part. (Examples: some azaleas and hollies)		13	
	Plant has coarse texture From a distance of about 10-15 feet, it is easy to distinguish individual leaves and branches. Examples include Hydrangea, Beauty-berrry, and and Witch Hazel.		13	
12	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		13	
13	Plant is very dense These shrubs are so dense that it is difficult to place your hand in the shrub and touch a main stem. They have dense branching, and include plants like Boxwood and junipers.		14	
	Plant is moderately dense These shrubs are dense enough that you can't clearly see through them, but it is reasonably easy to place your hand in the shrub and touch a main stem.		18	
	Plant is sparsely dense Plants have an open branching pattern, making it easy to see through the shrub. Examples include American Beauty-berry and some hydrangeas.		18	
14	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		18	
15	Less Firewise - Vines can be flammable, and are problematic in that they add fuel directly to a structure, or act as ladder fuels. Place 2 points in the far right column and go to:		18	
16	Grass, more than 8 inches tall		17	
	All other herbaceous ornamentals, or mowed/green grass		18	
17	Less Firewise - Grass that is tall, dead, and/or dormant (yellow or brown in color) is extrememly flammable and carries fire rapidly. Place 6 points in the far right column and go to:		18	6
18	Plant retains dead leaves for more than two months of the year		19	
	Plant does not usually retain dead leaves, except when shedding leaves		20	
19	Less Firewise - Plants with dead foliage are highly flammable, because of the low moisture content of the leaves and fine twigs. Place 3 points in the far right column and go to:		20	3
20	**Note:** Make sure leaves are not poisonous before touching them			
	Leaves have a waxy coating These plants have a very distinctive waxy coating on the leaf. (Ex.: Wax Myrtle, Gallberry, & Rhododendron)		21	
	Leaves do not have a waxy coating		22	
21	Less Firewise - Proper placement and maintenance are necessary. Place 1 point in the far right column and go to:		22	
22	Species is seriously susceptible to disease, pests, and/or drought All plants can get diseases, but plants seriously susceptible to disease or drought are likely to be stressed and have less vigorous growth. When this happens, the foliage has a lower moisture content and a greater number of dead leaves are retained.		23	
	Species is not seriously susceptible to disease, pests, and/or drought		24	
23	Less Firewise - Make a note of, and routinely monitor for, diseases or pests. Obtain proper diagnosis and treatment of problems. Select plants that are native and/or well-adapted to local climate conditions. Place 1 point in the far right column and go to:		24	
24	FINISHED - Total all the points in the far right column and compare this number to the table below, to get the flammability rating of this plant.			
		Total Points:		9

Total Points	Flammability Rating
0 - 1	Low Flammability
2 - 4	Moderate Flammability
5 - 8	High Flammability
9+	Very High Flammability

Indiangrass

Sorghastrum nutans

Score: **9, very high flammability**

Great Plains Native

Appendix X: Typology 2 Plant Selection

Step #	Plant Characteristic Description		If Yes, Go To #	Points
1. Type of Plant	Tree Trees can provide shade, windbreak, energy savings, wildlife habitat, & erosion control.		2	
	Shrub or Woody Groundcover Shrubs are typically 2-12 feet tall and have a hard, woody stem. Woody groundcovers are low to the ground, but still have a hard, woody stem & branches.		2	
	Vine Vines can be herbaceous or woody, but require a trellis, plant, or building for support.		15	
	Herbaceous Ornamental or Grass Herbaceous plants are usually low-growing annuals or perennials, without a woody stem.		16	
2	Conifer and/or Evergreen Conifers have needle-like or scale-like leaves, and include pines, spruces, junipers & cedars. Evergreen plants retain their leaves throughout the year, and include Rhododendron & Azalea.		3	
	Broadleaf and/or Deciduous Broadleaf plants have wider leaves (ex.: maples, oaks, Forsythia, and Butterfly Bush.) Deciduous plants drop their leaves once each year.	For trees, go to: For shrubs, go to:	9 11	
3	Resinous Resinous plants produce resin, typically giving off a pungent odor when the leaves are crushed. These include pines, spruces, junipers and cedars.		4	
	Non-Resinous or Less Resinous Plants with less resin will usually give off less of a pungent odor when crushed.		5	
4	Less Firewise - Resinous plants are highly flammable and should not be used in close proximity to structures. Place 4 points in the far right column and go to:		5	4
5	Conifer sheds large amounts of leaves or needles (many pine species)		6	
	Conifer does not regularly shed leaves or needles		7	
6	Less Firewise - Shed needles need to periodically be removed from roofs and the ground around structures. Place 2 points in the far right column and go to:		7	2
7	Branches are less than 4 feet above the ground. This includes almost all shrubs.		8	
	Branches are more than 4 feet above the ground		9	
8	Less Firewise - Trees should be pruned and dead/low-hanging branches removed to be Firewise. Place 1 point in the far right column and go to:		11	1
9	Trunk has papery bark or loose fibers		10	
	Trunk does not have papery bark or loose fibers		18	
10	Less Firewise - Papery bark or loose fibers can act as ladder fuels; proper placement is necessary. Place 1 point in the far right column and go to:		18	
11	Plant has fine texture Texture is a term to describe the overall appearance of a plant from a distance. From a distance of about 10-15 feet, it is not easy to distinguish individual leaves or branches. (Examples: Boxwood, Spirea, junipers)		12	
	Plant has medium texture From a distance of about 10-15 feet, some individual leaves and branches can be distinguished on the outer part of the shrub, but not the inner part. (Examples: some azaleas and hollies)		13	
	Plant has coarse texture From a distance of about 10-15 feet, it is easy to distinguish individual leaves and branches. Examples include Hydrangea, Beauty-berrry, and and Witch Hazel.		13	
12	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		13	
13	Plant is very dense These shrubs are so dense that it is difficult to place your hand in the shrub and touch a main stem. They have dense branching, and include plants like Boxwood and junipers.		14	
	Plant is moderately dense These shrubs are dense enough that you can't clearly see through them, but it is reasonably easy to place your hand in the shrub and touch a main stem.		18	
	Plant is sparsely dense Plants have an open branching pattern, making it easy to see through the shrub. Examples include American Beauty-berry and some hydrangeas.		18	
14	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		18	
15	Less Firewise - Vines can be flammable, and are problematic in that they add fuel directly to a structure, or act as ladder fuels. Place 2 points in the far right column and go to:		18	
16	Grass, more than 8 inches tall		17	
	All other herbaceous ornamentals, or mowed/green grass		18	
17	Less Firewise - Grass that is tall, dead, and/or dormant (yellow or brown in color) is extrememly flammable and carries fire rapidly. Place 6 points in the far right column and go to:		18	
18	Plant retains dead leaves for more than two months of the year		19	
	Plant does not usually retain dead leaves, except when shedding leaves		20	
19	Less Firewise - Plants with dead foliage are highly flammable, because of the low moisture content of the leaves and fine twigs. Place 3 points in the far right column and go to:		20	
20	**Note:** Make sure leaves are not poisonous before touching them			
	Leaves have a waxy coating These plants have a very distinctive waxy coating on the leaf. (Ex.: Wax Myrtle, Gallberry, & Rhododendron)		21	
	Leaves do not have a waxy coating		22	
21	Less Firewise - Proper placement and maintenance are necessary. Place 1 point in the far right column and go to:		22	
22	Species is seriously susceptible to disease, pests, and/or drought All plants can get diseases, but plants seriously susceptible to disease or drought are likely to be stressed and have less vigorous growth. When this happens, the foliage has a lower moisture content and a greater number of dead leaves are retained.		23	
	Species is not seriously susceptible to disease, pests, and/or drought		24	
23	Less Firewise - Make a note of, and routinely monitor for, diseases or pests. Obtain proper diagnosis and treatment of problems. Select plants that are native and/or well-adapted to local climate conditions. Place 1 point in the far right column and go to:		24	
24	FINISHED - Total all the points in the far right column and compare this number to the table below, to get the flammability rating of this plant.			
		Total Points:		7

Total Points	Flammability Rating
0 - 1	Low Flammability
2 - 4	Moderate Flammability
5 - 8	High Flammability
9+	Very High Flammability

Siberian larch

Larix sibirica

Score: **7, high flammability**

Non-Native

Step #	Plant Characteristic Description		If Yes, Go To #	Points
1. Type of Plant	Tree Trees can provide shade, windbreak, energy savings, wildlife habitat, & erosion control.		2	
	Shrub or Woody Groundcover Shrubs are typically 2-12 feet tall and have a hard, woody stem. Woody groundcovers are low to the ground, but still have a hard, woody stem & branches.		2	
	Vine Vines can be herbaceous or woody, but require a trellis, plant, or building for support.		15	
	Herbaceous Ornamental or Grass Herbaceous plants are usually low-growing annuals or perennials, without a woody stem.		16	
2	Conifer and/or Evergreen Conifers have needle-like or scale-like leaves, and include pines, spruces, junipers & cedars. Evergreen plants retain their leaves throughout the year, and include Rhododendron & Azalea.		3	
	Broadleaf and/or Deciduous Broadleaf plants have wider leaves (ex.: maples, oaks, Forsythia, and Butterfly Bush.) Deciduous plants drop their leaves once each year.	For trees, go to: For shrubs, go to:	9 11	
3	Resinous Resinous plants produce resin, typically giving off a pungent odor when the leaves are crushed. These include pines, spruces, junipers and cedars.		4	
	Non-Resinous or Less Resinous Plants with less resin will usually give off less of a pungent odor when crushed.		5	
4	Less Firewise - Resinous plants are highly flammable and should not be used in close proximity to structures. Place 4 points in the far right column and go to:		5	
5	Conifer sheds large amounts of leaves or needles (many pine species)		6	
	Conifer does not regularly shed leaves or needles		7	
6	Less Firewise - Shed needles need to periodically be removed from roofs and the ground around structures. Place 2 points in the far right column and go to:		7	
7	Branches are less than 4 feet above the ground. This includes almost all shrubs.		8	
	Branches are more than 4 feet above the ground		9	
8	Less Firewise - Trees should be pruned and dead/low-hanging branches removed to be Firewise. Place 1 point in the far right column and go to:		11	
9	Trunk has papery bark or loose fibers		10	
	Trunk does not have papery bark or loose fibers		18	
10	Less Firewise - Papery bark or loose fibers can act as ladder fuels; proper placement is necessary. Place 1 point in the far right column and go to:		18	
11	Plant has fine texture Texture is a term to describe the overall appearance of a plant from a distance. From a distance of about 10-15 feet, it is not easy to distinguish individual leaves or branches. (Examples: Boxwood, Spirea, junipers)		12	
	Plant has medium texture From a distance of about 10-15 feet, some individual leaves and branches can be distinguished on the outer part of the shrub, but not the inner part. (Examples: some azaleas and hollies)		13	
	Plant has coarse texture From a distance of about 10-15 feet, it is easy to distinguish individual leaves and branches. Examples include Hydrangea, Beauty-berrry, and and Witch Hazel.		13	
12	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		13	
13	Plant is very dense These shrubs are so dense that it is difficult to place your hand in the shrub and touch a main stem. They have dense branching, and include plants like Boxwood and junipers.		14	
	Plant is moderately dense These shrubs are dense enough that you can't clearly see through them, but it is reasonably easy to place your hand in the shrub and touch a main stem.		18	
	Plant is sparsely dense Plants have an open branching pattern, making it easy to see through the shrub. Examples include American Beauty-berry and some hydrangeas.		18	
14	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		18	
15	Less Firewise - Vines can be flammable, and are problematic in that they add fuel directly to a structure, or act as ladder fuels. Place 2 points in the far right column and go to:		18	
16	Grass, more than 8 inches tall		17	
	All other herbaceous ornamentals, or mowed/green grass		18	
17	Less Firewise - Grass that is tall, dead, and/or dormant (yellow or brown in color) is extrememly flammable and carries fire rapidly. Place 6 points in the far right column and go to:		18	
18	Plant retains dead leaves for more than two months of the year		19	
	Plant does not usually retain dead leaves, except when shedding leaves		20	
19	Less Firewise - Plants with dead foliage are highly flammable, because of the low moisture content of the leaves and fine twigs. Place 3 points in the far right column and go to:		20	
20	**Note:** Make sure leaves are not poisonous before touching them			
	Leaves have a waxy coating These plants have a very distinctive waxy coating on the leaf. (Ex.: Wax Myrtle, Gallberry, & Rhododendron)		21	
	Leaves do not have a waxy coating		22	
21	Less Firewise - Proper placement and maintenance are necessary. Place 1 point in the far right column and go to:		22	
22	Species is seriously susceptible to disease, pests, and/or drought All plants can get diseases, but plants seriously susceptible to disease or drought are likely to be stressed and have less vigorous growth. When this happens, the foliage has a lower moisture content and a greater number of dead leaves are retained.		23	
	Species is not seriously susceptible to disease, pests, and/or drought		24	
23	Less Firewise - Make a note of, and routinely monitor for, diseases or pests. Obtain proper diagnosis and treatment of problems. Select plants that are native and/or well-adapted to local climate conditions. Place 1 point in the far right column and go to:		24	
24	FINISHED - Total all the points in the far right column and compare this number to the table below, to get the flammability rating of this plant.			
		Total Points:		0

Total Points	Flammability Rating
0 - 1	Low Flammability
2 - 4	Moderate Flammability
5 - 8	High Flammability
9+	Very High Flammability

Thornless honeylocust

Gleditsia triacanthos var. inermis

Score: **0, low flammability**

Great Plains Native

Step #	Plant Characteristic Description		If Yes, Go To #	Points
1. Type of Plant	Tree Trees can provide shade, windbreak, energy savings, wildlife habitat, & erosion control.		2	
	Shrub or Woody Groundcover Shrubs are typically 2-12 feet tall and have a hard, woody stem. Woody groundcovers are low to the ground, but still have a hard, woody stem & branches.		2	
	Vine Vines can be herbaceous or woody, but require a trellis, plant, or building for support.		15	
	Herbaceous Ornamental or Grass Herbaceous plants are usually low-growing annuals or perennials, without a woody stem.		16	
2	Conifer and/or Evergreen Conifers have needle-like or scale-like leaves, and include pines, spruces, junipers & cedars. Evergreen plants retain their leaves throughout the year, and include Rhododendron & Azalea.		3	
	Broadleaf and/or Deciduous Broadleaf plants have wider leaves (ex.: maples, oaks, Forsythia, and Butterfly Bush.) Deciduous plants drop their leaves once each year.	For trees, go to: For shrubs, go to:	9 11	
3	Resinous Resinous plants produce resin, typically giving off a pungent odor when the leaves are crushed. These include pines, spruces, junipers and cedars.		4	
	Non-Resinous or Less Resinous Plants with less resin will usually give off less of a pungent odor when crushed.		5	
4	Less Firewise - Resinous plants are highly flammable and should not be used in close proximity to structures. Place 4 points in the far right column and go to:		5	
5	Conifer sheds large amounts of leaves or needles (many pine species)		6	
	Conifer does not regularly shed leaves or needles		7	
6	Less Firewise - Shed needles need to periodically be removed from roofs and the ground around structures. Place 2 points in the far right column and go to:		7	
7	Branches are less than 4 feet above the ground. This includes almost all shrubs.		8	
	Branches are more than 4 feet above the ground		9	
8	Less Firewise - Trees should be pruned and dead/low-hanging branches removed to be Firewise. Place 1 point in the far right column and go to:		11	
9	Trunk has papery bark or loose fibers		10	
	Trunk does not have papery bark or loose fibers		18	
10	Less Firewise - Papery bark or loose fibers can act as ladder fuels; proper placement is necessary. Place 1 point in the far right column and go to:		18	
11	Plant has fine texture Texture is a term to describe the overall appearance of a plant from a distance. From a distance of about 10-15 feet, it is not easy to distinguish individual leaves or branches. (Examples: Boxwood, Spirea, junipers)		12	
	Plant has medium texture From a distance of about 10-15 feet, some individual leaves and branches can be distinguished on the outer part of the shrub, but not the inner part. (Examples: some azaleas and hollies)		13	
	Plant has coarse texture From a distance of about 10-15 feet, it is easy to distinguish individual leaves and branches. Examples include Hydrangea, Beauty-berrry, and and Witch Hazel.		13	
12	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		13	
13	Plant is very dense These shrubs are so dense that it is difficult to place your hand in the shrub and touch a main stem. They have dense branching, and include plants like Boxwood and junipers.		14	
	Plant is moderately dense These shrubs are dense enough that you can't clearly see through them, but it is reasonably easy to place your hand in the shrub and touch a main stem.		18	
	Plant is sparsely dense Plants have an open branching pattern, making it easy to see through the shrub. Examples include American Beauty-berry and some hydrangeas.		18	
14	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		18	
15	Less Firewise - Vines can be flammable, and are problematic in that they add fuel directly to a structure, or act as ladder fuels. Place 2 points in the far right column and go to:		18	
16	Grass, more than 8 inches tall		17	
	All other herbaceous ornamentals, or mowed/green grass		18	
17	Less Firewise - Grass that is tall, dead, and/or dormant (yellow or brown in color) is extremely flammable and carries fire rapidly. Place 6 points in the far right column and go to:		18	
18	Plant retains dead leaves for more than two months of the year		19	
	Plant does not usually retain dead leaves, except when shedding leaves		20	
19	Less Firewise - Plants with dead foliage are highly flammable, because of the low moisture content of the leaves and fine twigs. Place 3 points in the far right column and go to:		20	3
20	**Note:** Make sure leaves are not poisonous before touching them			
	Leaves have a waxy coating These plants have a very distinctive waxy coating on the leaf. (Ex.: Wax Myrtle, Gallberry, & Rhododendron)		21	
	Leaves do not have a waxy coating		22	
21	Less Firewise - Proper placement and maintenance are necessary. Place 1 point in the far right column and go to:		22	
22	Species is seriously susceptible to disease, pests, and/or drought All plants can get diseases, but plants seriously susceptible to disease or drought are likely to be stressed and have less vigorous growth. When this happens, the foliage has a lower moisture content and a greater number of dead leaves are retained.		23	
	Species is not seriously susceptible to disease, pests, and/or drought		24	
23	Less Firewise - Make a note of, and routinely monitor for, diseases or pests. Obtain proper diagnosis and treatment of problems. Select plants that are native and/or well-adapted to local climate conditions. Place 1 point in the far right column and go to:		24	
24	FINISHED - Total all the points in the far right column and compare this number to the table below, to get the flammability rating of this plant.			
		Total Points:		3

Total Points	Flammability Rating
0 - 1	Low Flammability
2 - 4	Moderate Flammability
5 - 8	High Flammability
9+	Very High Flammability

Post Oak

Quercus stellata

Score: **3, moderate flammability**

Great Plains Native

Step #	Plant Characteristic Description		If Yes, Go To #	Points
1. Type of Plant	Tree Trees can provide shade, windbreak, energy savings, wildlife habitat, & erosion control.		2	
	Shrub or Woody Groundcover Shrubs are typically 2-12 feet tall and have a hard, woody stem. Woody groundcovers are low to the ground, but still have a hard, woody stem & branches.		2	
	Vine Vines can be herbaceous or woody, but require a trellis, plant, or building for support.		15	
	Herbaceous Ornamental or Grass Herbaceous plants are usually low-growing annuals or perennials, without a woody stem.		16	
2	Conifer and/or Evergreen Conifers have needle-like or scale-like leaves, and include pines, spruces, junipers & cedars. Evergreen plants retain their leaves throughout the year, and include Rhododendron & Azalea.		3	
	Broadleaf and/or Deciduous Broadleaf plants have wider leaves (ex.: maples, oaks, Forsythia, and Butterfly Bush.) Deciduous plants drop their leaves once each year.	For trees, go to: For shrubs, go to:	9 11	
3	Resinous Resinous plants produce resin, typically giving off a pungent odor when the leaves are crushed. These include pines, spruces, junipers and cedars.		4	
	Non-Resinous or Less Resinous Plants with less resin will usually give off less of a pungent odor when crushed.		5	
4	Less Firewise - Resinous plants are highly flammable and should not be used in close proximity to structures. Place 4 points in the far right column and go to:		5	
5	Conifer sheds large amounts of leaves or needles (many pine species)		6	
	Conifer does not regularly shed leaves or needles		7	
6	Less Firewise - Shed needles need to periodically be removed from roofs and the ground around structures. Place 2 points in the far right column and go to:		7	
7	Branches are less than 4 feet above the ground. This includes almost all shrubs.		8	
	Branches are more than 4 feet above the ground		9	
8	Less Firewise - Trees should be pruned and dead/low-hanging branches removed to be Firewise. Place 1 point in the far right column and go to:		11	1
9	Trunk has papery bark or loose fibers		10	
	Trunk does not have papery bark or loose fibers		18	
10	Less Firewise - Papery bark or loose fibers can act as ladder fuels; proper placement is necessary. Place 1 point in the far right column and go to:		18	
11	Plant has fine texture Texture is a term to describe the overall appearance of a plant from a distance. From a distance of about 10-15 feet, it is not easy to distinguish individual leaves or branches. (Examples: Boxwood, Spirea, junipers)		12	
	Plant has medium texture From a distance of about 10-15 feet, some individual leaves and branches can be distinguished on the outer part of the shrub, but not the inner part. (Examples: some azaleas and hollies)		13	
	Plant has coarse texture From a distance of about 10-15 feet, it is easy to distinguish individual leaves and branches. Examples include Hydrangea, Beauty-berrry, and and Witch Hazel.		13	
12	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		13	
13	Plant is very dense These shrubs are so dense that it is difficult to place your hand in the shrub and touch a main stem. They have dense branching, and include plants like Boxwood and junipers.		14	
	Plant is moderately dense These shrubs are dense enough that you can't clearly see through them, but it is reasonably easy to place your hand in the shrub and touch a main stem.		18	
	Plant is sparsely dense Plants have an open branching pattern, making it easy to see through the shrub. Examples include American Beauty-berry and some hydrangeas.		18	
14	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		18	
15	Less Firewise - Vines can be flammable, and are problematic in that they add fuel directly to a structure, or act as ladder fuels. Place 2 points in the far right column and go to:		18	
16	Grass, more than 8 inches tall		17	
	All other herbaceous ornamentals, or mowed/green grass		18	
17	Less Firewise - Grass that is tall, dead, and/or dormant (yellow or brown in color) is extremely flammable and carries fire rapidly. Place 6 points in the far right column and go to:		18	
18	Plant retains dead leaves for more than two months of the year		19	
	Plant does not usually retain dead leaves, except when shedding leaves		20	
19	Less Firewise - Plants with dead foliage are highly flammable, because of the low moisture content of the leaves and fine twigs. Place 3 points in the far right column and go to:		20	
20	**Note:** Make sure leaves are not poisonous before touching them			
	Leaves have a waxy coating These plants have a very distinctive waxy coating on the leaf. (Ex.: Wax Myrtle, Gallberry, & Rhododendron)		21	
	Leaves do not have a waxy coating		22	
21	Less Firewise - Proper placement and maintenance are necessary. Place 1 point in the far right column and go to:		22	
22	Species is seriously susceptible to disease, pests, and/or drought All plants can get diseases, but plants seriously susceptible to disease or drought are likely to be stressed and have less vigorous growth. When this happens, the foliage has a lower moisture content and a greater number of dead leaves are retained.		23	
	Species is not seriously susceptible to disease, pests, and/or drought		24	
23	Less Firewise - Make a note of, and routinely monitor for, diseases or pests. Obtain proper diagnosis and treatment of problems. Select plants that are native and/or well-adapted to local climate conditions. Place 1 point in the far right column and go to:		24	
24	FINISHED - Total all the points in the far right column and compare this number to the table below, to get the flammability rating of this plant.			
		Total Points:		1

Total Points	Flammability Rating
0 - 1	Low Flammability
2 - 4	Moderate Flammability
5 - 8	High Flammability
9+	Very High Flammability

Eastern redbud

Cercis canadensis

Score: **1, low flammability**

Great Plains Native

Step #	Plant Characteristic Description		If Yes, Go To #	Points
1. Type of Plant	Tree Trees can provide shade, windbreak, energy savings, wildlife habitat, & erosion control.		2	
	Shrub or Woody Groundcover Shrubs are typically 2-12 feet tall and have a hard, woody stem. Woody groundcovers are low to the ground, but still have a hard, woody stem & branches.		2	
	Vine Vines can be herbaceous or woody, but require a trellis, plant, or building for support.		15	
	Herbaceous Ornamental or Grass Herbaceous plants are usually low-growing annuals or perennials, without a woody stem.		16	
2	Conifer and/or Evergreen Conifers have needle-like or scale-like leaves, and include pines, spruces, junipers & cedars. Evergreen plants retain their leaves throughout the year, and include Rhododendron & Azalea.		3	
	Broadleaf and/or Deciduous Broadleaf plants have wider leaves (ex.: maples, oaks, Forsythia, and Butterfly Bush.) Deciduous plants drop their leaves once each year.	For trees, go to: For shrubs, go to:	9 11	
3	Resinous Resinous plants produce resin, typically giving off a pungent odor when the leaves are crushed. These include pines, spruces, junipers and cedars.		4	
	Non-Resinous or Less Resinous Plants with less resin will usually give off less of a pungent odor when crushed.		5	
4	Less Firewise - Resinous plants are highly flammable and should not be used in close proximity to structures. Place 4 points in the far right column and go to:		5	
5	Conifer sheds large amounts of leaves or needles (many pine species)		6	
	Conifer does not regularly shed leaves or needles		7	
6	Less Firewise - Shed needles need to periodically be removed from roofs and the ground around structures. Place 2 points in the far right column and go to:		7	
7	Branches are less than 4 feet above the ground. This includes almost all shrubs.		8	
	Branches are more than 4 feet above the ground		9	
8	Less Firewise - Trees should be pruned and dead/low-hanging branches removed to be Firewise. Place 1 point in the far right column and go to:		11	1
9	Trunk has papery bark or loose fibers		10	
	Trunk does not have papery bark or loose fibers		18	
10	Less Firewise - Papery bark or loose fibers can act as ladder fuels; proper placement is necessary. Place 1 point in the far right column and go to:		18	
11	Plant has fine texture Texture is a term to describe the overall appearance of a plant from a distance. From a distance of about 10-15 feet, it is not easy to distinguish individual leaves or branches. (Examples: Boxwood, Spirea, junipers)		12	
	Plant has medium texture From a distance of about 10-15 feet, some individual leaves and branches can be distinguished on the outer part of the shrub, but not the inner part. (Examples: some azaleas and hollies)		13	
	Plant has coarse texture From a distance of about 10-15 feet, it is easy to distinguish individual leaves and branches. Examples include Hydrangea, Beauty-berrry, and and Witch Hazel.		13	
12	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		13	
13	Plant is very dense These shrubs are so dense that it is difficult to place your hand in the shrub and touch a main stem. They have dense branching, and include plants like Boxwood and junipers.		14	
	Plant is moderately dense These shrubs are dense enough that you can't clearly see through them, but it is reasonably easy to place your hand in the shrub and touch a main stem.		18	
	Plant is sparsely dense Plants have an open branching pattern, making it easy to see through the shrub. Examples include American Beauty-berry and some hydrangeas.		18	
14	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		18	
15	Less Firewise - Vines can be flammable, and are problematic in that they add fuel directly to a structure, or act as ladder fuels. Place 2 points in the far right column and go to:		18	
16	Grass, more than 8 inches tall		17	
	All other herbaceous ornamentals, or mowed/green grass		18	
17	Less Firewise - Grass that is tall, dead, and/or dormant (yellow or brown in color) is extremely flammable and carries fire rapidly. Place 6 points in the far right column and go to:		18	
18	Plant retains dead leaves for more than two months of the year		19	
	Plant does not usually retain dead leaves, except when shedding leaves		20	
19	Less Firewise - Plants with dead foliage are highly flammable, because of the low moisture content of the leaves and fine twigs. Place 3 points in the far right column and go to:		20	
20	**Note:** Make sure leaves are not poisonous before touching them			
	Leaves have a waxy coating These plants have a very distinctive waxy coating on the leaf. (Ex.: Wax Myrtle, Gallberry, & Rhododendron)		21	
	Leaves do not have a waxy coating		22	
21	Less Firewise - Proper placement and maintenance are necessary. Place 1 point in the far right column and go to:		22	
22	Species is seriously susceptible to disease, pests, and/or drought All plants can get diseases, but plants seriously susceptible to disease or drought are likely to be stressed and have less vigorous growth. When this happens, the foliage has a lower moisture content and a greater number of dead leaves are retained.		23	
	Species is not seriously susceptible to disease, pests, and/or drought		24	
23	Less Firewise - Make a note of, and routinely monitor for, diseases or pests. Obtain proper diagnosis and treatment of problems. Select plants that are native and/or well-adapted to local climate conditions. Place 1 point in the far right column and go to:		24	
24	FINISHED - Total all the points in the far right column and compare this number to the table below, to get the flammability rating of this plant.			
		Total Points:		1

Total Points	Flammability Rating
0 - 1	Low Flammability
2 - 4	Moderate Flammability
5 - 8	High Flammability
9+	Very High Flammability

Downy serviceberry

Amelanchier arborea

Score: **1, low flammability**

Great Plains Native

Step #	Plant Characteristic Description		If Yes, Go To #	Points
1. Type of Plant	Tree Trees can provide shade, windbreak, energy savings, wildlife habitat, & erosion control.		2	
	Shrub or Woody Groundcover Shrubs are typically 2-12 feet tall and have a hard, woody stem. Woody groundcovers are low to the ground, but still have a hard, woody stem & branches.		2	
	Vine Vines can be herbaceous or woody, but require a trellis, plant, or building for support.		15	
	Herbaceous Ornamental or Grass Herbaceous plants are usually low-growing annuals or perennials, without a woody stem.		16	
2	Conifer and/or Evergreen Conifers have needle-like or scale-like leaves, and include pines, spruces, junipers & cedars. Evergreen plants retain their leaves throughout the year, and include Rhododendron & Azalea.		3	
	Broadleaf and/or Deciduous Broadleaf plants have wider leaves (ex.: maples, oaks, Forsythia, and Butterfly Bush.) Deciduous plants drop their leaves once each year.	For trees, go to: For shrubs, go to:	9 11	
3	Resinous Resinous plants produce resin, typically giving off a pungent odor when the leaves are crushed. These include pines, spruces, junipers and cedars.		4	
	Non-Resinous or Less Resinous Plants with less resin will usually give off less of a pungent odor when crushed.		5	
4	Less Firewise - Resinous plants are highly flammable and should not be used in close proximity to structures. Place 4 points in the far right column and go to:		5	
5	Conifer sheds large amounts of leaves or needles (many pine species)		6	
	Conifer does not regularly shed leaves or needles		7	
6	Less Firewise - Shed needles need to periodically be removed from roofs and the ground around structures. Place 2 points in the far right column and go to:		7	
7	Branches are less than 4 feet above the ground. This includes almost all shrubs.		8	
	Branches are more than 4 feet above the ground		9	
8	Less Firewise - Trees should be pruned and dead/low-hanging branches removed to be Firewise. Place 1 point in the far right column and go to:		11	1
9	Trunk has papery bark or loose fibers		10	
	Trunk does not have papery bark or loose fibers		18	
10	Less Firewise - Papery bark or loose fibers can act as ladder fuels; proper placement is necessary. Place 1 point in the far right column and go to:		18	
11	Plant has fine texture Texture is a term to describe the overall appearance of a plant from a distance. From a distance of about 10-15 feet, it is not easy to distinguish individual leaves or branches. (Examples: Boxwood, Spirea, junipers)		12	
	Plant has medium texture From a distance of about 10-15 feet, some individual leaves and branches can be distinguished on the outer part of the shrub, but not the inner part. (Examples: some azaleas and hollies)		13	
	Plant has coarse texture From a distance of about 10-15 feet, it is easy to distinguish individual leaves and branches. Examples include Hydrangea, Beauty-berrry, and and Witch Hazel.		13	
12	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		13	
13	Plant is very dense These shrubs are so dense that it is difficult to place your hand in the shrub and touch a main stem. They have dense branching, and include plants like Boxwood and junipers.		14	
	Plant is moderately dense These shrubs are dense enough that you can't clearly see through them, but it is reasonably easy to place your hand in the shrub and touch a main stem.		18	
	Plant is sparsely dense Plants have an open branching pattern, making it easy to see through the shrub. Examples include American Beauty-berry and some hydrangeas.		18	
14	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		18	
15	Less Firewise - Vines can be flammable, and are problematic in that they add fuel directly to a structure, or act as ladder fuels. Place 2 points in the far right column and go to:		18	
16	Grass, more than 8 inches tall		17	
	All other herbaceous ornamentals, or mowed/green grass		18	
17	Less Firewise - Grass that is tall, dead, and/or dormant (yellow or brown in color) is extremely flammable and carries fire rapidly. Place 6 points in the far right column and go to:		18	
18	Plant retains dead leaves for more than two months of the year		19	
	Plant does not usually retain dead leaves, except when shedding leaves		20	
19	Less Firewise - Plants with dead foliage are highly flammable, because of the low moisture content of the leaves and fine twigs. Place 3 points in the far right column and go to:		20	
20	**Note:** Make sure leaves are not poisonous before touching them			
	Leaves have a waxy coating These plants have a very distinctive waxy coating on the leaf. (Ex.: Wax Myrtle, Gallberry, & Rhododendron)		21	
	Leaves do not have a waxy coating		22	
21	Less Firewise - Proper placement and maintenance are necessary. Place 1 point in the far right column and go to:		22	
22	Species is seriously susceptible to disease, pests, and/or drought All plants can get diseases, but plants seriously susceptible to disease or drought are likely to be stressed and have less vigorous growth. When this happens, the foliage has a lower moisture content and a greater number of dead leaves are retained.		23	
	Species is not seriously susceptible to disease, pests, and/or drought		24	
23	Less Firewise - Make a note of, and routinely monitor for, diseases or pests. Obtain proper diagnosis and treatment of problems. Select plants that are native and/or well-adapted to local climate conditions. Place 1 point in the far right column and go to:		24	
24	FINISHED - Total all the points in the far right column and compare this number to the table below, to get the flammability rating of this plant.			
		Total Points:		1

Total Points	Flammability Rating
0 - 1	Low Flammability
2 - 4	Moderate Flammability
5 - 8	High Flammability
9+	Very High Flammability

Roughleaf dogwood

Cornus drummondii

Score: **1, low flammability**

Great Plains Native

Step #	Plant Characteristic Description		If Yes, Go To #	Points
1. Type of Plant	Tree Trees can provide shade, windbreak, energy savings, wildlife habitat, & erosion control.		2	
	Shrub or Woody Groundcover Shrubs are typically 2-12 feet tall and have a hard, woody stem. Woody groundcovers are low to the ground, but still have a hard, woody stem & branches.		2	
	Vine Vines can be herbaceous or woody, but require a trellis, plant, or building for support.		15	
	Herbaceous Ornamental or Grass Herbaceous plants are usually low-growing annuals or perennials, without a woody stem.		16	
2	Conifer and/or Evergreen Conifers have needle-like or scale-like leaves, and include pines, spruces, junipers & cedars. Evergreen plants retain their leaves throughout the year, and include Rhododendron & Azalea.		3	
	Broadleaf and/or Deciduous Broadleaf plants have wider leaves (ex.: maples, oaks, Forsythia, and Butterfly Bush.) Deciduous plants drop their leaves once each year.	For trees, go to: For shrubs, go to:	9 11	
3	Resinous Resinous plants produce resin, typically giving off a pungent odor when the leaves are crushed. These include pines, spruces, junipers and cedars.		4	
	Non-Resinous or Less Resinous Plants with less resin will usually give off less of a pungent odor when crushed.		5	
4	Less Firewise - Resinous plants are highly flammable and should not be used in close proximity to structures. Place 4 points in the far right column and go to:		5	
5	Conifer sheds large amounts of leaves or needles (many pine species)		6	
	Conifer does not regularly shed leaves or needles		7	
6	Less Firewise - Shed needles need to periodically be removed from roofs and the ground around structures. Place 2 points in the far right column and go to:		7	
7	Branches are less than 4 feet above the ground. This includes almost all shrubs.		8	
	Branches are more than 4 feet above the ground		9	
8	Less Firewise - Trees should be pruned and dead/low-hanging branches removed to be Firewise. Place 1 point in the far right column and go to:		11	1
9	Trunk has papery bark or loose fibers		10	
	Trunk does not have papery bark or loose fibers		18	
10	Less Firewise - Papery bark or loose fibers can act as ladder fuels; proper placement is necessary. Place 1 point in the far right column and go to:		18	
11	Plant has fine texture Texture is a term to describe the overall appearance of a plant from a distance. From a distance of about 10-15 feet, it is not easy to distinguish individual leaves or branches. (Examples: Boxwood, Spirea, junipers)		12	
	Plant has medium texture From a distance of about 10-15 feet, some individual leaves and branches can be distinguished on the outer part of the shrub, but not the inner part. (Examples: some azaleas and hollies)		13	
	Plant has coarse texture From a distance of about 10-15 feet, it is easy to distinguish individual leaves and branches. Examples include Hydrangea, Beauty-berrry, and and Witch Hazel.		13	
12	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		13	
13	Plant is very dense These shrubs are so dense that it is difficult to place your hand in the shrub and touch a main stem. They have dense branching, and include plants like Boxwood and junipers.		14	
	Plant is moderately dense These shrubs are dense enough that you can't clearly see through them, but it is reasonably easy to place your hand in the shrub and touch a main stem.		18	
	Plant is sparsely dense Plants have an open branching pattern, making it easy to see through the shrub. Examples include American Beauty-berry and some hydrangeas.		18	
14	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		18	
15	Less Firewise - Vines can be flammable, and are problematic in that they add fuel directly to a structure, or act as ladder fuels. Place 2 points in the far right column and go to:		18	
16	Grass, more than 8 inches tall		17	
	All other herbaceous ornamentals, or mowed/green grass		18	
17	Less Firewise - Grass that is tall, dead, and/or dormant (yellow or brown in color) is extrememly flammable and carries fire rapidly. Place 6 points in the far right column and go to:		18	
18	Plant retains dead leaves for more than two months of the year		19	
	Plant does not usually retain dead leaves, except when shedding leaves		20	
19	Less Firewise - Plants with dead foliage are highly flammable, because of the low moisture content of the leaves and fine twigs. Place 3 points in the far right column and go to:		20	
20	**Note:** Make sure leaves are not poisonous before touching them			
	Leaves have a waxy coating These plants have a very distinctive waxy coating on the leaf. (Ex.: Wax Myrtle, Gallberry, & Rhododendron)		21	
	Leaves do not have a waxy coating		22	
21	Less Firewise - Proper placement and maintenance are necessary. Place 1 point in the far right column and go to:		22	1
22	Species is seriously susceptible to disease, pests, and/or drought All plants can get diseases, but plants seriously susceptible to disease or drought are likely to be stressed and have less vigorous growth. When this happens, the foliage has a lower moisture content and a greater number of dead leaves are retained.		23	
	Species is not seriously susceptible to disease, pests, and/or drought		24	
23	Less Firewise - Make a note of, and routinely monitor for, diseases or pests. Obtain proper diagnosis and treatment of problems. Select plants that are native and/or well-adapted to local climate conditions. Place 1 point in the far right column and go to:		24	
24	FINISHED - Total all the points in the far right column and compare this number to the table below, to get the flammability rating of this plant.			
		Total Points:		2

Total Points	Flammability Rating
0 - 1	Low Flammability
2 - 4	Moderate Flammability
5 - 8	High Flammability
9+	Very High Flammability

Winged sumac

Rhus copallinum

Score: **2, moderate flammability**

Great Plains Native

Step #	Plant Characteristic Description		If Yes, Go To #	Points
1. Type of Plant	Tree Trees can provide shade, windbreak, energy savings, wildlife habitat, & erosion control.		2	
	Shrub or Woody Groundcover Shrubs are typically 2-12 feet tall and have a hard, woody stem. Woody groundcovers are low to the ground, but still have a hard, woody stem & branches.		2	
	Vine Vines can be herbaceous or woody, but require a trellis, plant, or building for support.		15	
	Herbaceous Ornamental or Grass Herbaceous plants are usually low-growing annuals or perennials, without a woody stem.		16	
2	Conifer and/or Evergreen Conifers have needle-like or scale-like leaves, and include pines, spruces, junipers & cedars. Evergreen plants retain their leaves throughout the year, and include Rhododendron & Azalea.		3	
	Broadleaf and/or Deciduous Broadleaf plants have wider leaves (ex.: maples, oaks, Forsythia, and Butterfly Bush.) Deciduous plants drop their leaves once each year.	For trees, go to: For shrubs, go to:	9 11	
3	Resinous Resinous plants produce resin, typically giving off a pungent odor when the leaves are crushed. These include pines, spruces, junipers and cedars.		4	
	Non-Resinous or Less Resinous Plants with less resin will usually give off less of a pungent odor when crushed.		5	
4	Less Firewise - Resinous plants are highly flammable and should not be used in close proximity to structures. Place 4 points in the far right column and go to:		5	
5	Conifer sheds large amounts of leaves or needles (many pine species)		6	
	Conifer does not regularly shed leaves or needles		7	
6	Less Firewise - Shed needles need to periodically be removed from roofs and the ground around structures. Place 2 points in the far right column and go to:		7	
7	Branches are less than 4 feet above the ground. This includes almost all shrubs.		8	
	Branches are more than 4 feet above the ground		9	
8	Less Firewise - Trees should be pruned and dead/low-hanging branches removed to be Firewise. Place 1 point in the far right column and go to:		11	1
9	Trunk has papery bark or loose fibers		10	
	Trunk does not have papery bark or loose fibers		18	
10	Less Firewise - Papery bark or loose fibers can act as ladder fuels; proper placement is necessary. Place 1 point in the far right column and go to:		18	
11	Plant has fine texture Texture is a term to describe the overall appearance of a plant from a distance. From a distance of about 10-15 feet, it is not easy to distinguish individual leaves or branches. (Examples: Boxwood, Spirea, junipers)		12	
	Plant has medium texture From a distance of about 10-15 feet, some individual leaves and branches can be distinguished on the outer part of the shrub, but not the inner part. (Examples: some azaleas and hollies)		13	
	Plant has coarse texture From a distance of about 10-15 feet, it is easy to distinguish individual leaves and branches. Examples include Hydrangea, Beauty-berrry, and and Witch Hazel.		13	
12	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		13	
13	Plant is very dense These shrubs are so dense that it is difficult to place your hand in the shrub and touch a main stem. They have dense branching, and include plants like Boxwood and junipers.		14	
	Plant is moderately dense These shrubs are dense enough that you can't clearly see through them, but it is reasonably easy to place your hand in the shrub and touch a main stem.		18	
	Plant is sparsely dense Plants have an open branching pattern, making it easy to see through the shrub. Examples include American Beauty-berry and some hydrangeas.		18	
14	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		18	
15	Less Firewise - Vines can be flammable, and are problematic in that they add fuel directly to a structure, or act as ladder fuels. Place 2 points in the far right column and go to:		18	
16	Grass, more than 8 inches tall		17	
	All other herbaceous ornamentals, or mowed/green grass		18	
17	Less Firewise - Grass that is tall, dead, and/or dormant (yellow or brown in color) is extrememly flammable and carries fire rapidly. Place 6 points in the far right column and go to:		18	
18	Plant retains dead leaves for more than two months of the year		19	
	Plant does not usually retain dead leaves, except when shedding leaves		20	
19	Less Firewise - Plants with dead foliage are highly flammable, because of the low moisture content of the leaves and fine twigs. Place 3 points in the far right column and go to:		20	
20	**Note:** Make sure leaves are not poisonous before touching them			
	Leaves have a waxy coating These plants have a very distinctive waxy coating on the leaf. (Ex.: Wax Myrtle, Gallberry, & Rhododendron)		21	
	Leaves do not have a waxy coating		22	
21	Less Firewise - Proper placement and maintenance are necessary. Place 1 point in the far right column and go to:		22	
22	Species is seriously susceptible to disease, pests, and/or drought All plants can get diseases, but plants seriously susceptible to disease or drought are likely to be stressed and have less vigorous growth. When this happens, the foliage has a lower moisture content and a greater number of dead leaves are retained.		23	
	Species is not seriously susceptible to disease, pests, and/or drought		24	
23	Less Firewise - Make a note of, and routinely monitor for, diseases or pests. Obtain proper diagnosis and treatment of problems. Select plants that are native and/or well-adapted to local climate conditions. Place 1 point in the far right column and go to:		24	
24	FINISHED - Total all the points in the far right column and compare this number to the table below, to get the flammability rating of this plant.			
		Total Points:		1

Total Points	Flammability Rating
0 - 1	Low Flammability
2 - 4	Moderate Flammability
5 - 8	High Flammability
9+	Very High Flammability

Fragrant sumac

Rhus aromatica

Score: **1, low flammability**

Great Plains Native

Step #	Plant Characteristic Description	If Yes, Go To #	Points
1. Type of Plant	Tree Trees can provide shade, windbreak, energy savings, wildlife habitat, & erosion control.	2	
	Shrub or Woody Groundcover Shrubs are typically 2-12 feet tall and have a hard, woody stem. Woody groundcovers are low to the ground, but still have a hard, woody stem & branches.	2	
	Vine Vines can be herbaceous or woody, but require a trellis, plant, or building for support.	15	
	Herbaceous Ornamental or Grass Herbaceous plants are usually low-growing annuals or perennials, without a woody stem.	16	
2	Conifer and/or Evergreen Conifers have needle-like or scale-like leaves, and include pines, spruces, junipers & cedars. Evergreen plants retain their leaves throughout the year, and include Rhododendron & Azalea.	3	
	Broadleaf and/or Deciduous — For trees, go to:	9	
	Broadleaf plants have wider leaves (ex.: maples, oaks, Forsythia, and Butterfly Bush.) Deciduous plants drop their leaves once each year. — For shrubs, go to:	11	
3	Resinous Resinous plants produce resin, typically giving off a pungent odor when the leaves are crushed. These include pines, spruces, junipers and cedars.	4	
	Non-Resinous or Less Resinous Plants with less resin will usually give off less of a pungent odor when crushed.	5	
4	Less Firewise - Resinous plants are highly flammable and should not be used in close proximity to structures. Place 4 points in the far right column and go to:	5	
5	Conifer sheds large amounts of leaves or needles (many pine species)	6	
	Conifer does not regularly shed leaves or needles	7	
6	Less Firewise - Shed needles need to periodically be removed from roofs and the ground around structures. Place 2 points in the far right column and go to:	7	
7	Branches are less than 4 feet above the ground. This includes almost all shrubs.	8	
	Branches are more than 4 feet above the ground	9	
8	Less Firewise - Trees should be pruned and dead/low-hanging branches removed to be Firewise. Place 1 point in the far right column and go to:	11	
9	Trunk has papery bark or loose fibers	10	
	Trunk does not have papery bark or loose fibers	18	
10	Less Firewise - Papery bark or loose fibers can act as ladder fuels; proper placement is necessary. Place 1 point in the far right column and go to:	18	
11	Plant has fine texture Texture is a term to describe the overall appearance of a plant from a distance. From a distance of about 10-15 feet, it is not easy to distinguish individual leaves or branches. (Examples: Boxwood, Spirea, junipers)	12	
	Plant has medium texture From a distance of about 10-15 feet, some individual leaves and branches can be distinguished on the outer part of the shrub, but not the inner part. (Examples: some azaleas and hollies)	13	
	Plant has coarse texture From a distance of about 10-15 feet, it is easy to distinguish individual leaves and branches. Examples include Hydrangea, Beauty-berrry, and and Witch Hazel.	13	
12	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:	13	
13	Plant is very dense These shrubs are so dense that it is difficult to place your hand in the shrub and touch a main stem. They have dense branching, and include plants like Boxwood and junipers.	14	
	Plant is moderately dense These shrubs are dense enough that you can't clearly see through them, but it is reasonably easy to place your hand in the shrub and touch a main stem.	18	
	Plant is sparsely dense Plants have an open branching pattern, making it easy to see through the shrub. Examples include American Beauty-berry and some hydrangeas.	18	
14	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:	18	
15	Less Firewise - Vines can be flammable, and are problematic in that they add fuel directly to a structure, or act as ladder fuels. Place 2 points in the far right column and go to:	18	
16	Grass, more than 8 inches tall	17	
	All other herbaceous ornamentals, or mowed/green grass	18	
17	Less Firewise - Grass that is tall, dead, and/or dormant (yellow or brown in color) is extrememly flammable and carries fire rapidly. Place 6 points in the far right column and go to:	18	
18	Plant retains dead leaves for more than two months of the year	19	
	Plant does not usually retain dead leaves, except when shedding leaves	20	
19	Less Firewise - Plants with dead foliage are highly flammable, because of the low moisture content of the leaves and fine twigs. Place 3 points in the far right column and go to:	20	
20	**Note:** Make sure leaves are not poisonous before touching them		
	Leaves have a waxy coating These plants have a very distinctive waxy coating on the leaf. (Ex.: Wax Myrtle, Gallberry, & Rhododendron)	21	
	Leaves do not have a waxy coating	22	
21	Less Firewise - Proper placement and maintenance are necessary. Place 1 point in the far right column and go to:	22	
22	Species is seriously susceptible to disease, pests, and/or drought All plants can get diseases, but plants seriously susceptible to disease or drought are likely to be stressed and have less vigorous growth. When this happens, the foliage has a lower moisture content and a greater number of dead leaves are retained.	23	
	Species is not seriously susceptible to disease, pests, and/or drought	24	
23	Less Firewise - Make a note of, and routinely monitor for, diseases or pests. Obtain proper diagnosis and treatment of problems. Select plants that are native and/or well-adapted to local climate conditions. Place 1 point in the far right column and go to:	24	
24	FINISHED - Total all the points in the far right column and compare this number to the table below, to get the flammability rating of this plant.		
	Total Points:		0

Total Points	Flammability Rating
0 - 1	Low Flammability
2 - 4	Moderate Flammability
5 - 8	High Flammability
9+	Very High Flammability

Woodland sunflower

Helianthus strumosus

Score: **0, low flammability**

Great Plains Native

Step #	Plant Characteristic Description	If Yes, Go To #	Points
1. Type of Plant	Tree Trees can provide shade, windbreak, energy savings, wildlife habitat, & erosion control.	2	
	Shrub or Woody Groundcover Shrubs are typically 2-12 feet tall and have a hard, woody stem. Woody groundcovers are low to the ground, but still have a hard, woody stem & branches.	2	
	Vine Vines can be herbaceous or woody, but require a trellis, plant, or building for support.	15	
	Herbaceous Ornamental or Grass Herbaceous plants are usually low-growing annuals or perennials, without a woody stem.	16	
2	Conifer and/or Evergreen Conifers have needle-like or scale-like leaves, and include pines, spruces, junipers & cedars. Evergreen plants retain their leaves throughout the year, and include Rhododendron & Azalea.	3	
	Broadleaf and/or Deciduous — For trees, go to:	9	
	Broadleaf plants have wider leaves (ex.: maples, oaks, Forsythia, and Butterfly Bush.) Deciduous plants drop their leaves once each year. — For shrubs, go to:	11	
3	Resinous Resinous plants produce resin, typically giving off a pungent odor when the leaves are crushed. These include pines, spruces, junipers and cedars.	4	
	Non-Resinous or Less Resinous Plants with less resin will usually give off less of a pungent odor when crushed.	5	
4	Less Firewise - Resinous plants are highly flammable and should not be used in close proximity to structures. Place 4 points in the far right column and go to:	5	
5	Conifer sheds large amounts of leaves or needles (many pine species)	6	
	Conifer does not regularly shed leaves or needles	7	
6	Less Firewise - Shed needles need to periodically be removed from roofs and the ground around structures. Place 2 points in the far right column and go to:	7	
7	Branches are less than 4 feet above the ground. This includes almost all shrubs.	8	
	Branches are more than 4 feet above the ground	9	
8	Less Firewise - Trees should be pruned and dead/low-hanging branches removed to be Firewise. Place 1 point in the far right column and go to:	11	
9	Trunk has papery bark or loose fibers	10	
	Trunk does not have papery bark or loose fibers	18	
10	Less Firewise - Papery bark or loose fibers can act as ladder fuels; proper placement is necessary. Place 1 point in the far right column and go to:	18	
11	Plant has fine texture Texture is a term to describe the overall appearance of a plant from a distance. From a distance of about 10-15 feet, it is not easy to distinguish individual leaves or branches. (Examples: Boxwood, Spirea, junipers)	12	
	Plant has medium texture From a distance of about 10-15 feet, some individual leaves and branches can be distinguished on the outer part of the shrub, but not the inner part. (Examples: some azaleas and hollies)	13	
	Plant has coarse texture From a distance of about 10-15 feet, it is easy to distinguish individual leaves and branches. Examples include Hydrangea, Beauty-berrry, and and Witch Hazel.	13	
12	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:	13	
13	Plant is very dense These shrubs are so dense that it is difficult to place your hand in the shrub and touch a main stem. They have dense branching, and include plants like Boxwood and junipers.	14	
	Plant is moderately dense These shrubs are dense enough that you can't clearly see through them, but it is reasonably easy to place your hand in the shrub and touch a main stem.	18	
	Plant is sparsely dense Plants have an open branching pattern, making it easy to see through the shrub. Examples include American Beauty-berry and some hydrangeas.	18	
14	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:	18	
15	Less Firewise - Vines can be flammable, and are problematic in that they add fuel directly to a structure, or act as ladder fuels. Place 2 points in the far right column and go to:	18	
16	Grass, more than 8 inches tall	17	
	All other herbaceous ornamentals, or mowed/green grass	18	
17	Less Firewise - Grass that is tall, dead, and/or dormant (yellow or brown in color) is extrememly flammable and carries fire rapidly. Place 6 points in the far right column and go to:	18	
18	Plant retains dead leaves for more than two months of the year	19	
	Plant does not usually retain dead leaves, except when shedding leaves	20	
19	Less Firewise - Plants with dead foliage are highly flammable, because of the low moisture content of the leaves and fine twigs. Place 3 points in the far right column and go to:	20	
20	**Note:** Make sure leaves are not poisonous before touching them		
	Leaves have a waxy coating These plants have a very distinctive waxy coating on the leaf. (Ex.: Wax Myrtle, Gallberry, & Rhododendron)	21	
	Leaves do not have a waxy coating	22	
21	Less Firewise - Proper placement and maintenance are necessary. Place 1 point in the far right column and go to:	22	
22	Species is seriously susceptible to disease, pests, and/or drought All plants can get diseases, but plants seriously susceptible to disease or drought are likely to be stressed and have less vigorous growth. When this happens, the foliage has a lower moisture content and a greater number of dead leaves are retained.	23	
	Species is not seriously susceptible to disease, pests, and/or drought	24	
23	Less Firewise - Make a note of, and routinely monitor for, diseases or pests. Obtain proper diagnosis and treatment of problems. Select plants that are native and/or well-adapted to local climate conditions. Place 1 point in the far right column and go to:	24	
24	FINISHED - Total all the points in the far right column and compare this number to the table below, to get the flammability rating of this plant.		
	Total Points:		0

Total Points	Flammability Rating
0 - 1	Low Flammability
2 - 4	Moderate Flammability
5 - 8	High Flammability
9+	Very High Flammability

Wild bergamot

Monarda fistulosa

Score: **0, low flammability**

Great Plains Native

Step #	Plant Characteristic Description		If Yes, Go To #	Points
1. Type of Plant	Tree Trees can provide shade, windbreak, energy savings, wildlife habitat, & erosion control.		2	
	Shrub or Woody Groundcover Shrubs are typically 2-12 feet tall and have a hard, woody stem. Woody groundcovers are low to the ground, but still have a hard, woody stem & branches.		2	
	Vine Vines can be herbaceous or woody, but require a trellis, plant, or building for support.		15	
	Herbaceous Ornamental or Grass Herbaceous plants are usually low-growing annuals or perennials, without a woody stem.		16	
2	Conifer and/or Evergreen Conifers have needle-like or scale-like leaves, and include pines, spruces, junipers & cedars. Evergreen plants retain their leaves throughout the year, and include Rhododendron & Azalea.		3	
	Broadleaf and/or Deciduous Broadleaf plants have wider leaves (ex.: maples, oaks, Forsythia, and Butterfly Bush.) Deciduous plants drop their leaves once each year.	For trees, go to: For shrubs, go to:	9 11	
3	Resinous Resinous plants produce resin, typically giving off a pungent odor when the leaves are crushed. These include pines, spruces, junipers and cedars.		4	
	Non-Resinous or Less Resinous Plants with less resin will usually give off less of a pungent odor when crushed.		5	
4	Less Firewise - Resinous plants are highly flammable and should not be used in close proximity to structures. Place 4 points in the far right column and go to:		5	
5	Conifer sheds large amounts of leaves or needles (many pine species)		6	
	Conifer does not regularly shed leaves or needles		7	
6	Less Firewise - Shed needles need to periodically be removed from roofs and the ground around structures. Place 2 points in the far right column and go to:		7	
7	Branches are less than 4 feet above the ground. This includes almost all shrubs.		8	
	Branches are more than 4 feet above the ground		9	
8	Less Firewise - Trees should be pruned and dead/low-hanging branches removed to be Firewise. Place 1 point in the far right column and go to:		11	
9	Trunk has papery bark or loose fibers		10	
	Trunk does not have papery bark or loose fibers		18	
10	Less Firewise - Papery bark or loose fibers can act as ladder fuels; proper placement is necessary. Place 1 point in the far right column and go to:		18	
11	Plant has fine texture Texture is a term to describe the overall appearance of a plant from a distance. From a distance of about 10-15 feet, it is not easy to distinguish individual leaves or branches. (Examples: Boxwood, Spirea, junipers)		12	
	Plant has medium texture From a distance of about 10-15 feet, some individual leaves and branches can be distinguished on the outer part of the shrub, but not the inner part. (Examples: some azaleas and hollies)		13	
	Plant has coarse texture From a distance of about 10-15 feet, it is easy to distinguish individual leaves and branches. Examples include Hydrangea, Beauty-berrry, and and Witch Hazel.		13	
12	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		13	
13	Plant is very dense These shrubs are so dense that it is difficult to place your hand in the shrub and touch a main stem. They have dense branching, and include plants like Boxwood and junipers.		14	
	Plant is moderately dense These shrubs are dense enough that you can't clearly see through them, but it is reasonably easy to place your hand in the shrub and touch a main stem.		18	
	Plant is sparsely dense Plants have an open branching pattern, making it easy to see through the shrub. Examples include American Beauty-berry and some hydrangeas.		18	
14	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		18	
15	Less Firewise - Vines can be flammable, and are problematic in that they add fuel directly to a structure, or act as ladder fuels. Place 2 points in the far right column and go to:		18	
16	Grass, more than 8 inches tall		17	
	All other herbaceous ornamentals, or mowed/green grass		18	
17	Less Firewise - Grass that is tall, dead, and/or dormant (yellow or brown in color) is extrememly flammable and carries fire rapidly. Place 6 points in the far right column and go to:		18	
18	Plant retains dead leaves for more than two months of the year		19	
	Plant does not usually retain dead leaves, except when shedding leaves		20	
19	Less Firewise - Plants with dead foliage are highly flammable, because of the low moisture content of the leaves and fine twigs. Place 3 points in the far right column and go to:		20	
20	**Note:** Make sure leaves are not poisonous before touching them			
	Leaves have a waxy coating These plants have a very distinctive waxy coating on the leaf. (Ex.: Wax Myrtle, Gallberry, & Rhododendron)		21	
	Leaves do not have a waxy coating		22	
21	Less Firewise - Proper placement and maintenance are necessary. Place 1 point in the far right column and go to:		22	
22	Species is seriously susceptible to disease, pests, and/or drought All plants can get diseases, but plants seriously susceptible to disease or drought are likely to be stressed and have less vigorous growth. When this happens, the foliage has a lower moisture content and a greater number of dead leaves are retained.		23	
	Species is not seriously susceptible to disease, pests, and/or drought		24	
23	Less Firewise - Make a note of, and routinely monitor for, diseases or pests. Obtain proper diagnosis and treatment of problems. Select plants that are native and/or well-adapted to local climate conditions. Place 1 point in the far right column and go to:		24	
24	FINISHED - Total all the points in the far right column and compare this number to the table below, to get the flammability rating of this plant.			
		Total Points:		0

Total Points	Flammability Rating
0 - 1	Low Flammability
2 - 4	Moderate Flammability
5 - 8	High Flammability
9+	Very High Flammability

Canadian columbine

Aquilegia canadensis

Score: **0, low flammability**

Great Plains Native

Step #	Plant Characteristic Description		If Yes, Go To #	Points
1. Type of Plant	Tree Trees can provide shade, windbreak, energy savings, wildlife habitat, & erosion control.		2	
	Shrub or Woody Groundcover Shrubs are typically 2-12 feet tall and have a hard, woody stem. Woody groundcovers are low to the ground, but still have a hard, woody stem & branches.		2	
	Vine Vines can be herbaceous or woody, but require a trellis, plant, or building for support.		15	
	Herbaceous Ornamental or Grass Herbaceous plants are usually low-growing annuals or perennials, without a woody stem.		16	
2	Conifer and/or Evergreen Conifers have needle-like or scale-like leaves, and include pines, spruces, junipers & cedars. Evergreen plants retain their leaves throughout the year, and include Rhododendron & Azalea.		3	
	Broadleaf and/or Deciduous Broadleaf plants have wider leaves (ex.: maples, oaks, Forsythia, and Butterfly Bush.) Deciduous plants drop their leaves once each year.	For trees, go to: For shrubs, go to:	9 11	
3	Resinous Resinous plants produce resin, typically giving off a pungent odor when the leaves are crushed. These include pines, spruces, junipers and cedars.		4	
	Non-Resinous or Less Resinous Plants with less resin will usually give off less of a pungent odor when crushed.		5	
4	Less Firewise - Resinous plants are highly flammable and should not be used in close proximity to structures. Place 4 points in the far right column and go to:		5	
5	Conifer sheds large amounts of leaves or needles (many pine species)		6	
	Conifer does not regularly shed leaves or needles		7	
6	Less Firewise - Shed needles need to periodically be removed from roofs and the ground around structures. Place 2 points in the far right column and go to:		7	
7	Branches are less than 4 feet above the ground. This includes almost all shrubs.		8	
	Branches are more than 4 feet above the ground		9	
8	Less Firewise - Trees should be pruned and dead/low-hanging branches removed to be Firewise. Place 1 point in the far right column and go to:		11	
9	Trunk has papery bark or loose fibers		10	
	Trunk does not have papery bark or loose fibers		18	
10	Less Firewise - Papery bark or loose fibers can act as ladder fuels; proper placement is necessary. Place 1 point in the far right column and go to:		18	
11	Plant has fine texture Texture is a term to describe the overall appearance of a plant from a distance. From a distance of about 10-15 feet, it is not easy to distinguish individual leaves or branches. (Examples: Boxwood, Spirea, junipers)		12	
	Plant has medium texture From a distance of about 10-15 feet, some individual leaves and branches can be distinguished on the outer part of the shrub, but not the inner part. (Examples: some azaleas and hollies)		13	
	Plant has coarse texture From a distance of about 10-15 feet, it is easy to distinguish individual leaves and branches. Examples include Hydrangea, Beauty-berrry, and and Witch Hazel.		13	
12	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		13	
13	Plant is very dense These shrubs are so dense that it is difficult to place your hand in the shrub and touch a main stem. They have dense branching, and include plants like Boxwood and junipers.		14	
	Plant is moderately dense These shrubs are dense enough that you can't clearly see through them, but it is reasonably easy to place your hand in the shrub and touch a main stem.		18	
	Plant is sparsely dense Plants have an open branching pattern, making it easy to see through the shrub. Examples include American Beauty-berry and some hydrangeas.		18	
14	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		18	
15	Less Firewise - Vines can be flammable, and are problematic in that they add fuel directly to a structure, or act as ladder fuels. Place 2 points in the far right column and go to:		18	
16	Grass, more than 8 inches tall		17	
	All other herbaceous ornamentals, or mowed/green grass		18	
17	Less Firewise - Grass that is tall, dead, and/or dormant (yellow or brown in color) is extrememly flammable and carries fire rapidly. Place 6 points in the far right column and go to:		18	
18	Plant retains dead leaves for more than two months of the year		19	
	Plant does not usually retain dead leaves, except when shedding leaves		20	
19	Less Firewise - Plants with dead foliage are highly flammable, because of the low moisture content of the leaves and fine twigs. Place 3 points in the far right column and go to:		20	
20	**Note:** Make sure leaves are not poisonous before touching them			
	Leaves have a waxy coating These plants have a very distinctive waxy coating on the leaf. (Ex.: Wax Myrtle, Gallberry, & Rhododendron)		21	
	Leaves do not have a waxy coating		22	
21	Less Firewise - Proper placement and maintenance are necessary. Place 1 point in the far right column and go to:		22	
22	Species is seriously susceptible to disease, pests, and/or drought All plants can get diseases, but plants seriously susceptible to disease or drought are likely to be stressed and have less vigorous growth. When this happens, the foliage has a lower moisture content and a greater number of dead leaves are retained.		23	
	Species is not seriously susceptible to disease, pests, and/or drought		24	
23	Less Firewise - Make a note of, and routinely monitor for, diseases or pests. Obtain proper diagnosis and treatment of problems. Select plants that are native and/or well-adapted to local climate conditions. Place 1 point in the far right column and go to:		24	
24	FINISHED - Total all the points in the far right column and compare this number to the table below, to get the flammability rating of this plant.			
		Total Points:		0

Total Points	Flammability Rating
0 - 1	Low Flammability
2 - 4	Moderate Flammability
5 - 8	High Flammability
9+	Very High Flammability

Great Solomon's seal

Polygonatum biflorum

Score: **0, low flammability**

Great Plains Native

Step #	Plant Characteristic Description	If Yes, Go To #	Points
1. Type of Plant	Tree Trees can provide shade, windbreak, energy savings, wildlife habitat, & erosion control.	2	
	Shrub or Woody Groundcover Shrubs are typically 2-12 feet tall and have a hard, woody stem. Woody groundcovers are low to the ground, but still have a hard, woody stem & branches.	2	
	Vine Vines can be herbaceous or woody, but require a trellis, plant, or building for support.	15	
	Herbaceous Ornamental or Grass Herbaceous plants are usually low-growing annuals or perennials, without a woody stem.	16	
2	Conifer and/or Evergreen Conifers have needle-like or scale-like leaves, and include pines, spruces, junipers & cedars. Evergreen plants retain their leaves throughout the year, and include Rhododendron & Azalea.	3	
	Broadleaf and/or Deciduous — For trees, go to:	9	
	Broadleaf plants have wider leaves (ex.: maples, oaks, Forsythia, and Butterfly Bush.) Deciduous plants drop their leaves once each year. — For shrubs, go to:	11	
3	Resinous Resinous plants produce resin, typically giving off a pungent odor when the leaves are crushed. These include pines, spruces, junipers and cedars.	4	
	Non-Resinous or Less Resinous Plants with less resin will usually give off less of a pungent odor when crushed.	5	
4	Less Firewise - Resinous plants are highly flammable and should not be used in close proximity to structures. Place 4 points in the far right column and go to:	5	
5	Conifer sheds large amounts of leaves or needles (many pine species)	6	
	Conifer does not regularly shed leaves or needles	7	
6	Less Firewise - Shed needles need to periodically be removed from roofs and the ground around structures. Place 2 points in the far right column and go to:	7	
7	Branches are less than 4 feet above the ground. This includes almost all shrubs.	8	
	Branches are more than 4 feet above the ground	9	
8	Less Firewise - Trees should be pruned and dead/low-hanging branches removed to be Firewise. Place 1 point in the far right column and go to:	11	
9	Trunk has papery bark or loose fibers	10	
	Trunk does not have papery bark or loose fibers	18	
10	Less Firewise - Papery bark or loose fibers can act as ladder fuels; proper placement is necessary. Place 1 point in the far right column and go to:	18	
11	Plant has fine texture Texture is a term to describe the overall appearance of a plant from a distance. From a distance of about 10-15 feet, it is not easy to distinguish individual leaves or branches. (Examples: Boxwood, Spirea, junipers)	12	
	Plant has medium texture From a distance of about 10-15 feet, some individual leaves and branches can be distinguished on the outer part of the shrub, but not the inner part. (Examples: some azaleas and hollies)	13	
	Plant has coarse texture From a distance of about 10-15 feet, it is easy to distinguish individual leaves and branches. Examples include Hydrangea, Beauty-berrry, and and Witch Hazel.	13	
12	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:	13	
13	Plant is very dense These shrubs are so dense that it is difficult to place your hand in the shrub and touch a main stem. They have dense branching, and include plants like Boxwood and junipers.	14	
	Plant is moderately dense These shrubs are dense enough that you can't clearly see through them, but it is reasonably easy to place your hand in the shrub and touch a main stem.	18	
	Plant is sparsely dense Plants have an open branching pattern, making it easy to see through the shrub. Examples include American Beauty-berry and some hydrangeas.	18	
14	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:	18	
15	Less Firewise - Vines can be flammable, and are problematic in that they add fuel directly to a structure, or act as ladder fuels. Place 2 points in the far right column and go to:	18	
16	Grass, more than 8 inches tall	17	
	All other herbaceous ornamentals, or mowed/green grass	18	
17	Less Firewise - Grass that is tall, dead, and/or dormant (yellow or brown in color) is extrememly flammable and carries fire rapidly. Place 6 points in the far right column and go to:	18	6
18	Plant retains dead leaves for more than two months of the year	19	
	Plant does not usually retain dead leaves, except when shedding leaves	20	
19	Less Firewise - Plants with dead foliage are highly flammable, because of the low moisture content of the leaves and fine twigs. Place 3 points in the far right column and go to:	20	3
20	**Note:** Make sure leaves are not poisonous before touching them		
	Leaves have a waxy coating These plants have a very distinctive waxy coating on the leaf. (Ex.: Wax Myrtle, Gallberry, & Rhododendron)	21	
	Leaves do not have a waxy coating	22	
21	Less Firewise - Proper placement and maintenance are necessary. Place 1 point in the far right column and go to:	22	
22	Species is seriously susceptible to disease, pests, and/or drought All plants can get diseases, but plants seriously susceptible to disease or drought are likely to be stressed and have less vigorous growth. When this happens, the foliage has a lower moisture content and a greater number of dead leaves are retained.	23	
	Species is not seriously susceptible to disease, pests, and/or drought	24	
23	Less Firewise - Make a note of, and routinely monitor for, diseases or pests. Obtain proper diagnosis and treatment of problems. Select plants that are native and/or well-adapted to local climate conditions. Place 1 point in the far right column and go to:	24	
24	FINISHED - Total all the points in the far right column and compare this number to the table below, to get the flammability rating of this plant.		
	Total Points:		9

Total Points	Flammability Rating
0 - 1	Low Flammability
2 - 4	Moderate Flammability
5 - 8	High Flammability
9+	Very High Flammability

Northern sea oats

Chasmanthium latifolium

Score: **9, very high flammability**

Great Plains Native

Step #	Plant Characteristic Description	If Yes, Go To #	Points
1. Type of Plant	Tree Trees can provide shade, windbreak, energy savings, wildlife habitat, & erosion control.	2	
	Shrub or Woody Groundcover Shrubs are typically 2-12 feet tall and have a hard, woody stem. Woody groundcovers are low to the ground, but still have a hard, woody stem & branches.	2	
	Vine Vines can be herbaceous or woody, but require a trellis, plant, or building for support.	15	
	Herbaceous Ornamental or Grass Herbaceous plants are usually low-growing annuals or perennials, without a woody stem.	16	
2	Conifer and/or Evergreen Conifers have needle-like or scale-like leaves, and include pines, spruces, junipers & cedars. Evergreen plants retain their leaves throughout the year, and include Rhododendron & Azalea.	3	
	Broadleaf and/or Deciduous — For trees, go to:	9	
	Broadleaf plants have wider leaves (ex.: maples, oaks, Forsythia, and Butterfly Bush.) Deciduous plants drop their leaves once each year. — For shrubs, go to:	11	
3	Resinous Resinous plants produce resin, typically giving off a pungent odor when the leaves are crushed. These include pines, spruces, junipers and cedars.	4	
	Non-Resinous or Less Resinous Plants with less resin will usually give off less of a pungent odor when crushed.	5	
4	Less Firewise - Resinous plants are highly flammable and should not be used in close proximity to structures. Place 4 points in the far right column and go to:	5	
5	Conifer sheds large amounts of leaves or needles (many pine species)	6	
	Conifer does not regularly shed leaves or needles	7	
6	Less Firewise - Shed needles need to periodically be removed from roofs and the ground around structures. Place 2 points in the far right column and go to:	7	
7	Branches are less than 4 feet above the ground. This includes almost all shrubs.	8	
	Branches are more than 4 feet above the ground	9	
8	Less Firewise - Trees should be pruned and dead/low-hanging branches removed to be Firewise. Place 1 point in the far right column and go to:	11	
9	Trunk has papery bark or loose fibers	10	
	Trunk does not have papery bark or loose fibers	18	
10	Less Firewise - Papery bark or loose fibers can act as ladder fuels; proper placement is necessary. Place 1 point in the far right column and go to:	18	
11	Plant has fine texture Texture is a term to describe the overall appearance of a plant from a distance. From a distance of about 10-15 feet, it is not easy to distinguish individual leaves or branches. (Examples: Boxwood, Spirea, junipers)	12	
	Plant has medium texture From a distance of about 10-15 feet, some individual leaves and branches can be distinguished on the outer part of the shrub, but not the inner part. (Examples: some azaleas and hollies)	13	
	Plant has coarse texture From a distance of about 10-15 feet, it is easy to distinguish individual leaves and branches. Examples include Hydrangea, Beauty-berrry, and and Witch Hazel.	13	
12	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:	13	
13	Plant is very dense These shrubs are so dense that it is difficult to place your hand in the shrub and touch a main stem. They have dense branching, and include plants like Boxwood and junipers.	14	
	Plant is moderately dense These shrubs are dense enough that you can't clearly see through them, but it is reasonably easy to place your hand in the shrub and touch a main stem.	18	
	Plant is sparsely dense Plants have an open branching pattern, making it easy to see through the shrub. Examples include American Beauty-berry and some hydrangeas.	18	
14	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:	18	
15	Less Firewise - Vines can be flammable, and are problematic in that they add fuel directly to a structure, or act as ladder fuels. Place 2 points in the far right column and go to:	18	
16	Grass, more than 8 inches tall	17	
	All other herbaceous ornamentals, or mowed/green grass	18	
17	Less Firewise - Grass that is tall, dead, and/or dormant (yellow or brown in color) is extrememly flammable and carries fire rapidly. Place 6 points in the far right column and go to:	18	6
18	Plant retains dead leaves for more than two months of the year	19	
	Plant does not usually retain dead leaves, except when shedding leaves	20	
19	Less Firewise - Plants with dead foliage are highly flammable, because of the low moisture content of the leaves and fine twigs. Place 3 points in the far right column and go to:	20	3
20	**Note:** Make sure leaves are not poisonous before touching them		
	Leaves have a waxy coating These plants have a very distinctive waxy coating on the leaf. (Ex.: Wax Myrtle, Gallberry, & Rhododendron)	21	
	Leaves do not have a waxy coating	22	
21	Less Firewise - Proper placement and maintenance are necessary. Place 1 point in the far right column and go to:	22	
22	Species is seriously susceptible to disease, pests, and/or drought All plants can get diseases, but plants seriously susceptible to disease or drought are likely to be stressed and have less vigorous growth. When this happens, the foliage has a lower moisture content and a greater number of dead leaves are retained.	23	
	Species is not seriously susceptible to disease, pests, and/or drought	24	
23	Less Firewise - Make a note of, and routinely monitor for, diseases or pests. Obtain proper diagnosis and treatment of problems. Select plants that are native and/or well-adapted to local climate conditions. Place 1 point in the far right column and go to:	24	
24	FINISHED - Total all the points in the far right column and compare this number to the table below, to get the flammability rating of this plant.		
	Total Points:		9

Total Points	Flammability Rating
0 - 1	Low Flammability
2 - 4	Moderate Flammability
5 - 8	High Flammability
9+	Very High Flammability

Switchgrass

Panicum virgatum

Score: **9, very high flammability**

Great Plains Native

Appendix XI: Typology 3 Plant Selection

Step #	Plant Characteristic Description	If Yes, Go To #	Points
1. Type of Plant	Tree Trees can provide shade, windbreak, energy savings, wildlife habitat, & erosion control.	2	
	Shrub or Woody Groundcover Shrubs are typically 2-12 feet tall and have a hard, woody stem. Woody groundcovers are low to the ground, but still have a hard, woody stem & branches.	2	
	Vine Vines can be herbaceous or woody, but require a trellis, plant, or building for support.	15	
	Herbaceous Ornamental or Grass Herbaceous plants are usually low-growing annuals or perennials, without a woody stem.	16	
2	Conifer and/or Evergreen Conifers have needle-like or scale-like leaves, and include pines, spruces, junipers & cedars. Evergreen plants retain their leaves throughout the year, and include Rhododendron & Azalea.	3	
	Broadleaf and/or Deciduous — For trees, go to:	9	
	Broadleaf plants have wider leaves (ex.: maples, oaks, Forsythia, and Butterfly Bush.) Deciduous plants drop their leaves once each year. — For shrubs, go to:	11	
3	Resinous Resinous plants produce resin, typically giving off a pungent odor when the leaves are crushed. These include pines, spruces, junipers and cedars.	4	
	Non-Resinous or Less Resinous Plants with less resin will usually give off less of a pungent odor when crushed.	5	
4	Less Firewise - Resinous plants are highly flammable and should not be used in close proximity to structures. Place 4 points in the far right column and go to:	5	
5	Conifer sheds large amounts of leaves or needles (many pine species)	6	
	Conifer does not regularly shed leaves or needles	7	
6	Less Firewise - Shed needles need to periodically be removed from roofs and the ground around structures. Place 2 points in the far right column and go to:	7	
7	Branches are less than 4 feet above the ground. This includes almost all shrubs.	8	
	Branches are more than 4 feet above the ground	9	
8	Less Firewise - Trees should be pruned and dead/low-hanging branches removed to be Firewise. Place 1 point in the far right column and go to:	11	
9	Trunk has papery bark or loose fibers	10	
	Trunk does not have papery bark or loose fibers	18	
10	Less Firewise - Papery bark or loose fibers can act as ladder fuels; proper placement is necessary. Place 1 point in the far right column and go to:	18	
11	Plant has fine texture Texture is a term to describe the overall appearance of a plant from a distance. From a distance of about 10-15 feet, it is not easy to distinguish individual leaves or branches. (Examples: Boxwood, Spirea, junipers)	12	
	Plant has medium texture From a distance of about 10-15 feet, some individual leaves and branches can be distinguished on the outer part of the shrub, but not the inner part. (Examples: some azaleas and hollies)	13	
	Plant has coarse texture From a distance of about 10-15 feet, it is easy to distinguish individual leaves and branches. Examples include Hydrangea, Beauty-berrry, and and Witch Hazel.	13	
12	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:	13	
13	Plant is very dense These shrubs are so dense that it is difficult to place your hand in the shrub and touch a main stem. They have dense branching, and include plants like Boxwood and junipers.	14	
	Plant is moderately dense These shrubs are dense enough that you can't clearly see through them, but it is reasonably easy to place your hand in the shrub and touch a main stem.	18	
	Plant is sparsely dense Plants have an open branching pattern, making it easy to see through the shrub. Examples include American Beauty-berry and some hydrangeas.	18	
14	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:	18	
15	Less Firewise - Vines can be flammable, and are problematic in that they add fuel directly to a structure, or act as ladder fuels. Place 2 points in the far right column and go to:	18	
16	Grass, more than 8 inches tall	17	
	All other herbaceous ornamentals, or mowed/green grass	18	
17	Less Firewise - Grass that is tall, dead, and/or dormant (yellow or brown in color) is extrememly flammable and carries fire rapidly. Place 6 points in the far right column and go to:	18	
18	Plant retains dead leaves for more than two months of the year	19	
	Plant does not usually retain dead leaves, except when shedding leaves	20	
19	Less Firewise - Plants with dead foliage are highly flammable, because of the low moisture content of the leaves and fine twigs. Place 3 points in the far right column and go to:	20	3
20	**Note:** Make sure leaves are not poisonous before touching them		
	Leaves have a waxy coating These plants have a very distinctive waxy coating on the leaf. (Ex.: Wax Myrtle, Gallberry, & Rhododendron)	21	
	Leaves do not have a waxy coating	22	
21	Less Firewise - Proper placement and maintenance are necessary. Place 1 point in the far right column and go to:	22	
22	Species is seriously susceptible to disease, pests, and/or drought All plants can get diseases, but plants seriously susceptible to disease or drought are likely to be stressed and have less vigorous growth. When this happens, the foliage has a lower moisture content and a greater number of dead leaves are retained.	23	
	Species is not seriously susceptible to disease, pests, and/or drought	24	
23	Less Firewise - Make a note of, and routinely monitor for, diseases or pests. Obtain proper diagnosis and treatment of problems. Select plants that are native and/or well-adapted to local climate conditions. Place 1 point in the far right column and go to:	24	
24	FINISHED - Total all the points in the far right column and compare this number to the table below, to get the flammability rating of this plant.		
		Total Points:	3

Total Points	Flammability Rating
0 - 1	Low Flammability
2 - 4	Moderate Flammability
5 - 8	High Flammability
9+	Very High Flammability

Bur oak

Quercus macrocarpa

Score: **3, moderate flammability**

Great Plains Native

Step #	Plant Characteristic Description	If Yes, Go To #	Points
1. Type of Plant	Tree Trees can provide shade, windbreak, energy savings, wildlife habitat, & erosion control.	2	
	Shrub or Woody Groundcover Shrubs are typically 2-12 feet tall and have a hard, woody stem. Woody groundcovers are low to the ground, but still have a hard, woody stem & branches.	2	
	Vine Vines can be herbaceous or woody, but require a trellis, plant, or building for support.	15	
	Herbaceous Ornamental or Grass Herbaceous plants are usually low-growing annuals or perennials, without a woody stem.	16	
2	Conifer and/or Evergreen Conifers have needle-like or scale-like leaves, and include pines, spruces, junipers & cedars. Evergreen plants retain their leaves throughout the year, and include Rhododendron & Azalea.	3	
	Broadleaf and/or Deciduous — For trees, go to:	9	
	Broadleaf plants have wider leaves (ex.: maples, oaks, Forsythia, and Butterfly Bush.) Deciduous plants drop their leaves once each year. — For shrubs, go to:	11	
3	Resinous Resinous plants produce resin, typically giving off a pungent odor when the leaves are crushed. These include pines, spruces, junipers and cedars.	4	
	Non-Resinous or Less Resinous Plants with less resin will usually give off less of a pungent odor when crushed.	5	
4	Less Firewise - Resinous plants are highly flammable and should not be used in close proximity to structures. Place 4 points in the far right column and go to:	5	
5	Conifer sheds large amounts of leaves or needles (many pine species)	6	
	Conifer does not regularly shed leaves or needles	7	
6	Less Firewise - Shed needles need to periodically be removed from roofs and the ground around structures. Place 2 points in the far right column and go to:	7	
7	Branches are less than 4 feet above the ground. This includes almost all shrubs.	8	
	Branches are more than 4 feet above the ground	9	
8	Less Firewise - Trees should be pruned and dead/low-hanging branches removed to be Firewise. Place 1 point in the far right column and go to:	11	
9	Trunk has papery bark or loose fibers	10	
	Trunk does not have papery bark or loose fibers	18	
10	Less Firewise - Papery bark or loose fibers can act as ladder fuels; proper placement is necessary. Place 1 point in the far right column and go to:	18	
11	Plant has fine texture Texture is a term to describe the overall appearance of a plant from a distance. From a distance of about 10-15 feet, it is not easy to distinguish individual leaves or branches. (Examples: Boxwood, Spirea, junipers)	12	
	Plant has medium texture From a distance of about 10-15 feet, some individual leaves and branches can be distinguished on the outer part of the shrub, but not the inner part. (Examples: some azaleas and hollies)	13	
	Plant has coarse texture From a distance of about 10-15 feet, it is easy to distinguish individual leaves and branches. Examples include Hydrangea, Beauty-berrry, and and Witch Hazel.	13	
12	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:	13	
13	Plant is very dense These shrubs are so dense that it is difficult to place your hand in the shrub and touch a main stem. They have dense branching, and include plants like Boxwood and junipers.	14	
	Plant is moderately dense These shrubs are dense enough that you can't clearly see through them, but it is reasonably easy to place your hand in the shrub and touch a main stem.	18	
	Plant is sparsely dense Plants have an open branching pattern, making it easy to see through the shrub. Examples include American Beauty-berry and some hydrangeas.	18	
14	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:	18	
15	Less Firewise - Vines can be flammable, and are problematic in that they add fuel directly to a structure, or act as ladder fuels. Place 2 points in the far right column and go to:	18	
16	Grass, more than 8 inches tall	17	
	All other herbaceous ornamentals, or mowed/green grass	18	
17	Less Firewise - Grass that is tall, dead, and/or dormant (yellow or brown in color) is extrememly flammable and carries fire rapidly. Place 6 points in the far right column and go to:	18	
18	Plant retains dead leaves for more than two months of the year	19	
	Plant does not usually retain dead leaves, except when shedding leaves	20	
19	Less Firewise - Plants with dead foliage are highly flammable, because of the low moisture content of the leaves and fine twigs. Place 3 points in the far right column and go to:	20	3
20	**Note:** Make sure leaves are not poisonous before touching them		
	Leaves have a waxy coating These plants have a very distinctive waxy coating on the leaf. (Ex.: Wax Myrtle, Gallberry, & Rhododendron)	21	
	Leaves do not have a waxy coating	22	
21	Less Firewise - Proper placement and maintenance are necessary. Place 1 point in the far right column and go to:	22	
22	Species is seriously susceptible to disease, pests, and/or drought All plants can get diseases, but plants seriously susceptible to disease or drought are likely to be stressed and have less vigorous growth. When this happens, the foliage has a lower moisture content and a greater number of dead leaves are retained.	23	
	Species is not seriously susceptible to disease, pests, and/or drought	24	
23	Less Firewise - Make a note of, and routinely monitor for, diseases or pests. Obtain proper diagnosis and treatment of problems. Select plants that are native and/or well-adapted to local climate conditions. Place 1 point in the far right column and go to:	24	
24	FINISHED - Total all the points in the far right column and compare this number to the table below, to get the flammability rating of this plant.		
		Total Points:	3

Total Points	Flammability Rating
0 - 1	Low Flammability
2 - 4	Moderate Flammability
5 - 8	High Flammability
9+	Very High Flammability

Chinkapin oak

Quercus muhlenbergii

Score: **3, moderate flammability**

Great Plains Native

Step #	Plant Characteristic Description		If Yes, Go To #	Points
1. Type of Plant	Tree Trees can provide shade, windbreak, energy savings, wildlife habitat, & erosion control.		2	
	Shrub or Woody Groundcover Shrubs are typically 2-12 feet tall and have a hard, woody stem. Woody groundcovers are low to the ground, but still have a hard, woody stem & branches.		2	
	Vine Vines can be herbaceous or woody, but require a trellis, plant, or building for support.		15	
	Herbaceous Ornamental or Grass Herbaceous plants are usually low-growing annuals or perennials, without a woody stem.		16	
2	Conifer and/or Evergreen Conifers have needle-like or scale-like leaves, and include pines, spruces, junipers & cedars. Evergreen plants retain their leaves throughout the year, and include Rhododendron & Azalea.		3	
	Broadleaf and/or Deciduous Broadleaf plants have wider leaves (ex.: maples, oaks, Forsythia, and Butterfly Bush.) Deciduous plants drop their leaves once each year.	For trees, go to: For shrubs, go to:	9 11	
3	Resinous Resinous plants produce resin, typically giving off a pungent odor when the leaves are crushed. These include pines, spruces, junipers and cedars.		4	
	Non-Resinous or Less Resinous Plants with less resin will usually give off less of a pungent odor when crushed.		5	
4	Less Firewise - Resinous plants are highly flammable and should not be used in close proximity to structures. Place 4 points in the far right column and go to:		5	
5	Conifer sheds large amounts of leaves or needles (many pine species)		6	
	Conifer does not regularly shed leaves or needles		7	
6	Less Firewise - Shed needles need to periodically be removed from roofs and the ground around structures. Place 2 points in the far right column and go to:		7	
7	Branches are less than 4 feet above the ground. This includes almost all shrubs.		8	
	Branches are more than 4 feet above the ground		9	
8	Less Firewise - Trees should be pruned and dead/low-hanging branches removed to be Firewise. Place 1 point in the far right column and go to:		11	
9	Trunk has papery bark or loose fibers		10	
	Trunk does not have papery bark or loose fibers		18	
10	Less Firewise - Papery bark or loose fibers can act as ladder fuels; proper placement is necessary. Place 1 point in the far right column and go to:		18	
11	Plant has fine texture Texture is a term to describe the overall appearance of a plant from a distance. From a distance of about 10-15 feet, it is not easy to distinguish individual leaves or branches. (Examples: Boxwood, Spirea, junipers)		12	
	Plant has medium texture From a distance of about 10-15 feet, some individual leaves and branches can be distinguished on the outer part of the shrub, but not the inner part. (Examples: some azaleas and hollies)		13	
	Plant has coarse texture From a distance of about 10-15 feet, it is easy to distinguish individual leaves and branches. Examples include Hydrangea, Beauty-berrry, and and Witch Hazel.		13	
12	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		13	
13	Plant is very dense These shrubs are so dense that it is difficult to place your hand in the shrub and touch a main stem. They have dense branching, and include plants like Boxwood and junipers.		14	
	Plant is moderately dense These shrubs are dense enough that you can't clearly see through them, but it is reasonably easy to place your hand in the shrub and touch a main stem.		18	
	Plant is sparsely dense Plants have an open branching pattern, making it easy to see through the shrub. Examples include American Beauty-berry and some hydrangeas.		18	
14	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		18	
15	Less Firewise - Vines can be flammable, and are problematic in that they add fuel directly to a structure, or act as ladder fuels. Place 2 points in the far right column and go to:		18	
16	Grass, more than 8 inches tall		17	
	All other herbaceous ornamentals, or mowed/green grass		18	
17	Less Firewise - Grass that is tall, dead, and/or dormant (yellow or brown in color) is extrememly flammable and carries fire rapidly. Place 6 points in the far right column and go to:		18	
18	Plant retains dead leaves for more than two months of the year		19	
	Plant does not usually retain dead leaves, except when shedding leaves		20	
19	Less Firewise - Plants with dead foliage are highly flammable, because of the low moisture content of the leaves and fine twigs. Place 3 points in the far right column and go to:		20	
20	**Note:** Make sure leaves are not poisonous before touching them			
	Leaves have a waxy coating These plants have a very distinctive waxy coating on the leaf. (Ex.: Wax Myrtle, Gallberry, & Rhododendron)		21	
	Leaves do not have a waxy coating		22	
21	Less Firewise - Proper placement and maintenance are necessary. Place 1 point in the far right column and go to:		22	
22	Species is seriously susceptible to disease, pests, and/or drought All plants can get diseases, but plants seriously susceptible to disease or drought are likely to be stressed and have less vigorous growth. When this happens, the foliage has a lower moisture content and a greater number of dead leaves are retained.		23	
	Species is not seriously susceptible to disease, pests, and/or drought		24	
23	Less Firewise - Make a note of, and routinely monitor for, diseases or pests. Obtain proper diagnosis and treatment of problems. Select plants that are native and/or well-adapted to local climate conditions. Place 1 point in the far right column and go to:		24	
24	FINISHED - Total all the points in the far right column and compare this number to the table below, to get the flammability rating of this plant.			
		Total Points:		0

Total Points	Flammability Rating
0 - 1	Low Flammability
2 - 4	Moderate Flammability
5 - 8	High Flammability
9+	Very High Flammability

Black locust

Robinia pseudoacacia

Score: **0, low flammability**

Great Plains Native

Step #	Plant Characteristic Description		If Yes, Go To #	Points
1. Type of Plant	Tree Trees can provide shade, windbreak, energy savings, wildlife habitat, & erosion control.		2	
	Shrub or Woody Groundcover Shrubs are typically 2-12 feet tall and have a hard, woody stem. Woody groundcovers are low to the ground, but still have a hard, woody stem & branches.		2	
	Vine Vines can be herbaceous or woody, but require a trellis, plant, or building for support.		15	
	Herbaceous Ornamental or Grass Herbaceous plants are usually low-growing annuals or perennials, without a woody stem.		16	
2	Conifer and/or Evergreen Conifers have needle-like or scale-like leaves, and include pines, spruces, junipers & cedars. Evergreen plants retain their leaves throughout the year, and include Rhododendron & Azalea.		3	
	Broadleaf and/or Deciduous Broadleaf plants have wider leaves (ex.: maples, oaks, Forsythia, and Butterfly Bush.) Deciduous plants drop their leaves once each year.	For trees, go to: For shrubs, go to:	9 11	
3	Resinous Resinous plants produce resin, typically giving off a pungent odor when the leaves are crushed. These include pines, spruces, junipers and cedars.		4	
	Non-Resinous or Less Resinous Plants with less resin will usually give off less of a pungent odor when crushed.		5	
4	Less Firewise - Resinous plants are highly flammable and should not be used in close proximity to structures. Place 4 points in the far right column and go to:		5	
5	Conifer sheds large amounts of leaves or needles (many pine species)		6	
	Conifer does not regularly shed leaves or needles		7	
6	Less Firewise - Shed needles need to periodically be removed from roofs and the ground around structures. Place 2 points in the far right column and go to:		7	
7	Branches are less than 4 feet above the ground. This includes almost all shrubs.		8	
	Branches are more than 4 feet above the ground		9	
8	Less Firewise - Trees should be pruned and dead/low-hanging branches removed to be Firewise. Place 1 point in the far right column and go to:		11	1
9	Trunk has papery bark or loose fibers		10	
	Trunk does not have papery bark or loose fibers		18	
10	Less Firewise - Papery bark or loose fibers can act as ladder fuels; proper placement is necessary. Place 1 point in the far right column and go to:		18	
11	Plant has fine texture Texture is a term to describe the overall appearance of a plant from a distance. From a distance of about 10-15 feet, it is not easy to distinguish individual leaves or branches. (Examples: Boxwood, Spirea, junipers)		12	
	Plant has medium texture From a distance of about 10-15 feet, some individual leaves and branches can be distinguished on the outer part of the shrub, but not the inner part. (Examples: some azaleas and hollies)		13	
	Plant has coarse texture From a distance of about 10-15 feet, it is easy to distinguish individual leaves and branches. Examples include Hydrangea, Beauty-berrry, and and Witch Hazel.		13	
12	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		13	
13	Plant is very dense These shrubs are so dense that it is difficult to place your hand in the shrub and touch a main stem. They have dense branching, and include plants like Boxwood and junipers.		14	
	Plant is moderately dense These shrubs are dense enough that you can't clearly see through them, but it is reasonably easy to place your hand in the shrub and touch a main stem.		18	
	Plant is sparsely dense Plants have an open branching pattern, making it easy to see through the shrub. Examples include American Beauty-berry and some hydrangeas.		18	
14	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		18	
15	Less Firewise - Vines can be flammable, and are problematic in that they add fuel directly to a structure, or act as ladder fuels. Place 2 points in the far right column and go to:		18	
16	Grass, more than 8 inches tall		17	
	All other herbaceous ornamentals, or mowed/green grass		18	
17	Less Firewise - Grass that is tall, dead, and/or dormant (yellow or brown in color) is extrememly flammable and carries fire rapidly. Place 6 points in the far right column and go to:		18	
18	Plant retains dead leaves for more than two months of the year		19	
	Plant does not usually retain dead leaves, except when shedding leaves		20	
19	Less Firewise - Plants with dead foliage are highly flammable, because of the low moisture content of the leaves and fine twigs. Place 3 points in the far right column and go to:		20	
20	**Note:** Make sure leaves are not poisonous before touching them			
	Leaves have a waxy coating These plants have a very distinctive waxy coating on the leaf. (Ex.: Wax Myrtle, Gallberry, & Rhododendron)		21	
	Leaves do not have a waxy coating		22	
21	Less Firewise - Proper placement and maintenance are necessary. Place 1 point in the far right column and go to:		22	
22	Species is seriously susceptible to disease, pests, and/or drought All plants can get diseases, but plants seriously susceptible to disease or drought are likely to be stressed and have less vigorous growth. When this happens, the foliage has a lower moisture content and a greater number of dead leaves are retained.		23	
	Species is not seriously susceptible to disease, pests, and/or drought		24	
23	Less Firewise - Make a note of, and routinely monitor for, diseases or pests. Obtain proper diagnosis and treatment of problems. Select plants that are native and/or well-adapted to local climate conditions. Place 1 point in the far right column and go to:		24	
24	FINISHED - Total all the points in the far right column and compare this number to the table below, to get the flammability rating of this plant.			
		Total Points:		1

Total Points	Flammability Rating
0 - 1	Low Flammability
2 - 4	Moderate Flammability
5 - 8	High Flammability
9+	Very High Flammability

Staghorn sumac

Rhus typhina

Score: **1, low flammability**

Great Plains Native

Step #	Plant Characteristic Description		If Yes, Go To #	Points
1. Type of Plant	Tree Trees can provide shade, windbreak, energy savings, wildlife habitat, & erosion control.		2	
	Shrub or Woody Groundcover Shrubs are typically 2-12 feet tall and have a hard, woody stem. Woody groundcovers are low to the ground, but still have a hard, woody stem & branches.		2	
	Vine Vines can be herbaceous or woody, but require a trellis, plant, or building for support.		15	
	Herbaceous Ornamental or Grass Herbaceous plants are usually low-growing annuals or perennials, without a woody stem.		16	
2	Conifer and/or Evergreen Conifers have needle-like or scale-like leaves, and include pines, spruces, junipers & cedars. Evergreen plants retain their leaves throughout the year, and include Rhododendron & Azalea.		3	
	Broadleaf and/or Deciduous Broadleaf plants have wider leaves (ex.: maples, oaks, Forsythia, and Butterfly Bush.) Deciduous plants drop their leaves once each year.	For trees, go to: For shrubs, go to:	9 11	
3	Resinous Resinous plants produce resin, typically giving off a pungent odor when the leaves are crushed. These include pines, spruces, junipers and cedars.		4	
	Non-Resinous or Less Resinous Plants with less resin will usually give off less of a pungent odor when crushed.		5	
4	Less Firewise - Resinous plants are highly flammable and should not be used in close proximity to structures. Place 4 points in the far right column and go to:		5	
5	Conifer sheds large amounts of leaves or needles (many pine species)		6	
	Conifer does not regularly shed leaves or needles		7	
6	Less Firewise - Shed needles need to periodically be removed from roofs and the ground around structures. Place 2 points in the far right column and go to:		7	
7	Branches are less than 4 feet above the ground. This includes almost all shrubs.		8	
	Branches are more than 4 feet above the ground		9	
8	Less Firewise - Trees should be pruned and dead/low-hanging branches removed to be Firewise. Place 1 point in the far right column and go to:		11	1
9	Trunk has papery bark or loose fibers		10	
	Trunk does not have papery bark or loose fibers		18	
10	Less Firewise - Papery bark or loose fibers can act as ladder fuels; proper placement is necessary. Place 1 point in the far right column and go to:		18	
11	Plant has fine texture Texture is a term to describe the overall appearance of a plant from a distance. From a distance of about 10-15 feet, it is not easy to distinguish individual leaves or branches. (Examples: Boxwood, Spirea, junipers)		12	
	Plant has medium texture From a distance of about 10-15 feet, some individual leaves and branches can be distinguished on the outer part of the shrub, but not the inner part. (Examples: some azaleas and hollies)		13	
	Plant has coarse texture From a distance of about 10-15 feet, it is easy to distinguish individual leaves and branches. Examples include Hydrangea, Beauty-berrry, and and Witch Hazel.		13	
12	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		13	
13	Plant is very dense These shrubs are so dense that it is difficult to place your hand in the shrub and touch a main stem. They have dense branching, and include plants like Boxwood and junipers.		14	
	Plant is moderately dense These shrubs are dense enough that you can't clearly see through them, but it is reasonably easy to place your hand in the shrub and touch a main stem.		18	
	Plant is sparsely dense Plants have an open branching pattern, making it easy to see through the shrub. Examples include American Beauty-berry and some hydrangeas.		18	
14	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		18	
15	Less Firewise - Vines can be flammable, and are problematic in that they add fuel directly to a structure, or act as ladder fuels. Place 2 points in the far right column and go to:		18	
16	Grass, more than 8 inches tall		17	
	All other herbaceous ornamentals, or mowed/green grass		18	
17	Less Firewise - Grass that is tall, dead, and/or dormant (yellow or brown in color) is extrememly flammable and carries fire rapidly. Place 6 points in the far right column and go to:		18	
18	Plant retains dead leaves for more than two months of the year		19	
	Plant does not usually retain dead leaves, except when shedding leaves		20	
19	Less Firewise - Plants with dead foliage are highly flammable, because of the low moisture content of the leaves and fine twigs. Place 3 points in the far right column and go to:		20	
20	**Note:** Make sure leaves are not poisonous before touching them			
	Leaves have a waxy coating These plants have a very distinctive waxy coating on the leaf. (Ex.: Wax Myrtle, Gallberry, & Rhododendron)		21	
	Leaves do not have a waxy coating		22	
21	Less Firewise - Proper placement and maintenance are necessary. Place 1 point in the far right column and go to:		22	
22	Species is seriously susceptible to disease, pests, and/or drought All plants can get diseases, but plants seriously susceptible to disease or drought are likely to be stressed and have less vigorous growth. When this happens, the foliage has a lower moisture content and a greater number of dead leaves are retained.		23	
	Species is not seriously susceptible to disease, pests, and/or drought		24	
23	Less Firewise - Make a note of, and routinely monitor for, diseases or pests. Obtain proper diagnosis and treatment of problems. Select plants that are native and/or well-adapted to local climate conditions. Place 1 point in the far right column and go to:		24	
24	FINISHED - Total all the points in the far right column and compare this number to the table below, to get the flammability rating of this plant.			
		Total Points:		1

Total Points	Flammability Rating
0 - 1	Low Flammability
2 - 4	Moderate Flammability
5 - 8	High Flammability
9+	Very High Flammability

Eastern wahoo

Euonymus atropurpureus

Score: **1, low flammability**

Great Plains Native

Step #	Plant Characteristic Description		If Yes, Go To #	Points
1. Type of Plant	Tree Trees can provide shade, windbreak, energy savings, wildlife habitat, & erosion control.		2	
	Shrub or Woody Groundcover Shrubs are typically 2-12 feet tall and have a hard, woody stem. Woody groundcovers are low to the ground, but still have a hard, woody stem & branches.		2	
	Vine Vines can be herbaceous or woody, but require a trellis, plant, or building for support.		15	
	Herbaceous Ornamental or Grass Herbaceous plants are usually low-growing annuals or perennials, without a woody stem.		16	
2	Conifer and/or Evergreen Conifers have needle-like or scale-like leaves, and include pines, spruces, junipers & cedars. Evergreen plants retain their leaves throughout the year, and include Rhododendron & Azalea.		3	
	Broadleaf and/or Deciduous Broadleaf plants have wider leaves (ex.: maples, oaks, Forsythia, and Butterfly Bush.) Deciduous plants drop their leaves once each year.	For trees, go to: For shrubs, go to:	9 11	
3	Resinous Resinous plants produce resin, typically giving off a pungent odor when the leaves are crushed. These include pines, spruces, junipers and cedars.		4	
	Non-Resinous or Less Resinous Plants with less resin will usually give off less of a pungent odor when crushed.		5	
4	Less Firewise - Resinous plants are highly flammable and should not be used in close proximity to structures. Place 4 points in the far right column and go to:		5	
5	Conifer sheds large amounts of leaves or needles (many pine species)		6	
	Conifer does not regularly shed leaves or needles		7	
6	Less Firewise - Shed needles need to periodically be removed from roofs and the ground around structures. Place 2 points in the far right column and go to:		7	
7	Branches are less than 4 feet above the ground. This includes almost all shrubs.		8	
	Branches are more than 4 feet above the ground		9	
8	Less Firewise - Trees should be pruned and dead/low-hanging branches removed to be Firewise. Place 1 point in the far right column and go to:		11	
9	Trunk has papery bark or loose fibers		10	
	Trunk does not have papery bark or loose fibers		18	
10	Less Firewise - Papery bark or loose fibers can act as ladder fuels; proper placement is necessary. Place 1 point in the far right column and go to:		18	
11	Plant has fine texture Texture is a term to describe the overall appearance of a plant from a distance. From a distance of about 10-15 feet, it is not easy to distinguish individual leaves or branches. (Examples: Boxwood, Spirea, junipers)		12	
	Plant has medium texture From a distance of about 10-15 feet, some individual leaves and branches can be distinguished on the outer part of the shrub, but not the inner part. (Examples: some azaleas and hollies)		13	
	Plant has coarse texture From a distance of about 10-15 feet, it is easy to distinguish individual leaves and branches. Examples include Hydrangea, Beauty-berrry, and and Witch Hazel.		13	
12	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		13	
13	Plant is very dense These shrubs are so dense that it is difficult to place your hand in the shrub and touch a main stem. They have dense branching, and include plants like Boxwood and junipers.		14	
	Plant is moderately dense These shrubs are dense enough that you can't clearly see through them, but it is reasonably easy to place your hand in the shrub and touch a main stem.		18	
	Plant is sparsely dense Plants have an open branching pattern, making it easy to see through the shrub. Examples include American Beauty-berry and some hydrangeas.		18	
14	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		18	
15	Less Firewise - Vines can be flammable, and are problematic in that they add fuel directly to a structure, or act as ladder fuels. Place 2 points in the far right column and go to:		18	
16	Grass, more than 8 inches tall		17	
	All other herbaceous ornamentals, or mowed/green grass		18	
17	Less Firewise - Grass that is tall, dead, and/or dormant (yellow or brown in color) is extrememly flammable and carries fire rapidly. Place 6 points in the far right column and go to:		18	
18	Plant retains dead leaves for more than two months of the year		19	
	Plant does not usually retain dead leaves, except when shedding leaves		20	
19	Less Firewise - Plants with dead foliage are highly flammable, because of the low moisture content of the leaves and fine twigs. Place 3 points in the far right column and go to:		20	3
20	**Note:** Make sure leaves are not poisonous before touching them			
	Leaves have a waxy coating These plants have a very distinctive waxy coating on the leaf. (Ex.: Wax Myrtle, Gallberry, & Rhododendron)		21	
	Leaves do not have a waxy coating		22	
21	Less Firewise - Proper placement and maintenance are necessary. Place 1 point in the far right column and go to:		22	
22	Species is seriously susceptible to disease, pests, and/or drought All plants can get diseases, but plants seriously susceptible to disease or drought are likely to be stressed and have less vigorous growth. When this happens, the foliage has a lower moisture content and a greater number of dead leaves are retained.		23	
	Species is not seriously susceptible to disease, pests, and/or drought		24	
23	Less Firewise - Make a note of, and routinely monitor for, diseases or pests. Obtain proper diagnosis and treatment of problems. Select plants that are native and/or well-adapted to local climate conditions. Place 1 point in the far right column and go to:		24	
24	FINISHED - Total all the points in the far right column and compare this number to the table below, to get the flammability rating of this plant.			
		Total Points:		3

Total Points	Flammability Rating
0 - 1	Low Flammability
2 - 4	Moderate Flammability
5 - 8	High Flammability
9+	Very High Flammability

Blue false indigo

Baptisia australis

Score: **3, moderate flammability**

Great Plains Native

Step #	Plant Characteristic Description		If Yes, Go To #	Points
1. Type of Plant	Tree Trees can provide shade, windbreak, energy savings, wildlife habitat, & erosion control.		2	
	Shrub or Woody Groundcover Shrubs are typically 2-12 feet tall and have a hard, woody stem. Woody groundcovers are low to the ground, but still have a hard, woody stem & branches.		2	
	Vine Vines can be herbaceous or woody, but require a trellis, plant, or building for support.		15	
	Herbaceous Ornamental or Grass Herbaceous plants are usually low-growing annuals or perennials, without a woody stem.		16	
2	Conifer and/or Evergreen Conifers have needle-like or scale-like leaves, and include pines, spruces, junipers & cedars. Evergreen plants retain their leaves throughout the year, and include Rhododendron & Azalea.		3	
	Broadleaf and/or Deciduous Broadleaf plants have wider leaves (ex.: maples, oaks, Forsythia, and Butterfly Bush.) Deciduous plants drop their leaves once each year.	For trees, go to: For shrubs, go to:	9 11	
3	Resinous Resinous plants produce resin, typically giving off a pungent odor when the leaves are crushed. These include pines, spruces, junipers and cedars.		4	
	Non-Resinous or Less Resinous Plants with less resin will usually give off less of a pungent odor when crushed.		5	
4	Less Firewise - Resinous plants are highly flammable and should not be used in close proximity to structures. Place 4 points in the far right column and go to:		5	
5	Conifer sheds large amounts of leaves or needles (many pine species)		6	
	Conifer does not regularly shed leaves or needles		7	
6	Less Firewise - Shed needles need to periodically be removed from roofs and the ground around structures. Place 2 points in the far right column and go to:		7	
7	Branches are less than 4 feet above the ground. This includes almost all shrubs.		8	
	Branches are more than 4 feet above the ground		9	
8	Less Firewise - Trees should be pruned and dead/low-hanging branches removed to be Firewise. Place 1 point in the far right column and go to:		11	
9	Trunk has papery bark or loose fibers		10	
	Trunk does not have papery bark or loose fibers		18	
10	Less Firewise - Papery bark or loose fibers can act as ladder fuels; proper placement is necessary. Place 1 point in the far right column and go to:		18	
11	Plant has fine texture Texture is a term to describe the overall appearance of a plant from a distance. From a distance of about 10-15 feet, it is not easy to distinguish individual leaves or branches. (Examples: Boxwood, Spirea, junipers)		12	
	Plant has medium texture From a distance of about 10-15 feet, some individual leaves and branches can be distinguished on the outer part of the shrub, but not the inner part. (Examples: some azaleas and hollies)		13	
	Plant has coarse texture From a distance of about 10-15 feet, it is easy to distinguish individual leaves and branches. Examples include Hydrangea, Beauty-berrry, and and Witch Hazel.		13	
12	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		13	
13	Plant is very dense These shrubs are so dense that it is difficult to place your hand in the shrub and touch a main stem. They have dense branching, and include plants like Boxwood and junipers.		14	
	Plant is moderately dense These shrubs are dense enough that you can't clearly see through them, but it is reasonably easy to place your hand in the shrub and touch a main stem.		18	
	Plant is sparsely dense Plants have an open branching pattern, making it easy to see through the shrub. Examples include American Beauty-berry and some hydrangeas.		18	
14	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		18	
15	Less Firewise - Vines can be flammable, and are problematic in that they add fuel directly to a structure, or act as ladder fuels. Place 2 points in the far right column and go to:		18	
16	Grass, more than 8 inches tall		17	
	All other herbaceous ornamentals, or mowed/green grass		18	
17	Less Firewise - Grass that is tall, dead, and/or dormant (yellow or brown in color) is extrememly flammable and carries fire rapidly. Place 6 points in the far right column and go to:		18	
18	Plant retains dead leaves for more than two months of the year		19	
	Plant does not usually retain dead leaves, except when shedding leaves		20	
19	Less Firewise - Plants with dead foliage are highly flammable, because of the low moisture content of the leaves and fine twigs. Place 3 points in the far right column and go to:		20	
20	**Note:** Make sure leaves are not poisonous before touching them			
	Leaves have a waxy coating These plants have a very distinctive waxy coating on the leaf. (Ex.: Wax Myrtle, Gallberry, & Rhododendron)		21	
	Leaves do not have a waxy coating		22	
21	Less Firewise - Proper placement and maintenance are necessary. Place 1 point in the far right column and go to:		22	
22	Species is seriously susceptible to disease, pests, and/or drought All plants can get diseases, but plants seriously susceptible to disease or drought are likely to be stressed and have less vigorous growth. When this happens, the foliage has a lower moisture content and a greater number of dead leaves are retained.		23	
	Species is not seriously susceptible to disease, pests, and/or drought		24	
23	Less Firewise - Make a note of, and routinely monitor for, diseases or pests. Obtain proper diagnosis and treatment of problems. Select plants that are native and/or well-adapted to local climate conditions. Place 1 point in the far right column and go to:		24	
24	FINISHED - Total all the points in the far right column and compare this number to the table below, to get the flammability rating of this plant.			
		Total Points:		0

Total Points	Flammability Rating
0 - 1	Low Flammability
2 - 4	Moderate Flammability
5 - 8	High Flammability
9+	Very High Flammability

New England aster

Aster novae-angliae

Score: **0, low flammability**

Great Plains Native

Step #	Plant Characteristic Description		If Yes, Go To #	Points
1. Type of Plant	Tree Trees can provide shade, windbreak, energy savings, wildlife habitat, & erosion control.		2	
	Shrub or Woody Groundcover Shrubs are typically 2-12 feet tall and have a hard, woody stem. Woody groundcovers are low to the ground, but still have a hard, woody stem & branches.		2	
	Vine Vines can be herbaceous or woody, but require a trellis, plant, or building for support.		15	
	Herbaceous Ornamental or Grass Herbaceous plants are usually low-growing annuals or perennials, without a woody stem.		16	
2	Conifer and/or Evergreen Conifers have needle-like or scale-like leaves, and include pines, spruces, junipers & cedars. Evergreen plants retain their leaves throughout the year, and include Rhododendron & Azalea.		3	
	Broadleaf and/or Deciduous Broadleaf plants have wider leaves (ex.: maples, oaks, Forsythia, and Butterfly Bush.) Deciduous plants drop their leaves once each year.	For trees, go to: For shrubs, go to:	9 11	
3	Resinous Resinous plants produce resin, typically giving off a pungent odor when the leaves are crushed. These include pines, spruces, junipers and cedars.		4	
	Non-Resinous or Less Resinous Plants with less resin will usually give off less of a pungent odor when crushed.		5	
4	Less Firewise - Resinous plants are highly flammable and should not be used in close proximity to structures. Place 4 points in the far right column and go to:		5	
5	Conifer sheds large amounts of leaves or needles (many pine species)		6	
	Conifer does not regularly shed leaves or needles		7	
6	Less Firewise - Shed needles need to periodically be removed from roofs and the ground around structures. Place 2 points in the far right column and go to:		7	
7	Branches are less than 4 feet above the ground. This includes almost all shrubs.		8	
	Branches are more than 4 feet above the ground		9	
8	Less Firewise - Trees should be pruned and dead/low-hanging branches removed to be Firewise. Place 1 point in the far right column and go to:		11	
9	Trunk has papery bark or loose fibers		10	
	Trunk does not have papery bark or loose fibers		18	
10	Less Firewise - Papery bark or loose fibers can act as ladder fuels; proper placement is necessary. Place 1 point in the far right column and go to:		18	
11	Plant has fine texture Texture is a term to describe the overall appearance of a plant from a distance. From a distance of about 10-15 feet, it is not easy to distinguish individual leaves or branches. (Examples: Boxwood, Spirea, junipers)		12	
	Plant has medium texture From a distance of about 10-15 feet, some individual leaves and branches can be distinguished on the outer part of the shrub, but not the inner part. (Examples: some azaleas and hollies)		13	
	Plant has coarse texture From a distance of about 10-15 feet, it is easy to distinguish individual leaves and branches. Examples include Hydrangea, Beauty-berrry, and and Witch Hazel.		13	
12	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		13	
13	Plant is very dense These shrubs are so dense that it is difficult to place your hand in the shrub and touch a main stem. They have dense branching, and include plants like Boxwood and junipers.		14	
	Plant is moderately dense These shrubs are dense enough that you can't clearly see through them, but it is reasonably easy to place your hand in the shrub and touch a main stem.		18	
	Plant is sparsely dense Plants have an open branching pattern, making it easy to see through the shrub. Examples include American Beauty-berry and some hydrangeas.		18	
14	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		18	
15	Less Firewise - Vines can be flammable, and are problematic in that they add fuel directly to a structure, or act as ladder fuels. Place 2 points in the far right column and go to:		18	
16	Grass, more than 8 inches tall		17	
	All other herbaceous ornamentals, or mowed/green grass		18	
17	Less Firewise - Grass that is tall, dead, and/or dormant (yellow or brown in color) is extrememly flammable and carries fire rapidly. Place 6 points in the far right column and go to:		18	
18	Plant retains dead leaves for more than two months of the year		19	
	Plant does not usually retain dead leaves, except when shedding leaves		20	
19	Less Firewise - Plants with dead foliage are highly flammable, because of the low moisture content of the leaves and fine twigs. Place 3 points in the far right column and go to:		20	0
20	**Note:** Make sure leaves are not poisonous before touching them			
	Leaves have a waxy coating These plants have a very distinctive waxy coating on the leaf. (Ex.: Wax Myrtle, Gallberry, & Rhododendron)		21	
	Leaves do not have a waxy coating		22	
21	Less Firewise - Proper placement and maintenance are necessary. Place 1 point in the far right column and go to:		22	
22	Species is seriously susceptible to disease, pests, and/or drought All plants can get diseases, but plants seriously susceptible to disease or drought are likely to be stressed and have less vigorous growth. When this happens, the foliage has a lower moisture content and a greater number of dead leaves are retained.		23	
	Species is not seriously susceptible to disease, pests, and/or drought		24	
23	Less Firewise - Make a note of, and routinely monitor for, diseases or pests. Obtain proper diagnosis and treatment of problems. Select plants that are native and/or well-adapted to local climate conditions. Place 1 point in the far right column and go to:		24	
24	FINISHED - Total all the points in the far right column and compare this number to the table below, to get the flammability rating of this plant.			
		Total Points:		0

Total Points	Flammability Rating
0 - 1	Low Flammability
2 - 4	Moderate Flammability
5 - 8	High Flammability
9+	Very High Flammability

Plains zinnia

Zinnia grandiflora

Score: **0, low flammability**

Great Plains Native

Step #	Plant Characteristic Description		If Yes, Go To #	Points
1. Type of Plant	Tree Trees can provide shade, windbreak, energy savings, wildlife habitat, & erosion control.		2	
	Shrub or Woody Groundcover Shrubs are typically 2-12 feet tall and have a hard, woody stem. Woody groundcovers are low to the ground, but still have a hard, woody stem & branches.		2	
	Vine Vines can be herbaceous or woody, but require a trellis, plant, or building for support.		15	
	Herbaceous Ornamental or Grass Herbaceous plants are usually low-growing annuals or perennials, without a woody stem.		16	
2	Conifer and/or Evergreen Conifers have needle-like or scale-like leaves, and include pines, spruces, junipers & cedars. Evergreen plants retain their leaves throughout the year, and include Rhododendron & Azalea.		3	
	Broadleaf and/or Deciduous Broadleaf plants have wider leaves (ex.: maples, oaks, Forsythia, and Butterfly Bush.) Deciduous plants drop their leaves once each year.	For trees, go to: For shrubs, go to:	9 11	
3	Resinous Resinous plants produce resin, typically giving off a pungent odor when the leaves are crushed. These include pines, spruces, junipers and cedars.		4	
	Non-Resinous or Less Resinous Plants with less resin will usually give off less of a pungent odor when crushed.		5	
4	Less Firewise - Resinous plants are highly flammable and should not be used in close proximity to structures. Place 4 points in the far right column and go to:		5	
5	Conifer sheds large amounts of leaves or needles (many pine species)		6	
	Conifer does not regularly shed leaves or needles		7	
6	Less Firewise - Shed needles need to periodically be removed from roofs and the ground around structures. Place 2 points in the far right column and go to:		7	
7	Branches are less than 4 feet above the ground. This includes almost all shrubs.		8	
	Branches are more than 4 feet above the ground		9	
8	Less Firewise - Trees should be pruned and dead/low-hanging branches removed to be Firewise. Place 1 point in the far right column and go to:		11	
9	Trunk has papery bark or loose fibers		10	
	Trunk does not have papery bark or loose fibers		18	
10	Less Firewise - Papery bark or loose fibers can act as ladder fuels; proper placement is necessary. Place 1 point in the far right column and go to:		18	
11	Plant has fine texture Texture is a term to describe the overall appearance of a plant from a distance. From a distance of about 10-15 feet, it is not easy to distinguish individual leaves or branches. (Examples: Boxwood, Spirea, junipers)		12	
	Plant has medium texture From a distance of about 10-15 feet, some individual leaves and branches can be distinguished on the outer part of the shrub, but not the inner part. (Examples: some azaleas and hollies)		13	
	Plant has coarse texture From a distance of about 10-15 feet, it is easy to distinguish individual leaves and branches. Examples include Hydrangea, Beauty-berrry, and and Witch Hazel.		13	
12	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		13	
13	Plant is very dense These shrubs are so dense that it is difficult to place your hand in the shrub and touch a main stem. They have dense branching, and include plants like Boxwood and junipers.		14	
	Plant is moderately dense These shrubs are dense enough that you can't clearly see through them, but it is reasonably easy to place your hand in the shrub and touch a main stem.		18	
	Plant is sparsely dense Plants have an open branching pattern, making it easy to see through the shrub. Examples include American Beauty-berry and some hydrangeas.		18	
14	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		18	
15	Less Firewise - Vines can be flammable, and are problematic in that they add fuel directly to a structure, or act as ladder fuels. Place 2 points in the far right column and go to:		18	
16	Grass, more than 8 inches tall		17	
	All other herbaceous ornamentals, or mowed/green grass		18	
17	Less Firewise - Grass that is tall, dead, and/or dormant (yellow or brown in color) is extrememly flammable and carries fire rapidly. Place 6 points in the far right column and go to:		18	
18	Plant retains dead leaves for more than two months of the year		19	
	Plant does not usually retain dead leaves, except when shedding leaves		20	
19	Less Firewise - Plants with dead foliage are highly flammable, because of the low moisture content of the leaves and fine twigs. Place 3 points in the far right column and go to:		20	3
20	**Note:** Make sure leaves are not poisonous before touching them			
	Leaves have a waxy coating These plants have a very distinctive waxy coating on the leaf. (Ex.: Wax Myrtle, Gallberry, & Rhododendron)		21	
	Leaves do not have a waxy coating		22	
21	Less Firewise - Proper placement and maintenance are necessary. Place 1 point in the far right column and go to:		22	
22	Species is seriously susceptible to disease, pests, and/or drought All plants can get diseases, but plants seriously susceptible to disease or drought are likely to be stressed and have less vigorous growth. When this happens, the foliage has a lower moisture content and a greater number of dead leaves are retained.		23	
	Species is not seriously susceptible to disease, pests, and/or drought		24	
23	Less Firewise - Make a note of, and routinely monitor for, diseases or pests. Obtain proper diagnosis and treatment of problems. Select plants that are native and/or well-adapted to local climate conditions. Place 1 point in the far right column and go to:		24	
24	FINISHED - Total all the points in the far right column and compare this number to the table below, to get the flammability rating of this plant.			
		Total Points:		3

Total Points	Flammability Rating
0 - 1	Low Flammability
2 - 4	Moderate Flammability
5 - 8	High Flammability
9+	Very High Flammability

Prairie blazing star

Liatris pycnostachya

Score: **3, moderate flammability**

Great Plains Native

Step #	Plant Characteristic Description		If Yes, Go To #	Points
1. Type of Plant	Tree Trees can provide shade, windbreak, energy savings, wildlife habitat, & erosion control.		2	
	Shrub or Woody Groundcover Shrubs are typically 2-12 feet tall and have a hard, woody stem. Woody groundcovers are low to the ground, but still have a hard, woody stem & branches.		2	
	Vine Vines can be herbaceous or woody, but require a trellis, plant, or building for support.		15	
	Herbaceous Ornamental or Grass Herbaceous plants are usually low-growing annuals or perennials, without a woody stem.		16	
2	Conifer and/or Evergreen Conifers have needle-like or scale-like leaves, and include pines, spruces, junipers & cedars. Evergreen plants retain their leaves throughout the year, and include Rhododendron & Azalea.		3	
	Broadleaf and/or Deciduous Broadleaf plants have wider leaves (ex.: maples, oaks, Forsythia, and Butterfly Bush.) Deciduous plants drop their leaves once each year.	For trees, go to: For shrubs, go to:	9 11	
3	Resinous Resinous plants produce resin, typically giving off a pungent odor when the leaves are crushed. These include pines, spruces, junipers and cedars.		4	
	Non-Resinous or Less Resinous Plants with less resin will usually give off less of a pungent odor when crushed.		5	
4	Less Firewise - Resinous plants are highly flammable and should not be used in close proximity to structures. Place 4 points in the far right column and go to:		5	
5	Conifer sheds large amounts of leaves or needles (many pine species)		6	
	Conifer does not regularly shed leaves or needles		7	
6	Less Firewise - Shed needles need to periodically be removed from roofs and the ground around structures. Place 2 points in the far right column and go to:		7	
7	Branches are less than 4 feet above the ground. This includes almost all shrubs.		8	
	Branches are more than 4 feet above the ground		9	
8	Less Firewise - Trees should be pruned and dead/low-hanging branches removed to be Firewise. Place 1 point in the far right column and go to:		11	
9	Trunk has papery bark or loose fibers		10	
	Trunk does not have papery bark or loose fibers		18	
10	Less Firewise - Papery bark or loose fibers can act as ladder fuels; proper placement is necessary. Place 1 point in the far right column and go to:		18	
11	Plant has fine texture Texture is a term to describe the overall appearance of a plant from a distance. From a distance of about 10-15 feet, it is not easy to distinguish individual leaves or branches. (Examples: Boxwood, Spirea, junipers)		12	
	Plant has medium texture From a distance of about 10-15 feet, some individual leaves and branches can be distinguished on the outer part of the shrub, but not the inner part. (Examples: some azaleas and hollies)		13	
	Plant has coarse texture From a distance of about 10-15 feet, it is easy to distinguish individual leaves and branches. Examples include Hydrangea, Beauty-berrry, and and Witch Hazel.		13	
12	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		13	
13	Plant is very dense These shrubs are so dense that it is difficult to place your hand in the shrub and touch a main stem. They have dense branching, and include plants like Boxwood and junipers.		14	
	Plant is moderately dense These shrubs are dense enough that you can't clearly see through them, but it is reasonably easy to place your hand in the shrub and touch a main stem.		18	
	Plant is sparsely dense Plants have an open branching pattern, making it easy to see through the shrub. Examples include American Beauty-berry and some hydrangeas.		18	
14	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		18	
15	Less Firewise - Vines can be flammable, and are problematic in that they add fuel directly to a structure, or act as ladder fuels. Place 2 points in the far right column and go to:		18	
16	Grass, more than 8 inches tall		17	
	All other herbaceous ornamentals, or mowed/green grass		18	
17	Less Firewise - Grass that is tall, dead, and/or dormant (yellow or brown in color) is extrememly flammable and carries fire rapidly. Place 6 points in the far right column and go to:		18	
18	Plant retains dead leaves for more than two months of the year		19	
	Plant does not usually retain dead leaves, except when shedding leaves		20	
19	Less Firewise - Plants with dead foliage are highly flammable, because of the low moisture content of the leaves and fine twigs. Place 3 points in the far right column and go to:		20	
20	**Note:** Make sure leaves are not poisonous before touching them			
	Leaves have a waxy coating These plants have a very distinctive waxy coating on the leaf. (Ex.: Wax Myrtle, Gallberry, & Rhododendron)		21	
	Leaves do not have a waxy coating		22	
21	Less Firewise - Proper placement and maintenance are necessary. Place 1 point in the far right column and go to:		22	
22	Species is seriously susceptible to disease, pests, and/or drought All plants can get diseases, but plants seriously susceptible to disease or drought are likely to be stressed and have less vigorous growth. When this happens, the foliage has a lower moisture content and a greater number of dead leaves are retained.		23	
	Species is not seriously susceptible to disease, pests, and/or drought		24	
23	Less Firewise - Make a note of, and routinely monitor for, diseases or pests. Obtain proper diagnosis and treatment of problems. Select plants that are native and/or well-adapted to local climate conditions. Place 1 point in the far right column and go to:		24	
24	FINISHED - Total all the points in the far right column and compare this number to the table below, to get the flammability rating of this plant.			
		Total Points:		1

Total Points	Flammability Rating
0 - 1	Low Flammability
2 - 4	Moderate Flammability
5 - 8	High Flammability
9+	Very High Flammability

Lanceleaf coreopsis

Coreopsis lanceolata

Score: **0, low flammability**

Great Plains Native

Step #	Plant Characteristic Description		If Yes, Go To #	Points
1. Type of Plant	Tree Trees can provide shade, windbreak, energy savings, wildlife habitat, & erosion control.		2	
	Shrub or Woody Groundcover Shrubs are typically 2-12 feet tall and have a hard, woody stem. Woody groundcovers are low to the ground, but still have a hard, woody stem & branches.		2	
	Vine Vines can be herbaceous or woody, but require a trellis, plant, or building for support.		15	
	Herbaceous Ornamental or Grass Herbaceous plants are usually low-growing annuals or perennials, without a woody stem.		16	
2	Conifer and/or Evergreen Conifers have needle-like or scale-like leaves, and include pines, spruces, junipers & cedars. Evergreen plants retain their leaves throughout the year, and include Rhododendron & Azalea.		3	
	Broadleaf and/or Deciduous Broadleaf plants have wider leaves (ex.: maples, oaks, Forsythia, and Butterfly Bush.) Deciduous plants drop their leaves once each year.	For trees, go to: For shrubs, go to:	9 11	
3	Resinous Resinous plants produce resin, typically giving off a pungent odor when the leaves are crushed. These include pines, spruces, junipers and cedars.		4	
	Non-Resinous or Less Resinous Plants with less resin will usually give off less of a pungent odor when crushed.		5	
4	Less Firewise - Resinous plants are highly flammable and should not be used in close proximity to structures. Place 4 points in the far right column and go to:		5	
5	Conifer sheds large amounts of leaves or needles (many pine species)		6	
	Conifer does not regularly shed leaves or needles		7	
6	Less Firewise - Shed needles need to periodically be removed from roofs and the ground around structures. Place 2 points in the far right column and go to:		7	
7	Branches are less than 4 feet above the ground. This includes almost all shrubs.		8	
	Branches are more than 4 feet above the ground		9	
8	Less Firewise - Trees should be pruned and dead/low-hanging branches removed to be Firewise. Place 1 point in the far right column and go to:		11	
9	Trunk has papery bark or loose fibers		10	
	Trunk does not have papery bark or loose fibers		18	
10	Less Firewise - Papery bark or loose fibers can act as ladder fuels; proper placement is necessary. Place 1 point in the far right column and go to:		18	
11	Plant has fine texture Texture is a term to describe the overall appearance of a plant from a distance. From a distance of about 10-15 feet, it is not easy to distinguish individual leaves or branches. (Examples: Boxwood, Spirea, junipers)		12	
	Plant has medium texture From a distance of about 10-15 feet, some individual leaves and branches can be distinguished on the outer part of the shrub, but not the inner part. (Examples: some azaleas and hollies)		13	
	Plant has coarse texture From a distance of about 10-15 feet, it is easy to distinguish individual leaves and branches. Examples include Hydrangea, Beauty-berrry, and and Witch Hazel.		13	
12	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		13	
13	Plant is very dense These shrubs are so dense that it is difficult to place your hand in the shrub and touch a main stem. They have dense branching, and include plants like Boxwood and junipers.		14	
	Plant is moderately dense These shrubs are dense enough that you can't clearly see through them, but it is reasonably easy to place your hand in the shrub and touch a main stem.		18	
	Plant is sparsely dense Plants have an open branching pattern, making it easy to see through the shrub. Examples include American Beauty-berry and some hydrangeas.		18	
14	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		18	
15	Less Firewise - Vines can be flammable, and are problematic in that they add fuel directly to a structure, or act as ladder fuels. Place 2 points in the far right column and go to:		18	
16	Grass, more than 8 inches tall		17	
	All other herbaceous ornamentals, or mowed/green grass		18	
17	Less Firewise - Grass that is tall, dead, and/or dormant (yellow or brown in color) is extrememly flammable and carries fire rapidly. Place 6 points in the far right column and go to:		18	6
18	Plant retains dead leaves for more than two months of the year		19	
	Plant does not usually retain dead leaves, except when shedding leaves		20	
19	Less Firewise - Plants with dead foliage are highly flammable, because of the low moisture content of the leaves and fine twigs. Place 3 points in the far right column and go to:		20	3
20	**Note:** Make sure leaves are not poisonous before touching them			
	Leaves have a waxy coating These plants have a very distinctive waxy coating on the leaf. (Ex.: Wax Myrtle, Gallberry, & Rhododendron)		21	
	Leaves do not have a waxy coating		22	
21	Less Firewise - Proper placement and maintenance are necessary. Place 1 point in the far right column and go to:		22	
22	Species is seriously susceptible to disease, pests, and/or drought All plants can get diseases, but plants seriously susceptible to disease or drought are likely to be stressed and have less vigorous growth. When this happens, the foliage has a lower moisture content and a greater number of dead leaves are retained.		23	
	Species is not seriously susceptible to disease, pests, and/or drought		24	
23	Less Firewise - Make a note of, and routinely monitor for, diseases or pests. Obtain proper diagnosis and treatment of problems. Select plants that are native and/or well-adapted to local climate conditions. Place 1 point in the far right column and go to:		24	
24	FINISHED - Total all the points in the far right column and compare this number to the table below, to get the flammability rating of this plant.			
		Total Points:		9

Total Points	Flammability Rating
0 - 1	Low Flammability
2 - 4	Moderate Flammability
5 - 8	High Flammability
9+	Very High Flammability

Little bluestem

Schizachyrium scoparium

Score: **9, very high flammability**

Great Plains Native

Step #	Plant Characteristic Description		If Yes, Go To #	Points
1. Type of Plant	Tree Trees can provide shade, windbreak, energy savings, wildlife habitat, & erosion control.		2	
	Shrub or Woody Groundcover Shrubs are typically 2-12 feet tall and have a hard, woody stem. Woody groundcovers are low to the ground, but still have a hard, woody stem & branches.		2	
	Vine Vines can be herbaceous or woody, but require a trellis, plant, or building for support.		15	
	Herbaceous Ornamental or Grass Herbaceous plants are usually low-growing annuals or perennials, without a woody stem.		16	
2	Conifer and/or Evergreen Conifers have needle-like or scale-like leaves, and include pines, spruces, junipers & cedars. Evergreen plants retain their leaves throughout the year, and include Rhododendron & Azalea.		3	
	Broadleaf and/or Deciduous Broadleaf plants have wider leaves (ex.: maples, oaks, Forsythia, and Butterfly Bush.) Deciduous plants drop their leaves once each year.	For trees, go to: For shrubs, go to:	9 11	
3	Resinous Resinous plants produce resin, typically giving off a pungent odor when the leaves are crushed. These include pines, spruces, junipers and cedars.		4	
	Non-Resinous or Less Resinous Plants with less resin will usually give off less of a pungent odor when crushed.		5	
4	Less Firewise - Resinous plants are highly flammable and should not be used in close proximity to structures. Place 4 points in the far right column and go to:		5	
5	Conifer sheds large amounts of leaves or needles (many pine species)		6	
	Conifer does not regularly shed leaves or needles		7	
6	Less Firewise - Shed needles need to periodically be removed from roofs and the ground around structures. Place 2 points in the far right column and go to:		7	
7	Branches are less than 4 feet above the ground. This includes almost all shrubs.		8	
	Branches are more than 4 feet above the ground		9	
8	Less Firewise - Trees should be pruned and dead/low-hanging branches removed to be Firewise. Place 1 point in the far right column and go to:		11	
9	Trunk has papery bark or loose fibers		10	
	Trunk does not have papery bark or loose fibers		18	
10	Less Firewise - Papery bark or loose fibers can act as ladder fuels; proper placement is necessary. Place 1 point in the far right column and go to:		18	
11	Plant has fine texture Texture is a term to describe the overall appearance of a plant from a distance. From a distance of about 10-15 feet, it is not easy to distinguish individual leaves or branches. (Examples: Boxwood, Spirea, junipers)		12	
	Plant has medium texture From a distance of about 10-15 feet, some individual leaves and branches can be distinguished on the outer part of the shrub, but not the inner part. (Examples: some azaleas and hollies)		13	
	Plant has coarse texture From a distance of about 10-15 feet, it is easy to distinguish individual leaves and branches. Examples include Hydrangea, Beauty-berrry, and and Witch Hazel.		13	
12	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		13	
13	Plant is very dense These shrubs are so dense that it is difficult to place your hand in the shrub and touch a main stem. They have dense branching, and include plants like Boxwood and junipers.		14	
	Plant is moderately dense These shrubs are dense enough that you can't clearly see through them, but it is reasonably easy to place your hand in the shrub and touch a main stem.		18	
	Plant is sparsely dense Plants have an open branching pattern, making it easy to see through the shrub. Examples include American Beauty-berry and some hydrangeas.		18	
14	Less Firewise - Proper placement and routine pruning are necessary. Place 2 points in the far right column and go to:		18	
15	Less Firewise - Vines can be flammable, and are problematic in that they add fuel directly to a structure, or act as ladder fuels. Place 2 points in the far right column and go to:		18	
16	Grass, more than 8 inches tall		17	
	All other herbaceous ornamentals, or mowed/green grass		18	
17	Less Firewise - Grass that is tall, dead, and/or dormant (yellow or brown in color) is extrememly flammable and carries fire rapidly. Place 6 points in the far right column and go to:		18	6
18	Plant retains dead leaves for more than two months of the year		19	
	Plant does not usually retain dead leaves, except when shedding leaves		20	
19	Less Firewise - Plants with dead foliage are highly flammable, because of the low moisture content of the leaves and fine twigs. Place 3 points in the far right column and go to:		20	3
20	**Note:** Make sure leaves are not poisonous before touching them			
	Leaves have a waxy coating These plants have a very distinctive waxy coating on the leaf. (Ex.: Wax Myrtle, Gallberry, & Rhododendron)		21	
	Leaves do not have a waxy coating		22	
21	Less Firewise - Proper placement and maintenance are necessary. Place 1 point in the far right column and go to:		22	
22	Species is seriously susceptible to disease, pests, and/or drought All plants can get diseases, but plants seriously susceptible to disease or drought are likely to be stressed and have less vigorous growth. When this happens, the foliage has a lower moisture content and a greater number of dead leaves are retained.		23	
	Species is not seriously susceptible to disease, pests, and/or drought		24	
23	Less Firewise - Make a note of, and routinely monitor for, diseases or pests. Obtain proper diagnosis and treatment of problems. Select plants that are native and/or well-adapted to local climate conditions. Place 1 point in the far right column and go to:		24	
24	FINISHED - Total all the points in the far right column and compare this number to the table below, to get the flammability rating of this plant.			
		Total Points:		9

Total Points	Flammability Rating
0 - 1	Low Flammability
2 - 4	Moderate Flammability
5 - 8	High Flammability
9+	Very High Flammability

Prairie dropseed

Sporobolus heterolepis

Score: **9, very high flammability**

Great Plains Native

Appendix XII
IRB Exemption Letter

KANSAS STATE UNIVERSITY | University Research Compliance Office

TO: Hyung Kim
Landscape Archit & Comm Plan
Manhattan, KS 66506

Proposal Number: IRB-11933

FROM: Lisa Rubin, Chair
Committee on Research Involving Human Subjects

DATE: 11/15/2023

RE: Proposal Entitled, "Heartburn: Mitigating Wildfire Risk to Interface Communities in America's Heartland."

The Committee on Research Involving Human Subjects / Institutional Review Board (IRB) for Kansas State University has reviewed the proposal identified above and has determined that it is EXEMPT from further IRB review. This exemption applies only to the proposal - as written – and currently on file with the IRB. Any change potentially affecting human subjects must be approved by the IRB prior to implementation and may disqualify the proposal from exemption.

Based upon information provided to the IRB, this activity is exempt under the criteria set forth in the Federal Policy for the Protection of Human Subjects, **45 CFR §104(d), category:Exempt Category 2 Subsection ii.**

Certain research is exempt from the requirements of HHS/OHRP regulations. A determination that research is exempt does not imply that investigators have no ethical responsibilities to subjects in such research; it means only that the regulatory requirements related to IRB review, informed consent, and assurance of compliance do not apply to the research.

Any unanticipated problems involving risk to subjects or to others must be reported immediately to the Chair of the Committee on Research Involving Human Subjects, the University Research Compliance Office, and if the subjects are KSU students, to the Director of the Student Health Center.

Electronically signed by Lisa Rubin on 11/15/2023 5:15 PM ET

203 Fairchild Hall, Manhattan, KS 66502 | (785) 532-3224 | fax: (785) 532-3278